Best Practices in Energy Management: Experience with IAC Assessments in the Metals Fabrication Industry

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ABSTRACT

The Industrial Technology and Energy Management (ITEM) division of the University City Science Center played a managerial role in founding and establishing the Energy Analysis and Diagnostic Center (EADC) program, now known as the Industrial Assessment Center (IAC) program. ITEM is responsible for the field management of 15 IACs in the western United States. This DOE funded program utilizes teams of engineering faculty and students to conduct assessments of small to medium-size plants to identify cost savings by conserving energy, minimizing waste, and improving productivity. These assessments are provided at no direct cost to participating manufacturers, who are under no obligation to act on any recommendations.

Centers managed by ITEM have conducted assessments in more than 700 plants in the metals fabrication industry (SIC 34). Recommendations made have the potential to reduce energy costs by about 10% on average. The average metals fabrication plant served achieved a 5.7% reduction in annual energy costs. These cost savings are accompanied by a reduction in energy usage of about 1.2×10^{12} Btu/yr. Another benefit of the program is that it provides hands-on industrial experience and energy efficiency training for engineering students who will take these skills into industry.

Since the program began more than 20 years ago, IACs have served less than 2% of the plants in this industry. To provide an effective means for plant managers to access and utilize the knowledge gained over the years ITEM has summarized recommendations that identify specific actions that plant management can take to save money.

Introduction

For more than twenty years Industrial Assessment Centers (IACs), formerly called Energy Analysis and Diagnostic Centers, have been conducting assessments in small to medium-sized manufacturing plants. This US DOE funded program utilizes teams of engineering (or engineering technology) faculty and students to identify cost savings in three areas: energy conservation, waste minimization, and productivity enhancement. These assessments are provided at no direct cost to participating manufacturers who are under no obligation to act on any of the recommendations. The IACs perform engineering and financial analyses of data collected at the plant, develop specific recommendations to reduce costs, and incorporate them into a report. Within one year of receiving the report a plant representative is contacted to determine which recommendations have been implemented or will be in the immediate future.

The IACs are located at thirty universities throughout the US. Each center provides 25 assessments per year at plants within 150 miles of the university. To qualify for an assessment the plant must be in SIC 20-39 and meet three of the following criteria: annual gross sales below $75 million, fewer than 500 employees, annual energy bills between $75,000 and $1.75 million, and lack of in-house professional expertise in energy use and conservation.

Typically, cost savings at each plant are on the order of about $50,000/yr. In addition to the cost savings achieved at the plants served, the IAC program provides many other benefits. Implementation of assessment recommendations increases energy efficiency in the industrial sector and helps to mitigate climate change by reducing greenhouse gas emissions. The program fosters market transformation of energy efficient technologies. It has provided more than 2,000 engineering students with practical field experience making them better future employees. At the university level, it provides opportunities to establish productive relationships with local industry. In addition, when the nearly 100 engineering faculty who have been part of the program incorporate the knowledge gained into their coursework it benefits their students' education. Although these benefits are difficult to quantify they have a long lasting effect on the prosperity of the institutions involved and the future of energy efficient manufacturing in the US.

ITEM played a managerial role in founding and establishing the program and is responsible for the field management of 15 IACs located in the western US. The Office of Industrial Productivity and Energy Assessment (OIPEA) at Rutgers University provides field management for 15 IACs in the eastern US. Since the program's inception more than 20 years ago, IACs have performed more than 8,000 industrial assessments. To date IACs under ITEM's management have conducted more than 700 assessments at plants in the metals fabrication industry. Engineers from ITEM's staff have reviewed all of the assessment reports for these plants to ensure consistency and quality of recommendations and analyses. In addition, IAC and ITEM staff have conducted follow-up studies in these plants to establish the extent to which manufacturers have implemented recommendations and the degree of manufacturers' satisfaction with the services received. The chief purpose of this paper is to present a summary of the results from plants served in the metals fabrication industry.

Industry Overview

The 1992 Economic Census indicates that there are 32,959 companies with 36,429 establishments in the fabricated metal products industry (SIC 34). These plants produce annual shipments worth approximately $166.5 billion and employ 1.3 million people throughout the United States. This major group manufactures a wide variety of products separated into nine industry groups (3-digit SICs).

Three of the nine industry groups are responsible for about two thirds of the total annual shipments. Listed in decreasing order of annual shipments they are: SIC 344 – fabricated structural metal products (e.g., bridge sections, metal doors, boilers, downspouts, and fire escapes), SIC 349 – miscellaneous fabricated metal products (e.g., industrial valves, steel springs, and pipe fittings), and SIC 346 – metal forgings and stampings (e.g., anchors, hub caps, and jar tops).

Plants in this industry are widely distributed throughout the US. Seven states (California, Ohio, Illinois, Michigan, Texas, New York, and Pennsylvania) account for 50% of the total number of plants in this industry. In addition, these same seven states are responsible for 51% of the total annual value of shipments.

Total annual energy cost in the production of goods in SIC 34 is about $2.8 billion of which electricity encompasses approximately 69%. A profile of energy usage for the 713 plants in this industry that have been served by IACs under ITEM's field management shows that electricity accounts for approximately 33% of the energy consumption, natural gas for 64%, and all other fuels (primarily fuel oil and LPG) for the remaining 3%. Energy usage data from these assessments are presented in Table 1. Similar data extracted from the 1991 Manufacturing Consumption of Energy Survey (MECS) are included in the table. A comparison of the two data sources shows that the consumption pattern of plants served by the IACs is very similar to the larger national survey. In addition, the vast majority (99.4%) of plants in this industry meet the criterion of fewer than 500 employees.

Table 1. Energy Usage Profile – SIC 34

	IACs	MECS
% Electricity	32.6	33.3
% Natural Gas	64.4	57.0
% Fuel Oil	1.9	3.0
% LPG	0.7	1.3
% Other	0.4	5.3

Cost Saving Recommendations

The energy conservation opportunities recommended in the 713 plants served have the potential to conserve more than 2 trillion Btu/yr which represents 8.5% of the total energy consumed in these plants. These and other energy-related measures (some measures such as restructuring utility rate structures do not conserve energy but can have significant cost-savings potential) identified could reduce annual energy costs by about 10% on average. A summary of the IAC implementation results for this industry shows that 61% of all energy-related measures were implemented. This corresponds to a 5.7% reduction in annual energy costs and a 5.0% reduction in energy usage.

The typical assessment report included an average of six energy-related recommendations with 200 unique measures identified. By examining the data from the 713 energy audits these 200 unique measures can be aggregated into nine categories as follows: combustion; steam; electricity supply and demand reduction; compressed air; process equipment; lighting; space heating, ventilation, and air conditioning (HVAC); and fuel switching. Within these categories are specific measures that are frequently made and have significant cost savings potential. These measures, aggregated by category, are shown in Table 2 and described in greater detail in the sections that follow. The frequency of each recommendation, the percentage of those recommendations that were implemented (% Impl.), and their average payback period in years are included in the table.

Table 2. Cost-saving Measures

Measure Description	Frequency	% Impl.	Average Payback (yr)
Combustion			
Adjust air/fuel ratio	137	82	0.4
Recover heat from flue gases	80	43	1.6
Steam			
Insulate steam system components	54	67	0.6
Repair steam leaks	21	81	0.3
Electricity Supply and Demand Reduction			
Reduce peak electrical usage	108	52	0.4
Improve power factor	75	53	1.2
Compressed Air			
Reduce compressed air leaks	338	88	0.1
Use outside air for compressor intakes	260	60	0.4
Process Equipment			
Motor maintenance and replacement	583	66	0.8
Process heat confinement	225	46	0.7
Lighting			
Install high efficiency lighting	728	71	1.5
Install occupancy sensors	194	45	0.5
HVAC			
Reduce building infiltration	98	60	0.9
Fuel Switching			
Replace electric with natural gas equipment	88	39	1.1

Combustion Measures

Adjust air/fuel ratio. The air/fuel ratio on combustion equipment should be checked and adjusted as needed to reduce the amount of excess air passing through to improve the efficiency. A flue gas analysis of the stack gases performed during the assessment and operating parameters are used to determine the current combustion efficiency. The majority of these measures involved the tuning of natural gas-fired boilers. The optimum amount of O_2 in the flue gas of a natural gas-fired boiler is 2.2%, corresponding to 10% excess air. To be conservative, the savings calculations are typically based on a reduction in excess O_2 to about 3%. The proposed efficiency is estimated by using combustion efficiency charts that compare the net stack temperature to an excess O_2 level of 3%.

A review of the 20 most recent recommendations of this type shows an average increase in combustion efficiency of 5.3%. In order to adjust the air/fuel ratio for maximum efficiency, a flue gas analysis kit is needed. The primary air and fuel flow rates to the combustion chamber should be checked bimonthly and adjusted to obtain the optimum ratio. The typical payback for this measure is about 0.4 years (5 months).

An alternative to manually adjusting the air/fuel ratio is to install automatic O_2 trim controls that adjust the amount of excess air continuously. IACs who have recommended this option report a similar increase in efficiency and an average payback of about 1.1 years.

Case in Point: A manufacturer of hot dipped galvanized parts in Oregon operates a kettle to melt zinc and keep it molten. The plant installed an inlet modulation system on the blower motor and controls, which adjusts the O_2 level according to the firing rate of the kettle. Prior to implementing this measure the blower to the kettle supplied the same amount of air regardless of the firing rate of the burner. The team from the Oregon State University IAC estimated a 43% increase in burner efficiency when in the low-fire setting and a 2% increase when operating at high-fire. At a cost of $3.80/MCF this plant reduced its annual natural gas cost by about $27,900/yr. The installed cost of the control system was $12,000, resulting in a payback of 0.4 years.

Recover heat from flue gases. Heat can be recovered from the exhaust gases of combustion equipment. The most common use of recovered heat identified by IACs serving this industry is preheating combustion air. Other uses of recovered waste heat included preheating boiler feedwater, heating service hot water, augmenting space heating, and preheating materials entering ovens and dryers.

To estimate the decrease in fuel consumption associated with preheating combustion air the IACs typically assume a 1% increase in combustion equipment efficiency for every 40°F increase in combustion air. (Caution: It is important to ensure that the exhaust temperature remains above approximately 250°F to prevent the condensation of exhaust gases and the resultant corrosive liquids.)

A flue gas analysis is performed to estimate the current boiler efficiency (EFF_c). To estimate the proposed efficiency (EFF_p) the following relationship is utilized:

$$EFFp = EFFc + \left[\Delta T_{air} \times \frac{1\%}{40°F}\right]$$

A review of the 20 most recent recommendations of this type made in this industry shows an average increase in combustion air temperature (ΔT_{air}) of 310°F, which relates to a 7.8% increase in efficiency. The costs to implement this measure include a heat exchanger, duct work, fan, and labor. In addition, the IACs typically recommend hiring an engineering company to provide the design work. The typical payback for preheating combustion air is about 1.9 years. A review of all heat recovery measures shows a payback of 1.6 years.

Case in Point: A manufacturer of aluminum cans in Colorado served by the Colorado State University IAC operates a 125 hp steam boiler to heat water for the can washer. By using a stack heat exchanger, the combustion inlet air temperature was raised by about 140°F providing a 3.5% increase in efficiency. At a cost of $2.90/MCF this plant reduced its natural gas cost by about $3,600/yr. The cost of the system including the heat exchanger, fan, ducting, and labor was about $5,000, resulting in a payback of 1.4 years.

Steam Measures

Insulate steam system components. Steam system components (e.g., pipes, boilers, and condensate return tanks) should be insulated to reduce heat losses and associated energy costs. Reducing heat loss leads to savings for the heating of make-up water, and for reduced water purchase and treatment.

A review of the twenty most recently recommended insulation measures indicates that the average energy savings reduced heat loss by approximately 90% as compared to bare surfaces. The typical payback for this type of measure is 0.6 years (7 months).

Several of the IACs utilize the 3E Plus Insulation Thickness Computer Program developed by the North American Insulation Manufacturers Association (NAIMA) to determine the heat loss from the bare and insulated surfaces. The program determines the most economically attractive thickness of a selected insulation type.

Case in Point: In Oklahoma a manufacturer of pier systems for boats uses steam for expanding styrofoam beads in the production of flotation devices. The plant installed fiberglass insulation on piping spanning a total length of 133 feet. The IAC team from Oklahoma State University estimated that heat loss could be reduced by 89% by installing 1-inch thick insulation. The energy conserved after implementation was about 800 MMBtu/yr, and the natural gas cost savings was $4,460/yr. The cost of insulation materials and labor was $1,800 resulting in a payback in 0.4 years.

Repair steam leaks. Steam leaks and condensate leaks in live steam lines and condensate return lines should be checked and repaired on a regular basis. The potential savings are due to reduced energy usage for heating of make-up water. The energy conservation that can be realized by fixing steam leaks is calculated as follows:

$$EC = \frac{M \, x \, H \, x \, (h_2 - h_1)}{EFF}$$

where

M	=	mass flow rate from an individual leak of a given size, lb/h
H	=	annual hours during which leak occurs, h/yr
h_2	=	enthalpy of steam at line pressure, Btu/lb
h_1	=	enthalpy of feedwater makeup water, Btu/lb
EFF	=	boiler efficiency, no units

Repairing the leaks will require any or all of the following actions: repairing of steam traps, purchase and installation of valve packaging, welding of faulty piping, sealing around fittings, and repairing condensate return lines. The typical payback for this measure is approximately 0.3 years (4 months).

Case in Point: A Texas manufacturer who uses steam to cure rubber linings repaired steam leaks in their boiler system. The team from the Texas A&M University IAC estimated that at a cost of $2.92/MCF the plant was able to conserve 824 MMBtu/yr of natural gas, with a reduced annual cost of $6,200/yr. The cost of repairing the steam leaks was $960, resulting in a payback of approximately 0.2 years.

Electricity Supply and Demand Reduction Measures

Reduce peak electrical usage. Demand is the average rate at which energy (measured in kWh) is used during a specific metered period. The peak demand is the highest average load (measured in kW) reached over all of the demand intervals within a given billing period. A high demand charge therefore results from a large usage of power during any demand interval of the billing period. Common strategies to reduce the peak demand identified by the IACs are: distribute demand over alternate shifts, interlock pieces of equipment, and reschedule operation of machinery (e.g., charge forklifts at night).

Studying daily plots of energy usage can identify periods of the day when high demand is a problem for a facility. This information can then be used to determine which solution is feasible. A review of the twenty-five most recent recommendations for this measure indicates that the average energy demand reduction is approximately 135 kW. The typical payback for this measure is 0.4 years (5 months).

Case in Point: A manufacturer of security hardware in Texas reduced the peak demand by shifting the operation of an induction heater to a late afternoon shift. The Texas A&M University IAC in Kingsville calculated a demand reduction of 187 kW which corresponds to a savings of $12,130/yr. The schedule change required no additional labor costs; therefore, the payback was immediate.

Improve power factor. Power factor is a way of quantifying the reaction of alternating current (AC) electricity to various types of electrical loads. Inductive loads, such as motors and fluorescent lamp ballasts, cause the voltage and current to shift out of phase. The utility company must supply additional power, commonly measured in kilovolt-amps (kVA), to make up for the phase shift. The total power requirement of the load is made up of two components, the resistive, or real, component and the reactive component. The resistive component, measured in kilowatts (kW) by a watt meter, does the useful work.

The ratio of real, useable power (kW) to apparent power (kVA) is known as the power factor. To reduce reactive losses, the user should increase the power factor to a value as close to unity (1.0) as is practical for the entire manufacturing plant.

Capacitor banks can be installed to decrease the apparent power. Capacitors draw current which leads the voltage, while inductive loads draw current which lags the voltage. The net result is that the current in the supply line is brought more closely in phase with the supply voltage. Capacitors can be added at each piece of equipment, ahead of groups of small motors, or at main services. The placement of capacitors should be discussed with a qualified professional from a capacitor supplier, electrical contractor, or an engineering firm. The typical payback for this measure is approximately 1.2 years.

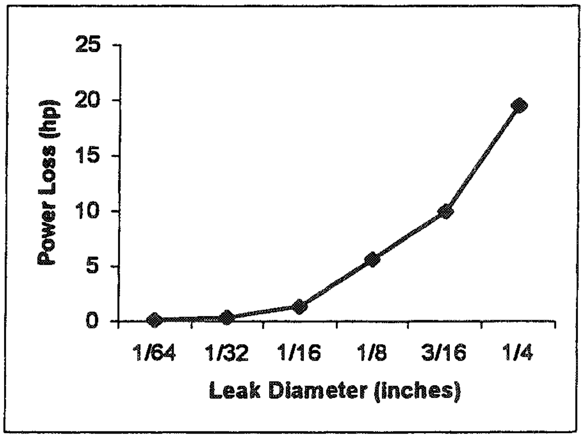
Case in Point: A manufacturer of wire fencing in Nevada pays an excess reactive energy charge when the power factor is less than 0.9. The team from the University of Nevada-Reno IAC estimated the minimum capacitance required to eliminate the additional charge. The plant was able to save about $1,700/yr with a 2.3 year payback.

Compressed Air Measures

Reduce compressed air leaks. Leaks in compressed air lines should be repaired on a regular basis. The cost of compressed air leaks is the energy cost to compress the volume of lost air from atmospheric pressure to the compressor operating pressure. The amount of air lost depends on the line pressure, the compressed air temperature at the point of the leak, the air temperature at the compressor inlet, and the area of the leak.

A review of the twenty most recent recommendations indicates that on average 34% of the total on-line horsepower was lost. For the recommendations reviewed, the average temperature at the point of the leak was 70°F and average pressure was 100 psig. Figure 1 illustrates power loss as a function of leak diameter for these conditions.

Figure 1. Horsepower Loss to Air Leaks



Repairing the leaks typically requires any or all of the following actions: replacement of couplings, hoses, seals around filters, and repairing breaks in lines. To reduce compressed air costs it is necessary to implement a program to identify the leaks on a continuing basis. What has worked for many plants is to educate plant personnel on the importance of reducing the leaks and have them assist in identifying the leaks. For example, to help the maintenance staff locate leaks some plants have provided production workers with yellow ribbons which are tied to hoses or equipment at the site of a leak. The typical payback for this measure is approximately 0.1 years (1 month).

Case in Point: In Minnesota a metals fabricator uses compressed air primarily for sand blasting, painting, and pneumatic tools. The South Dakota State University IAC found 11 air leaks in the plant ranging in size from 1/64 to 1/4 inches. Facility maintenance personnel repaired the leaks and estimated the cost at $220. The cost savings of $5,200/yr will payback in 0.1 years.

Use outside air for compressor intakes. Outside air is (on average) cooler and more dense than indoor air. Therefore, less work is required to reach a given operating pressure using outdoor air.

The work performed by compressors, for typical operating conditions in manufacturing plants, is proportional to the absolute temperature of the intake air. Thus, the fractional reduction in compressor work, WR, resulting from lowering the intake air temperature can be estimated as:

$$WR = \frac{IT - OT}{IT + C}$$

where

IT = average inside temperature, °F

OT = average annual outside temperature, °F

C = constant, 460 Rankine

The most common material used for ducting outside air to compressor intakes is plastic (PVC) pipe. One end of the pipe is attached to the air cleaner intake or other appropriate intake port and the other end is routed through the wall or ceiling to the outside. Reviewing the 20 most recent recommendations for this measure, the average fractional reduction in compressor work resulting from lowering the intake air temperature is about 7% and the typical payback approximately 0.4 years (5 months).

Case in Point: A manufacturer in Missouri who makes custom fabricated stainless steel products operates a 150 hp air compressor. The University of Missouri-Rolla IAC estimated a reduction in compressor work of 7% resulting from lowering the intake air temperature by 39°F. The implementation cost for materials and labor is $200. The total cost savings for this measure is $2,500/yr with a payback period of one month.

Process Equipment Measures

Motor maintenance and replacement. IACs typically recommend motor-related measures that fall into three categories: replacement with higher efficiency motors, improvements in the drive system, and better maintenance practices.

Motor replacement with a higher efficiency model is recommended as the current motor wears out. High efficiency motors are constructed with better bearings and windings to reduce frictional and electrical losses. Efficiencies may be from about 1% to 10% higher than the operating efficiencies of the existing motors. In general, the larger the motor, the smaller the efficiency increase. Normally, a cost premium must be paid for the higher efficiency motors. To evaluate the potential energy conservation and cost savings the IACs utilize the MotorMaster+ computer program developed for the US DOE by the Washington State University Cooperative Extension Program. Historically, motor replacement measures have shown a payback of about 1.7 years for this industry.

The most common drive system improvements recommended by IACs for this industry are for the use of notched V-belts and synchronous belts. These belts save energy through a reduction in belt slippage on drive sheaves and reduced load on bearings. Typically, the IACs assume an energy reduction of 2-5% for notched V-belts and 5-15% for synchronous belts and sprocket drives. The average payback for belt replacement recommendations is about 0.5 years.

The majority of motor maintenance recommendations focus on improved lubrication procedures. IACs frequently stress the importance of periodic lubrication and the potential cost savings associated with the use of synthetic lubricants. Synthetic lubes have demonstrated a reduction of 10-20% in energy losses due to friction in electric motors. The average payback for this measure is about 0.2 years.

Case in Point: A sheet metal fabricator in Arizona saves $12,300/yr by implementing three motor-related recommendations made by the Arizona State University IAC. The plant is replacing motors with higher efficiency models as they wear out, installed notched V-belts on several motors, and uses synthetic oils and grease to lubricate a 75 hp air compressor. The cost savings resulted in a payback of 1.2 years.

Process heat confinement. Heat losses from process equipment such as ovens, furnaces, and heated tanks constitute significant energy losses. Three methods of minimizing heat losses commonly made by IACs serving this industry are: installing/repairing/increasing insulation on equipment surfaces, covering heated tanks with floating insulation, and adding covers or curtains at equipment openings.

To estimate the cost savings potential associated with insulating equipment surfaces the IACs estimate (often using the previously mentioned NAIMA software) heat losses before and after the insulation is added. The typical payback for this recommendation is about 1.1 years.

The use of floating insulation in heated tanks reduces heat loss and minimizes evaporation. Cost savings result from a decrease in energy to heat the tank and the chemicals used in the tank. An additional benefit is a reduction in fumes from the tank. These measures typically payback in about 0.3 years (4 months).

Another common recommendation is to cover oven and furnace openings. This equipment loses significant amounts of heat at its entrances and exits. The IACs typically recommend installing a curtain (either air or strip) or a moveable cover to minimize heat losses. Typical payback for this measure is about 0.3 years.

Case in point: A metal plating facility in Nebraska uses numerous tanks that are heated by steam supplied from a 200 hp boiler. Tank temperatures range from 120-200°F. After following a recommendation from the University of Kansas IAC to use a layer of plastic balls to cover the liquid surface the plant saved about $17,300/yr. The cost of the balls was $11,000, which resulted in a payback of 0.6 years (8 months).

Lighting Measures

Install high efficiency lighting. Energy savings occur by replacing existing lamps and ballasts with high efficiency, lower wattage lamps and ballasts. A review of the twenty most recent recommendations indicates that the average reduction in energy usage for lighting is approximately 30%. Table 2 illustrates the most common recommended lighting replacements by IACs for this industry.

Table 2. Lighting Recommendations

Current Conditions	Proposed Conditions
T12 Fluor. lamps and magnetic ballasts	T8 Fluor. Lamps and electronic ballasts
T12 Magnetic ballasts	T12 Electronic ballasts
Incandescent bulbs	Compact fluorescent lamps
Metal halide lamps	HP Sodium lamps
Mercury vapor lamps	HP Sodium or metal halide lamps

A common practice for many facilities is to relamp on a spot basis as the lamps burn out or relamp a fraction of the fixtures in an area of the plant. These methods of relamping spread the total implementation cost over several years, as lamps and ballasts are replaced only as the existing ones burn out. The average payback for this measure is 1.5 years.

Case in Point: In Minnesota a manufacturer of tools and heavy equipment uses conventional fluorescent lamps and incandescent lamps in the office and production areas of the plant. The South Dakota State University IAC recommended replacing the T12 fluorescent lamps and magnetic ballasts in 4' and 8' fixtures with T8 lamps and electronic ballasts. In addition, the IAC recommended switching from 150-Watt and 100-Watt incandescent flood lamps to 90-Watt halogen lamps and 22-Watt compact fluorescent lamps. The total energy savings and cost savings after all the lamps were replaced were 314,900 kWh/yr and $15,970/yr. At a cost of approximately $40,000 the measure paid back in 2.5 years.

Install occupancy sensors. Occupancy sensors are used as an automatic switch for lighting control in areas that do not require constant light, such as conference rooms and lavatories. By wiring the occupancy sensors in the areas designated lighting can be eliminated during unoccupied periods. The amount of energy savings depends on the actual time that the light would otherwise be left on when the room is unoccupied.

Several types of controls are available including timer switches, door controls, and motion sensors. Some occupancy sensors replace wall switches while others work in conjunction with existing switches. An ultrasonic motion-sensing controller, which produces a low intensity, inaudible sound and detects changes in the sound waves caused by any type of motion, is commonly recommended. The number of sensors can vary for each area depending on the number of lamps that the sensor has to control. The average payback for this measure is 0.5 years (6 months).

Case in Point: A hydraulic hose assembler in Iowa installed occupancy sensors in several office and production areas at their facility following a recommendation made by the Iowa State University IAC. Energy and cost savings resulted from reducing electrical energy usage. Additional cost savings associated with a reduction in labor and lamp costs were also realized. The cost savings for this plant were $1,120/yr with a simple payback in 0.8 years (10 months).

HVAC Measure

Reduce building infiltration. Infiltration is the unintentional air exchange between the indoors and outdoors, driven primarily by temperature difference and wind. In winter, cold air entering a building forces the warm air out, causing heat losses. Typically, infiltration is responsible for 20 to 40 percent of the thermal load of buildings.

Measures identified by IACs to eliminate infiltration have included caulking windows and doors, using fasteners and corrugated steel to seal openings, applying plastic and vinyl stripping, and installing air curtains or plastic strip doors at loading docks. The typical payback for these measures is approximately 0.9 years (11 months).

Case in Point: In Illinois a manufacturer of metal stampings installed a plastic strip door at the loading dock doorway to reduce heating losses. With a natural gas cost of $4.44/MCF the Bradley University IAC estimated cost savings of $2,720/yr. The implementation cost was $1,500 resulting in a payback of 0.6 years (7 months).

Fuel Switching Measure

Replace electrical equipment with natural gas equipment. The energy supply of equipment, such as boilers, space heaters, water heaters, and wash tanks is commonly changed from electricity to natural gas. At the plant there is typically an increase in the plants' energy usage due to the lower efficiency of the natural gas equipment. This increase in usage can be thought of as negative energy savings; however, in a global sense energy is actually saved since more energy is required to generate electricity than natural gas. The cost savings results from the fact that the per unit energy cost of natural gas is significantly less than that of electricity. For this industry the average payback period is about 1.1 years.

Case in Point: In Arizona a manufacturer of anodized and plated metal components implemented a recommendation made by the Arizona State University IAC to replace the electrical immersion heaters in the plating tanks with steam jacket heaters. The plant realized a cost savings of $60,000/yr. Implementation of this measure required the purchase of a gas-fired steam boiler, piping, controls, and heat exchangers. The installed cost of the system was $40,000, resulting in a payback of 0.7 years (8 months).

Summary

With funding from the US DOE, IACs under ITEM's field management have performed more than 700 industrial assessments at metals fabrication plants. As a result of these efforts manufacturers served have reduced their annual energy costs by 5.7% and reduced energy consumption by 5.0%. The recommendations summarized in this report account for about one half of the cost savings found at these plants. This small sample of recommendations (there were 200 unique recommendations made in this industry) does not tell the complete story of energy-related cost savings potential in the metals fabrication industry. However, it should provide a good starting point for manufacturers in this industry.

Census data indicate that there are currently about 36,400 metals fabrication plants operating in the US. Over a twenty-year period IACs have served fewer than 2% of the plants in this industry. In addition, the 1994 Manufacturing Energy Consumption Survey indicates that less than 10% of metals fabrication plants have received an energy audit by any source. What is needed is an effective means for plant managers to access and utilize the information and know-how which has been accumulated over the years so the potential benefits can be realized by the large number of plants which still need to be upgraded. Utilizing their experience with more than 6,000 industrial assessments in this and other industries ITEM staff can develop best practice summaries and workbooks that identify specific actions that plant management in a particular industry can take to save money. Each measure is described in detail with sample savings calculations and typical payback periods. Worksheets, provided for each measure, allow the user to estimate the cost savings for their own plant.

References

U.S. Department of Commerce, *1992 Economic Census CD-ROM Report Series*, U.S. Department of Commerce, Bureau of the Census, 1997.

U.S. Department of Energy, *Manufacturing Consumption of Energy 1994*, U.S. Department of Energy, Energy Information Administration.

Standard Industrial Classification Manual, U.S. Office of Management and Budget, 1987.