Driving Business Decisions: A Look at Business Drivers of Industrial Energy Efficiency

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ABSTRACT

Business conditions typically drive energy efficiency decisions more than purely technical opportunities. How industrial companies operate and their major business costs may determine how effectively these firms respond to energy efficiency programs and other opportunities. Based on an ongoing industry characterization study, this paper identifies key factors that influence participation in energy efficiency initiatives for select industrial segments. Competitive issues and economic factors, such as the operational model, cost structure, business cycles and the availability of capital and credit are considered. Regulatory issues that drive decision-making are discussed and tied to industry competitiveness.

For example, sectors that are dominated by a small number of large sophisticated companies will have different needs from an energy efficiency program than sectors that are comprised of many small players. Capital expenditures for large companies often are planned strategically for the long term; energy efficiency programs can be designed to partner with the customer to improve the project's energy efficiency. Sectors that consist of mostly small companies may be more focused on day to day operations and regulatory compliance, requiring a different program design to encourage energy efficiency.

This paper reviews strategic business factors that differentiate priorities for decision making. The paper will be of interest to energy efficiency program implementers, policymakers, and industrial facility managers, and will provide insights for more effective interventions to increase adoption of efficiency in the industrial sector.

Introduction

The industrial sector requires an immense amount of energy, at nearly 32% of total U.S. consumption in 2008 (US Census Bureau, 2008) to produce goods and materials for wholesale and retail sales. In the past three decades, the overall energy efficiency of the industrial sector in the U.S. has increased dramatically, and there is evidence that substantial potential for efficiency gains exists (NAS, 2010). It has thus been an attractive target sector for states looking to reach new levels of energy savings through efficiency.

However, numerous market forces beyond simple energy cost drive industrial customer decision making (Sullivan, 2009). Attaining a better understanding of the industrial customer's world may assist policymakers and utilities in their design and implementation of industrial energy efficiency programs.

While much of the discussion and conclusions in this paper can be applied to industrial sectors nationwide, it is important to note that each geographic area will have unique industry characteristics. For example, the chemicals industry (excluding refineries) in California is quite different than the chemicals industry in Texas. In California, the chemical industry is comprised

of inorganics, industrial gases, pharmaceutical and agricultural products, whereas in Texas organic chemicals are a significant industry. These regional differences may determine regional program design.

Study Approach

This research project utilized secondary source data and research to provide insight into the business aspects of major industrial sectors. Additionally, direct customer contact was sought, in the form of interviews and in-person meetings, to check study conclusions against industry insiders' perspectives on the intersection between their business functions and energy efficiency. Key business intelligence was obtained from industry research studies from the U.S. Department of Energy; IBISWorld; Datamonitor; Lawrence Berkeley National Labs as well as technical and industrial specific journal articles. In this ongoing study, the market and business conditions for select industrial segments have been assessed both nationally and within California. The segments discussed in this paper are cement, chemicals manufacturing, glass, metalworking, minerals, and plastics. Table 1 shows NAICS codes, energy consumption, and energy intensity for these sectors.

Table 1. Sector Energy Consumption and Energy Intensity in 2006

Sector	NAICS	Energy Consumption (TBtu)	Energy Consumption per Dollar Value of Shipments (thousand Btu)
Cement & Concrete	3273	382	34.0
Chemical Manufacturing	325	3,195	5.1
Glass	3272, 32799	332	70.0
Metalworking	331, 332	2,141	5.6
Minerals	327	1,105	9.7
Plastics	325211, 326	895	9.7

Source: Manufacturing Energy Consumption Survey (MECS). 2006, Tables 3.2 and 6.1

How Manufacturers Operate

This section covers business models and customer segmentation. Table 2 provides a summary of the business models and customer segmentation of the select industrial sectors.

Table 2. Business Models and Customer Segmentation, by Industrial Sector

Sector	Major Business Models	Customer Segmentation	Largest Variable Operating Expense
Cement	Commodity, vertically integrated	Concentrated	Material purchases
Chemicals	Commodity (large) and specialty (small)	Concentrated by industry / few customers	Feedstock
Glass	Commodity (large) and specialty (small)	Few (commodity) or many (specialty)	Material inputs/labor
Metalworking	Commodity (large) and specialty (small)	Few (commodity) or many (specialty)	Labor and raw materials
Minerals	Regional production & distribution model	Local / regional construction	Varies by subsector (capital or energy intensive)
Plastics	Commodity and specialty	Wide range	Raw material (oil/gas)

Business Models

Business models, broadly defined, describe and explain many aspects of how firms conduct business and create value (Zott, Amit & Massa, 2010). These business models can be explained in terms of a company's approach to the marketplace. These factors, which may include business purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies, broadly describe how companies earn profits from the production and sales of their products (Baden-Fuller and Morgan, 2010).

Business model research is instructive for the energy efficiency industry to understand customers' needs and tailor solutions and programs that fit these firms' existing business structures and models. Business models may also explain strategic issues such as competitive advantage, value creation, and firm performance (Zott, Amit & Massa, 2010).

These factors may determine industrial segment receptivity to energy efficiency as well as the approaches that best fit with the overall business model for that industry segment. Understanding how companies approach the marketplace can be important to determine which energy efficiency measures and targets may be most appropriate and receive the most receptive audience.

Two prominent business models cover the industrial segments reviewed: commodity and specialty producer. Many of the industries studied contain both of these business models, some more prominently than others.

Commodity manufacturers produce a standard product and price is the dominant component. Often, commodity manufacturers are vertically integrated to exert control over raw materials costs.

Under this business model, vertically integrated companies produce or control the inputs of their production. Efficiency programs for vertically integrated programs would effectively

address the entire supply chain. Well-integrated companies are also excellent targets for continuous energy improvement programs as they are accustomed to major planning and coordinating activities, consistent with developing and implementing management systems. Specialty manufacturers, where companies produce products according to customer specifications, are common in many industries. Patents can be critical for specialty producers. Efficiency programs for specialty producers must address the risk-averse nature of changing operations for these high value producers. Energy efficiency opportunities outside the specific production line may find the best reception, such as optimizing motor, compressor, and boiler efficiencies.

For commodity and specialty manufacturers, the more basic the product, the more sales depend purely on pricing. For example, commodity products compete almost purely on price, with the profitability of individual companies closely tied to efficient operations.

Customer Segmentation

How businesses define their customers and markets have implications for energy efficiency. An understanding of the industrial manufacturer's relationship to its customers is helpful for energy efficiency program designers and implementers.

Industrial customer segmentation can be according to many key factors such as:

- **Major targets**. In some industries, a small number of customers comprise the bulk of the major firms' revenue. Industries may also serve a narrow or wide range of end-user industries.
- **Geographic concentration**. Industrial facility location may be related to the customer location (i.e. fungicides production in California due to the wine industry) or less frequently, may be related to shipping costs (i.e. reducted costs when located closer to customer site). For example, aluminum manufacturers, which have high energy costs, generally are built close to dams to take advantage of this hydropower.

Some industrial subsectors are heavily tied to a specific industry or customer type. These production processes are not as flexible as other industries which serve a wider range of customers. For example, flat glass and metalworking companies are heavily tied to automotive plants. These manufacturers are consequently not as flexible as basic chemical manufacturers which sell a commodity product and serve many different types of customers.

Industries such as the plastic and glass bottle manufacturers can sign long-term contracts with a select few customers and produce products to their exacting standards. These manufacturers are less likely to implement process modifications that risk deviation from these standards, much more so than manufacturers of commodity products where profit depends in part on efficient production of standardized goods.

By contrast, for pharmaceuticals or other industries tied to production innovation, good opportunities for energy efficiency are during planning, designing or retooling phases for new products.

Response to External Forces

This section covers industrial manufacturers' response to external factors and how it may affect receptivity to energy efficiency initiatives. These forces are economic factors such as business cycles, capital/credit and energy prices; cost structure; and regulatory compliance. Table 3 provides a brief overview of industrial sector responses to these factors.

Table 3. Response to External Forces, by Industrial Sector

Sector	External Factors Influence	Major External Business Factors	Regulations
Cement	High	Business cycles-housing / construction	Medium/High
Chemicals	High	Volatile demand, except for patented products	High
Glass	Medium		Medium
Metalworking	High	Energy costs	Medium/High
Minerals	Low/Medium	Cyclical business cycles (construction)	Low
Plastics	Low	Oil/gas prices as raw material costs	Medium

Economic Factors

The following economic factors influence manufacturing firms' adoption of energy efficiency technologies:

Business cycles. Firms with diversified customer bases and large operations are able to better weather economic downturns than less diversified rivals or with highly concentrated customer bases. For example, plastic is a component in nearly all manufactured products. Minerals, cement, and fiberglass industries are all affected by a downturn in consumption while cement is hit particularly hard by downturns in housing and downstream building and construction markets.

Availability of capital and credit. Access to capital and credit is difficult for many smaller firms, and access has tightened considerably for nearly all businesses since the economic downturn started in 2008. Large multi-national corporate players can fund new projects and facility improvements from operating cash. They also have access to the corporate debt market and issue bonds, but they sport a range of credit ratings. Energy intensive industries such as cement and glass require enormous financial investment to construct a new plant or product line, and consequently fewer opportunities exist to embed energy efficiency technologies into new capital projects. As capital tightens, firms look to do more with what they have, focusing on maintenance, controls, and behavior rather than capital projects.

Price of energy. The inability to forecast energy pricing is a significant business issue for energy-intensive industrial sectors. This makes energy efficiency more attractive.

The current recession and economic downturn in general, has presented a unique set of challenges to industrial energy efficiency programs since macroeconomic cycles tend to impact investments in energy efficiency. Major players with deeper resources have weathered the recession, but some weaker and smaller design-driven or specialty firms do not have the resources to compete and have gone out of business.

Cost Structure

It is widely assumed that labor represents the major manufacturing cost, but in practice, the three largest major manufacturing costs are raw materials, labor, and energy (IBISWorld Industry Reports, 2007-2010).

For manufacturers, components of cost structure include raw materials, product innovation, pricing and technology development. In more detail, these include:

Purchasing feedstocks and raw materials. Where feedstocks and raw material costs are based on fossil fuels, energy efficiency can reduce the vulnerability to pricing fluctuations.

Product innovation. Since product innovation can require new manufacturing processes, this can be an optimal time to introduce energy efficiency.

Pricing. For commodity products like aluminum and copper, pricing is set on world-wide markets. Other products like cement display short term product pricing volatility in response to the cyclical fluctuations in downstream construction markets. Specialty products in all sectors can support high prices. Businesses with high volatility in price may be less willing to invest in major capital improvements for energy efficiency, but may be receptive to energy efficiency programs that support lowering routine operating costs and improving reliability.

Technology development. Generally, enhancing production flexibility and responding quickly to customer demand drive technology development, often through automation and better control.

Product development and rollout. For chemical companies involved in pharmaceuticals and consumer products, new product development is a significant expansion strategy. For these subsectors, product development is driven primarily by technological developments to reduce consumer costs, improve product quality, reduce side effects (both health and environmental impacts) and penetrate new market niches. For both technology development and product development, aligning efficiency program offerings to the technology development will improve receptivity.

Supply chain management. Controlling the source of upstream feedstocks and raw materials is a critical factor in industries such as chemicals manufacturing. Manufacturers seek to vertically integrate the supply chain, where the chemicals are sold to other business units within the same company to be used in the manufacture of intermediate and/or final chemical and plastic products. Energy efficiency may therefore target the entire supply chain.

Receptivity to energy efficiency initiatives increases when a firm's major business costs are positively affected (e.g. reduced). Industries where significant labor is required may be most receptive to energy efficiency measures in productivity improvements, such as improved control systems. Likewise, industries where raw material is a major cost may be more receptive to efficiency measures that improve product yield as well as energy efficiency. Establishing preventative and predictive maintenance programs that improve efficiency and reliability will improve yield as well. However, if energy is the largest production cost, these firms are more likely to be interested in larger projects, such as complicated heat recovery systems.

Regulatory Compliance

Many industrial manufacturers are long accustomed to complying with existing environmental regulations as part of their normal course of business. Nearly every industrial facility will have routine requirements to comply with under the federal Clean Water Act, the Clean Air Act and the Resource Conservation and Recovery Act, to manage all waste discharges.

Many industrial segments must also comply with regulations specific to that industry, such as the federal Toxics Substances Control Act in the chemical manufacturing sector, and the Federal Insecticide, Fungicide and Rodenticide Act in the pesticide (chemicals) industry. Climate change regulations, such as California's Global Warming Solutions Act (AB 32) will affect the largest energy users most significantly across numerous industries.

Since regulations are not optional, regulatory drivers will always trump energy efficiency and other voluntary cost saving opportunities. This effect is significant for highly regulated businesses such as pharmaceuticals and chemicals. Generally, highly regulated industries are particularly risk-averse about any changes that could affect their compliance with regulations.

Regulatory changes requiring capital improvements present an opportunity for energy efficiency to be included as part of the upgrade. As an example, California plants that were required to upgrade boilers to comply with more stringent air regulations had the opportunity to select a more efficient boiler than their previous model.

Energy Efficiency Implications by Sector

This section provides examples and insights for specific industrial sectors reviewed in this study that can provide intelligence and guidance for program design. Table 4 shows energy efficiency opportunities and barriers, by select industrial sector.

Table 4. Energy Efficiency Opportunities and Challenges, by Industrial Sector

Sector	Energy Efficiency Opportunities	Challenges
Cross-sector opportunities	O&M, behavior, central plant improvements, especially compressed air	Risk averse approach, lack of management support, staff time for energy efficiency, access to capital
Cement	High efficiency equipment/process; process controls	Basic technologies in cement production are well established
Chemicals	Energy use varies substantially by sub-sector	High ROI typical for automated plants
Glass	State of the art technologies are oxy-fuel conversion and electric boosting	Industry contraction; few new plants built
Metalworking	Marginal improvements (larger firms); automation and control, information technology, and best practices for manufacturing (smaller firms). Significant gains have already been achieved among large producers (e.g. minimills).	Minimizing downtime is essential; access to capital difficult for the numerous smaller firms.
Minerals	Kiln and heating technologies (large) or enhanced automation & control (small firms)	Small and diffuse subsectors challenging to target
Plastics	High concentration of electric powered motors and drives	Regulatory concerns and competing with low cost imports take precedence

In more detail, energy efficiency opportunities and challenges by industry sector are as follows:

Cement

This industry is dominated by several large scale multinational corporations with substantial sunken capital due to the extremely high capital requirements of production. Basic technologies in cement production are well established, and change slowly due to industry products that must meet exacting building specifications. New cement and concrete formulas, such as incorporating fly ash — a byproduct of burning coal — and/or slag cement in concrete or increasing limestone content in cement, reduce the amount of energy needed in manufacturing. (IBISWorld Industry Report, 2009; ACEEE, 2009).

Chemicals Manufacturing

Energy costs comprise up to 30% total production costs, depending on the sector (Datamonitor, 2009), resulting in increased motivation for energy efficiency. A strong corporate wide energy management program is essential for managing energy costs and improving energy efficiency. Industrial chemical plants are highly automated and capital-intensive. Therefore, return on investments need to be relatively high to justify expenditures for large capital improvements. Efficiency improvements are most cost-effective when industrial facilities are already making a large investment in a new plant or plant upgrade. These industry investments coincide with plant operational cycles.

Glass

Energy costs comprise 5 - 15% total production costs. (IBISWorld Industry Report, 2009). The potential for energy efficiency improvements could be limited among the largest plants because such plants often spend considerable effort to optimize their production processes. Small businesses and specialty glass makers often have more room for improvement – by some accounts small businesses as a group may be able to increase energy efficiency by up to 40% – but limited free working capital to pursue efficiency gains.

Metalworking

Generally, cost pressures and technology have led the largest metal manufacturers to make major efficiency gains over the last 20 years. In reducing energy use, major firms must employ innovation or seek the modest gains associated with marginal efficiency improvements (IBISWorld Industry Report, 2009). Individually, there are ready opportunities with applied metal producers, but programs must aggregate improvements across the diffuse market to capture quantitative gains.

Minerals

The industry as a whole does not consume a disproportionate share of energy and many small and specialized mineral product manufacturers are not significant energy users. The highest revenue segments – lime and gypsum – along with clay and ceramic manufacturers all utilize kilns of varying types for parts of the production process. Kilns are the most energy-intensive elements of the entire industry and represent a major target for energy efficiency. Efficiency improvement potential among other parts of the manufacturing process is typically incremental (IBISWorld Industry Report, 2009).

Plastics

Large firms may be the most receptive to energy efficiency since their business model is based on producing large quantities of standardized products, and profitability depends on production efficiency and product mix (IBISWorld Industry Report, 2009). Smaller individual customers have similar energy efficiency needs and opportunities as larger product manufacturers, but have less access to capital and credit, and require more sales time to target each company individually. Resin manufacturers are large energy users but have costly, specialized equipment less likely to be upgraded than specialty product manufacturers. Three major industry priorities compete with energy efficiency goals: cutting production costs, competing with low cost imports, and effectively managing environmental concerns of its products such as contributing to pollution and waste and health concerns. Energy efficiency measures that contribute to these identified industry concerns will be more likely to move forward.

Discussion

Understanding the business drivers of specific industrial segments can enhance the effectiveness of energy efficiency programs. The results of the research indicate that the range of conditions in each sector vary sufficiently that a sector specific energy efficiency program approach can be effective. A sector specific approach allows for adapting to the conditions of the marketplace in that industry. Following are examples of how the sector specific approach could affect program design.

- Industries dominated by a few big players such as glass, cement, and chemicals, can be addressed with programs that understand their needs. The program design would recognize expenditure patterns for large capital outlays when major changes are required. Ideally, long term programs could be implemented that establish dialogue and technical support for energy efficiency as new projects are developed. In addition to the large projects, a program focused on whole plant approaches for continuous improvement could be developed designed for sophisticated large customers.
- Industries with numerous smaller companies benefit from strategies designed to reach many customers and offer programs that focus on the key unit operations in that industry, such as injection molding in the plastics industry. Communication can be facilitated through trade associations, such as NEEA's work with the food industry and the Northwest Food Processors Association. A neutral forum for exchanging energy efficiency ideas, whether developed by the utility alone or partnering with other groups, can provide technical assistance and encouragement for energy efficiency.
- Market trends and economic conditions can be designed into a sector-specific approach. Where businesses are stable or growing, partnering approaches can facilitate addressing energy efficiency as upgrades and new facilities are developed. Technical assistance can be focused on that industry, allowing holistic solutions rather than equipment based efficiency alone. For business sectors in a downturn, programs can address cost savings that involve minimal capital, and emphasize the elements that help businesses stay in operation. These could include technical assistance in developing a strong preventative maintenance program, continuous improvement elements, and even support for the most energy efficient way to mothball portions of the operation.
- Regulations may be sector-specific, or have aspects that are applied differently across different industries. Often, regulatory agencies have meetings and forums during the development and implementation of new regulations. Utilities or interested organizations can partner with the regulators and industry to engage energy efficiency at the same time.
- Program designs that consider the business models, competitive forces, regulatory requirements and day-to-day needs to satisfy production, safety, and quality will be more likely to meet customer and program administrator goals. Energy efficiency measures that contribute to these identified industry concerns will be more likely to move forward.

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