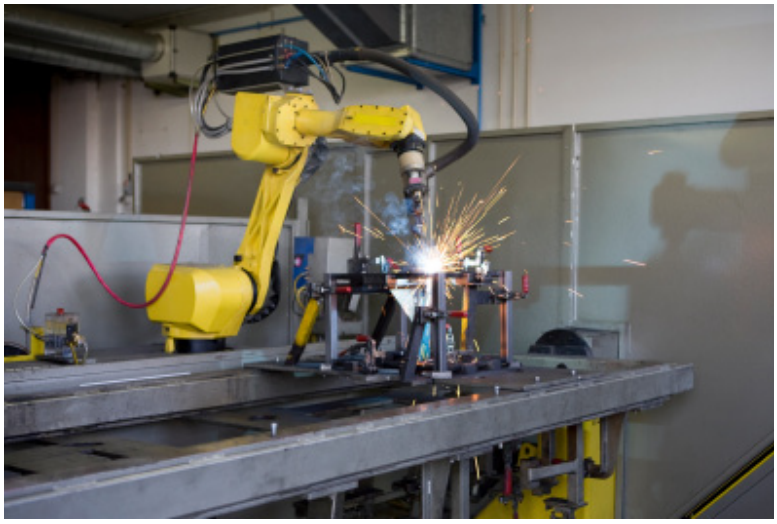
Energy Efficiency and Cook County Manufacturers



An unrealized opportunity

Delta

August 2012

About Delta Institute

Delta is a center of innovation that creates market opportunities to achieve environmental sustainability and economic development. In partnership with business, government and local communities, we develop and implement practical solutions to build regional economies that are job rich and inclusive.

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Energy Efficiency and Cook County Manufacturers: An unrealized opportunity

Overview

Today's economy requires Cook County manufacturing firms to compete on cost and quality in a global marketplace, with firms that have less regulation, cheaper labor and more ready access to raw materials. As a result manufacturers are striving to do more with less. They are searching for ways to cut costs, increase productivity and at the same time shift toward high precision and high value-added products and processes. In this context, energy efficiency is an exceptional investment.

Saving energy saves money. Energy efficiency measures improve the operation of equipment and processes while increasing energy security and environmental quality. Interest in energy efficiency is strong, the business case for investment is convincing – particularly for manufacturers – but energy utilization improvements are not happening in Cook County manufacturing firms at the rates that the financial case would suggest are possible.

This paper describes energy efficiency measures commonly recommended for manufacturers in Illinois and Cook County and the frequency of their implementation. The analysis is based on Delta Institute's insights from 39 energy audits of manufacturing firms in Cook County, completed in 2011 and 2012, and data collected over a ten year period from 2002-2011 by the Industrial Assessment Center (IAC).[1] This paper identifies the measures most recommended by the auditors, those measures that were actually implemented by the firms audited, and those not implemented. It also lists the recommended measures with the lowest costs and shortest paybacks, and discusses why the most cost effective measures are not necessarily the investments that are made.

In today's world of volatile and increasing energy costs, manufacturers that incorporate efficient and innovative energy practices will gain a cost competitive edge. If such practices were the norm for Cook County manufacturers it would make the manufacturing sector more sustainable and resilient, and would strengthen the economy of the region as a whole. Thirty nine energy audits performed by Delta Institute demonstrate potential savings of over $1.4 million every year for those firms alone. Implementation of recommended energy efficiency measures by these 39 firms would also eliminate over 10,000 metric tons of greenhouse gas emissions each year. These savings represent only a small fraction of the opportunity across the 8,440 manufacturing firms in Cook County.

How can manufacturing firms realize the potential offered by energy efficiency? The first step is acquiring information that allows firms to both identify and prioritize those energy efficiency investments that are inexpensive, effective and can be readily adopted. This paper will help businesses do this by identifying successes from other similar manufacturers and noting possible barriers to implementation. Implementing energy efficiency measures can involve changing the equipment, the daily routine, employee goals and incentives and sometimes

1 Further detail on the data sources and research approach is contained in Appendix 1.

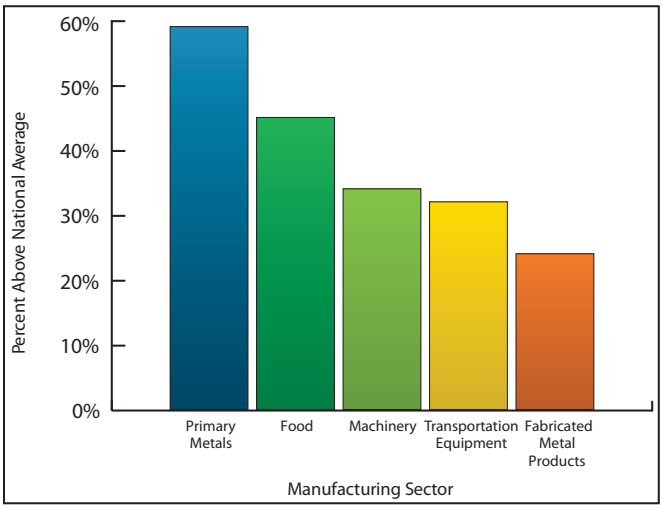
the manufacturing process itself. In implementing change, four actions will be particularly important:

1) High level organizational buy-in and support for energy efficiency
2) Inclusion of efficiency goals and objectives in job responsibilities and annual performance plans, combined with incentives
3) Education and encouragement of staff to change behavior
4) Provision of technical, on-site assistance to ensure energy efficiency improvements are implemented effectively.

Background

Cook County manufacturers and their energy efficiency potential

Figure 1 - 2006 Midwest Energy Intensity Compared to National Average

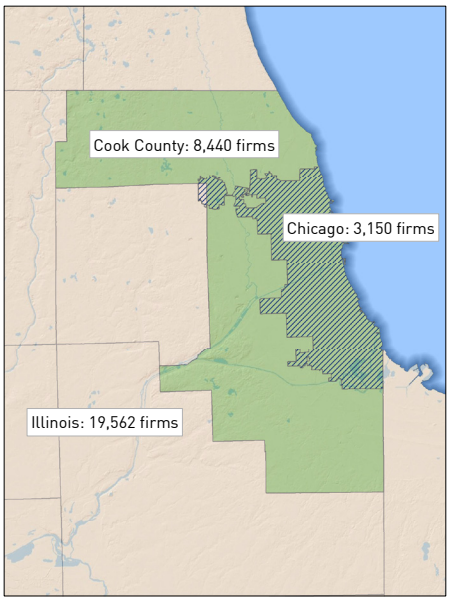


Source: Department of Energy, 2009

Since Chicago was founded, manufacturing, from steel to paper to chemicals, has been a driver of the regional economy. Chicago is a freight and logistics hub, ideally located for a steady flow of manufactured and raw goods in and out of the nation's interior. In 2010 alone, over $240 billion dollars' worth of goods were transported through Illinois.[2] Illinois is home to 19,562 manufacturers, with around half of them located in Cook County and about 3,000 in the City of Chicago, as shown in the figure below. The sheer number of manufacturers reveals the potential impact on the regional economy if those firms enact energy efficiency improvements. This potential, throughout the Midwest, has been described by the Department of Energy (DoE). The DoE reports that many sectors of the Midwest's manufacturing industry have energy intensities significantly above the national average for those sectors. In part, this is due to lower-than-average energy prices in the Midwest region. Some of the sectors with the greatest potential for improvement are primary metal products, machinery, transportation, food, and fabricated metal products (see Figure 1). The latter two industries have a strong presence in Illinois. If these five manufacturing sectors were to improve energy efficiency – simply to levels of par with the national average – they would save 670 trillion British thermal units (Btu) of energy and $7.3 billion.[3]

2 United States Census Bureau, 2012
3 Department of Energy, 2009, *Energy Efficiency as a Resource: Midwest Region*

Figure 2 - Manufacturers in Illinois, Cook County and Chicago



Sources: number of Illinois manufacturers (Illinois Department of Commerce & Economic Opportunity, 2011); number of Cook County and Chicago manufacturers (Hoovers Online, 2011).

The most prevalent manufacturing industries in the region include fabricated metal products, printing, machinery, and computer and electronics (Figure 3). Food processing and chemicals manufacturing are also strongly represented. In each of these industries the factory production line represents the highest energy cost, and efficiency improvements there offer the largest opportunity for cost savings.

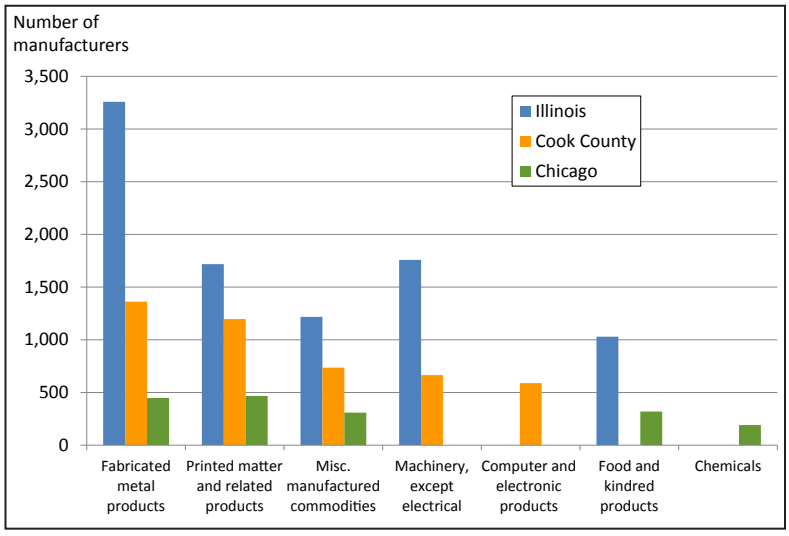
In recent years there has been much discussion of a manufacturing renaissance, particularly in high precision, high value-added industries. To realize such possibilities firms must operate cleverly and efficiently. Manufacturers that incorporate cost-effective and innovative practices in the way they use energy will save money and gain a competitive advantage. Using energy more efficiently will also benefit the community and Cook County more broadly.

Findings

Lighting, leaks and motors are among the most recommended energy efficiency measures

From data collected by the IAC over the last decade and by Delta Institute over the past year, a clear pattern emerges in the most frequently recommended energy efficiency measures. The energy efficiency measures most often recommended to Illinois and Cook County firms are set out in the table below. Delta's own work parallels the findings of the IAC, with the same measures appearing in the top recommendations.

Figure 3 - Top five manufacturing sectors in each of Illinois, Cook County and City of Chicago



Notes and sources: Illinois manufacturing numbers are for 2008 (United State Census Bureau, 2008) and Cook County and Chicago figures are for 2011 (Hoover's Online, 2011)

Table 1 - Most recommended energy efficiency measures by IAC, and rankings in Delta audit recommendations

	IAC	Delta
Time period of audits	2002-2011	2011-2012
Recommended measure	Number of times recommended in Illinois by IAC (in 223 audits)	Number of times recommended in Cook County by Delta Institute (in 39 audits)
Higher efficiency/ better lighting	256 (rank 1)	[39] (Rank 1)
Eliminating leaks from gas lines, compressed air and steam lines	131 (rank 2)	[12] (Rank 5)
Using more efficient electric motors	119 (rank 3)	[18] (Rank 3)
Installing occupancy sensors programmable components	160 (rank 4)	[18] (Rank 2)

Note: The fourth most recommended measure in the Delta audits was to repair or replace steam traps (with 15 recommendations).

The fact that both lists are almost identical is significant. Despite different timeframes and different firms sampled, the data reinforce the fact that these four relatively simple energy efficiency measures are a good idea. These recommendations were rational improvements ten years ago, and remain so today.

Energy efficiency opportunities have large benefits for manufacturers and the region

Delta Institute's database of manufacturing audits highlights the major financial benefits and operational improvements that result from implementing recommended energy efficiency measures. Conversations on the shop floor and with owners provide evidence that there are significant cost savings and some can be achieved with little capital investment. The potential benefits of implementing these changes among the region's manufacturers are summarized in the table below.

Table 2 - Average benefits from implementing energy efficiency measures recommended by Delta Institute

	Annual cost savings	Blended payback period	Energy savings (MBTUs)	Greenhouse gas emissions reductions (metric ton CO_2-e)
Total outcomes of measures recommended in 39 Delta audits	$1,403,006	5.5 years	136,648	10,883
Extrapolated to 8,440 Cook County manufacturers	$303,624,888	5.5 years	1,153,309,120	2,355,193
Extrapolated to 19,562 Illinois manufacturers	$703,733,420	5.5 years	2,673,108,176	4,458,801

Note: Taking the average projected savings in cost, energy and carbon from Delta's 39 audits, line one of this table reflects the savings accounted for by all of the recommended measures. Lines two and three calculate those savings if they were projected across all manufacturers in Cook County and in Illinois. This is a blunt approach, and it assumes that the savings projected from Delta's work are representative of firms across the county and state. While not definitive evidence, the methodology does afford, however, an illustration of the order of magnitude of savings that could be available.

These 39 firms represent only a small sample of the 8,440 firms in Cook County, and demonstrate the significance of the opportunity to strengthen the financial position of manufacturing firms, to make them more efficient and sustainable, and to improve energy security and environmental performance of the region.

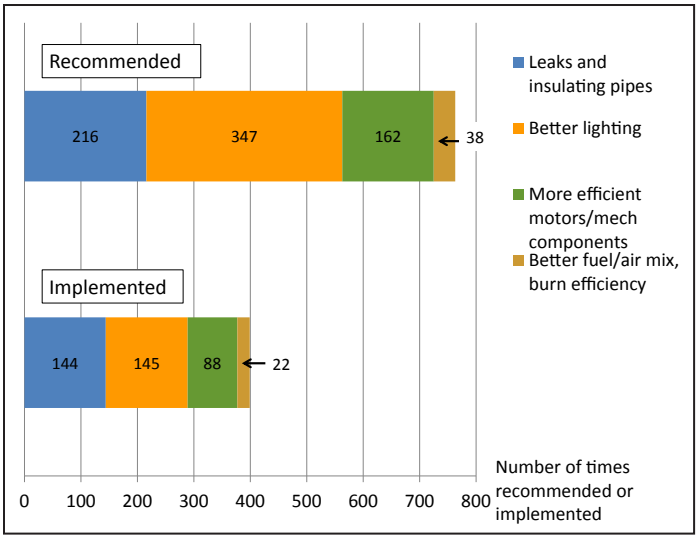
Recommended energy efficiency measures are implemented by about half the businesses

The potential benefits from energy efficiency measures for manufacturers are not being realized. In Delta's experience, attitudes regarding follow up to the energy audits range widely; a small number of Cook County businesses refused even to take a follow up visit to discuss the audit findings, while others implemented all energy efficiency measures within two weeks of receiving their audit findings. The IAC data tracked implementation of recommended measures within 12 months of the conclusion of the audit, and conducted follow up interviews with firms about reactions to the recommended measures. Across all manufacturers audited by the IAC, three measures were implemented at relatively high rates, as illustrated in Figure 4:

- Sealing leaks and insulating pipes (67% of those receiving recommendation implemented)
- Improved fuel/air mix and burn efficiency (58% implemented)
- Using more efficient motors or mechanical components (54% implemented).

It is notable that within twelve months of the audit businesses chose *not* to implement these energy efficiency measures between 33% and 46% of the time.

Figure 4 - Number of recommendations and implementation for selected measures (IAC audits)



Further research is necessary to gain a deep understanding of manufacturers' decision process in terms of implementing energy improvements. However, Delta Institute's audit analysis offers some insight into the reasons that businesses implement – or choose not to implement – recommended energy efficiency measures. The following section reveals that cost is *not always* the deciding factor. In the case of the strong uptake of measures to seal leaks, for example, Delta's observation is that the decision to fix leaks may relate largely to the fact that leaks can be seen and heard and that they represent a loss of efficiency and money on the production line. Many businesses act quickly to maintain equipment and ensure processes function as they should. Avoiding disruption to processes or production is a clear priority of manufacturers in making investments and budget decisions.

By contrast, lighting improvements were implemented just 41% of the time. Delta Institute's experience suggests that lighting improvements are not adopted by more manufacturers because the energy consumption and costs of running shop lights are dwarfed by the energy costs for the production processes. For this reason, the net benefits of lighting improvements are seen as marginal.

Finally, the Delta audits and manufacturers' response to recommendations occurred in 2011 and early 2012, during a continued economic downturn when businesses were extremely cautious about capital investment. It would be instructive to see how responses and behavior would change in a strong growth cycle.

Measures that are implemented are not necessarily those with lowest costs or best paybacks

Many energy efficiency investments are affordable. Table 3 shows that the average payback periods for many of the energy efficiency measures are less than two years – relatively short for capital improvements in a manufacturing firm.

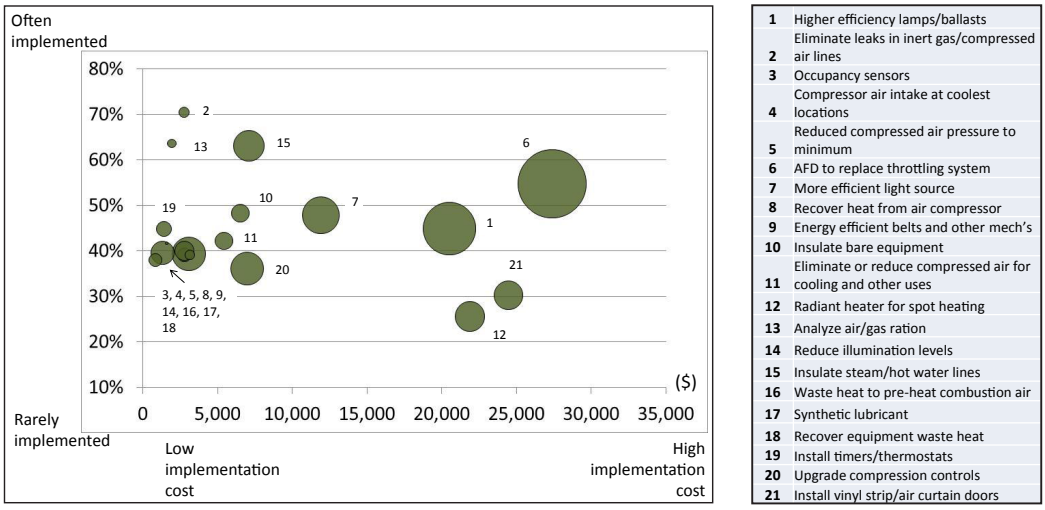
Table 3 - Average payback periods for commonly recommended measures (IAC audits)

Energy efficiency measure	Average implementation cost	Average payback period
Turning off equipment when not in use	$3,276[4]	5 months
Sealing leaks and insulating pipes	$5,529	9 months
Improving fuel/air mix and burn efficiency	$19,638	10 months
Better lighting	$12,116	1 year, 8 months
More efficient motors/ mechanical components	$15,478	1 year, 10 months

However, the most affordable measures are not necessarily those implemented. Figure 5 shows the distribution of 26 measures frequently recommended in the IAC energy audits and their rate of implementation by the firms. There is no clear correlation between the size of the payback (represented by circle size in Figure 5 below) or the cost of implementation, and the implementation rate. Around half of companies adopted recommended measures with costs of over $18,000 and with paybacks of over two years, while half of the businesses failed to implement measures that cost below $1,000 and had paybacks of close to six months.

The cluster of circles in the lower left of the figure below highlights untapped potential for inexpensive energy efficiency opportunities. By understanding barriers that prevent their uptake, discussed further below, manufacturers may be able to pick more of these low-hanging fruit.

Figure 5 - Rate of implementation of measures, relative to cost and payback (IAC audits)



Note: size of circle represents payback period. Source: Delta Institute analysis of IAC data.

4 Costs result from installing a control or sensor (e.g. occupancy, chemical) and/or the labor costs of modifying a building automation system to take advantage of existing controls. In some cases equipment (e.g. steam systems) can be powered down, but it may be undesirable to do so because of productivity and production losses.

Many reasons exist for the lack of alignment between implementation rates and payback periods. Reasons low cost measures were *not* implemented range from entrenched behaviors, to lack of understanding of how to implement recommendations, to company-specific infrastructure barriers, such as capital cost and management hierarchy. Budgets cycles also presented difficulties, with resistance to allocating capital to non-process expenditures. Further research with participating companies is needed to fully address the barriers to implementing low and no cost energy efficiency strategies.

One example that illustrates that cost is *not* the only deciding factor is that only 53% of businesses receiving the recommendation to turn off equipment when not in use actually implemented the measure. Despite having one of the best payback periods – less than six months – this measure ranked 7th in frequency of implementation. Delta's experience reinforces this: Delta offered twelve audited companies $2,000 each in grant dollars to fully fund the implementation of certain low cost measures. Only one company took advantage of the grant, despite the clear identification of the measure and notice of the grant opportunity at post-visits. Delta Institute's experience with Cook County manufacturers suggests two barriers to such improvements: inertia and incentives that actually discourage energy efficiency. Manufacturing staff explained that practices – even those that are counter-intuitive, like leaving unused equipment running – often continued unquestioned because "that was how things had always been done". This type of behavior requires new procedures, staff training and senior level emphasis of their importance.

Changing staff behavior is often difficult because people fear reprisals for identifying or "admitting" inefficiencies in equipment or processes that are their responsibility. Staff can be reluctant to highlight inefficiencies or the need for behavior changes in areas or equipment that were the responsibility of others. One metal manufacturer, for instance, had staff rewire motors instead of replacing them with high efficiency models. Staff had concluded the payback for replacing motors would be greater than two years and therefore rewiring was more cost effective. However, the payback analysis did not include the labor cost for rewiring the motors which would have changed the payback analysis. Creating incentives or rewards tied to responsibility for finding opportunities for energy efficiencies would be beneficial for realizing the savings that are available to manufacturing firms.

Delta's experience with firms in Cook County also underscores the importance of senior level direction and support for energy efficiency. One large campus visited by Delta had recently undergone a senior leadership change, which led to confusion about responsibilities and processes. Staff on the shop floor were disregarding an opportunity to save 10% of the cost of the steam vault energy conservation measures due to uncertainty about the priorities of the new senior leadership.

Similarly, there are a number of factors that affect which energy efficiency measures are implemented by firms. Some manufacturers selected measures based on their ability to meet other larger corporate goals, such as compliance with environmental regulations or alignment with voluntary standards (e.g. Leadership in Energy and Environmental Design, LEED, certification). There were businesses, too, that selected particular measures that would help enhance reputation, for example, to suppliers interested in green credentials, or that would

allow them to take advantage of rebates. Other manufacturers highlighted co-benefits of particular measures, such as indoor air quality or comfort, which encouraged them to invest in heating, cooling and ventilation systems. Selected measures, such as upgraded equipment, were also appealing because they improved safety of production lines or reduced waste. This wide range of motivations for action again underscores the relatively weak relationship between cost of energy efficiency measures and their rate of implementation.

Reasons that energy efficiency measures are not implemented are many and varied

Delta Institute's post-audit conversations confirm that there are a range of factors – far beyond cost – that prevent the uptake of energy efficiency opportunities. These include:

- Inappropriate point of contact. The point of contact receiving the recommendations may not have the authority to implement a project without approval, may lack the skills to understand the audit and communicate the benefits, or may not be in a position to sell the project benefits to those with budget authority.

- Lack of incentives for energy efficiency or incentives that reward energy use as opposed to energy efficiency. Often, staff do not receive credit for identifying or implementing energy efficiency opportunities, so are reluctant to invest time and effort in them. Others may actually fear a negative consequence from an energy efficiency audit or retrofit, concerned that implementation may show they, or others, have not been doing their job well. This fear can sometimes be expressed as skepticism of savings estimates.

- Budget challenges. Only a single year of budget resources may be available, but the project payback might exceed this period. Alternatively, the cost savings may be an expense to one department's budget and a benefit to someone else's budget. This often happens when a project must be funded through the capital budget but the savings accrue to the operational budget through lower utility bills.

- Lack of long term financial planning. Energy efficiency measures in manufacturing firms often involve equipment upgrades or replacement. Investment in new equipment with a payback longer than 12 months requires a longer term view of profit potential than is standard for some firms. Down time for the production line for equipment installation or improvements which might impact short term financial results could be a barrier to adoption in some instances as well.

- Lack of attention. The point of contact that has the authority to implement the energy efficiency measure is simply too busy or overworked to make energy efficiency a priority. In today's lean staffing environments, everyone has to do more with less and it is difficult to take the time to change processes or implement new measures, even if they are relatively simple changes like shutting down equipment when not in use.

- A mismatch between skills needed to run the business and skills needed to improve energy efficiency. Implementation of some measures requires new equipment or significant changes to existing equipment. This may require specialized expertise in evaluating new equipment, installation contractors, and computing payback periods from different equipment models. This can require specialized skill sets that are not needed in the everyday running of the business, and finding a trusted advisor to assist in this evaluation can be time-intensive and difficult.

Recommendations

How to get more cost-effective energy efficiency

Investment in energy efficiency among Cook County manufacturing firms will save money, will make processes and equipment more effective, and will result in stronger, more profitable and more competitive companies. At a time when manufacturers are striving to produce more with less, energy efficiency is an excellent investment. This opportunity has been apparent for decades – yet still not acted upon.

Delta Institute's analysis of energy efficiency audits of manufacturing firms demonstrate that to realize the benefits of greater energy efficiency, manufacturers must fully understand the energy efficiency measures recommended; appreciate the cost savings; be willing to evaluate the financial payback of energy efficiency investments over more than one operating year; incent new behaviors and reward energy efficiency results. Governments and energy experts must address the range of enablers and barriers for these businesses. Businesses need information and support – from the top of the company to its factory floor – in order to implement change effectively.

Delta Institute recommends four key elements to increase the energy efficiency of Cook County manufacturers.

1) High level organizational buy-in and support for energy efficiency:
Energy audits provide rigorous and detailed information on which to base investment decisions, but the information must reach the right people. Information on energy consumption and the potential for savings must be provided to executives or owners of businesses – that is, those with the ability to make decisions, the power to implement and the will to reshape workplace culture. The ongoing benefits of energy efficiency can only be realized with some upfront investment, so those with the power to approve budget allocations must be involved. Leadership and a strong, committed team to support energy efficiency are critical.

2) Inclusion of sustainability responsibilities in job descriptions and performance plans:
It is the norm for staff to be busy, focusing on immediate demands and short-term plans. Often sustainability and efficiency improvements are not a major part of their role. Formally including "sustainability" or "efficiency" as a goal or performance measure in position descriptions bestows responsibility, and can drastically increase the attention it

receives. Setting annual performance objectives for employees to attain energy savings can provide the motivation for staff to take the time and make the effort to change behaviors and find new ways to do things. Energy efficiency should not be a one-off; it needs to be embedded in company culture as an ongoing continuous improvement opportunity. This will help staff look for new opportunities as knowledge and technology evolves. Embedding energy savings as a staff performance measure also provides a regular opportunity to recognize those who find and implement efficiency improvements.

3) Education and encouragement for a change in staff behavior:
Delta's experience highlights the difficulty in changing entrenched staff behavior. It is common for something to be done simply because "that is the way it has always been done". Some staff may be embarrassed to have their processes and procedures subject to outside audit and may be concerned that results will reflect poorly on the job they have been doing. Others may resist identifying opportunities for efficiency because they are reluctant to question processes or machinery under another department or person's control. Making a clear, compelling case for change is the first step. Empowering employees with this information will help them sell the benefits to others and communicate it to new staff. Many firms find that it helps when this case is provided by an independent source rather than a contractor or provider of energy efficient products and services. Once awareness and interest is raised, regular reminders and motivation are important to support a widespread, continuing change towards more efficient behaviors.

4) Provision of technical, on-site assistance to ensure energy efficiency improvements are implemented effectively:
Simply providing information is not enough. Energy efficiency audits must be discussed with management and line supervisors so that they are well understood and the recommendations are translated into the reality of the bottom line. Sometimes the projected savings in the audit may seem inflated relative to shop floor perceptions and sometimes the initial investment required seems daunting in a time of economic contraction. Translation of audit findings into measures that can be integrated with business practices and result in better economic performance can ease these concerns and help firms make sound decisions on implementation. Manufacturing firms in Cook County need practical assistance to ensure measures are implemented effectively. This will help ensure changes occur in a logical, coordinated way. On-site engagement is essential, and can ensure equipment and processes are working as they should. To obtain the most appropriate technical assistance, current contractors and vendors may need to be reevaluated to ensure that they have the interest and the skills to help firms achieve energy efficiency.

Conclusion

Improving the energy efficiency of Cook County manufacturers has the potential to save companies money and significantly reduce greenhouse gas emissions. Delta Institute estimates that hundreds of millions of dollars and 2.4 million metric tons of emissions can be saved through implementation of energy efficiency measures in Cook County's 8,440 manufacturing firms. Other research suggests that raising energy efficiency in line with the national average could save billions of dollars throughout the Midwest manufacturing sector (Table 4).[5]

Table 4 - 2006 Potential energy and economic savings with national average energy intensities

Manufacturing sector description	Energy saved in trillion Btu if at national average	Economic savings in $ billions
Primary Metals (NAICS 331)	361	$3.9
Food (NAICS 311)	175	$1.9
Machinery (NAICS 333)	29	$0.3
Transportation (NAICS336)	68	$0.8
Fabricated Metals (NAICS 332)	37	$0.4

Source: Department of Energy, 2009

Common energy efficiency measures offer average paybacks of less than three years. Energy efficiency is not yet happening at the rate we would expect, or hope. Energy efficiency is one of the tools that can strengthen the manufacturing sector in Illinois and increase its competitiveness in the global marketplace. It can make manufacturers more sustainable and resilient. This is good for business, good for Cook County and good for the environment.

5 Department of Energy, 2009

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Appendix 1: Delta's research approach

This paper is based primarily on two sources of information.

1) Industrial Assessment Center (IAC) data collected from 2002-2011:

The IAC database includes results from industrial energy assessment of small and medium-sized manufacturing firms funded by the Department of Energy. The manufacturers assessed:

- had gross annual sales of $100 million or less;
- spent $100,000 to $2.5 million on energy each year;
- employed no more than 500 people; and
- had no technical staff primarily responsible for energy analysis.

This paper includes results from 223 Illinois manufacturers.
Energy assessments were performed by university engineering departments in most states, with collated data held at Rutgers University. Assessment teams made specific efficiency recommendations, including implementation costs, anticipated savings and simple payback times for each. Follow up interviews were conducted six to nine months later to determine the level of implementation of the recommendations.

2) Delta Institute's own experience during 2011-12 with 39 Cook County manufacturers:

Cook County, under the Energy Efficiency Block Grant Program, funded energy and steam audits in 2011 and early 2012 for 150 businesses in the County. Participants included 39 diverse industrial businesses, from a tannery to metal fabricators, to a lab facility. Delta Institute managed the program, qualified the auditors, met with businesses and reviewed audit reports. From audit reports Delta identified the most often recommended measures. Implementation figures are not available at this time, but insights from site visits and discussions with businesses owners and operators illustrated their priorities and intentions on investment in energy efficiency.

Hoover's data and codes

The Hoover's database comprises the Dunn & Bradstreet data for US businesses, grouped by NAICS code. Delta Institute extracted businesses and grouped them according to geography, to determine the number and type of manufacturing/industrial businesses in Cook County and Chicago (codes for Figure 2 are below).

Misc Manufacturing

339 Miscellaneous Manufacturing

3391 Medical Equipment and Supplies Manufacturing

33911 Medical Equipment and Supplies Manufacturing

339112 Surgical and Medical Instrument Manufacturing

339113 Surgical Appliance and Supplies Manufacturing

339114 Dental Equipment and Supplies Manufacturing

339115 Ophthalmic Goods Manufacturing

339116 Dental Laboratories

3399 Other Miscellaneous Manufacturing

33991 Jewelry and Silverware Manufacturing

339910 Jewelry and Silverware Manufacturing

33992 Sporting and Athletic Goods Manufacturing

339920 Sporting and Athletic Goods Manufacturing

33993 Doll, Toy, and Game Manufacturing

339930 Doll, Toy, and Game Manufacturing

33994 Office Supplies (except Paper Manufacturing

339940 Office Supplies (except Paper) Manufacturing

33995 Sign Manufacturing33999 All Other Miscellaneous Manufacturing

339991 Gasket, Packing, and Sealing Device Manufacturing

339992 Musical Instrument Manufacturing

339993 Fastener, Button, Needle, and Pin Manufacturing

339994 Broom, Brush, and Mop Manufacturing

339995 Burial Casket Manufacturing

339999 All Other Miscellaneous Manufacturing

339950 Sign Manufacturing

Appendix 2: Summary of cost and outcomes of most frequently recommended and implemented measures

The table below sets out the recommended measures, ranked according to gross number of times a measure was recommended. Recommendation descriptions were combined, where appropriate, to reach the categories of measures recommended/implemented in Figure 4, in the body of the paper.

Table 5 - Summary of recommendation and implementation rates, average costs and payback, for top 26 measures (IAC audits)

Implementation Rank	Recommendation Description	Implemention Rate	Recommendation Count	Average Implementation Cost	Average Payback (years)	Implementation Count
1	Utilize Higher Efficiency Lamps and/or Ballasts	0.417969	256	$18,050	2.19	107
2	Eliminate Leaks in Inert Gas and Compressed Air Lines/Valves	0.717557	131	$2,654	0.44	94
3	Use Most Efficient Type of Electric Motors	0.563025	119	$2,7722	2.64	67
4	Install Occupancy Sensors	0.38125	160	$2,955	1.29	61
5	Reduce the Pressure of Compressed Air to the Minimum Required	0.438017	121	$2,535	0.06	53
6	Use More Efficient Light Source	0.417582	91	$6,182	1.21	38
7	Install Compressor Air Intakes in Coolest Locations	0.37234	94	$1,310	0.94	35
8	Utilize Energy-Efficient Belts and Other Improved Mechanisms	0.488372	43	$3,235	1.03	21

9	Insulate Steam/ Hot Water Lines	0.552632	38	$8,085	1.33	21
10	Analyze Flue gas For Proper Air/Fuel Ratio	0.6	25	$3,053	0.51	15
11	Use Radiant Heater for Spot Heating	0.19697	66	$16,945	1.21	13
12	Use Synthetic Lubricant	0.361111	36	$1,017	0.58	13
13	Use Photocell Controls	0.34375	32	$1,308	0.77	11
14	Repair and Eliminate Steam Leaks	0.785714	14	$1,936	0.39	11
15	Reduce Illumination to Minimum Necessary Levels	0.25641	39	$1,095	0.29	10
16	Insulate Bare Equipment	0.47619	21	$1,0627	0.71	10
17	Contract a Wood Pallet Recycling Company	0.47619	21	$737	0.62	10
18	Recover Heat From Air Compressor	0.236842	38	$2,807	0.82	9
19	Recover Waste Heat From Equipment	0.375	24		1.63	9
20	Turn Off Equipment When Not in Use	0.529412	17	$3,276	0.37	9
21	Repair Leaks in Lines and Valves	0.666667	12	$4,339	0.87	8
22	Use or Replace With Energy Efficient Substitutes (Equipment)	0.318182	22	$36,8252	1.70	7
23	Direct Warmest Air to Combustion Intake	0.411765	17	$2,933	0.90	7

24	Eliminate or Reduce Compressed Air Used for Cooling, Agitating Liquids, Moving Product, or Drying	0.411765	17	$11,511	1.22	7
25	Recover Heat from Oven Exhaust/Kilns	0.4375	16	$23,316	0.99	7
26	Adjust Burners for Efficient Operation	0.538462	13	$36,223	1.22	7

Source: Delta Institute analysis of IAC data