Understanding Industrial Investment Decision-Making

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- "State/Province" indicates the location of each respondent's office. Some respondent organizations have interstate or multi-province activities.
- "Type" describes respondent organizations as follows: (L) = large manufacturing companies with annual revenues of $10 billion or more; (M) = medium-sized manufacturers with annual revenues between $1 billion and $10 billion; (S) = small manufacturers with annual revenues below $1 billion, and (F) = facilitators, which can be solution providers, trade groups, or coordinators of government- or utility-sponsored assistance programs. Each facilitator observes dozens of mostly small and medium-sized companies.

Name	Title	Company	State or Province	Type
Joseph Allen	General Manager	Caterpillar	IL	L
William Bailey	Energy Center of Competency Leader	DuPont	NC	L
Charles Ballou	Engineering Fellow	Sasol	LA	M
David Chamberlain	Principal Energy Engineer	Raytheon	MA	L
Sumit Chatterjee	Energy Lead	LyondellBasell	TX	L
Tim Dantoin	Senior Engineer	SAIC	WI	F
Brad Fitzke	Manager, Process Maintenance	Hunter Douglas Window Fashions	CO	M
Jeffrey Freemont	Plant Manager	Ferro Corp	OH	M
Al Halvorsen	Sr. Director of Sustainability	Frito Lay	TX	M
Neil Hoopes	Energy Champion	JR Simplot	WY	M
Jeff Kaman	Energy Manager	Deere & Co	IA	L
Ram Kondapi	Sr. Customer Energy Solutions Engineer	National Grid	NY	F
Elodie Michaels	Senior Director	cb richard Ellis	NJ	F
Raymond Monroe	Exec. Vice President	Steel Founder's Society	IL	F
Mike Pappas	Vice President	Modular Process Control	MO	F
Ray Ratheal	Director, Energy Policy & Planning	Eastman	TN	M
Emily Rice	Business Development Manager	The Energy Group	IA	F
Marcus Rivas	Environmental Engineer	EPA	KS	F
Frank Roberto	Global Energy Advisor	ExxonMobil	TX	L
Preston "Pete" Roberts	Director, Energy Management Institute	Northampton Community College	PA	F
Robert Roche	Founder	CTRL Systems	MD	F
Marie Steinwachs	Director	Environmental Assistance Center	MO	F
Tanja Stockmann	Sr. Industry Analyst	Natural Resources Canada	ON Canada	F
Keith Togna	Lead Energy Process Engineer	Honeywell	VA	L
Bob Townley-Smith	Director, Energy Optimization	Huntsman	TX	M
Jack Vanier	Team Lead	Fransen Engineering	BC Canada	F
Olaf Vinje	Energy Manager	Freybe Gourmet Foods	BC Canada	S
Jennifer Solovan	Chemical Engineer	PPG	WV	L
Jim Warram	Environmental Programs Manager	Xerox	OR	L
Jerry Zolkowski	Global Energy Leader	Dow Corning	MI	M

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Executive Summary

After a prolonged recession, the U.S. economy is poised for recovery. Economic rebound implies growth and renewal to accompany the ongoing evolution of energy markets, regulations, and technologies. And because manufacturing is by nature a capital-intensive activity, we anticipate that the sector's economic renewal is partially dependent on capital investment in new and efficient technologies. Industrial energy efficiency opportunities coincide with economic recovery and the growth and modernization of domestic production capacity.

Economic recovery prospects across the manufacturing sector are stronger for some industries than for others. As the manufacturing sector changes, so should the nature of energy efficiency programs. Industry's motivation for achieving energy improvements still lags its true potential, as the propensity to adopt energy management principles remains irregular, even across facilities of the same company. As facilities continues to capture many of the low- and no-cost energy improvement opportunities, future improvements will be increasingly linked to industry's capital investment activity. Industrial energy program administrators will need a better understanding of capital investment processes as these vary throughout industry. By influencing capital investment decisions, the next generation of energy efficiency programs can influence the profile of industrial energy use for years to come.

Despite a decade of sluggish economic growth (2000-2009), output and productivity data from 1998-2009 reveal an industrial sector with elements of growth, recuperation, and surprisingly little retrenchment. Productivity gains achieved by many industries during this decade despite their low growth of output are evidence of the muscle needed for an economic rebound, while capacity utilization and investment rates point to opportunities for industrial expansion. This report provides answers to these questions:

- How do growth prospects vary among industries?
- What indicators reveal industry growth and propensities to make capital investment?
- What does the corporate investment process generally entail?
- What are the implications of all the above for energy program design and conduct?

The first section of this report analyzes industrial sector economic performance data. Patterns in this data suggest priorities and nuances for engaging industry with capital investment energy program initiatives. The second section of the report examines the nature of capital investment decision-making within corporations. A non-scientific survey of manufacturers, program administrators, and solution providers provides a balanced view of this activity. Survey responses describe the motivations for energy-related capital investment, competing considerations, and the means for obtaining relevant knowledge. Respondents also describe industry's current receptiveness to assistance programs. This study yields a number of critical success factors for implementing energy-related capital investment projects.

We found that capital investment procedures are not specific to any individual industry or group. We do, however, find generalities according to the size of the enterprise. Generalities by size also describe industrial perceptions of energy and program assistance opportunities. While small organizations tend to be less sophisticated or deliberate in their approach to energy improvements, their decision-making can be faster and more flexible than it is in large corporations.

To build on their past successes, energy efficiency programs will need to evolve to a new level of interaction with industry. Advisors increasingly encourage industry to adopt internal, continuous energy improvement efforts, over and above episodic, capital projects. Continuous improvement programs tend to harvest the "low-hanging fruit" that comes from tweaking existing assets. Program outreach must increasingly recognize advanced technologies that not only cause direct reductions in energy intensity, but also cause indirect reductions as a result of improved process throughput and cycle times. Energy savings, both direct and indirect, will increasingly be realized through capital investment in the modernization of industrial infrastructure.

Almost all manufacturing facilities rely to varying degrees on consulting vendors to diagnose, design, and implement energy-related assets. Also, economic development advisors have a pivotal role that needs to be better coordinated with energy policy and program conduct. Energy program administrators must harmonize their industry outreach with these other influencers.

Knowledge of industry growth dynamics, coupled with corporate decision making protocols, will allow energy program administrators to better influence industrial competitiveness and economic recovery.

Note

Any discussion of industrial investment presents differences of jargon as used by technical versus financial professionals. It is important for programs to use the language of business if they are to effectively communicate. The glossary presented in Appendix A is intended to address this issue. Terms that are defined in the glossary appear in **bold text** in this report.

Introduction

In 2012, the U.S. economy is poised for recovery from a prolonged recession. Aiding the recovery is the trend of re-shoring of industrial production facilities from overseas locations (MAPI 2012, BCG 2012). Recovery will in part reflect capital investment in new and more efficient manufacturing facilities on U.S. soil. At the core of this activity is capital investment in industrial assets. Investment in durable facility and production assets will shape industrial energy intensity for years to come. This is an opportunity to evolve and intensify industrial energy efficiency programs to support the implementation of efficient technologies. Successful industrial energy programs will increasingly depend on knowledge of industry's capital investment decision-making process. This report examines industrial capital investment experience, using macroeconomic data as well as a survey of industrial energy users and related market and program facilitators.[1] The findings suggest an evolution of energy program design and conduct.

Trends in manufacturing output have direct implications for the national economy on three broad dimensions. First, while U.S. manufacturing output is decreasing as a proportion of total GDP, the absolute volume of manufacturing output is still increasing. This simply means that manufacturing as a whole is not growing as quickly as some other sectors (Pollack 2012). Still, each dollar of manufacturing output also generates an additional $1.40 worth of non-manufacturing services throughout the domestic economy (NAM 2009). Second, the industrial sector represents 31 percent of all domestic energy consumption (EIA 2010). The sector is therefore an inescapable component of ongoing energy policy and program development. Finally, prospects for the national economy and its energy resources are inextricably linked by capital investment in more efficient productive assets.

Because energy is a universal ingredient in all manufacturing, improved energy technologies provide potential benefits to all industries, regardless of their product mix or facility size. Similarly, the sheer magnitude of manufacturing energy consumption makes it an unavoidable focus for achieving the state and regional energy supply balances sought by regulators of energy distribution utilities.

At first glance, the growth of U.S. manufacturing output during the first decade of the 21st century appeared to be stagnant. Observers have raised a variety of concerns about this performance, debating the need for a national manufacturing policy (Romer 2012, Sperling 2012). But in 2012, after a decade capped off by a prolonged recession, manufacturers have an unprecedented opportunity for contributing to economic recovery. Several facts point to this opportunity. First, publically-traded U.S. corporations are sitting on a lot of cash. Their balance sheets have cash balances of over $2.2 trillion, up from $1.5 trillion at the end of 2007 (Fortune 2012). The same decade was

[1] See Acknowledgements, p. iv, for a definition of survey respondent types.

characterized by the off-shoring of some industrial production capacity combined with reluctance to reinvest in domestic capacity due to economic uncertainty. As noted in an earlier study, by 2008 the U.S. manufacturing sector was not only reaching full capacity, it was also beginning to reverse the trend of production off-shoring, thanks to the costs and difficulties of global supply chains (Elliott et al. 2008). Additionally, the manufacturing sector reflects pent-up demand for new capacity after a decade of tepid capital investment (Kaushal et al. 2011). Together, these facts suggest that domestic manufacturers have an opportunity to not only build new capacity, but to obtain the competitive edge that new technology will provide. Reinvestment in domestic manufacturing should directly contribute to U.S. economic recovery. New macroeconomic data, not yet available at the time of this report, may verify the recovery's relationship to capital investment.

Recently, an unprecedented volume of public and utility ratepayer funds have been poured into energy incentive and assistance programs for the manufacturing sector (Chittum and Nowak 2012). While assistance programs frequently reveal improvement opportunities of all kinds and magnitudes, many facilities tend to favor solutions that involve low- and no-cost improvements to existing assets. Meanwhile, a sluggish economic recovery combined with uncertain future tax and regulatory consequences have discouraged many companies from making strategic capital investment in energy-intensive systems. In sum, great potential remains for industrial energy improvement. However, various industries experience cycles of **capital infrastructure** renewal over intervals of five, ten, or more years (Elliott et al. 2008). This means that recently-gained awareness of potential energy improvements should lead to implementation of efficiency measures throughout the coming decade.

Various manufacturing corporations respond differently to energy program incentives. Each company demonstrates a unique combination of motivations and investment decision-making processes. This is an ongoing challenge for energy efficiency program administrators. To improve their future effectiveness, program administrators will need a better understanding of the industrial sector's prospects for investment, as well as the nature of the corporate decision process. While previous studies of industrial output and energy consumption typically examine energy intensity (e.g., Kolwey 2005), there is a need to study capital investment dynamics as these may shape the design and conduct of future energy efficiency programs.

To gain this insight, we present a two-part study. The first section synthesizes macroeconomic data into a profile of manufacturing output and related indicators. The intent of the first part is to segment manufacturing industries by their output and productivity performance, then to demonstrate how these segments vary in their energy use and capital investment potential. The second section presents the results from a non-scientific survey of 30 industrial energy stakeholders.[2] Respondents are mostly corporate end-users but some program administrators and solution providers are included as well.

[2] A scientific survey would have collected a much larger number of responses, using a sample frame that included respondents from each industry in proportion to their population numbers. This approach would have anticipated industry-specific generalities in the data collected from survey responses. Even had this been achieved, the knowledge of any "average tendency" for a given industry would be of little use to an energy program administrator planning the next facility engagement. Simply put, each facility is unique with respect to its capital budgeting and investment procedures, which underscores the need for individualized outreach.

The survey yields some generalizations about manufacturers' investment decision-making process as well as their perceptions and strategies for using energy efficiency programs. Appendix B presents the survey questionnaire and methodology.

Section 1: Analysis of Industrial Macroeconomic Data

This section examines macroeconomic data that describes manufacturing sector performance as captured in 1998-2009 data. The data reveals a mix of decline and renewal, with implications for targeting future energy efficiency programs.

This analysis purposely focuses on industry output, productivity, and capital investment performance for strategic reasons. Various commentators (e.g., Romer 2012) express doubt about the need for government-sponsored manufacturing policies of any kind. As a prelude to energy policy and program evaluation, it is imperative to first re-establish the manufacturing sector's ongoing vital contribution to the U.S. economy.

Manufacturing output includes not just the items consumed by households, but the many intermediate inputs from which those products are fabricated. Given the intricacies of global supply chains, marketing, and ever-changing economic conditions, growth rates vary widely among industries. Similarly, the nature of various industrial processes explains the different types and quantities of energy they require.

Methodology in Section 1. This section relies on published times-series data describing the performance of industries as identified by their 3-digit North American Industrial Classification System (NAICS) code. This analysis is confined to 1998-2009 because these are the most recent, contiguous years for which data were consistently available for all variables. Data sources are indicated with each table displayed in this section. Table 1 introduces manufacturing industries by their NAICS code, along with 2009 data describing each industry's percent contribution to total manufacturing value added and total energy expenditures. [3]

[3] A preferred alternative metric for energy expense would be the ratio of a dollar value of output dollar value to physical units of energy. However, data describing physical units are not consistently available for this time period of study. Trends in energy expense can be driven by changes in energy prices, therefore hiding the true efficiencies that are apparent when measuring energy by volume.

Table 1. U.S. Manufacturing Industries in 2009
Percentages of Value Added and Energy Expense

NAICS	Industry	Value Added	Energy Expense
311, 312	Food and Beverage and Tobacco Products	16%	19%
313, 314	Textile Mills & Tex. product mills	1%	1%
315, 316	Apparel, Leather & Allied Products	<1%	<1%
321	Wood Products	2%	2%
322	Paper	4%	10%
323	Printing and Related Support	2%	2%
324	Petroleum and Coal Products	12%	4%
325	Chemicals	13%	21%
326	Plastics and Rubber Products	4%	4%
327	Non-metallic Mineral Products	2%	6%
331	Primary Metals	3%	10%
332	Fabricated Metal Products	7%	5%
333	Machinery	7%	2%
334	Computer and Electronic Products	7%	2%
335	Elec. Equip., Appliances, & Components	3%	1%
336	Transportation Equipment	12%	5%
337	Furniture and Related Products	2%	1%
339	Miscellaneous	3%	1%
	All Manufacturing	100%	100%

Source: BLS 2012

Industry performance is described using output (value produced), **multifactor productivity**, capacity utilization, capital investment in new equipment, and energy expense. When generalizing these data for their 1998-2009 performance, linear regression is used to calculate an average annual percent change. The macroeconomic variables include:

- **Output**. This figure represents the annual value of production by a selected industry for sale outside of that industry. Data provided by the U.S. Bureau of Labor Statistics (BLS 2012).

- **Productivity**. Data represents "multifactor productivity" measures maintained by the U.S. Bureau of Labor Statistics (BLS 2012). The metric relates annual output to the joint influence of changes in labor, **capital**, materials, energy, and purchased services. Productivity describes the change in output value over and above the value of the enabling inputs.

- **Capacity Utilization**. This metric describes the annual level of industry output compared to the maximum output volume (100 percent) that current facilities are theoretically prepared to generate. A high and rising capacity utilization rate suggests that investment in additional capacity would be warranted. Data provided by the Governors of the Federal Reserve System (FRS 2012).

- **Capital Investment in New Equipment**. The U.S. Census Bureau conducts an annual survey of business investment in structures and equipment, both new and used (Census 2012). This analysis assumes that energy efficiency improvements are most likely to be caused by investment in new equipment, so this data excludes investment in structures and used equipment.

- **Output per Energy Input**. This is a ratio, provided by the Bureau of Labor Statistics, that relates current dollar values for output to energy expense (BLS 2012). An increasing value of this trend over time indicates (1) an increase in output value relative to energy expenses, (2) a decline in energy expenses for a given volume of output, or (3) both.

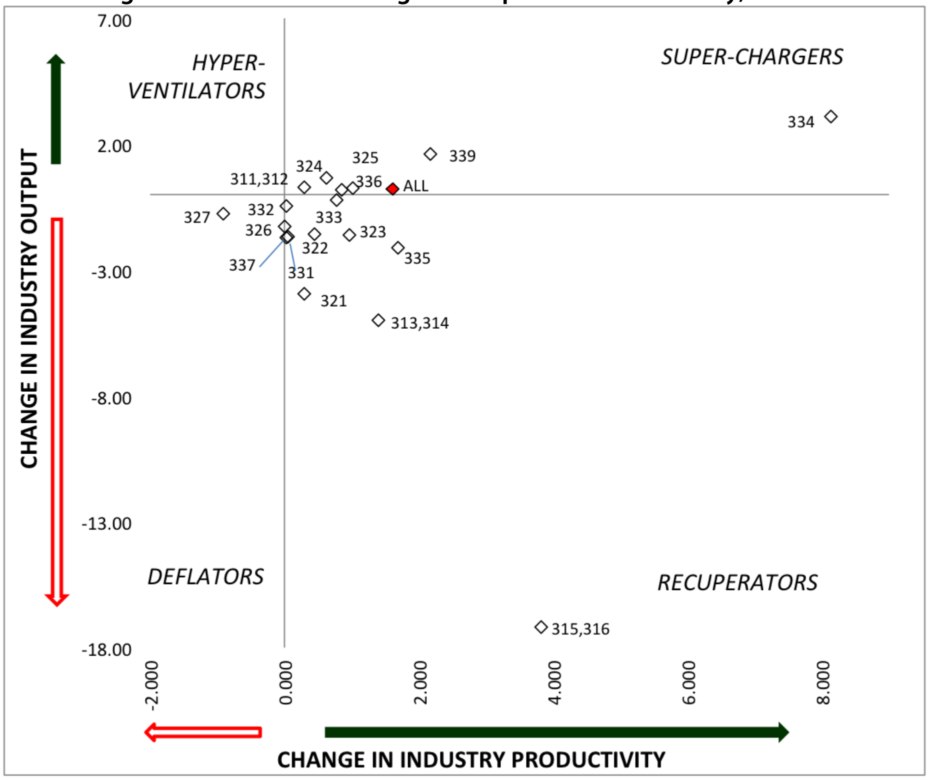
DATA AND TRENDS

Trend data from 1998-2009 describing changes in output and productivity for these industries are shown below in Figure 1. While manufacturing in total displayed sluggish growth in output, the sector as a whole made greater percent changes in productivity. Variances in output and productivity among industries are apparent, providing a basis for segmentation by performance results. Industry performance segments can be described as follows:

- **Superchargers**: industries with positive growth for both output and productivity
- **Hyperventilators**: industries experiencing output growth combined with declining productivity
- **Recuperators**: industries with declining output but increasing productivity
- **Deflators**: industries experiencing declines both in output and productivity.

In reality, U.S. manufacturing industries fell into three out of these four categories during the 1998-2009 time period. There are no "hyperventilators" at the 3-digit NAICS level for this time period. The segmentation results are shown in Figure 1. Some industries, but not all, experienced declines in output over this period. Only two industries suffered decline both in output and productivity. It is notable that most industries experienced productivity increases over this period. In fact, manufacturing in total experienced a slight growth of output combined with modest productivity gains. The result for all manufacturing combined (represented by the "All" symbol in Figure 1) is a composite for all industry in total, weighted by value of output. This composite reflects the greater magnitude of value produced by some of the positive growth industries, relative to the composite of industries with declining output.

Figure 1: U.S. Manufacturing Industries
Average Annual Percent Change in Output and Productivity, 1998-2009



NAICS Code	Industry
311, 312	Food, Beverages, Tobacco
313, 314	Textiles & Allied Mill Products
315, 316	Apparel, Leather, & Allied Products
321	Wood Products
322	Paper
323	Printing & Related Support
324	Petroleum & Coal Products
325	Chemicals
326	Plastics & Rubber Products
327	Nonmetallic Mineral Products
331	Primary Metals
332	Fabricated Metal Products
333	Machinery
334	Computer and Electronic Products
335	Electrical Equipment, Appliances, and Components
336	Transportation Equipment
337	Furniture & Related Products
339	Miscellaneous

Source: BLS 2012

Table 2 develops industrial sector segmentation further by adding metrics for capacity utilization, capital investment in new equipment, and the ratio of output value to energy expense. Note that the figures in Table 2 describe the average annual percent change for each variable over the 1998-2009 time period.

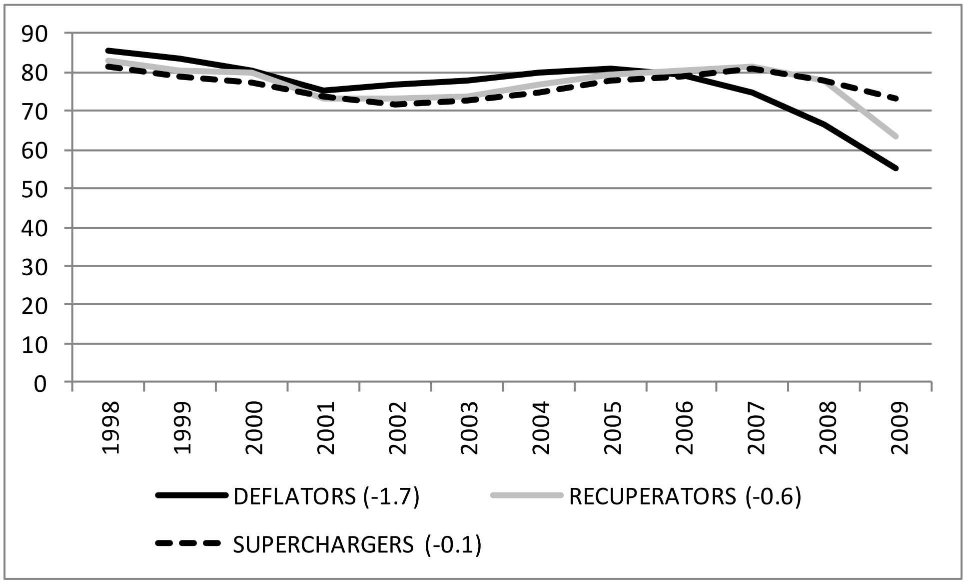
Table 2. Average Annual Percent Change, 1998-2009
Output, Productivity, Capacity Utilization, Capital Investment in New Equipment, and Output per Unit Of Energy Input U.S. Manufacturing Industries, Segmented By Output/Productivity Performance

NAICS	Industry	Output	Prodctvty	Capacity Utilizn	Capital Invstmnt, New Equip	$Output Per $Energy Input
311, 312	Food/Beverage/Tobacco Products	0.3	0.3	-0.3	3.2	-1.0
324	Petroleum and Coal Products	0.7	0.6	-0.7	14.0	-2.2
325	Chemicals	0.2	0.9	-0.5	-0.7	1.7
334	Computer and Electronic Products	3.1	8.1	-0.4	-9.3	9.7
336	Transportation Equipment	0.3	1.0	0.4	-3.6	2.9
339	Miscellaneous	1.6	2.2	-0.3	6.6	4.7
	ALL SUPERCHARGERS	0.9	2.0	-0.1	-1.6	2.5
313, 314	Textile Mills & Tex. Product Mills	-5.0	1.4	-1.5	-8.7	2.4
315, 316	Apparel, Leather & Allied Products	-17.2	3.8	-0.6	-17.5	8.9
321	Wood Products	-3.9	0.3	-1.5	-2.1	1.0
322	Paper	-1.6	0.4	-0.5	-6.6	-1.3
323	Printing and Related Support	-1.6	1.0	-0.9	-3.1	0.3
331	Primary Metals	-1.7	0.0	-1.3	5.1	-3.1
332	Fabricated Metal Products	-0.5	0.0	-0.2	-2.6	2.9
333	Machinery	-0.2	0.8	-0.1	1.0	3.6
335	Elec. Equip., Appliances, etc.	-2.1	1.7	-0.4	-4.6	2.8
337	Furniture and Related Products	-1.7	0.0	-0.9	-7.7	2.9
	ALL RECUPERATORS	-2.1	0.6	-0.6	-2.5	1.6
326	Plastics and Rubber Products	-1.3	0.0	-1.4	-4.5	2.7
327	Nonmetallic Mineral Products	-0.8	-0.9	-2.4	-1.2	-0.8
	ALL DEFLATORS	-1.1	-0.3	-1.7	-2.2	1.5
Total	ALL MANUFACTURING	0.2	1.6	-0.7	-1.5	1.9

Sources: BLS 2012; FRS 2012; Census 2012

Capacity utilization deserves some additional description. While the data in Table 2 provides the average annual percent change between 1998 and 2009, it says nothing about the absolute level for this variable. Figure 2 (next page) graphically indicates capacity utilization levels for the four performance segments, relative to their theoretical maximum of 100 percent.

Figure 2. Capacity Utilization, 1998-2009
Aggregate Trend for Each Industrial Performance Segment



Source: Adapted from Federal Reserve System data (FRS 2012)

Information from Table 2 and Figure 2 allows some observations about manufacturing industry segments as of 2009 (percentages shown here describe average annual percent changes from 1999-2009):

- Sixty-four percent of all manufacturing output came from "superchargers," the six industry groups that experienced positive growth both in output and productivity. Of all segments, this experienced the least decline in capacity utilization (-0.1 percent) and capital investment (-1.6 percent), while showing the largest gains in output achieved per value of energy expenditure (+2.5 percent). This segment includes food, beverage, and tobacco products; petroleum and coal products; chemicals; computers and electronics; transportation equipment; and the "miscellaneous" catch-all.
- Thirty percent of manufacturing output came from the "recuperators" segment (negative output growth, positive gains in productivity). This segment experienced the worst change in output (-2.1 percent), but still achieved modest productivity gains (0.6 percent). Capacity utilization declined (-0.6 percent) while capital investment dropped (-2.5 percent). Still, output/energy climbed (+1.6 percent). This segment includes 10 industry groups: textiles and allied mill products; apparel, leather, and allied products; wood products; paper; printing and related goods; primary metals; fabricated metal products; machinery; electrical equipment, appliances, and related components; and furniture and related products.
- Six percent of manufacturing output came from the "deflators" group, which experienced declines in output and productivity. The segment saw the largest average annual drop in capacity utilization (-1.7 percent) and capital investment (-2.2 percent). Note that the entire segment's +1.5 percent gain in output/energy blends the results for this sector's two industry groups: +2.7 for plastic and rubber products versus -0.8 percent for non-metallic mineral products.

Conclusions—Section 1

In total, the macro study presented in Section 1 of this report reveals some information about the economic prospects for U.S. manufacturing. These observations are based on 1998-2009 data trends and the output/productivity segmentation described above.

Sixty-thee percent of U.S. manufacturing value produced comes from industries that are expanding their output. In addition, the vast majority (94 percent) of the manufacturing sector experienced productivity gains. More productive industries—compared to less productive ones—are better positioned to rebound with economic recovery. More importantly, this data suggests that the manufacturing sector remains vibrant overall as some industries grow while others decline. Capital investment can fuel growth, especially as energy efficiency technologies are implemented. In this way, energy efficiency can contribute to industrial competitiveness and overall economic recovery.

Superchargers, the single largest segment measured by value produced (63 percent of manufacturing value), lead all segments by trends in output, productivity, capacity utilization, capital investment, and output/energy. These are the industries with the best competitive attributes and long-term viability. Most of the industries in this segment are making gains in output value achieved per energy expense. Some of the best energy productivity case studies may come from these industries. However, two industries in this segment, food/beverage/tobacco and petroleum/coal, experienced declines in output/energy. Energy efficiency improvements may be the best remaining productivity opportunities for these industries because they are already doing well per the other metrics described here. Some options for future energy program communications may include documenting apparent output/energy gains made by various industries so that others may observe and emulate these success stories.

Recuperators, representing 30 percent of all industrial output value, feature the largest number and variety of industry types among the segments studied here. While all industries in this group suffered overall output declines during 1998-2009, none experienced a decline in productivity. Productivity gains, while modest, were achieved despite this segment's poor rates of capital investment. But this may indicate an opportunity: pent-up need for facility expansion and modernization indicates some potential for investment in a new generation of energy efficiency production technologies.

Deflators are a segment consisting of only two industries, with collective output representing six percent of all industrial sector production. This segment's performance metrics, as studied in this report, are uniformly disappointing. That does not spell the end for these industries, but it may presage future rounds of industry consolidation or off-shoring. But as always, the viability of individual firms may vary highly within an industry. Energy program administrators should think carefully about each firm when committing resources within this sector.

Hyperventilators are industries that experienced output growth along with a decline in productivity. No industries fit this description for the 1998-2009 time period. This may change as data from subsequent years become available.

Energy program outreach is ultimately conducted one facility at a time. The macroeconomic findings from this section suggest which industries to watch for growth potential—especially the "recuperator" segment, which experienced productivity gains despite the recession. Continuing analysis is warranted since the currently available data covers only years up to 2009. Some, but not yet all variables are becoming available for subsequent years. We may expect data to reflect economic retrenchment immediately after 2009, in the wake of the financial crisis. However, data through 2012 may point to recovery and perhaps the relative improvement of individual industry performance. The prospects for energy program outreach will evolve accordingly.

Section 2: The Corporate Decision-Making Process

The purpose of this section is to bring transparency to the capital investment decision-making process of industrial firms. This section synthesizes the results from a series of phone and e-mail interviews with industrial energy managers, engineers, sustainability managers, plant managers, presidents, and vice-presidents from a diverse pool of companies. In total, ACEEE interviewed 30 individuals, all from different companies, to inform our analysis.[4] All respondents were assured that their individual replies would be held in confidence, and that responses would be reported here in the context of overall patterns and trends. A total of 139 individuals were contacted and were asked to participate in the survey.[5]

Implementation rates for industrial energy efficiency programs vary (Russell 2010). Still, all programs have room for improvement. A better understanding of capital investment decision-making processes at the corporate level will allow industrial energy program administrators to boost implementation rates while making better use of their limited resources.

MOTIVATION TO ACT

Industrial sector interest in energy efficiency is often the result of top-down corporate goals to achieve cost reductions of any kind. These are sometimes to be achieved emphatically through environmental sustainability initiatives. Large companies are more likely than small ones to be forward-thinking and thus to set goals over a 5-10 year planning horizon. The eleven respondents citing top-down corporate energy goals included five large companies, five SMEs,[6] and one facilitator. Similarly, 14 respondents citing corporate interest in sustainability included seven large companies, four SMEs, and three facilitators. Two of these large companies also indicated an interest in LEED (Leadership in Energy Efficient Design) for at least influencing their facility design criteria. One facilitator notes that many organizations follow the example of Fortune 100 companies that set the pace for sustainability initiatives. Increasingly, supply chain relationships compel manufacturers to demonstrate sustainable production attributes, as two respondents indicate. Industry associations such as the American Chemistry Council have developed sustainability goals and guidelines for a relatively small number of large corporations. Still, the desire to achieve sustainability appears randomly across industry without

[4] See the Acknowledgements for more information on the respondents and the companies they represent.

[5] Of that total, 30 (22 percent) participated, four (3 percent) explicitly refused, and 64 (46 percent) simply failed to acknowledge the request.

[6] Small- and Medium-sized Enterprises. See glossary.

systematic cause. Privately-held companies that embrace sustainability, and thus energy efficiency, do so at the whim of their owners (Chouinard 2012).

Any purposeful pursuit of sustainability is sometimes the initiative of a single, visionary manager or board member. While such direction may lead to the creation of corporate goals, those goals may or may not have clear accountabilities attached to them. A few respondents indicated that such "soft" goals were merely for appearances, to support marketing goals or general public relations. Generally, capital investment strictly for energy-saving benefits is pursued by the most energy-intensive industries. About half the respondents report that general cost improvement, productivity, reliability, or all the above drive their **facility investment** priorities. Many respondents indicate that energy improvements are welcome but are only incidental consequences of facility improvements.

Apart from performance goals is the ever-present need to replace or repair existing equipment. Replacement activities contribute directly to plant reliability. Nine respondents indicate that breakdown or replacement needs supersede energy efficiency as an investment driver. These responses were split evenly among large companies, SMEs, and facilitators. About one-third of respondents say that energy improvement opportunities would be largely dismissed were they not linked to equipment replacement episodes.

Smaller companies and facilities tend to be less interested in energy savings than larger ones. However, according to one facilitator, their numbers are slowly growing: he notes that 20-25 percent of all unsolicited inquires about new equipment are driven by consumer interest in energy efficiency. Other survey respondents also indicate that state and utility energy program outreach continues to drive industry's investment, if not primarily for the sake of energy efficiency, but for the additional value that efficiency may provide over and above business growth and equipment replacement needs. However, some respondents point to the low availability of internal capital, which is a function of the overall financial health of the company, aversion to investment in today's economic climate, or both. Tight credit markets also limit access to conventional bank finance.

COMPETING CONSIDERATIONS

Broadly speaking, industrial asset management is a trade-off between two choices: squeezing incremental value from existing facilities and equipment—*doing things right*—versus updating facilities to obtain a strategic competitive advantage—*doing the right thing*. The trade-off reflects management strategy, and has direct implications for capital investment. By choosing to *do things right*, a company implicitly commits to refining its current products, markets, and processes. By contrast, a company wishing to *do the right thing* is thinking beyond today in anticipation of tomorrow's opportunities for innovation, relocation, expansion, and growth. This choice determines whether business returns are maximized for the short run or for the long term. These strategy differences explain why two manufacturing facilities, similar in every physical aspect, can demonstrate vastly different appetites for investment in energy efficiency.

At least seven respondents indicate that business growth is the primary goal of capital investment. Aside from meeting business growth needs, many manufacturers are compelled by statutory safety and environmental compliance needs to invest in existing facilities. Add to this the capital requirements to simply repair and maintain current facilities. According to most respondents, energy improvement proposals compete with (rather than contribute to) these primary investment goals. While "efficiency" is not entirely dismissed, it is usually a secondary priority. One respondent states that the primary goal for energy management is to ensure that energy supplies are distributed adequately throughout a facility in a timely fashion—a task that is sometimes at odds with efficiency rather than because of it.

Unless it is to replace a failed asset, an energy efficiency improvement is more difficult to justify than a growth-oriented investment. At least five respondents indicate that energy improvements are more easily addressed in new construction than in the retrofit of existing facilities. About half the respondents indicate that **capital allocations** favor proposals that promise growth, address mandatory safety or environmental compliance, or both. A similar number of respondents (not always the same counted for the last point) say that energy impacts are at least one of many factors to be considered when evaluating a capital investment. Six respondents (four of them large companies) indicate that energy improvements compete with all other capital funding requests. However, three respondents (all were large companies) indicate that their organization maintains a capital budget track for energy separate from all other investment purposes. A dedicated energy fund ensures that at least some capital is available each year for energy improvements. Of note is the claim by at least five respondents that energy projects are often the kind of items paid for from either non-capital funds or from any budget remainders at the end of the fiscal year. To the extent that this is true, it suggests that industrial energy improvements happen more by chance than by deliberate effort.

It is not accurate to conclude that energy improvements always "compete" with all other capital investment opportunities. As one large company respondent points out, energy improvements are sometimes the consequence of modernization or automation efforts. Documenting these impacts will help when assembling justifications for future improvements.

AWARENESS AND MOTIVATION

Manufacturers' readiness to pursue energy improvements varies not only with their strategic direction, but with their organizational sophistication. While companies are accustomed to managing operations, engineering, finance, and other traditional industrial functions, energy management is a relative new-comer to this mix. Many manufacturing firms lack the organizational acumen to develop or consistently support energy cost-control strategies. SMEs in particular are often unmotivated or unprepared to make room in their existing agendas for energy improvements. Larger companies tend to be more iterative in their project investigation and implementation process. Consequently, they become more proactive over time as staff learn not only the technologies, but the project development process itself. One facilitator notes that SMEs tend to react to specific opportunities as these are made evident by **energy assessment**s and related program outreach. By contrast, a larger company with an iterative process will systematically discover these opportunities. As another facilitator states, all the utility and government energy program outreach is having a positive impact: companies are generally more receptive to energy improvements than they were 15-20 years ago.

Thanks to recent utility and government-sponsored energy efficiency programs, energy assessments (audits) have become a common method for boosting industry's awareness of energy improvement potential. At least six respondents claim to have had a program-sponsored energy assessment. These respondents were split between large companies and SMEs. A few of the more sophisticated companies develop their own protocols for periodic, self-conducted energy assessments. Two facilitators note that energy assessments or facility benchmarking exercises can capture the management attention that's needed to investigate energy improvements.

Economic development advisory programs will, sometimes and unintentionally, work at cross purposes with energy efficiency program goals. One facilitator describes Small Business Administration (SBA) counselors' concern with the failure rate of start-up manufacturers: these owners are advised to acquire used (and therefore probably inefficient) equipment as a way to minimize capital losses in the event of failure. SBA loan analyses, which rely on debt-to-income and other ratios, do not recognize the impact of energy savings. Energy costs are either considered to be insignificant or they are consolidated with other expenses in financial statements. This suggests a need to improve the effectiveness of economic assistance program communications.

Many facilities rely on internal staff for identifying energy improvement opportunities, as at least six respondents (five of these being large companies) indicate. Another five (mostly different from the previous six, and four of the five being large companies) say they use internal **kaizen**, six-sigma, or other formal idea-generating forums to generate improvement concepts.

In lieu of obtaining audits or engineering studies for their facilities, four responding SMEs simply gather and refine ideas through trade group or professional society interaction—a trait that underscores the importance of pilot implementation, case studies, and peer-to-peer networking groups. Other respondents gather ideas from trade magazines and workshops. Some respondents claim that facility managers are already aware of their energy improvement needs, although they may not be able to act currently on them. Then again, even "knowledgeable" facility managers can learn of improvement opportunities from a proper energy assessment.

CAPITAL PROJECT CULTURE

Industrial investment decision-making reflects the prevailing business culture of the organization. Survey respondents provided insight on business culture as it shapes energy-related investments.

Business cultures, and therefore capital budget styles, vary throughout industry. There's nothing to indicate, for example, that food processors as a group manage capital in a way that's distinct from pharmaceutical manufacturers. The survey suggests a general difference between large, multi-plant companies versus SMEs, whose **capital expenditure** processes are often less rigid and certainly localized, often driven directly by the owner.

The business of manufacturing is intrinsically capital intensive. The mechanical nature of manufacturing ensures that it is an engineer-driven culture. Engineers are trained to craft solutions in the form of "projects," that is, discrete episodes of hardware design and implementation. Engineers instinctively perceive industrial energy improvements to be a project of some sort. Manufacturers' preference for projects is reinforced by the corporate tradition of capital rationing. Typically, a manufacturing enterprise develops an annual capital budget—reinvesting some of its earnings in its facilities in order to sustain or grow the business. By nature, the capital budgeting process stimulates a fierce internal competition among the departments within a **business unit**, since needs are almost always greater than the available funds. Proposals with clear, concise, measureable impacts—presented as "projects"—are usually the most effective way to compete for capital funds. One lesson is immediately clear from these observations: when a manager says the company "doesn't have money" for energy improvements, this may be misleading. A more accurate statement may be that the energy **champion** cannot compete effectively with other departments for the money that's available.

Large companies in particular (11 of 14 respondents) utilize an elaborate decision-making process to evaluate capital investment proposals. The vetting process for a specific proposal will often be conducted by a couple of teams: one that champions the proposal and the other with approval authority. The project champion team may be comprised of an energy manager plus staff from engineering, maintenance, and/or production. The approval team may include managers from operations, finance, environmental/health/safety, marketing, regulatory affairs, and/or other departments. Corporate review may examine economic, regulatory, and legislative considerations. Each manager's influence on investment decisions will vary. At least three respondents noted that an energy project is more likely to be awarded funding if the approval team includes an individual who is familiar with the proposal throughout its development. In general, expect leaders from operations and finance to carry the greatest weight for approval decisions. At least two respondents noted that the approval team not only evaluates investment proposals, but will also set the company's current investment priorities. The approval team sets these priorities in light of prevailing economic conditions as well as marketing considerations and regulatory requirements. Given these guidelines, subordinates develop investment proposals accordingly.

It is important to remember that professionals that share the same job title are not created equal, either in terms of their individual abilities or the authority vested in them by their organization. For energy program administrators, the path to implementation includes scoping the management team for each individual facility, becoming familiar with each manager on the decision team for energy improvements.

The complexity of the capital investment vetting process tends to increase with the size of the company and the magnitude of dollars involved. In general, proposals with successively higher dollar amounts are required to sustain additional levels of review. Industrial organizations tend to perform investment analysis in stages, beginning with a quick, low-effort feasibility analysis, usually performed by the staff that are closest to the concept. If a proposal passes this first hurdle, it will usually encounter one or more subsequent feasibility reviews, each requiring progressively more analysis.[7] This step-wise approach reflects the cost of devoting staff or consultant time to a project proposal.

[7] Engineering jargon such as "80/20 feasibility analysis" is often used in the vetting process. This example assumes that a cost-benefit analysis can be achieved with 80 percent certainty after investing only 20 percent of the level of effort needed for a definitive analysis. Another firm may pose a "50/50 analysis." These analysis percentages are not fixed in any way by industry—they reflect the judgment and customs of individual firms.

Note that in a tight fiscal environment, management may not have the resources to pursue such analyses, which effectively stalls the development of worthwhile investments. All of these observations explain why manufacturers do not react quickly to energy improvement incentives. Carefully designed energy program assistance should instigate many of improvements that are otherwise forfeited for reasons of time and money.

A facilitator commented that procrastination—bred by a lack of time—explains why companies fail to pursue so many good energy improvement opportunities. Another facilitator noted that even the easy, low-cost opportunities can be difficult to perform simply because of limited time availability. Meanwhile, the clock is always ticking on the budget calendar, a conundrum underscoring the need to spend money sooner rather than later before annual spending capacity is exhausted. Energy efficiency programs often recognize this hurdle and will respond by offering free or cost-shared project analysis services for selected technologies. One respondent, however, indicated that capital funding for a proposal must be approved before a concept moves into final design and engineering. Another noted that in some companies, approval for capital expenditure can be rescinded at the eleventh hour, as top executives make last-minute changes to priorities or as emergency conditions suddenly prevail. As this respondent put it, a capital expenditure is not certain until a final spending request has been ratified.

One program administrator noted outright unwillingness by large and small companies alike to borrow for energy projects, despite the enticement of low interest loans. The administrator attributed this to facility managers being unable or unwilling to assign collateral to such loans. This may also reflect debt covenants imposed by existing lenders that prevent borrowers from obtaining additional debt.

The origin of capital investment proposals varies widely across and within industries. Proposals may originate at the facility level to be considered for corporate approval. In other instances, corporate energy teams advocate concepts for facilities to consider. As at least five respondents indicated, capital spending by large companies is frequently managed at business unit levels below the top corporate office. As a result, the criteria for investment awards and performance evaluation can vary across business units. This is for valid business reasons: as growth prospects vary across business units, so will the need for capital infusion.

When energy improvement is pursued as a **capital project**, its implementation is squarely dependent on the pace and timing of a capital expenditure process. Almost all respondents indicated the use of an annual capital budget. A small number of respondents (mostly large companies) use a three- or five-year planning horizon to coordinate spending on projects that take more than 12 months to develop. These longer plans are usually subject to annual adjustment. At least one respondent said that an energy improvement is more likely to be approved if it has been developed through the capital planning process. By contrast, SMEs can often develop projects more quickly, especially when they don’t have a rigorous approval process. One facilitator noted that the decision cycle can be as fast as 24 hours.

Capital investment analysis may involve nothing more than a simple payback calculation that compares energy savings to the cost of the project. Survey respondents offered an array of creative approaches for making energy improvement proposals more compelling. One facilitator observed that some companies' proposal evaluation is extended to consider tax, depreciation, and maintenance implications. For at least three respondents, it's not just the "payback," it's the additional impacts that matter. One large company respondent said that the company will also evaluate a capital proposal for its potential to "change the facility's evolution" by making it more productive, faster, or more flexible. In many instances, a "good" energy project is one that also simplifies maintenance or generally makes work easier or more routine. They are projects that can be implemented with minimal interruption of the core business or without diversion of resources. As one facilitator noted, a truly good project is not only problem-free, it elicits expressions of appreciation from production people upon its conclusion. Regardless of the industrial organization's type or size, evaluation of proposed investments can be as much art as science, relying on the management style of key individuals. Again, no patterns are evident across industry to predict preferences. One respondent indicated that **life-cycle costs** are expressly considered; another specifically avoids them. Yet another respondent claimed that **avoided cost** measures are of no interest. Another individual noted that preferred investments are ones that feature a low risk of economic failure, which would effectively reverse a project's cash flow from positive to negative.

Simple payback remains the most frequently cited investment metric. Seven respondents claimed that capital investments are expected to pay for themselves in three years or less. Another three respondents (two of these being large companies) indicated a 12-month threshold. A chief financial officer expecting a 12-month payback or better essentially wants budget-neutral investments. In other words, capital expenditures are expected to be recovered through benefits realized before the end of the current budget year. This may not reflect a lack of capital, but rather the company's extreme risk aversion due to uncertainty about future market or economic conditions. It could also simply reflect an industry subject to rapid change. Or, it may reveal a disconnect between personal and organizational goals. For example, a corporate finance officer's personal bonus potential emphasizes current-year results over future results, even though the magnitude of future results may be much greater. In financial jargon, this means that future returns are heavily discounted. A couple of respondents noted that their energy team may negotiate the criteria for project evaluation, opening the conversation to include secondary benefits beyond crude payback criteria.

The popularity of simple payback is not absolute. One large company claimed to avoid this metric because it fails to account for too many variables. This company prefers to use discounted cash flow analyses. With ready access to spreadsheet software, there's no reason to not perform a more robust investment analysis. The real limitation is the organizational willingness to learn and adopt new methods.

Inconsistent and erroneous use of investment jargon is common throughout industry, especially among facility managers. Terminology may be standard within a facility, but it tends to vary across industries and sometimes across business units of the same company. The terms "simple payback" and "ROI" (return on investment) are often used interchangeably. For example, it's not unusual for a facility manager to observe "an ROI of two years or less." The confusion is this:

- Simple payback is a measure of time. Specifically, it is a total investment amount divided by the annual benefits that the investment creates. The result is the number of years that it takes for the flow of benefits to add up to the value of the investment.
- Return on investment describes a rate of return. Accounting ROI—the most basic and most commonly used measure of ROI—compares annual benefits to the value of the enabling investment. In effect, accounting ROI is the inverse of simple payback. More importantly, the ROI calculation results in a percentage that describes an annual rate of return on an investment.

Like any metric, payback measures are subject to manipulation—leading to biased investment choices. Investment in an energy project that yields savings in a defined cash flow cannot be fairly compared to an investment in safety measures that are required by law and prevent unknown future calamities. One large company respondent describes how a capital project proposal became the first investment priority—not because it had the best payback, but because it was alleged to be insurance against process failure. While the payback on energy savings can be calculated with a high level of confidence, predictions of hardware failure cannot. Peace of mind—a benefit without a dollar figure attached to it—often takes first priority.

Once committed to pursuing an energy improvement project, facility staff must coordinate its implementation with any other projects and ongoing production activities. Implementation usually cannot begin before the start of the budget year from which its funds are allocated. Also, managers usually plan for project implementation to coincide with scheduled facility maintenance shut-down episodes.

The Role of Program Advisory and Analysis Services

A growing number of utilities and governments offer energy management advisory programs to supplement the typically scarce resources available to industrial facility managers. As the scope and variety of advisory programs evolve, so do industry strategies for employing these resources. In general, advisory and analysis measures include energy assessment studies that investigate potential energy improvements for a system or entire facility, feasibility analyses for specific projects, and some combination of financial assistance such as a cost rebate or low-interest loan.

One large company claims that up-front rebates are preferred, even if the amount is less than what would be offered as a post-installation award. This essentially eases the capital budgeting process: dollars secured up front reassure the company's finance team that capital needs and uses are balanced.

Only some of the 30 respondents were openly enthusiastic about program support. Their comments yield a provisional segmentation of their attitudes:

Positive proponents (2 of 30 respondents). These respondents were energy managers, who claim that their job was made possible largely or entirely by direct funding from a utility assistance program.

Motivated Opportunists (10 of 30). These respondents indicate that they (or their program patrons) actively seek energy improvements because of the incentives. To paraphrase respondents, proposed energy improvements are prioritized only if incentives are involved (3 respondents, all SMEs); at least some initiatives are instigated by assistance programs (2 SME, 1 large); securing utility rebates is a precondition for approving projects (1 SME); and it's difficult to do energy improvements without utility support (1 large). One facilitator notes that incentive deadlines motivate many companies to act with more alacrity. The same facilitator states that companies are not attracted to incentives just for the money; their investments are driven by true business fundamentals (but see next point).

CASUAL OPPORTUNISTS (10 OF 30). These respondents indicate that their companies pursue capital projects as they normally will, not because of incentives, but they will pick up any incentives that happen to be available. Paraphrased comments: Will use utility incentives if available (2 large, 2 SME); good projects stand on their own merit, however, mid-sized companies in particular have learned to expect and seek incentives (1 facilitator); project timing coincides with the availability of incentives (1 large); incentives don't speed up implementation, but they do improve feasibility analyses (1 large, one SME); incentives make renewable energy projects more likely (1 large); and rebates are to be preferred over tax incentives simply because it's easier to apply rebates to a specific budget within the business unit (1 large). One facilitator, contrary to the above, says that some SMEs are really responding to the incentive money. Once they are aware of the offer, then they begin to investigate the potential for improvements.

DISMISSIVES (8 OF 30). These respondents indicate pessimism, if not hostility, toward program assistance. To paraphrase: reluctant to pursue assistance offerings due to volume of paperwork, too many points of contact, would need consultant help to navigate the process (3 SMEs); incentives are a small dollar volume relative to replacement needs (2 large); not able to take advantage of assistance programs because of the possible appearance of impropriety (1 large); audit suggestions are redundant to what they already know (1 large); and incentives help, but it's the magnitude of savings that will ensure project approval (1 facilitator).

Some program administrators insist that industry remains unaware of program incentives. The survey responses suggest that even when industrial managers are aware of such incentives, they vary widely in their willingness and ability to utilize them. Industry receptiveness varies with corporate cultures, as no two companies are alike in their setting of priorities and the pace at which these are pursued. Similarly, no two energy managers are alike in their combination of skills, empowerment, and abilities to inspire their colleagues to action. At the same time, the design and content of energy programs will vary as will industry's reaction. The immediate implication for future assistance program design is that one-size-fits-all offerings will have limited potential. Programs will depend more on custom measures that nuance the delivery of program services. To successfully engage the SME segment, programs may rely more on account reps that spend more time with a portfolio of clients, providing each with analytical and administrative support—therefore becoming an effective adjunct to facility management.

THE DYNAMICS OF THIRD-PARTY OUTSOURCING

All respondents indicate that third-party consultants and contractors are employed to varying degrees to assist with the analysis, design, and fabrication of capital projects (21 large, five SMEs, and four facilitators' observations of SMEs). Of these, the majority tend to employ local, trusted vendors with whom a long-term relationship has been established (12 total, eight large, four SMEs and facilitators). By contrast, there was one large company respondent that uses outsourcing sparingly, pointing to the difficulty of orienting an outsider to the complex facilities that an internal engineering team can adequately analyze. The kind of work that is outsourced varies. Companies tend to use their own staff for the engineering and installation of smaller projects. In a couple instances, respondents say that they retain critical **feasibility studies** while outsourcing simple, run-of-the-mill analysis. Some others do exactly the opposite. One large company respondent notes that third-party analyses boost the credibility of the staff's internally generated improvement concepts.

The overwhelming preference for long-term, trust based vendor relationships frequently eschews formal bidding procedures. But when bidding is performed, requests for proposals are usually issued to a well-established short list of familiar vendors. The bidding process is most often performed at the facility level as opposed to corporate, favoring local vendors. Especially among SME facility managers, the local vendors often enjoy professional group or even personal relationships. Note that two companies (one large, one SME) issue corporate direction to its facilities dictating the use of specific vendors. The large company limits such direction to certain technologies such as lighting retrofits.

LIMITS TO PROGRESS

Survey respondents commented on the hurdles, or at least extenuating circumstances, that determine the pace and volume of energy improvements. Note, however, that the respondents speak mostly from the perspective of middle managers from facility departments. These respondents may have strong knowledge of facility management agendas, but not all will necessarily understand or correctly interpret the dynamics of their top management's capital investment practices. Nor do corporate leaders always understand the realities of facilities management. In short, capital projects are often deliberated by decision-makers with disparate agendas and less than perfect knowledge. Dissenting opinions may exist within an organization's management team regarding what is, can be, or should be done regarding energy improvements.

A previously published report describes anecdotal observations of decision biases exhibited by corporate managers (McKinsey 2011). These can be categorized as:

- **Confirmation bias.** Decision makers' analyses tend to be more harshly critical of reasons to accept an investment; analysis of reasons to reject proposals is not nearly as strident. This leads to a tendency to underinvest.
- **Bias derived from inappropriate analogies**. The business world tends to rely on analogies, acronyms, and jargon—all forms of verbal shorthand—to communicate ideas. When such messages are wrongly interpreted, bad decisions can be made. Energy issues tend to be complex and are especially susceptible to this. The term "energy efficiency" may mean something different to each member of a management decision team. Energy program communications need to be crafted with this problem in mind.
- **Champion bias.** In some organizations, decision makers react more to the power and personality of an investment's proponent, rather than being convinced by the merit of the proposal itself.

Returning now to our survey, respondents also reveal disconnects between decision-makers within an organization. At least two respondents (both large companies) note that corporate leaders provide staff with few resources to back sustainability pledges made to the public. In one example, there are no accountabilities to compel the chief financial operating officer to make investments in sustainability outcomes—despite the company's public pledges. At least three respondents note that energy managers are simply not empowered to pursue energy-saving investments if these would supersede the competing wishes of operations or maintenance directors. One large company respondent notes that energy projects are more difficult to implement if the impacts are felt across departmental lines. Supporting this idea, another respondent notes that an energy improvement is more easily accepted when the idea comes from the department that has responsibility for the impact. Another reason for stalled energy projects is ever-changing incumbents among the decision team. Incoming managers bring with them a learning curve and a different set of values and priorities. The greater the rate of management turnover, the greater the chance for delaying, postponing, or outright cancelling capital project proposals.

Industrial investment priorities are shaped by operational philosophies. One facilitator describes the staff of one facility that stubbornly believes in a fixed ratio of energy per ton of product produced. To them, "energy efficiency" means a reduction of output and revenue. Old operating rules-of-thumb last for years, assuming a fixed trade-off among time, energy and money. All too often, these assumptions don't change even as the prices of these inputs vary.

Perhaps the most common barrier to industry's investment in energy improvements is a combination of fear and misunderstanding. A lack of information, or sometimes misinformation, feeds this fear. At least seven respondents (two large, two SMEs, and three facilitators) claim that the balance of an industrial organization cannot see the value of energy improvements. Many key decision-makers perceive no vested interest in the outcomes of such improvements. Fear can be further nuanced from individual survey responses: fear of projects failing to deliver promised results, or fear of adverse effects on production yield, capacity, or quality. Fear also breeds resistance: one facilitator suggests that staff on the shop floor can purposely derail corporate energy directives by simply failing to comply with them. Note that organizational politics can play a role: one respondent indicated that unionized facility staff were reluctant to suggest any changes that might impact collective bargaining work arrangements. Another facilitator says that long-time facility workers are often jaded by past episodes of failed energy efficiency promises. A different respondent, however, says that staff resistance to energy-related changes is minimal. As one large company respondent notes, a lot of the older staff have some good energy-saving ideas on the shelf that were passed over by earlier management teams.

Individual respondents also cite a lack of internal skills, a shortage of funds for employing consulting help (particularly among SMEs), and a lack of time to improve anything "that's not broken." Refusal to acquire outside expertise, for whatever reason, is a failure to benefit from new skills and experience. At least one large company respondent describes a cross section of his organization's staff—which includes an aging cohort of energy-smart professionals with sensitivities shaped by the 1970s oil shocks. Most employees added during the 1990s (a time of relatively low energy prices) tend to be less concerned with energy; unfortunately, these individuals are now entering their greatest years of organizational influence. Meanwhile, today's new hires include young people with a better appreciation for sustainability concepts. This should bode well for future support of sustainability agendas.

The hurdles discussed here—lack of resources, disparate internal philosophies, and disconnects of authority—explain industry's affinity for quick, cheap, easy energy solutions. Some respondents suggest that the easy solutions are becoming harder to find. To make more progress, energy program administrators will need to increasingly address their client's cultural and organizational issues in addition to the usual hands-on, technical aspects of energy cost control. This implies an agenda that not only takes more time, but aligns energy policy with economic and workforce development initiatives. In short, the traditional engineer-to-engineer dialogue of yesterday's energy programs is probably not sufficient to maximize capital investment in energy improvements.

IMPACTS OF ENERGY IMPROVEMENTS

Despite the many difficulties, many energy managers can and do overcome barriers. Two SME respondents note that their organizations originally avoided energy improvements in favor of other investments. But once some initial energy project results were available, managers were convinced and wanted more! Four respondents reiterate that project success is often predicated on non-energy benefits. Specifically: 90 percent of energy projects also have a productivity impact (one large company, one facilitator); energy improvements provide a four-fold return in the form of production improvements (one large company); and two other large companies claim that non-energy benefits "dominate" the returns from energy projects. There's still room for improvement: at least one large company respondent says the company experiences an implementation success rate for energy proposals of 30 percent or less. A facilitator claims an 80 percent implementation rate.

At least one respondent notes that energy improvements are harder to justify with today's relatively low gas prices. Upon reflection, this may reveal a strategic opportunity. As discussed in Part 1 of this report, the industrial sector is experiencing a re-shoring of production facilities on domestic soil. This is due in part to lower gas prices. But does this not underscore the need to invest in new facilities? If so, this investment is an opportunity to implement advanced, energy-saving technologies that will hedge these new facilities against future energy price increases.

CRITICAL SUCCESS FACTORS

What is it that allows some companies to implement more energy improvements than others? For many respondents, it begins with leadership: the influence of key top managers who communicate an inspired vision across all departments. Exactly who performs this role is determined more by personality and power than it is any specific job title.

Once a vision is in place, protocols are needed for execution. Eleven respondents (eight large, two SMEs, one facilitator) note that it is crucial to have a staff team dedicated to at least monitoring or investigating energy performance. In some instances, teams are organized at corporate levels, providing itinerant service to facilities. Some other facilities have their own local team, which may in turn receive corporate guidance. Note that almost all respondents have a capital budgeting process of some kind, which should not be confused with an "energy strategy." Three respondents (one large and two SMEs) claim to have a formal energy management strategy. A few respondents attribute success to supportive corporate leadership. In one case, this means instilling a work environment that incents and inspires new ideas. One large company respondent describes "mature energy thinking" as a work environment where staff at all levels submit energy improvement ideas on their own initiative. In this situation, energy improvements are perceived not as a distraction, but as a viable business solution.

One critical success factor cited by many respondents is that facilities need an internal energy management program of their own design and making. Energy-related goals, assignments, and accountabilities can then be coordinated with annual and multi-year capital investment plans. Absent a true energy management protocol, facilities are reduced to random projects—a hit-or-miss proposition at best.

A few respondents note that it is critical to have an energy champion at the facility site who can effectively "sell" improvement concepts to the balance of the organization. As one facilitator states, facilities are more likely to pursue energy improvements if care has been taken to explain the larger business impacts to key decision-makers. Another facilitator notes that skeptics are always present to varying degrees among a facility's decision-making team. To overcome their resistance, energy proponents—both internal champions and energy program administrators—are advised to make contact with as many of the relevant key managers as possible. Use this inner networking opportunity to reiterate the business impacts relevant to these managers' respective departments.

A facilitator advises energy program staff to pre-screen facility management teams for their ability and willingness to support energy improvement initiatives. Another facilitator recommends a facility screening strategy per this acronym: MAN (money, authority, need). In other words, evaluate the decision team to determine which individuals have each of these three attributes. This helps to plan the subsequent communication strategy.

At a tactical level, one facilitator notes that facts and figures serve the energy champion well when justifying proposed improvements. The better the analysis, the less room there is for capital budget politics. And as noted above, energy improvements are more likely to occur when they are linked somehow to other core-business investments.

To synthesize comments from survey respondents, Table 3 offers a provisional checklist of attributes that facilitate capital investment for energy improvement purposes. The more these attributes are in place, the greater the likelihood of success.

Table 3. Provisional Checklist for Successful Capital Investment in Energy Improvements

LEADERSHIP
- Top management support for cost improvement in general, and good projects in particular
- An empowered energy champion who has influence with multiple departments and directors
- Individuals familiar with the project from its inception are on the approval team
- The project development team draws membership from all departments to be affected by the change

CULTURE
- Company has a formal self-improvement idea generating mechanism
- A history of successful energy improvement projects
- A work culture that is amenable to change and new knowledge

ORGANIZATIONAL MECHANISMS
- Clear accountability for energy performance results
- Corporate goals for sustainability or overall cost improvement
- Capital spending decision-makers are located at production facilities
- Flexible investment evaluation criteria to recognize non-energy benefits
- Ability to schedule the energy improvement to coincide with expected shut-down maintenance episodes

BUSINESS RELEVANCE
- Clear articulation of energy impacts and their linkage to core business goals
- Evidence of a facility's deferred or pent-up demand for capital investment
- Knowledge of the capital renewal cycle for the industry and corresponding windows of opportunity for investment.
- Ability to link discrete energy projects to a current business goal or need

OPENNESS TO OUTSIDE RESOURCES
- Willingness to apply for energy program benefits
- A consultative relationship with vendors and consultants

CONCLUSIONS FOR FUTURE PROGRAM DESIGN AND CONDUCT

The U.S. manufacturing sector reveals varying readiness for economic recovery after a decade of capacity destruction and overall stagnant growth. Segmentation of the sector per trends in output and productivity reveal that most of the manufacturing sector (94 percent of value produced) in fact increased its productivity between 1998 and 2009. Considering also the sector's potential for increased capital investment in modernized facilities, the muscle for economic recovery seems to be in place. The industrial segmentation described in this report suggests where future energy program outreach should be focused.

The potential for manufacturing energy improvement, and therefore the investment that enables these improvements, is changing. Despite the volume of potential low- and no-cost improvements discovered by program-sponsored energy audits, many of these remain unimplemented. As one respondent notes, the "low hanging fruit" has a tendency to grow back in the absence of ongoing monitoring and control. The advent of certified energy management standards such as ISO 50001 should help in this regard (EERE 2012). But even as programs and standards are mass-promoted, industry will respond one company at a time, each on its own timetable, as key energy champions within each company are willing and able to muster the internal influence and resources needed to commit to energy management. Future program outreach may require program administrators to continually screen, coach, and support energy champions as they muster the organizational support needed to advance their energy improvement agendas. This task will draw on communication, financial, and change management skills in addition to the usual engineering expertise.

Respondents to the survey conducted for this paper reiterate the fact that energy improvements are not a priority, but rather a welcome indirect benefit of industrial investment. The advancement of industrial energy efficiency program goals must more effectively detect, document, and promote the affinities between energy savings and core business goals, then communicate these fully to key decision-makers in each organization.

To some observers, relatively low natural gas prices currently dilute the urgency for energy efficiency improvements. A more strategic perception would note the need to build more capacity in response to the re-shoring of production facilities—a trend driven in part by today's low natural gas prices (Young et. al. 2012). Capital investments made today can provide needed capacity while ensuring that facilities are efficient from their inception, therefore minimizing the future liabilities of energy waste.

The true business impacts of energy improvements remain underappreciated by professionals that influence industrial investment decisions. Even as energy program outreach to each facility requires some message refinement, so does the communication and advice offered by economic development advisors like those representing Small Business Administration (SBA) programs and state economic development offices. Advice given to SMEs in particular is sometimes counterproductive to energy efficiency goals. This suggests the need for greater coordination between, for example, utility companies and local economic development offices.

More than one survey respondent suggests that the real opportunity for manufacturers is to collectively address energy, water, material waste challenges. In effect, the energy manager evolves into a sustainability manager. Doing this would aggregate the cash flow recaptured from these media, allowing companies to more easily cover their cost of waste management. Aggregation of these functions has operational benefits as well by streamlining monitoring, verification, reporting, and project justification tasks.

Per the classic engineering mindset, many industry stakeholders equate energy efficiency measures with capital expenditure projects. Less technical observers may anticipate energy measures that result from behavioral and procedural change. Both groups are correct. The marriage of these philosophies calls for energy management as a *process* of continuous improvement, relying as much on performance measurement and staff action as it does capital projects. Accordingly, state and utility energy programs are evolving to support energy management practices as a complement to the project approach. This evolution is not without challenge: while capital projects involve a change of equipment, energy management imposes change on personnel roles and accountabilities. The suggestion of organizational change breeds fear and resistance in ways that the project approach does not. Compared to a capital project, the energy management process does not make a neat, one-time funding proposal. To compete effectively in the capital budgeting process, facility managers would rather *do things right*—pursue projects—as opposed to *doing the right things* that true energy management would require. Energy efficiency programs can coach facilities as they develop energy management disciplines over time—beginning with the easy, low-cost improvements, then by developing monitoring and maintenance best practices for current assets. Once these competencies are in place, energy champions can more convincingly justify capital investment in advanced technologies, pointing to energy as well as other ancillary benefits.

Program efforts can make better use of vendor-supplied expertise, as some respondents indicate. Industry's preference for trusted vendor relationships is a foundation for a true partnership with the customer. The vendor would move beyond selling commodity products, forming an advisory or consultative relationship that poses energy improvements to the customer as business solutions. "Trust" itself is a form of capital, crucial for customers to become more comfortable with the change that comes with energy improvements.

Overall Conclusions and Recommendations

Opportunities for manufacturing sector expansion are emerging after a decade of economic turmoil. With this expansion comes the opportunity to modernize industrial infrastructure, which can have direct, positive impacts for energy efficiency as well as industry competitiveness and overall economic growth. Manufacturing assets are employed for years or even decades at a time. Should companies fail to implement efficient technologies from the onset of facility construction, the cost liabilities will be long-lasting.

A sluggish economy during the past decade has created both challenges and opportunities for U.S. manufacturing. Industrial output stumbled over the 1998-2009 period, while capital investment in new equipment was curtailed and we saw the destruction of significant manufacturing capacity. Meanwhile, most of the sector still boosted its productivity even as their output declined, in part due to the closure of the least efficient facilities. At the same time, some corporations are beginning to re-shore their production facilities to the U.S., partly in response to economic and logistical uncertainties that characterize foreign operations, and partly due to lower prevailing natural gas prices. Finally, many public corporations have accumulated unprecedentedly large cash balances as a hedge against economic conditions.

These trends provide parameters for the next generation of industrial energy efficiency programs. Some program administrators suggest that much of the low-cost, prescriptive energy improvement opportunities are gone (note that other administrators vigorously object to this observation). In either case, future energy efficiency gains will still include larger, more significant capital investments. The re-shoring of industrial production facilities is an opportunity to influence capital investment in technologies that reduce energy waste either directly (by being more efficient) or indirectly, by improving throughput rates and production cycle times. This bodes well for the U.S. industry's competitiveness and an eventual economic rebound.

The industrial sector is by no means monolithic in its economic performance. A segmentation scheme based on data from the time period studied and presented in this study categorizes manufacturing industries as follows: *superchargers*, which experienced positive growth of output and productivity (64 percent of all industry output in 2009); *recuperators* (30 percent of output), which experienced productivity growth concurrent with declining output; and *decliners* (6 percent of output), which suffered declines both in output and productivity. The segmentation results discussed in this paper may help to prioritize scarce resources for future industry outreach and communications program efforts.

The survey portion of this study describes the nature of capital investment decision-making within corporations. Instead of finding patterns or preferences specific to individual industries, we found only generalizations about large- versus small- and medium-sized corporations. Capital investment decision-making activities reflect the workplace culture of individual companies, business units, and facilities—this explains why two identical production plants in the same industry can have very different strategies for capital investment. One generalization is that companies usually study investment opportunities in stages, seeking ever increasing analysis and approval at each stage. This process can take months, if not years to yield a decision, especially when large companies ponder large dollar-volume proposals. This suggests the need for energy program administrators to maintain long-term relationships with their facility contacts, monitoring each facility's capital renewal cycles for windows of investment opportunity that may occur every three, five, or ten years, depending on the industry.

A renaissance of domestic manufacturing, led by capital investment in modern infrastructure, is an opportunity to implement advanced, efficient production technologies. This also suggests a new phase in the design and conduct of energy efficiency programs. One opportunity for program administration is to document the unintended energy benefits of "non-energy" capital improvements—thus inspiring additional investment. Capital asset selection will increasingly characterize the relationship between energy program administrators and their industrial hosts. The effectiveness of this relationship depends on increased knowledge of process dynamics as well as the investment decision-making process. And with knowledge of the production process comes a broader awareness of improvement opportunities. This would permit expansion from a strictly energy-focused pursuit to one of broader resource management, harvesting value from a variety of waste streams. This would ensure that sufficient value is generated to maintain and refine cost control capabilities as a continuous improvement initiative.

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Appendix A: Glossary

A&E: Architectural and engineering (firm). A consulting entity that provides professionally certified design and engineering services. Facility managers and other customers rely on an A&E to produce designs, blueprints, and cost estimates for equipment installation.

All-in Costs: a complete measure of costs involved with implementing an energy project. In addition to the project costs summarized on a vendor's invoice, *all-in costs* will include additional expenses related to search, analysis, finance, permits, licensing, and other items.

Alpha Test: a first-time "pilot" installation of equipment to test its appropriateness before committing to routine deployment and replication.

Avoided Costs: a summary estimate of expenses eliminated by implementation of an improved method or more efficient equipment.

Bottom Line: an accounting concept that describes cash flow accruing to a business's shareholders. It represents revenue (or sales receipts) after deducting cash expenditures for operating and finance. Bottom line figures answer the question, "How much new wealth does the business create?"

Brownfield project: a new or rehabilitated industrial production facility established on land or in structures that previously hosted activities that pre-dated current environmental performance standards. As such, the site may be subject to remedial measures to bring it up to current compliance standards.

BU or Business Unit: an organizational subcomponent of a corporation. While the definition and scope of a BU varies across industry, it typically defines the capital, staff, resources, products, and business plan dedicated to manufacturing a specific product or family of products.

Capacity Utilization: a measure of industrial activity over a prescribed time period that describes the volume of output relative to total production capacity. Ideally, capacity utilization rates approach 100 percent. Any reduction of this metric reflects a decline in market demand, inefficient use of production facilities, or both.

CAPEX or Capital Expenditure: a business investment to purchase durable, long-lived assets that effectively grow the business' production capacity. Because such assets are employed for more than one year, their expense must be accounted over multiple years. As such, capital expenditures are distinct from operating expenditures, which occur entirely in the budget year of their occurrence.

Capital: the pool of wealth available to a company from some combination of investor equity, borrowed funds, or retained earnings from operations. Per management discretion, capital is reinvested by a firm to sustain or grow its asset base, and therefore its ability to continue creating new wealth. Capital spent on durable assets that will be employed for more than one year, and therefore it is not applied to operating expenses that are covered by annual operating (revenue) budgets.

Capital Allocations: earnings and or borrowed funds accrued by a corporate entity for reinvestment in its component business units. Amounts are ascribed per corporate strategy, reflecting judgment about each business unit's growth prospects.

Capital Infrastructure: the collective, fixed assets that make up an industrial production facility over the course of one or more years. This may include land, buildings, production process equipment and supporting utility assets.

Capital Project: a finite episode for the construction and implementation of a building, production system, or discrete equipment item or component. It is the culmination of an effort to replace or improve a specific facility component. As a long-lived asset, a capital project is expensed over multiple years.

Cash Cow: a business unit, facility, or production line dedicated to the manufacture of a product that is so profitable that it generates returns far in excess of what is needed to sustain the business. As such, management may lack urgency for improving cost performance.

Champion (or Energy Champion): a facility employee who assumes the primary responsibility for advancing energy optimization opportunities. The job title of this person may or may not reflect this responsibility. These individuals vary across industry in terms of their authority, influence, and skills for advancing their agendas.

Change Management: the planning and execution of an effort that moves individuals, teams, or entire organizations from a current operational paradigm to a desired new or improved paradigm. This approach seeks to ease the transition by constructively engaging stakeholders in the planning process.

Comfort Project: a finite episode for the construction or implementation of assets dedicated to improving the habitability of work areas. These may include lighting, ventilation, heating, cooling, and domestic water heating.

Commodity: a product or good that is routinely purchased without qualitative differentiation from one unit to the next. Commodities are fungible, meaning that the market perceives units as equivalent regardless of their origin. Competition for commodity sales is achieved mainly on price.

Compliance Project: an investment in hardware made necessary by law or regulation. Such investments may be to ensure workplace safety or containment of regulated emissions. Failure to employ such assets could result in fines, penalties, or forced closure of facilities. Such investments are prioritized for legal reasons as opposed to financial gain.

Continuous Improvement: a cost control strategy that relies on metrics to monitor business or production performance over time. Variances in performance data may indicate a lapse in process integrity, signaling the need for remediation.

Cycle Time: the length of time that an industrial process requires to fully convert inputs into a finished product. This is a facility-specific measure of productivity and a strategic performance measure for an industrial plant manager.

Discounted Cash Flow: a **financial analysis** technique that compresses a stream of future dollars into one, present value, lump sum equivalent. Discounting (a reduction of value) subjectively accounts for the risk that unforeseen future events may reduce projected investment returns.

Downtime: an episode of process stoppage, which may be planned or unplanned. The costs associated with downtime reflect the loss of revenue that would have been generated had the process remained in operation for the duration of the stoppage. Add to that value the any costs of repair needed to re-start the process.

ECMs (energy conservation measures): specific energy improvement opportunities identified and documented in an energy assessment or audit.

Economic Analysis: a calculation of investment value based on an investment's tax-adjusted cash flow returns, but prior to investment financing. As a calculation of value, economic analysis compares tax adjusted cash flows to the amount of relevant investment. This analysis answers the question, "Is this proposed investment valuable to the company?" Not to be confused with *financial analysis*.

Energy Assessment: an organized study of a facility that documents energy inputs and uses, and identifies specific opportunities to optimize the facility's energy cost performance.

Facility Investments: a subset of industrial investment that is specifically directed toward the upkeep and improvement of physical facility and machinery assets.

Feasibility Study: a summary of findings from an evaluation of a proposed investment prior to funds being committed to its completion. The summary should describe technical, managerial, market, and financial forces that are likely to impact the proposal's investment performance.

Financial Analysis: a calculation of value based on "free cash flow," which is the result of investment returns adjusted both for tax and finance costs. As a calculation of value, financial analysis compares free cash flow to the total amount of relative investment. This analysis answers the question, "Are the proposed terms of finance favorable to the investor?" Not to be confused with *economic analysis*.

First cost: The total investment cost for as asset at the time of origination. It excludes all other costs of ownership, including maintenance, energy, and interest costs incurred over the working lifespan of the asset.

Gate Keeper: an informal label assigned to any person who screens business proposals prior to their in-depth consideration by responsible decision-makers. This is a person whose trust and confidence is the key to the initial stages of advancing energy improvement initiatives.

Greenfield Project: a new production facility to be constructed on land that has not previously hosted an industrial facility, and therefore is uncompromised by lingering environmental liabilities caused by an earlier generation of industrial activity.

Growth Project: an investment in equipment, hardware, or structures that enables a company to increase its production capacity and business returns. See also *revenue project*.

Hurdle Rate: a performance benchmark for any investment that delineates acceptable from unacceptable performance. This can be a ratio measure (that is, returns as a percentage of the enabling investment amount), for example: "accept no investment with a rate of return below X percent," with X describing the hurdle rate as determined by management judgment. Alternatively, a hurdle rate can refer to a payback threshold, as in "an acceptable project must pay for itself in two years or less," in which case the hurdle rate is two years.

Ideation: an organizational process that collects staff, usually from a variety of departments and disciplines, to creatively generate thoughts and suggestions that can be refined by the group into actionable initiatives. The participants may or may not be expanded to include individuals from outside the organization.

In-Kind Replacement: an investment to replace an existing, failed asset, seeking to restore the operation to its original specifications without improvement.

Internal Rate of return: a finance concept that describes the wealth-generating power of an investment. This metric compares all future benefits provided by an investment to the investment amount. It is the percentage rate used to discount the future returns to an amount that is just equal to the enabling investment. In a sense, this metric measures the "horsepower" of an investment.

Kaizen: a quality control process that relies on input from all relevant staff to contribute ideas that support the continuous improvement of a specific process or operating system. Derived from the Japanese term "change for the better."

Life-cycle costs: the total cost of ownership as calculated for a specific asset or system. It includes the up-front cost of acquisition plus the ongoing costs of maintenance, energy, interest, licenses, permits, and insurance as these accrue over the functional life of the asset.

Low Hanging Fruit: a term that describes any improvement opportunity that can be achieved at little or no cost, and with minimal interruption of normal facility operations.

Mechanical contractor: an entity that is hired to fabricate an asset per the blueprints provided by design engineers.

Multifactor Productivity: A metric devised and maintained by the U.S. Bureau of Labor Statistics (BLS) that describes the relationship between the value of manufacturing output and the combined inputs required to create that output. BLS creates and maintains this index for each industry by dividing an output index by an index of combined inputs for labor, capital services, energy, non-energy materials, and purchased business services.

Net Present Value: a finance concept that describes the amount of wealth generated by an investment. This metric is the result of subtracting an investment amount from the total present-dollar value that the investment creates over its economic life. If this difference is positive, it means the investment will pay for itself and create additional new "net" value.

Operating Income: an accounting concept that compares revenue to production (operating) expenses. By subtracting operating expenses from revenue, the result is a value prior to adjustment for taxes. Operating income answers the question, "How efficient is the business at using inputs to create wealth?"

Output: the current dollar value of production for a selected industry or industry sector. Output as described Section 1 of this report relies on U.S. Bureau of Labor Statistics data, which is the sum of costs for capital, labor, materials, energy, and purchased business services. Note that interest costs and returns to equity are a component of capital costs.

Preventative Maintenance (PM): a class of activities pursued on a routine basis in order to minimize the risk of a facility's mechanical breakdown or failure. This concept breeds contention among people who feel that the known costs of maintenance may or may not compare favorably to the cost of operating without a preventative discipline.

Process Investments: an investment in equipment or hardware that enables a company to improve or expand its production capacity and or variety of products. Also called *process improvement.*

Productivity: a measure of production efficiency as described by the ratio of outputs to multifactor (combined) inputs. Output is the current dollar value of final goods sold. This report uses the U.S. Bureau of Labor Statistics definition for productivity, which is based on output divided by the current dollar values of combined input for capital, labor, energy, materials, and purchased business services.

Proof of Cost Study: similar to a feasibility study, but more narrowly focused on costs as opposed to financial returns, which would require a broader study of market and organizational factors.

Revenue Project: see *growth project.*

ROI project: an investment to be implemented for its ability to generate financial returns. This is distinct from an investment that is compelled by law or regulation and that may not generate financial returns.

Scoping analysis: a more simple and preliminary form of feasibility analysis that requires less effort and investment, but usually generates a less reliable measure of results.

Six Sigma: a quality control method that relies on statistics and iterative study and remediation to minimize defects or errors from an ongoing process. Some companies use six sigma methodology to refine studies of project feasibility.

SME (Small- to Medium sized Enterprise). A label for collectively describing smaller-scale manufacturing corporations. For current purposes, a small enterprise is one with under $1 billion in annual revenues, while a medium enterprise earns between $1 billion and $10 billion annually. SMEs are more likely to be privately held and owner-managed. Their smaller scale is reflected in simpler organizational structures and, usually, less procedural rigor. Accordingly, the dynamics of their capital investment methods can be distinctly different from large corporations. Energy program outreach strategies to SMEs may be adjusted accordingly.

Staying-in-Business Investments: A class of investment dedicated to sustaining the competitiveness of an organization. It includes more than *in-kind projects*, encompassing new innovations.

Sustainability: a management philosophy for businesses that seek to minimize pollution, waste, health impairments, and other damage as a consequence their production activities. For those industrial organizations attempting to improve their sustainability performance, the reduction of emissions caused by manufacturing activities is a critical component of their efforts.

Top Line: an accounting concept that describes the sales revenue earned by a business. This is a gross value prior to the subtraction of operating and finance costs. Revenues are an indicator of market success, answering the question, “Does the business excel at offering the best product mix at the right volume?”

Value produced: this is a measure the current dollar value of production as defined by the U.S. Bureau of Labor Statistics. For any one industry, it is the value of gross output minus the value of intermediate component sales within that industry.

Value engineering: the practice of adjusting an original, optimal system or facility design in order to reduce its cost. At best, this involves the elimination of unnecessary costs. At worst, it may result in compromising the quality of the original design, “cutting corners” so that the up-front investment cost is lowered.

Vetting: the process of seeking organizational approval from all responsible managers for any project or initiative. This is usually a prescribed, step-wise process that requires approval at one step before seeking successively higher levels of approval. This complexity of this process tends to increase with the size of the organization and dollar volume of the investment.

Working capital: an accounting term describing any surplus of current assets over current liabilities. In effect, it describes surplus cash available in an organization's current year operating budget. It is a source of internal short-term finance of operating expenditures. When energy savings are achieved, they directly boost working capital. This is a very tangible way to demonstrate energy savings' contribution to business performance.

Appendix B: Industrial Decision-Making Questionnaire

NOTE: This questionnaire was used not as a script, but to prompt a conversation with the respondent. Each interview proceeded in a unique direction, bounded by the questions below.

For the following questions, please think about your organization.

- Does energy consumption influence the investment in new facility assets? Elaborate with examples…
- Think about your organization's past investments in energy efficiency. What needs drove those investments?
- How do energy efficiency investments tend to coincide with other kinds of investment?
- Do energy-related investments typically compete for funding with any other specific kind of investment? If so, what?
- Are energy-related investments clearly linked to a larger corporate strategy (cost cutting, sustainability, etc.)?
- Think about the timing of energy-related investments. Do these events coincide with any other events or correspond to a planning calendar of any kind?
- Walk me through the process for making an energy-related capital investment decision in your organization.
- How does the suggestion for an energy-related capital improvement originate? Think about the responsible department, influence of key people…
- After an investment is suggested, do others have a say in its approval? Please explain…
- Tell me about the kind of entity you work with to obtain and install energy-related hardware. Vendors? Architects and engineers? What kind of business relationship?
- What are the criteria for a "good" investment of any kind?
- Does the company impose different investment criteria for energy-related investments, compared to other kinds?