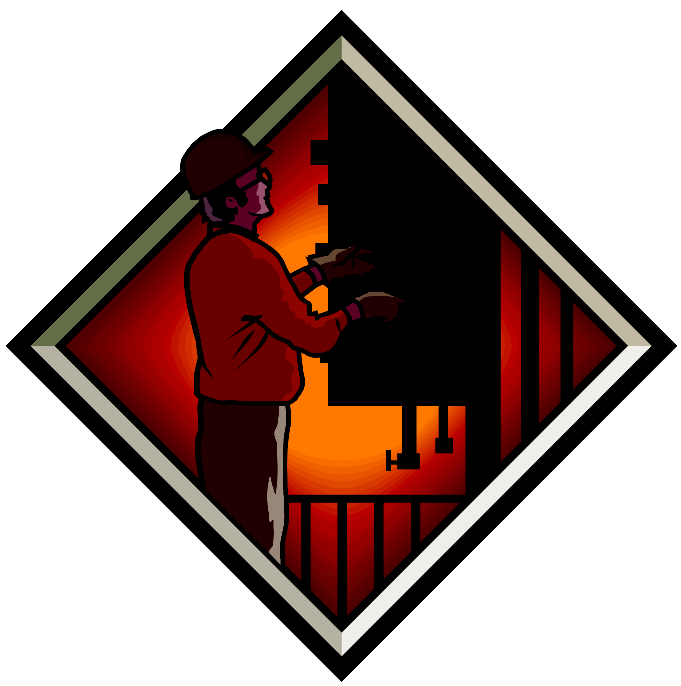
Establishing an Energy Management Program and Identifying Energy Savings Opportunities

A Guidebook for Small Manufacturers



Funding for this manual provided by the
New Jersey State Department of Environmental Protection

Produced by:
The Office of Industrial Productivity and Energy Assessment
Department of Mechanical and Aerospace Engineering

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ACKNOWLEDGEMENTS

The Office of Industrial Productivity and Energy Assessment, under the direction of Dr. Michael R. Muller would like to acknowledge the support of the State of New Jersey Department of Environmental Protection, specifically the Office of Pollution Prevention and Permit Coordination. Special thanks goes to Melinda Dower of Pollution Prevention Planning and Dr. Fu-Grand Lin, Project Manager of "Energy Conservation as a Mechanism for Pollution Prevention Management Opportunities".

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EXECUTIVE SUMMARY

This guidebook is intended to encourage manufacturers to develop a strategic plan for energy decisions, just as they would for other key business decisions. A major focus of an energy management plan is performing a self-assessment to identify energy savings opportunities. Establishing an energy management plan and implementing cost-effective energy conservation opportunities result in increased profitability and competitive advantage for the manufacturer. Equally significant, reduction in energy use can produce significant environmental improvements. Documentation of reductions in energy use, along with the resulting reduction in greenhouse gases (GHG), can benefit the manufacturer by generating GHG credits under New Jersey's Open Market Emissions Trading (OMET) program.

Because of the complexity of developing an energy management plan, this guidebook divides the task into 4 components:

1. Management Commitment
2. Review Of Utility Rate Structure And Purchasing Strategy
3. Self Assessment To Identify And Calculate Energy Savings
4. Continued Feedback And Analysis

This guidebook provides instructions and examples for each step of a self-assessment. The 4 steps are:

Step 1: Quantify Unit Costs for Energy
Step 2: List The Major Energy Consuming Equipment in the Plant
Step 3: Identify Savings Opportunities and Gather Relevant Data
Step 4: Calculating Cost Savings and Implementation Costs

The goal of this guidebook is to produce results that are meaningful to both industry and the environment.

PART 1: MANAGEMENT COMMITMENT

Strategic Planning at the Corporate Level

An energy management program should be designed to minimize energy costs, ensure a reliable energy supply, and identify energy savings opportunities. A comprehensive plan requires strategic planning at the corporate level. Information and participation is needed from all levels of your organization – corporate executives, plant managers, and procurement personnel. Also, energy costs and consequences of future energy shortages should be communicated throughout the plant to create an overall energy awareness.

Strategic planning is as essential for energy decisions as it is for other key business decisions. It involves identifying goals for energy and answering such questions as:

- How does the energy bill impact the company's bottom line?
- Is a fixed dollar amount allocated to energy?
- What is the target for energy cost as a percentage of cost of goods sold?
- How does the energy bill reflect the facility's operations?
- Does the capital plan include money for energy conservation projects?[1]

Benefits of Energy Management

Establishing an energy management plan and implementing cost-effective energy conservation opportunities result in increased profitability and competitive advantage for the manufacturer. Equally significant, reduction in energy use can produce significant environmental improvements.

Management should also consider participating in voluntary programs like **Climate Wise, EnergyStar,** and **New Jersey's Open Market Emissions Trading** program.

Climate Wise is a government-industry partnership sponsored by the U.S. Environmental Protection Agency (EPA) with technical support from the U.S. Department of Energy. The stated goal of the program is to help businesses turn energy efficiency and environmental performance into a corporate asset. This voluntary program was designed to help the United States honor its international commitment to reducing greenhouse gas emissions to 1990 levels by the year 2000. Climate change prevention measures can continue to be a prime focus of international negotiations in the future. Climate Wise can help strategically position businesses, putting them in step with these evolving global trends.[2]

[1] "Maximizing Your Energy Dollars- A Strategic Approach to Energy Management" http://www.statoilenergy.com/EnergyForum/wp_maxdol.htm

[2] http://www.epa.gov/climatewise/index.html

Energy Star offers voluntary partnerships that promote energy efficiency, reduce air pollution, and save money for businesses. Each year, these partnerships save over $1 billion in energy costs while also cutting air pollution. One Energy Star program, Energy Star Small Business is designed by and for small businesses and their advocates.[3]

New Jersey's Open Market Emissions Trading (OMET) program allows manufacturers who document their reductions in energy use to generate greenhouse gas (GHG) credits. The OMET Program was established by the NJ Department of Environmental Protection to provide incentives for voluntary reductions of air contaminant emissions. It was also established to provide alternative means for regulated entities to achieve compliance with their air pollution control obligations, when conventional control methods were not available or not cost effective. It was intended that both the economic viability of the State and the achievement of clean air goals would be promoted through the OMET Program.[4]

[3] http://www.epa.gov/energystar/
[4] http://www.state.nj.us/dep/aqm/ometp2ad.htm

PART 2: REVIEW OF UTILITY RATE STRUCTURES AND PURCHASING STRATEGY

Reducing energy costs is a two-part proposition. One half of the effort is performing a self-assessment to identify and calculate energy savings. Obtaining the best prices from your utilities is the other half. This section provides information on electric and natural gas rate structures and the cost implications of those structures.

In establishing a purchasing strategy, additional information (beyond rate structures) is necessary to make informed purchasing decisions. The sections on **NJ Energy Choice** and **Green Power** provide information that assist in considering both short-term long-term payoffs.

Rate Structures

Electric Tariffs

Cost Components

Utilities base their rate schedules on a variety of factors, such as type of customer (residential, commercial, industrial), amount of usage, and type of electric service (primary or secondary distribution). The various charges of the rate structure are often difficult to understand without an explanation from the utility. An on-going business typically does not question its rate structure even though its situation may have changed. This is an often overlooked as a cost savings opportunity.

Electricity must be treated in a different manner from fuel oil and natural gas. The cost of electricity is charged to the manufacturer using two different cost components, **electric consumption** and **demand**. Sometimes a third charge, **power factor** (so called reactive charge) also applies.

Electric Consumption Charges: The cost of **electric consumption** is similar to that for natural gas and fuel oil, i.e. all three are charges for units consumed. The usual unit of electrical consumption is the kilowatt-hour or kWhr. This is measured by the watt-hour meter and appears on the bill as kWhr consumed each month and has an associated cost. Even this charge may be broken down into a charge for consumption on-peak (usually 8AM-10PM) and off-peak (the rest of the day).

Demand Charges: The second cost component, **demand**, is based on the highest rate of consumption during the billing period. It is usually obtained by the electric utility by measurement of energy consumed in sequential fifteen-minute periods throughout the month. The fifteen-minute period with the maximum consumption is then converted to an average rate of consumption in units of kilowatts or kW. This maximum kW value is then multiplied by a demand cost factor, which can vary considerably depending on whether one is talking about demand during the on peak (daytime hours) or off-peak (night time hours). This demand charge is then added on to your consumption costs to yield the monthly electric cost.

Power Factor Charges: Many utility companies charge an additional fee if your **power factor** is less than 0.95. **A section on power factor is included in the Technical References portion of this guidebook.** Inductive loads (e.g. transformers, electric motors, and high intensity discharge lighting) constitute a major portion of the power consumed in industrial facilities, and they require current to create a magnetic field. The current used to create the magnetic field is required to operate the device, but does not produce work. The utility must provide both the power to produce the
magnetic field (Reactive Power, measured in kVAR) and the power that produces useful work (Real Power, measured in kW). Power factor is the ratio of Real Power to Apparent Power (all the power provided by the utility, measured in kVA). Your electric bill is based on measurement of Real Power, measured in kilowatts (kW). However, low power factor requires an increase in the electric utility's generation and transmission capacity to handle the reactive power component caused by inductive loads. Low power factor also reduces your electrical system's distribution capacity by increasing current flow and causing voltage drops. [5]

Some strategies for correcting your power factor are:

- Minimize operation of idling or lightly loaded motors.
- Avoid operation of equipment above its rated voltage.
- Replace standard motors as they burn out with energy efficient motors. Note, however, that a motor must be operated near its rated capacity to realize the benefits of a high power factor design.
- Install capacitors to decrease the magnitude of reactive power. Capacitor suppliers and engineering firms can help you determine the optimum power factor correction and the correct installation of capacitors in your electrical system.[6]

A Billing Comparison: Demand Costs

Below is a typical rate structure for large power and lighting service/ secondary distribution.[7] **These rates will be used to show how a company's electric cost can vary significantly even though the exact same amount of kilowatt hours are used each month.** Demand costs can often make up 50% or more of the total electric bill. Since electricity frequently is the largest monthly energy cost it is important to understand how it is billed and what effect certain strategies will provide in terms of cost savings. Stated another way, it is often possible to decrease the monthly electric bill by fifteen to twenty percent by decreasing the demand cost while continuing to consume the same amount of electricity.

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[5] Reducing Power Factor Cost, US Department of Energy Fact Sheet #

[6] Reducing Power Factor Cost, US Department of Energy Fact Sheet #

[7] Public Service Electric and Gas Company, Tariff for Electric Service, Effective 8/1/99, Original Sheet NO. 76–77, available at www.pseg.com/pseandg/rateschedules/ index_i.html updated 1/19/2000.

RATE SCHEDULE LPL: LARGE POWER AND LIGHTING SERVICE

Applicable to use of service for general purposes at secondary distribution voltages where the customer's billing demand exceeds 150 kilowatts in any one month and also at primary distribution. The charges include NJ Sales and Use Tax.

CONSUMPTION		DEMAND		
TIME PERIOD	**$/kWhr**	**TIME PERIOD**	**# OF MONTHS**	**$/kW**
ON-PEAK: M-F 8AM-10PM	$0.082347	OCT-MAY PEAK	8	$7.61
INTERMEDIATE: SAT 8AM-10PM	$0.072065	JUN-SEP PEAK	4	$8.76
OFF-PEAK: ALL OTHER HOURS	$0.055752	ALL YEAR OTHER	12	$1.17

In the following comparison, calculations were simplified by making the following assumptions:

- Only charges for electric consumption and demand are considered. Other miscellaneous fees, which would be the same for each case, are ignored.
- Demand is assumed constant for one-hour periods. In reality, demand changes instantaneously throughout the day.
- Monthly costs are calculated by multiplying the daily figures by 22 working days/month.

Compare the two examples below. The difference in the monthly electric bill is $438. The only difference between these two situations is the highest demand recorded during the day. The following factors are identical in each of the examples:

- The electric tariff
- The company's hours of operation: 8AM to 4PM, with a ½ hour lunch break starting at 12 Noon (note: these are all on-peak hours, and for demand cost purposes, we are assuming it is June).

ELECTRIC DEMAND	8:00AM-9:00AM	9:00AM-10:00AM	10:00AM-11:00AM	11:00AM-12:00PM	12:00PM-12:30PM	12:30PM-1:00PM	1:00PM-2:00PM	2:00PM-3:00PM	3:00PM-4:00PM
EXAMPLE # 1	700	690	650	630	200	700	640	600	550
EXAMPLE # 2	650	650	650	630	200	650	650	650	630

MONTHLY ELECTRIC COST	**DAILY USAGE (kWhr)**	MONTHLY USAGE (kWhr)	HIGHEST DEMAND	DEMAND CHARGE $/KW	USAGE CHARGE $/KWH	**DEMAND COST**	USAGE COST	TOTAL COST	AVG COST PER kWhr
EXAMPLE # 1	**5260**	115720	700	$8.76	$0.082347	**$6,132.00**	$9,529.19	$15,661.19	$0.135
EXAMPLE # 2	**5260**	115720	650	$8.76	$0.082347	**$5,694.00**	$9,529.19	$15,223.19	$0.131

Ways to Lower Demand Costs

High demand charges can result from a high rate of energy use for short periods. Using strategies such as planned load scheduling, cycling, and shedding can reduce demand costs.

- If possible, distribute the facility's energy usage over alternate shifts. For example, to reduce a high peak demand during the day, move a production line requiring heavy electrical usage to the second shift.

- If practical, interlock specific pieces of equipment, preventing them from all consuming at their peak rates during any particular demand interval (electric utilities usually have 15 minute demand intervals).
- Minimize HVAC equipment when process demand is peaking.
- Schedule high consumption electrical machinery during lunch or break times.
- Utilize thermal storage.

<u>Billing Considerations</u>

Collecting the following information will help to ensure that you are minimizing your electric costs.

- ❑ Identify the kind of meter, i.e. what does it record?
- ❑ Is more than one meter employed in the plant (see electric bills)?
- ❑ Have discussions with electric utility billing agents taken place in last two years to determine appropriateness of rate scale used?
- ❑ Does the rate schedule of the plant show a demand charge? (If there is a demand charge on the bill, is there information on what time of day or part of the month demand maximum occurs? If not, get a printout of the hourly variation of the demand for an average month where production is fairly uniform. With this information:
    - (a) Is the demand maximum significantly greater at one time of day each day?
    - (b) Is the maximum demand significantly greater than the average demand during each day?
    - (c) Is the monthly maximum demand significantly greater on one day than any other?
- ❑ Does the bill show a power factor penalty? What is the average power factor value? If bill doesn't report the power factor, it can be calculated from the bill if the bill reports either KVAH (kilovolt-ampere-hours) or KVARH (kilovolt-ampere-reactive-hours).

Natural Gas Tariffs

Natural gas may be purchased monthly or purchased annually with monthly pricing. This approach requires constant attention to natural gas prices. Natural gas can also be purchased under a long-term contract. There are various pricing arrangements based on a company's financial objectives and needs. The most common pricing arrangements are *fixed* (one price for a specified period) and *index* (price is tied to the purchase price to a published index such as the New York Mercantile Exchange or an industry publication pricing report such as *Inside FERC*). Another pricing strategy is *triggering*. Triggering calls for a long-term purchasing commitment in order to benefit from low prices in the market. If the market price hits an agreed upon target during the specified time period, the triggered prices become the contracted prices; if not, a default price based upon published index is used.

In addition, natural gas savings may be possible by change to a bulk supply rate or signing up for an interruptible rate schedule. The latter may only be possible if an alternate fuel source (fuel oil or propane) is already available on site available as a suitable replacement.

Interruptible Service

Many gas and electric utilities offer lower rates to customers who agree to have their service interrupted when the demand on the utility's distribution system becomes too great. The utility notifies the customer in advance of the interruption. The utility's transmission and distribution equipment must be sized for the maximum load on its system, so such agreements allow the utility to save on capital costs. For interruptible gas service to be practical, a facility must have a back-up fuel source such as oil or propane. Generators are used by facilities with interruptible electric service.

NJ Energy Choice

NJ passed the Electric Discount and Energy Deregulation Act on January 28, 1999. The law guarantees all residential and business customers an automatic reduction of 15% on their electric rates over an initial three-year period, to remain in effect until August 1, 2003. On August 1, 1999, customers began receiving their initial 5% rate cut.

The law also established NJ Energy Choice. Before NJ Energy Choice, both the **supply** and **delivery** of your electricity were handled by a single company, your local utility. Now, your local utility is your **Electric Distribution Company**. However, you can choose your **Electric Generation Supplier** (the company that supplies your electricity). Regardless of which Electric Generation Supplier you choose, your Electric Distribution Company does not change. This could mean staying with your current supplier or selecting a new company for possible greater savings. **Natural gas was deregulated in the same manner.** Retail suppliers began soliciting business on August 1, 1999. However, the NJ Board of Public Utilities (BPU) delayed *implementation* of retail competition until November 14, 1999 to ensure that the utilities and the energy marketers' computers were ready to handle switching customer's accounts.

Additional information about NJ Energy Choice is included in Appendix 3.

Green Power

Since NJ Energy Choice allows you to choose your electric supplier, it is now possible to support electricity generation from more environmentally beneficial energy sources. "Green power" refers to electricity produced from renewable resources. Renewable sources include wind, solar, hydroelectric, and biomass. The traditional power supply comes mainly from polluting fossil fuels and nuclear power, whereas renewables have dramatically lower pollution emissions and cause much less environmental damage. Electricity choice means you can choose to protect the environment when you buy electricity.[8] In the past, renewable energy development has been limited by cost considerations. Regulated utilities have been reluctant to invest in these resources on behalf of all customers. Customer choice allows consumer preferences for cleaner energy sources to be reflected in market transactions.[9] Green power marketers, offering green products

[8] http://www.green-e.org/what/index.html
[9] http://www.nrel.gov/analysis/emaa/brief_5.html

and services to residential, commercial, and wholesale customers, are active in New Jersey. By purchasing from an electric service provider that sells green power, you help increase the overall production of green power and help reduce pollution. [10]

It is important to verify "green" power claims and become informed about environmentally preferable competitive market choices. A number of activities are already underway to help address product credibility, such as green power certification. The Green-e logo is a way for customers to easily identify “green” electricity products. The logo was developed by The Green-e Renewable Electricity Certification Program in order to encourage consumer confidence in buying “green” electricity.[11] The **Green Power Network (GPN)** provides news and information on green power markets and related activities. The site is operated and maintained by the National Renewable Energy Laboratory for the U.S. Department of Energy. Frequently updated, the site contains information on and links to green power providers and their product offerings, utility green pricing programs, and net metering and other policies that affect green power markets. The GPN also includes a reference library of relevant papers, articles and reports.[12]

Widespread use of “green power” can reap long term benefits, such as avoidance of future emission reduction strategies in the state. These may include more stringent emissions control standards, mandatory ridesharing, and even brownouts.

[10] http://www.eren.doe.gov/greenpower/intro.shtml
[11] http://www.green-e.org/what/index.html
[12] http://www.eren.doe.gov/greenpower/intro.shtml

PART 3: PERFORMING A SELF-ASSESSMENT

A step-by step approach is provided to help plant management perform a self-assessment to identify and calculate energy savings. There are four steps:

1. Quantify Unit Costs for Each Major Energy Stream

2. List the Major Energy Consuming Equipment In The Plant

3. Identify Savings Opportunities and Gather Relevant Data

4. Calculate Cost Savings And Implementation Costs

Step 1: Quantify Unit Costs for Energy

Accounting for energy and its cost is an essential component of an energy management program. It can best be done by keeping up to date bar graphs of energy consumption and associated costs on a monthly basis. The energy bills for electricity, natural gas, and fuel oil should be obtained for a period of at least one year. A spreadsheet showing energy consumption and cost should be created for each energy stream, such as electricity, natural gas, oil, or propane.

- Changes in energy use over time can be tracked. Increases in energy use can be investigated as to the causes.

- The company's energy profile can be identified. For instance, is your electric demand relatively flat, or are there spikes during the day? As explained earlier in this booklet, spikes in demand have a significant impact on costs even when consumption (kilowatt-hours) is constant.

- Unit energy costs can be calculated. Unit energy costs are necessary inputs to the calculation of savings involved with the specific cost saving measures and are necessary to determining the savings involved when switching from one energy source to another.

In addition the cost of other utilities such as water and sewer should be quantified if they form a significant part of the manufacturing costs.

Data analysis will be simplified if the energy units for different forms of energy (such as kilowatt hours of electricity, therms of natural gas, and gallons of oil) are converted to common energy units such as the BTU (British Thermal Unit). By comparing the cost of various fuels on the basis of cost per million BTU's, the cost of each fuel can be compared.

Appendix 1 contains conversion factors for various fuels.

Example Spreadsheets And Graphs For An Electric Account

Table 1: Costs for Electric Usage

	USAGE (KWH)				COST			
Billing Period	Peak	Intermediate	Off-Peak	Total	Peak	Intermediate	Off-Peak	Total
May-98	63,400	1,200	27,600	92,200	$5,911.42	$99.55	$1,839.26	$7,850.23
Jun-98	49,400	3,000	24,200	76,600	$4,606.06	$248.88	$1,612.69	$6,467.63
Jul-98	57,800	3,000	34,400	95,200	$5,389.27	$248.88	$2,292.42	$7,930.57
Aug-98	59,400	1,000	36,000	96,400	$5,538.46	$82.96	$2,399.04	$8,020.46
Sep-98	76,600	3,200	32,800	112,600	$7,142.18	$265.47	$2,185.79	$9,593.44
Oct-98	88,600	3,200	36,600	128,400	$8,261.06	$265.47	$2,439.02	$10,965.55
Nov-98	89,800	9,200	39,600	138,600	$8,372.95	$763.23	$2,638.94	$11,775.12
Dec-98	89,800	9,200	39,600	138,600	$8,372.95	$763.23	$2,638.94	$11,775.12
Jan-99	92,400	5,600	41,200	139,200	$8,576.57	$462.22	$2,728.68	$11,767.47
Feb-99	34,800	600	14,800	50,200	$3,230.14	$49.52	$980.20	$4,259.86
Mar-99	80,820	720	53,940	135,480	$7,501.71	$59.34	$3,572.45	$11,133.50
Apr-99	105,840	10,080	70,800	186,720	$9,824.07	$832.00	$4,689.08	$15,345.15
Total	888,660	50,000	451,540	1,390,200	$82,726.84	$4,140.75	$30,016.51	$116,884.10

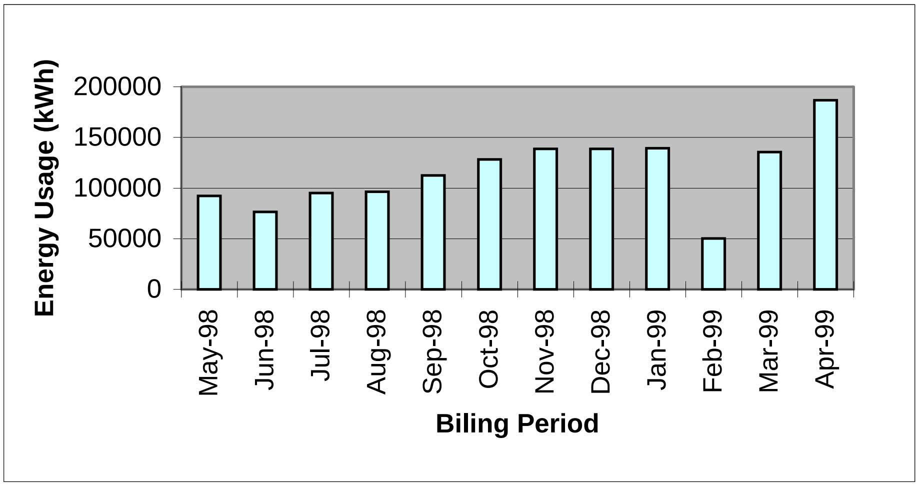
Table 2: Costs for Electric Demand

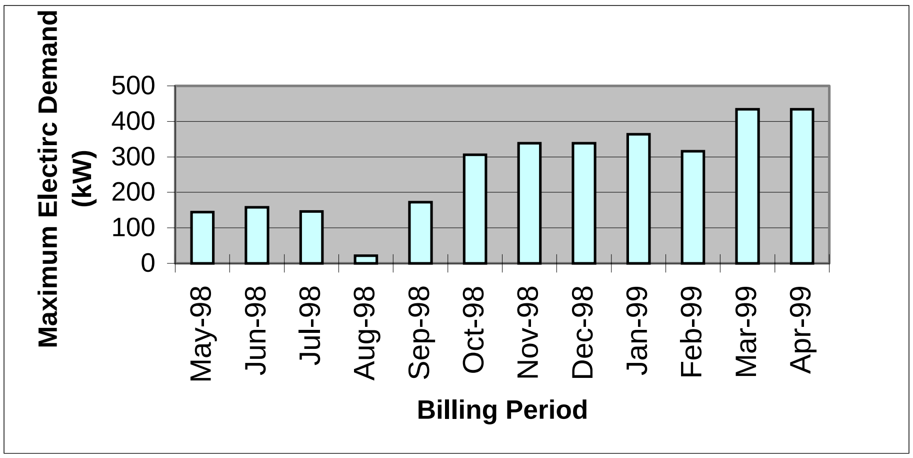
Billing Period	DEMAND (KW)			DEMAND COST			
	Peak	Intermediate	Off-Peak	Peak	Intermediate	Off-Peak	Total
May-98	318	144	292	$2,785.68	$168.48	$341.64	$3,295.80
Jun-98	266	158	264	$2,330.16	$184.86	$308.88	$2,823.90
Jul-98	298	146	292	$2,610.48	$170.82	$341.64	$3,122.94
Aug-98	228	22	266	$2,522.88	$25.74	$311.22	$2,859.84
Sep-98	358	172	352	$2,724.38	$201.24	$411.84	$3,337.46
Oct-98	382	306	352	$2,907.02	$358.02	$411.84	$3,676.88
Nov-98	386	338	358	$2,937.46	$395.46	$418.86	$3,751.78
Dec-98	386	338	358	$2,937.46	$395.46	$418.86	$3,751.78
Jan-99	396	364	380	$3,013.56	$425.88	$444.60	$3,884.04
Feb-99	316	74	296	$2,404.76	$86.58	$346.32	$2,837.66
Mar-99	434	48	401	$3,305.78	$56.16	$468.94	$3,830.88
Apr-99	427	374	434	$3,250.99	$438.05	$508.25	$4,197.29
Total				$33,730.61	$2,906.75	$4,732.89	$41,370.25

Table 3: Total Costs for Electricity

Billing Period	Total Electric Usage (kWhr)	Maximum Demand (kW)	ELECTRIC COSTS			
			USAGE	DEMAND	OTHER	TOTAL
May-98	92,200	144	$7,850.23	$3,295.80	-$547.45	$10,598.58
Jun-98	76,600	158	$6,467.63	$2,823.90	-$392.46	$8,899.07
Jul-98	95,200	146	$7,930.57	$3,122.94	-$577.27	$10,476.24
Aug-98	96,400	22	$8,020.46	$2,859.84	-$589.20	$10,291.10
Sep-98	112,600	172	$9,593.44	$3,337.46	-$750.16	$12,180.74
Oct-98	128,400	306	$10,965.55	$3,676.88	-$907.15	$13,735.28
Nov-98	138,600	338	$11,775.12	$3,751.78	-$1,008.49	$14,518.41
Dec-98	138,600	338	$11,775.12	$3,751.78	-$1,008.49	$14,518.41
Jan-99	139,200	364	$11,767.47	$3,884.04	-$1,014.45	$14,637.06
Feb-99	50,200	316	$4,259.86	$2,837.66	-$130.14	$6,967.38
Mar-99	135,480	434	$11,133.59	$3,830.88	-$977.49	$13,986.98
Apr-99	186,720	434	$15,345.15	$4,197.29	-$1,486.61	$18,055.83
Total	1,390,200		$116,884.19	$41,370.25	-$9,389.36	$148,865.08

Average Unit (KWH) Energy Cost = $148,865.08/1,390,200 = $0.107


Energy Usage (kWh)
200000
150000
100000
50000
0
May-98
Jun-98
Jul-98
Aug-98
Sep-98
Oct-98
Nov-98
Dec-98
Jan-99
Feb-99
Mar-99
Apr-99
Biling Period


Maximum Electirc Demand (kW)
500
400
300
200
100
0
May-98
Jun-98
Jul-98
Aug-98
Sep-98
Oct-98
Nov-98
Dec-98
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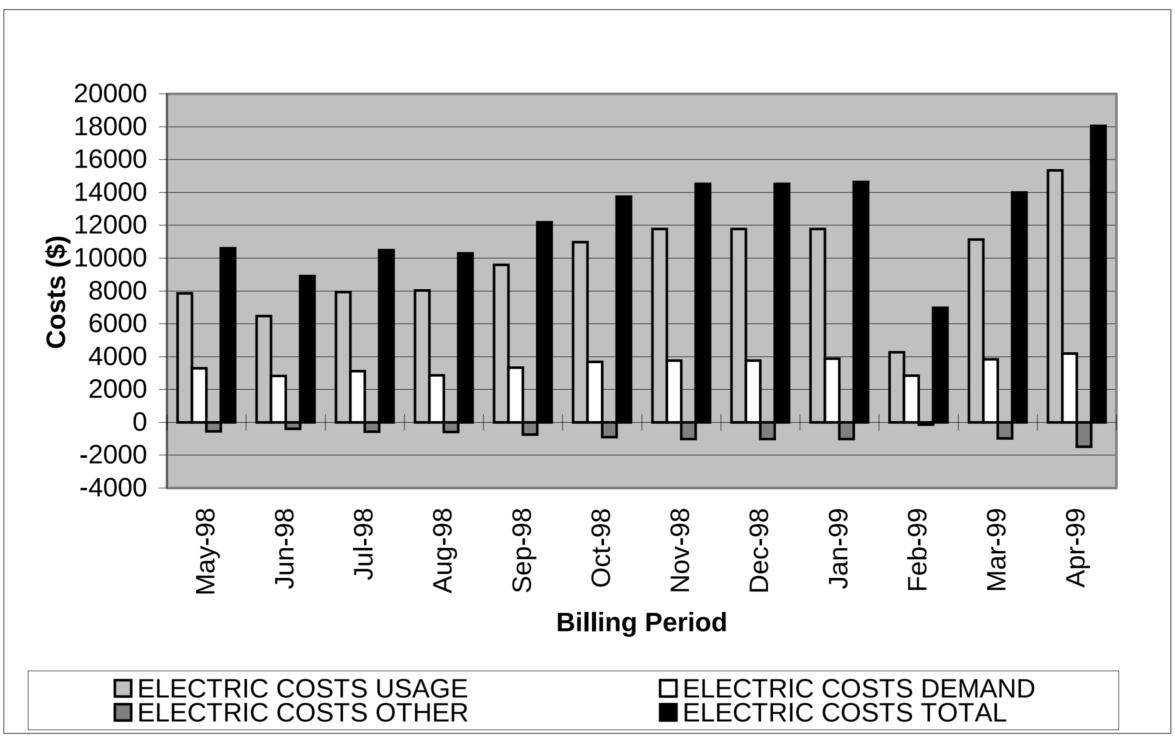
Feb-99
Mar-99
Apr-99
Billing Period


Costs ($)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
May-98
Jun-98
Jul-98
Aug-98
Sep-98
Oct-98
Nov-98
Dec-98
Jan-99
Feb-99
Mar-99
Apr-99
Billing Period
ELECTRIC COSTS USAGE
ELECTRIC COSTS DEMAND
ELECTRIC COSTS OTHER
ELECTRIC COSTS TOTAL

Step 2: List The Major Energy Consuming Equipment In The Plant

The following tables are provided as a starting point for listing your major energy consuming equipment.

1. HEATING, VENTILATING, AIR CONDITIONING

AREA SERVED	NUMBER OF UNITS	BTUH OR TONS	MONTHS / YEAR USED	AVG LOAD	TIMERS?

2. CHILLERS REFRIGERATORS/ FREEZERS

PURPOSE	NUMBER OF UNITS	BTUH OR TONS	HOURS OF OPERATION	COOLANT TEMP	ADDITONAL COMMENTS

3. COMPRESSORS

TYPE	# OF UNITS	HP	HOURS OF OPERATION	AVG LOAD	OUTLET PSI	HIGHEST PSI REQUIRED

4. FANS, FLUID PUMPS, LARGE MOTOR DRIVES

PURPOSE	NUMBER OF UNITS	HP	HOURS OF OPERATION	AVG LOAD	ADDITIONAL COMMENTS

5. BOILERS

PURPOSE	NUMBER OF UNITS	BHP, BTUH, OR KW	HOURS OF OPERATION	AVG LOAD	ADDITONAL COMMENTS

6. FURNACES/OVENS

PURPOSE	NUMBER OF UNITS	BHP, BTUH OR KW	HOURS OF OPERATION	AVG LOAD	ADDITIONAL COMMENTS

Step 3: Identify Savings Opportunities and Gather Relevant Data

A list of common manufacturing sub-systems is listed below. For each subsystem, a checklist is provided to help identify savings opportunities.

Boilers

- ❑ Does boiler operate at high fire during most operational time?
- ❑ Is a program to analyze flue gas for proper air/fuel ratio active?
- ❑ What is the measured 0_2 content and temperature of the flue gas?
- ❑ Is a feed-water treatment program active?
- ❑ Are the steam lines insulated?
- ❑ Is condensate returned from process areas?
- ❑ Is condensate tank insulated?
- ❑ Are there steam leaks?
- ❑ Is flue gas heat energy used for any purpose?

Air Compressors

- ❑ Is the air-compressor system operated at the lowest acceptable line pressure for machinery using compressed air?
- ❑ Is the intake of the air located either outdoors or at the coolest possible location?
- ❑ Is the cooling air for the compressor discharged outdoors in the summer and into areas requiring heat in the winter?
- ❑ With more than one compressor operating, are the compressors sequenced so that rather than operating several at part load, each operating compressor is operating at or near its maximum?
- ❑ If screw compressors and reciprocating compressors are used in parallel, is the screw compressor operated as close to its rated capacity as possible?
- ❑ Are screw compressors shut down when only small amounts of compressed air are in demand (weekends, nights, etc.)?
- ❑ Is the compressor lubricated with a synthetic lubricant?
- ❑ Is there an aggressive program to detect and eliminate leaks?
- ❑ Are filters (air and oil) changed on a regular schedule?

Chillers

- Can cooling tower water be used instead of refrigeration during any part of the year?
- Is chilled water produced at the highest acceptable temperature?
- Is frost forming on the evaporators?
- Can outside air be used in a drying process and instead of conditioned air?

Motors

- Do the motor systems employ direct drives, cog belts, or v-belts?
- Are motors sized with load?
- Can adjustable speed drive controls be utilized?

Systems and Employee Behavior

Certainly individual pieces of equipment will be the major consumers of electricity, but conservation measures are not limited to equipment upgrades. Changes in systems or employee behavior may also result in energy savings. For example, a case study involved disconnecting some rinsing equipment from a light switch in the plant and ended up saving half a million gallons of water in addition to energy. In other plants it may be beneficial to have energy consuming equipment directly connected to other process equipment so that the equipment runs only when the plant is in active production.

Lighting

- Are lighting levels for each area at or below those recommended by the ***American National Standard Practice for Industrial Lighting***?
- Can lighting hours be reduced?
- Are employees trained/encouraged to turn off unnecessary lights?
- What type of lighting is employed (energy efficient fluorescent, High Intensity Discharge)?
- Can delamping be employed?
- Are skylights used? Are they dirty?
- Can motion sensor lighting controls be employed in warehouses, storage areas, etc., where personnel entry is intermittent?
- Is a program to replace old ballasts with an energy efficient type in place? (This is especially important if power factor costs are high.)
- Are ceilings at least 15-20 feet high? If so, Metal Halide or Sodium lamps may be substituted for fluorescent or mercury vapor lamps.
- Is very fine color rendition required? If so energy efficient fluorescent lights should be used.
- Reduce exterior lighting to minimum safe level. Use timers or photocells to turn off exterior lights when daylight permits.

Heating, Ventilating and Air-Conditioning Equipment

- Is building air exchange minimized?
- Is the roof over air-conditioned spaces painted with a reflective paint?
- Inspect any roof-mounted air-conditioners or unit heaters proper maintenance.
- Are roof exhaust fans and other HVAC equipment using notched belts?
- Are filters on roof air intakes clean?
- Is proper thickness of insulation used on walls, ceilings, roofs, and doors?
- Are air seals used around truck loading doors? Are loading doors closed when not in use?
- Are radiant heaters installed in dock area? Are the radiant heaters exposed to wind/convection currents which will significantly reduce their effectiveness?
- Is the plant under negative or positive pressure from either too much exhaust air being drawn out of or too much supply air being blown into the plant? Are exhaust/supply fans shut down during non-working hours?
- Is the temperature of the workspace in a desirable range?
- Are destratification fans used?
- Are set back timers used to control space temperature during non-working hours?

Step 4: Calculate Cost Savings And Implementation Costs

An economic analysis is necessary to make an intelligent decision about implementation of energy savings projects.

- Energy and costs savings associated with the project must be quantified
- Implementation cost must be determined.
- Annual costs associated with the project must be estimated.
- Identify impacts associated with implementation, such as impacts on product quality or production time

It may be useful to identify whether there are any implementation costs or impacts associated with a project beyond the obvious dollar costs and savings. For example, would installation of new lighting or machinery have any negative impacts on product quality? Would new, more efficient machinery reduce the amount of time necessary to produce a product? This might result in increased profits for the facility that can be estimated.

In addition to the calculations listed above, reduction in CO_2 emissions should be calculated. The Energy Information Administration of the US Department of Energy uses an emission coefficient of 117.1 lbs of CO_2 per MMBtu of natural gas in Appendix F of Form EIA-1605EZ, Short Form for Voluntary Reporting of Greenhouse Gases. (The form can be found at **www.eia.doe.gov/oiaf/1605/forms.html)** The Penn-Jersey-Maryland (PJM) Grid carbon dioxide equivalence is 1.3 lbs of CO_2 per KWH.

Sample recommendations for some common energy savings opportunities are presented in this section.

Sample Recommendation #1: Install Condensate Return Line

Energy Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
786 MMBtus/yr	**46 tons**	**$9048**	**$8,075**	**1 year**

Current Practice and Observations:
Currently, a 300HP boiler provides 50 lb. steam for process use. Plant personnel reported that process steam use is usually around 4,000 lbs/hour. The condensate is not returned to the boiler. The direct sewering of condensate results in energy, water, and boiler chemical loss.

Recommended Action:
Install a condensate return line and tank to return the condensate to the boiler.

Anticipated Savings:
Plant personnel estimated that 60% of the condensate could be captured.

(.60)(4,000 lbs/hour)(2340 hrs/yr) = 5,616,000 lbs/year

(5,616,000 lbs/year)(1 gallon/8.34 lb) = 673,382 gallons/year

Energy and cost savings are due to reduced gas usage by the boiler. Condensate entering the boiler will be around 200°F, as opposed to tap water entering at 60°F. Additional cost savings will result from reduced water costs (due to the reduced volume of make-up boiler feedwater from the city water supply), reduced sewer costs and the reduced chemical treatment costs. Savings calculations for this recommendation are included in the Appendix. A summary is presented below:

SAVINGS SUMMARY	
Natural Gas (786MMBtus @ $ .44)	$3,459
Water (673,382 gal @ $ .0058/gal)	$3,906
Sewer (673,382 gal @ $ .0015/gal)	$1,010
Chemicals (673,382 gal @ $ .001/ gal of water treated)	$673
TOTAL	$9048

Implementation Cost:
It is estimated that the proposed condensate return system could be installed for approximately $8,075. A list of items required, with corresponding estimated costs, including installation, is given below. The total cost savings of $9,048 results in a payback period of one year.

250 ft. Pipe, Valves, Fittings, and Hangers	$525
Pipe Insulation	$125
Return pumps	$400
Condensate return tank	$500
Feedwater tank modifications	$125
Labor (320 manhours @ $20/hr)	$6,400
TOTAL	**$8,075**

Sample Recommendation #2: Steam Trap Maintenance

Energy Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
82 MMBtus	**4.8 tons**	**$304**	**$100**	**4 months**

Recommended Action:

A steam trap preventative maintenance program should be instituted. Steam traps are the key to optimum steam condensate system operation. The objective of the steam traps is to remove condensate, air and other non-condensable gases and prevent steam loss. Efficient operation of any steam system requires well designed trapping, which is periodically inspected and properly maintained. In a single day, steam loss can cost more than the trap and labor required to replace it.

The following table shows how costly unattended steam leaks can be:

Cost of Various Sized Leaks at 100 psi (assuming steam costs $5/1000 lbs)[13]

Size in Orifice (in)	Lbs Steam Wasted Per Month	Total Cost Per Month ($)	Total cost Per Year ($)
1/2	835,000	4,175	50,100
7/16	637,000	3,185	38,220
3/8	470,000	2,350	28,200
5/16	325,000	1,625	19,500
1/4	210,000	1,050	12,600
3/16	117,000	585	7,020
1/8	52,500	262.50	3,150

The preventative maintenance program would consist of the following:

- Constructing a detailed drafting schematic showing the location of each steam trap in the facility.
- Designating each steam trap a specific number for ease of identification
- Performing quarterly maintenance checks on steam traps and condensate return systems

[13] Steam Conservation Guidelines for Condensate Drainage, Handbook N-101, 1997 Armstrong International, Inc.

Anticipated Savings:
The mass flow rate due to failed traps must be estimated in order to do the calculations. The following spreadsheet shows calculations for a steam loss was estimated at a mass flow rate of 25 lb/hour.

STEAM TRAP MAINTAINANCE

INPUT DATA IN YELLOW CELLS ONLY; ALL OTHER CELLS ARE CALCULATED.

ENERGY SAVED						
RECOMMENDATION	MASS FLOW RATE (LB/HOUR)	HOURS LINE IS PRESSURIZED	E2 ENTHALPY AT LINE PRESSURE (Btu/lb)	E1 ENTHALPY OF BOILER FEEDWATER (Btu/lb)	BOILER EFFICIENCY	MMBTUS SAVED
REPAIR STEAM TRAPS	25	2340	1174	50	0.8	82.19

ENERGY USAGE SAVINGS CALCULATIONS					CO2 SAVINGS	
RECOMMENDATION	MMBTUS SAVED	THERMS OF NATURAL GAS SAVED	$/THERM	$ SAVED	**LBS OF CO2**	**TONS OF CO2**
REPAIR STEAM LEAKS	82	822	0.37	$304	**9,625**	**5**

The formulas used in the cells containing calculations are as follows:

MMBTUS SAVED = Mass Flow Rate (lb/hr) * Hours Line Is Pressurized * (E_2-E_1)/Boiler Efficiency/1000000

THERMS OF NATURAL GAS SAVED = MMBTUS SAVED * 10

$ SAVED = THERMS OF NATURAL GAS SAVED * $/THERM

CO_2 SAVINGS (LBS) = 117.1 * MMBTUS SAVED
(An emission coefficient of 117.1 lbs of CO_2 per MMBtu of natural gas is used by the Energy Information Administration of the US Department of Energy in Appendix F of Form EIA-1605EZ, Short Form for Voluntary Reporting of Greenhouse Gases.)

Implementation Cost:
Replacement of the failed steam trap is estimated at $100. In order to implement the steam traps management program, the company may need to recruit one of the maintenance staff to do this work. The total cost savings of $304 results in a payback period of 4 months.

Sample Recommendation #3: Insulate Steam Pipes

Energy Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
181.8 MMBtus	**10.6 tons**	**$1,018**	**$693**	**8 months**

Current Practice and Observations:

Several locations throughout the facility contain un-insulated vertical steam pipes. These pipes, which consist of high-pressure steam lines and condensate return lines, have surface temperatures exceeding 240F. The surface of pipes maintained at such high temperatures is not only a source of energy loss, but is also a potential source for worker injury due to accidental contact.

The following table is a summary of uninsulated steam pipe measurements.

LOCATION	LENGTH	DIAMETER	AREA	T (F) Hot/Cold
#1	15 ft	1.25 in	58.9 ft^2	240 / 190 F
#2	18 ft	1.25 in	70.6 ft^2	240 / 190 F
#3	15 ft	1.25 in	58.9 ft^2	240 / 190 F
#4	10 ft	1.25 in	39.3 ft^2	240 / 190 F

Recommended Action:

It is recommended that fiberboard pipe insulation be used to insulate exposed piping. This type of insulation is both durable and resilient and will adequately fulfill the facilities needs.

Anticipated Savings:

The values of heat loss for both exposed pipes and insulated pipes were obtained from a pipe insulation software package entitled *Heat Pipe.*

The values for heat loss due to insufficient insulation on supply steam pipes are as follows:

	Uninsulated Supply Line	Insulated Supply Line	Uninsulated Condensate Line	Insulated Condensate Line
Nominal Pipe Size (in)	1	1	1	1
Actual Pipe Diameter (in)	1.3	1.3	1.3	1.3
Process Temperature (F)	280	280	180	180
Average Ambient Temperature (F)	75	75	75	75
Emittance	0.8	0.8	0.8	0.8
Heat loss (BTU/ft2/hr)	**508**	**20.6**	**209**	**9.59**

Multiplying the obtained values for heat loss by individual pipe surface area will yield heat loss per hour. These values are summarized in the following table:

Heat Loss (BTU / HR)				
Location	Uninsulated Supply Line	Insulated Supply Line	Uninsulated Condensate Line	Insulated Condensate Line
#1	29,921	1,213	12,310	564
#2	35,864	1,454	14,755	677
#3	29,921	1,213	12,310	564
#4	19,964	821	8,213	376

The total heat loss per hour can be obtained by estimating a usage factor for the equipment, which utilizes the steam. Calculations for energy, CO_2, energy and cost savings for each of these locations are included below. A summary is shown below:

Energy and Cost Savings						
Location	Usage Factor	hr/year	Total Hours per year	Energy Savings (therms)	Average cost per therm	Annual Cost Savings
#1	0.67	2,080	1386.7	560.96	$0.56	$314.14
#2	0.67	2,080	1386.7	672.37	$0.56	$376.53
#3	0.25	2,080	520.0	210.36	$0.56	$117.80
#4	0.67	2,080	1386.7	374.12	$0.56	$209.51
				1,817.81		**$1,017.98**

CO2 SAVINGS	
LBS	TONS
6,569	3.28
7,873	3.94
2,463	1.23
4,381	2.19
21,287	10.64

Implementation Cost:

It is estimated that approximately 115 feet of fiberboard pipe insulation is needed.

Fiber Board Pipe Insulation
Temp Range: 50F - 1200F
K Factor: .25 at 100 F
Thickness: 1 inch
Cost: $4.49/foot

Aluminum Jacketing with Moisture Guard
Width: 48 in
Length/roll: 100 ft
Cost/roll: $147

Therefore, the total implementation cost = $4.49(115) + $147 (1.2) = $692.75

Sample Recommendation #4: Duct Outside Air To Compressor Intake

Energy Savings	Demand Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
11,568 kWhrs/yr	2.8 kW	7.5 tons	$1,168	$575	6 months

Current Practice and Observations:

The facility uses a 50 HP air compressor continuously for two shifts per day to supply compressed air to various processes. The air compressors draw air from inside the compressor room. The temperature inside the compressor room was measured at 96 F.

Recommended Action:

Outside air should be ducted to the intakes of the air compressors instead of air inside the compressor room. This is because the amount of work done by an air compressor is proportional to the temperature of the intake air. Less energy is needed to compress cool air than to compress warm air. On average outside air is cooler than air inside compressor room. This is often the case even on very hot days. Ducting can be installed so that cooler outside air can be supplied to the intake of the compressor. This should be simple and cost effective since the compressor is located adjacent to an exterior wall.

Savings

Calculations for energy, CO_2, and cost savings for this recommendation are presented below.

DEMAND SAVINGS CALCULATIONS									
RECOMMENDATION	# OF UNITS	HP	COMPRESSOR EFFICIENCY	USAGE FACTOR	HP CONVERTED TO kW	REDUCTION FACTOR	LOAD FACTOR	WORK REDUCTION	DEMAND (Kw)
OUTSIDE AIR FOR 50 HP COMPRESSOR	1	50	0.9	1	37	0.94	0.96	0.07	2.8

ENERGY USAGE SAVINGS CALCULATIONS									CO2 SAVINGS
RECOMMENDATION	HRS/YR ON-PEAK	HRS/YR INTER-MEDIATE	HRS/YR OFF PEAK	TOTAL HRS/ YEAR	kWHRS/YR ON-PEAK	kWHRS/YR INTER-MEDIATE	kWHRS/YR OFF PEAK	TOTAL kWHRS/ YEAR	LBS OF CO2
OUTSIDE AIR FOR 50 HP COMPRESSOR	2912	0	1248	4,160	8098	0	3471	11,568	15,039

COST SAVINGS CALCULATIONS									
RECOMMENDATION	ON-PEAK USAGE RATE	INTER-MEDIATE USAGE RATE	OFF-PEAK USAGE RATE	ANNUAL USAGE COST SAVINGS	OCT-MAY ON-PEAK DEMAND RATE	JUN-SEPT ON-PEAK DEMAND RATE	ALL YEAR INTER-MEDIATE AND OFF-PEAK	ANNUAL DEMAND COST SAVINGS	TOTAL ANNUAL COST SAVINGS
OUTSIDE AIR FOR 50 HP COMPRESSOR	$0.08	$0.07	$0.06	$856	$7.61	$8.76	$1.17	$312	$1,168

Implementation Cost:

Cost for material and labor of 2 men for 1 day is estimated at $575, resulting in a payback period of 6 months.

Sample Recommendation #5: Replace Motors With Premium Efficient Motors

Energy Savings	Demand Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
4,632 kWhrs/yr	1.1 kW	6,002 lbs	$468	$ 676	1.4 yrs

Existing Practices and Observations:

Energy usage for the most essential, heavily used motors are presented in the table below. Calculations are based on the assumption that the plant operates 4160 hours annually and that the load and usage factors are as stated above.

Number Of Motors	Annual Operating Hours, (hr/yr)	Size (HP)	Electric Consumption (kWhr/yr)	Cost @$.09/kWhr ($)
12	4,160	3	96,900	8,720
3	4,160	5	40,400	3,630
1	4,160	7.5	20,200	1,820
1	4,160	50	151,200	13,610

Electrical Consumption is calculated as follows:

$$EC = N \times H \times HP \times UF \times LF \times K \times 1/EFF$$

Where N= number of motors considered
H= annual operating time (hrs/yr)
HP = rated power (hp)
UF = usage factor (estimated)
LF = load factor (estimated)
K = conversion of horsepower to kW (0.746 kW/hp)
EFF = Full load efficiency

A conservative value of 83% for full load motor efficiency has been used for calculations involving all motors except the 50 HP. The 50 HP full load motor efficiency is 92.6%.

Recommended Action:

When replacement of motors must be made, a choice exists between premium efficiency and EPACT efficiency motors. (See ***Implementing A Motor Management Program*** in the Appendices.) We recommend that when the most heavily used motors fail, they be replaced with premium efficiency motors instead of EPACT efficiency motors.

Savings:

The calculations demonstrate savings achieved when all motors EXCEPT the 50 HP are replaced with premium efficiency motors. The efficiency of the 50HP motor is 92.6% for a full load and 93% for a 75% load. A premium efficiency motor is available with a 95% efficiency for a price difference of $1200. The annual savings of $386 results a payback period in excess of 3 years. Unless the current 50 HP motor fails, replacing it with a higher efficiency model would not be cost effective.

Assessment Recommendation: Motor Management

INPUT DATA IN YELLOW CELLS ONLY; ALL OTHER CELLS ARE CALCULATED.

Vacuum Pump Motors

DEMAND SAVINGS CALCULATIONS

RECOMMENDATION	# OF UNITS	HP	EPACT EFFICIENCY	PREMIUM EFFICIENCY	USAGE FACTOR	LOAD FACTOR	HP CONVERTED TO kW	DEMAND (Kw)
3 HP VACUUM PUMP MOTORS	12	3	86.5%	89.5%	0.9	0.80	2	**0.7**
5 HP VACUUM PUMP MOTORS	3	5	87.5%	89.5%	0.9	0.8	4	**0.2**
7.5 HP VACUUM PUMP MOTORS	1	7.5	88.5%	91.7%	0.9	0.8	6	**0.2**
								1.1

ENERGY USAGE SAVINGS CALCULATIONS

RECOMMENDATION	HRS/YR ON-PEAK	HRS/YR INTER-MEDIATE	HRS/YR OFF PEAK	TOTAL HRS/ YEAR	kWHRS/YR ON-PEAK	kWHRS/YR INTER-MEDIATE	kWHRS/YR OFF PEAK	TOTAL kWHRS/ YEAR
3 HP VACUUM PUMP MOTORS	2912	0	1248	4,160	2181	0	935	**3,116**
5 HP VACUUM PUMP MOTORS	2912	0	1248	4,160	599	0	257	**856**
7.5 HP VACUUM PUMP MOTORS	2912	0	1248	4,160	462	0	198	**661**
				0	0	0	0	**0**
				0	0	0	0	**0**
								4,632

COST SAVINGS CALCULATIONS

RECOMMENDATION	ON-PEAK USAGE RATE	INTER-MEDIATE USAGE RATE	OFF-PEAK USAGE RATE	ANNUAL USAGE COST SAVINGS		OCT-MAY ON-PEAK DEMAND RATE	JUN-SEPT ON-PEAK DEMAND RATE	ALL YEAR INTER-MEDIATE AND OFF-PEAK	ANNUAL DEMAND COST SAVINGS
3 HP VACUUM PUMP MOTORS	$0.08	$0.07	$0.06	$231		$7.61	$8.76	$1.17	$84
5 HP VACUUM PUMP MOTORS	$0.08	$0.07	$0.06	$63		$7.61	$8.76	$1.17	$23
7.5 HP VACUUM PUMP MOTORS	$0.08	$0.07	$0.06	$49		$7.61	$8.76	$1.17	$18
				$343					**$125**

Sample Recommendation #6: Disconnect Unnecessary Metal Halide Lamps

Energy Savings	Demand Savings	CO_2 Reduction	Dollar Savings	Implementation Cost	Payback Period
19,968 kWHrs/yr	4.8 kW	19,968 lbs	$2016	$150	1 month

Existing Practice and Observations:
Building #XXX is illuminated by both natural light and metal halide lamps.

Recommended Action:
The most widely used industrial lighting standards are those developed by the Illuminating Engineering Society of North America (IES). The American National Standards Institute's (ANSI) standard, "Practice for Industrial Lighting", is adopted from IES. The following table is from the IES Handbook.

Table III-3. Lighting Level Standards

TYPE OF ACTIVITY	LUMINANCE FOOT-CANDLES	REFERENCE WORK PLANE	CATEGORY
Public spaces with dark surroundings	2...5	General lighting	A
Simple orientation for short, temporary visits	5...10		B
Working spaces where visual tasks are sometimes done	10...20		C
Performance of visual tasks of high contrast	20...30	Luminance on task	D
Performance of visual tasks of medium contrast	50...75		E
Performance of visual tasks of low contrast	100...150		F
Performance of visual tasks of low contrast for a long Period of time	200...300	Illumination of task Obtained by local Lighting	G
Performance of very long and exacting visual tasks	500...750		H
Performance of special visual tasks of small size	1000...1500		I

After an inspection of Building #XXX, the recommendation is to disconnect 15 unnecessary metal halide lamps.

Savings

Calculations for energy, CO_2, and cost savings for each of these lighting recommendations is presented below.

INPUT DATA IN YELLOW CELLS ONLY; ALL OTHER CELLS ARE CALCULATED.

DEMAND SAVINGS CALCULATIONS			
RECOMMENDATION	# OF FIXTURES	WATTS/ FIXTURE	**DEMAND (Kw)**
DISCONNECT UNNECESSARY HALIDE LAMPS	15	400	**6.0**

ENERGY USAGE SAVINGS CALCULATIONS									CO2 SAVINGS
RECOMMENDATION	HRS/YR ON PEAK	HRS/YR INTER-MEDIATE	HRS/YR OFF PEAK	TOTAL HRS/YEAR	kWHRS/YR ON-PEAK	kWHRS/YR INTER-MEDIATE	kWHRS/YR OFF PEAK	**TOTAL kWHRS/ YEAR**	**LBS OF CO2**
DISCONNECT UNNECESSARY HALIDE LAMPS	2340	0	0	2340	14,040	0	0	**14,040**	**18,252**

COST SAVINGS CALCULATIONS									
RECOMMENDATION	ON-PEAK USAGE RATE	INTER-MEDIATE USAGE RATE	OFF-PEAK USAGE RATE	ANNUAL USAGE COST SAVINGS	OCT-MAY ON-PEAK DEMAND RATE	JUN-SEPT ON-PEAK DEMAND RATE	ALL YEAR INTER-MEDIATE AND OFF-PEAK	ANNUAL DEMAND COST SAVINGS	**TOTAL ANNUAL COST SAVINGS**
DISCONNECT UNNECESSARY HALIDE LAMPS	$0.08493	$0.07516	$0.06557	$1,192	$7.43	$8.56	$1.05	$651	**$1,844**

Implementation Cost:

Since this recommendation consists of simply disconnecting excess lighting, the implementation cost consists of pay received by laborers disconnecting the lights which can be estimated at 12 fixtures X 1/2 hour/fixture X $25/manhour X 1 man = $150.

PART 4: CONTINUED FEEDBACK AND ANALYSIS

Energy management efforts should not stop upon the implementation of an energy savings measure. On a regular basis, whether monthly or annually, progress toward conservation goals should be examined and a new set of goals defined. All goal setting will depend on the opportunities for energy conservation which data analyses have uncovered. Data listings and plots such as those presented in the previous sections should be used as a minimum to aid in the measurement and analysis of conservation efforts.

APPENDICES

Appendix 1: Conversion Factors

The conversion factors required are:

ENERGY UNIT	ENERGY EQUIVALENT
1 kWh	3,412 BTU
1 Therm	100,000 BTU
1 Cu. Ft. of Natural Gas	1,000 BTU
1 gallon #2 Oil	140,000 BTU*
1 gallon #4 Oil	144,000 BTU*
1 gallon #6 Oil	152,000 BTU*
1 gallon propane	91,600 BTU*
1 ton coal	28,000,000 BTU*
1 boiler horsepower	9.81 KW
1 horsepower	746 KW
1 ton refrigeration	12,000 BTU/hr

*varies slightly with supplier

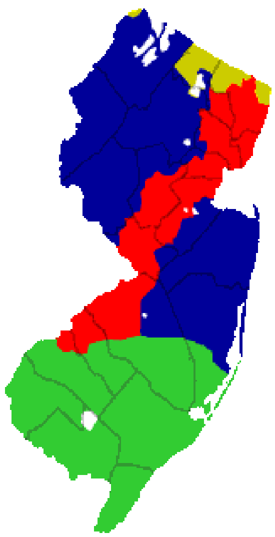
Appendix 2: Useful Equipment

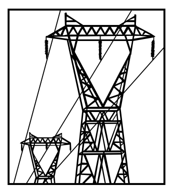
- Thermocouple or thermometer for:
    - (a) Temperature of Liquids
    - (b) Air Temperature
    - (c) Surface Temperatures of machines, furnaces, steam lines, etc.
- Combustion Analyzer for measuring O_2 (oxygen) levels in flue gases and their temperature
- Light meter for measuring lighting levels in different areas of plant
- Vibration meter
- Tape Measure
- Tachometer
- Gloves
- Flashlights
- Wire brushes

Appendix 3: NJ Energy Choice

NJ Energy Choice- Electricity

The map below shows the **Electric Distribution Companies** in NJ. They own the power lines and other equipment needed to handle the transmission and distribution of electricity to your business.





ELECTRIC DISTRIBUTION COMPANIES

GPU ENERGY
ROCKLAND ELECTRIC COMPANY
PSE&G
CONECTIV POWER DELIVERY

A list of Electric Generation Suppliers current as of 12/1/2000 is included below. For the most current information about electric supply and distribution in NJ, visit **www.state.nj.us/bpu**
A list of Suppliers licensed by the NJ BPU and associated with each of the distribution companies is also available at **www.state.nj.us/bpu/**.

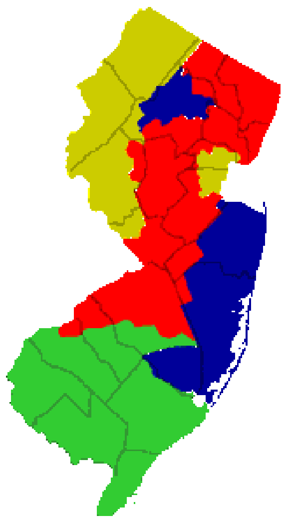
ELECTRIC SUPPLIERS

SUPPLIER	AVAILABILITY IN UTILITY SERVICE TERRITORY			
	CONNECTIV	GPU	PSE&G	ROCKLAND
AES Power Direct (888) 721-5100 www.powerdirect.com	Yes	Yes	Yes	No
All Energy Marketing (732) 356-2580 www.allenergy.com	Yes	Yes	Yes	No
Allegheny Energy (888)-232-4642 www.alleghenyenergysupply.com	Yes	Yes	Yes	No
Amerada Hess Corp. (800)-437-7872 www.hess.com	Yes	Yes	Yes	Yes
Central Hudson Enterprises (800) 628-1566 www.chenergy.com	No	No	Yes	No
Con Edison Solutions (888) 665-0955 www.conedsolutions.com	No	Yes	Yes	No
Conectiv Energy (888) 600-4198 www.conectiv.com	Yes	No	Yes	No
DTE Energy Marketing (888) 289-7937 www.dtece@dteenergy.com	Yes	Yes	Yes	No
Duke Solutions 800-427-8368 www.dukesolutions.com	Yes	Yes	Yes	No
ECONnergy Energy 800-805-8586 www.ECONnergy.com	Yes	Yes	Yes	Yes
Electric America (888) 817-8572 www.electric.com	Yes	No	Yes	No
Energy America (888) 305-3828 www.energyamerica.com	No	No	Yes	No
Enron Energy Services (800) 837-9584 www.ees.enron.com	No	Yes	Yes	No
Exelon Energy (800) 965-5795 www.exeloncorp.com	Yes	Yes	Yes	No
FirstEnergy Services 800-977-0500 www.firstenergyservices.com	Yes	Yes	Yes	No
FPL Energy Services (877) 375-4674 www.fplenergyservices.com	No	No	Yes	No
GASMARK (908) 624-1794 www.ugienergyservices.com	No	Yes	Yes	No
GPU Advanced Resources (800) 791-6261 http://www.gpuar.com/	Yes	Yes	Yes	No
Green Mountain.Com (888) 246-6730 www.greenmountain.com	Yes	Yes	Yes	No

SUPPLIER	AVAILABILITY IN UTILITY SERVICE TERRITORY			
	CONNECTIV	**GPU**	**PSE&G**	**ROCKLAND**
KeySpan Energy Services 888-KEYSPAN www.keyspanenergy.com/	Yes	Yes	Yes	No
Metromedia Energy (800) 828-9427 www.metromediaenergy.com	Yes	Yes	Yes	Yes
NewEnergy East (800) 638-1879 www.newenergy.com/	No	No	No	Yes
Niagara Mohawk Energy (888) 758-6888 www.nmenergy.com	Yes	Yes	Yes	Yes
NUI Energy, Inc. 888-NUIEnergy www.nuienergy.com/	Yes	No	Yes	No
Pepco Energy Services (800) 363-7499 www.pepco-services.com	Yes	Yes	Yes	No
PP&L Energy Plus (877) 375-8726 www.pplenergyplus.com	Yes	Yes	Yes	No
PSEG Energy Technologies (888) 972-7734 www.energytech.pseg.com	Yes	No	Yes	No
Reliant Energy Retail, Inc. (877) 216-6726 www.reliantenergy.com	No	No	No	No
Select Energy, Inc. (888) 810-5678 http://www.selectenergy.com/	Yes	Yes	Yes	Yes
SmartEnergy.com (87S)MART007 www.smartenergy.com	Yes	Yes	Yes	Yes
South Jersey Energy Solutions (800)756-3749 www.sjindustries.com/sje.htm	Yes	Yes	Yes	Yes
Statoil Energy, Inc.(877) 782-8645 www.statoilenergy.com	Yes	No	No	Yes
Strategic Energy Ltd. 888-448-5559 http://www.sel.com/	Yes	Yes	Yes	Yes
Total Gas and Electric (800) 517-9006 www.info@totalng.com	Yes	Yes	Yes	No
TXU Energy Services (609)-983-7007 www.txu.com	Yes	Yes	Yes	Yes
Utilimax.com (800) 611-8570 www.utilimax.com	Yes	Yes	Yes	No
Utility.com (800) UTILITY www.utility.com	Yes	Yes	Yes	Yes
Woodruff Energy (856) 455-1111	Yes	No	No	No

NJ Energy Choice-Natural Gas

The map below shows the **Natural Gas Distribution Companies** in NJ. They own the pipelines and other equipment needed to handle the transmission and distribution of natural to your business.



NATURAL GAS DISTRIBUTION COMPANIES

NUI ELIZABETHTOWN GAS
NJ NATURAL GAS COMPANY
PSE&G
SOUTH JERSEY GAS COMPANY

A list of Natural Gas Suppliers current as of 12/1/00 is included below. For the most current information about natural gas supply and distribution in NJ, visit **www.njenergychoice.com**. A list of Natural Gas Suppliers licensed by the NJ BPU and associated with each of the Distribution Companies is also available at **www.state.nj.us/bpu/wwwroot/energy/Gassupplierlist.htm**.

NATURAL GAS SUPPLIERS

SUPPLIER	AVAILABILITY IN UTILITY SERVICE TERRITORY			
	Elizabeth-town	**NJ Natural**	**PSE&G**	**South Jersey Gas**
All Energy Marketing (732) 356-2580 www.allenergy.com	Yes	Yes	Yes	Yes
Amerada Hess Corp. (800) 437-7872 www.hess.com	Yes	Yes	Yes	Yes
Castle Power (888) 381-6262 www.castleoil.com	No	Yes	Yes	No
Central Hudson (800) 628-1566	No	No	Yes	No
Conectiv Energy (800) 616-0600 www.conectiv.com/energy	Yes	Yes	Yes	Yes
ConEdison Solutions (888) 665-0955 www.conedsolutions.com	Yes	Yes	Yes	Yes
Cooperative Industries (800)628-9427 www.cooperativenet.com	Yes	Yes	Yes	Yes
Duke Solutions Inc. www.dukesolutions.com	Yes	Yes	Yes	Yes
ECONnergy Energy Co., Inc. www.econnergy.com	Yes	Yes	Yes	Yes
End-Users, Inc. (800) 239-9142	Yes	Yes	Yes	Yes
Enron Energy Services (800) 837-9584 www.ees.enron.com	Yes	Yes	Yes	Yes
Exelon Energy (800) 965-5789 www.exeloncorp.com	Yes	Yes	Yes	Yes
FirstEnergy Services (800) 977-0500 www.firstenergyservices.com	Yes	Yes	Yes	Yes
FSG Energy Services (732) 370-5236 www.fsgenergy.com	No	No	Yes	No
GASMARK (908) 624-1794 www.gasmark.com	Yes	Yes	Yes	Yes
KeySpan Energy (888) 539-7726 www.keyspanenergy.com	Yes	Yes	Yes	Yes
Metromedia Energy (877) 750-7047 www.metromediaenergy.com	Yes	Yes	Yes	Yes
NATGASCO (800) 840-4GAS www.mitchellsupreme.com	No	Yes	Yes	Yes

SUPPLIER	AVAILABILITY IN UTILITY SERVICE TERRITORY			
	Elizabeth-town	**NJ Natural**	**PSE&G**	**South Jersey Gas**
National Fuel Resources (800) 839-9993 www.nfrinc.com	No	Yes	Yes	Yes
Niagara Mohawk Energy (888) 758-6888 www.nmenergy.com	Yes	No	Yes	Yes
NJR Natural Energy (888) 653 6374 www.njne.com	No	Yes	No	No
NUI Energy (908) 242-5830 www.nui.com	Yes	Yes	Yes	Yes
Pepco Energy Services (800) 363-7499 www.pepco-services.com	No	Yes	Yes	Yes
Perry Gas Companies (800) 973-7794 www.perrygas.com	No	Yes	Yes	Yes
PP&L EnergyPlus Co. (877) 375-8726 www.pplenergyplus.com	Yes	Yes	Yes	Yes
PSEG Energy Technologies (888)972-7734 www.energytech.pseg.com	Yes	Yes	Yes	Yes
Reliant Energy Retail, Inc. (888) 299-8661 www.reliantenergy.com	Yes	Yes	Yes	Yes
Select Energy, Inc. (888) 810-5678 www.selectenergy.com	Yes	Yes	Yes	Yes
SmartEnergy.Com (87S)MART007 www.smartenergy.com	No	Yes	Yes	No
South Jersey Energy (800) 756-3749 www.sjindustries.com	Yes	Yes	Yes	Yes
Sprague Energy Corp. (800) 225-1560 www.spragueenergy.com	Yes	Yes	Yes	Yes
Statoil Energy, Inc. (877) 782-8645 www.statoilenergy.com	Yes	No	No	No
The New Power Company (877) 901-7090 www.newpower.com	No	Yes	No	No
Tiger Natural Gas (888) 225-1560 www.tigernaturalgas.com	No	No	Yes	No
Total Gas & Electric, Inc. (800) 517-9006 www.info@totalng.com	Yes	Yes	Yes	Yes
TXU Energy Services www.txu.com	Yes	No	Yes	Yes
U.S. UtiliPro Solutions, LLC www.upsolutions.net	No	Yes	No	No
Woodruff Energy (856) 455-1111	Yes	Yes	Yes	Yes

TECHNICAL REFERENCES

Implementing A Motor Management Program

A motor needs to be replaced after its useful life passes, but the question is, should you replace the motor with an EPACT efficiency motor, a premium efficiency motor, or have it rewound? The Energy Policy Act (EPACT), which became effective as of October 1997, set minimum standards for most industrial motors. EPACT covers general-purpose, T-frame, foot-mounted, continuous-rated, polyphase, squirrel-cage, induction motors of National Electrical Manufacturers Association (NEMA) designs A and B that are manufactured for sale in the United States rated 1 through 200 horsepower. EPACT also applies to 6 pole (1200 rpm), 4 pole (1800 rpm), and 2 pole (3600 rpm) open and enclosed motors. EPACT does not apply to definite-purpose motors or special purpose motors. EPACT makes provision for the Secretary of Energy to expand the scope of motors covered to include motors less than 1 hp or greater than 200 hp. Although many manufacturers now sell premium motors that meet these efficiency standards, most currently available motors do not. EPACT should increase the availability of energy-efficient motors for many end-use applications. In addition to motor efficiency standards, EPACT requires testing procedures and labeling.

NEMA Threshold Full-Load Nominal Efficiency Values for Energy-Efficient Motors										
Open Motors						Enclosed Motors				
hp	3600	1800	1200	900		hp	3600	1800	1200	900
1	-	82.5	80.0	74.0		1	72.5	82.5	80.0	74.0
1.5	82.5	84.0	84.0	75.5		1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	85.5	85.5		2	84.0	84.0	86.5	82.5
3	84.0	86.5	86.5	86.5		3	85.5	87.5	87.5	84.0
5	85.5	87.5	87.5	87.5		5	87.5	87.5	87.5	85.5
7.5	87.5	88.5	88.5	88.5		7.5	88.5	89.5	89.5	85.5
10	88.5	89.5	90.2	89.5		10	89.5	89.5	89.5	88.5
15	89.5	91.0	90.2	89.5		15	90.2	91.0	90.2	88.5
20	90.2	91.0	91.0	90.2		20	90.2	91.0	90.2	89.5
25	91.0	91.7	91.7	90.2		25	91.0	92.4	91.7	89.5
30	91.0	92.4	92.4	91.0		30	91.0	92.4	91.7	91.0
40	91.7	93.0	93.0	91.0		40	91.7	93.0	91.7	91.0
50	92.4	93.0	93.0	91.7		50	92.4	93.0	93.0	91.7
60	93.0	93.6	93.6	92.4		60	93.0	93.6	93.0	91.7
75	93.0	94.1	93.6	93.6		75	93.0	94.1	93.6	93.0
100	93.0	94.1	94.1	93.6		100	93.6	94.5	93.6	93.0
125	93.6	94.5	94.1	93.6		125	94.5	94.5	94.1	93.6
150	93.6	95.0	94.5	93.6		150	94.5	95.0	94.1	93.6
200	94.5	95.0	94.5	93.6		200	95.0	95.0	95.0	94.1
250	94.5	95.4	95.4	94.5		250	95.4	95.0	95.0	94.5
300	95.0	95.4	95.4	-		300	95.4	95.4	95.0	-
350	95.0	95.4	95.4	-		350	95.4	95.4	95.0	-
400	95.4	95.4	-	-		400	95.4	95.4	-	-
450	95.8	95.8	-	-		450	95.4	95.4	-	-
500	95.8	95.8	-	-		500	95.4	95.8	-	-

In many cases the old model numbers for motors are still used, but efficiency of the motor is actually higher than an old motor with the same model number. ***Premium*** efficient motors on the market today ***exceed*** EPACT standards. Some examples of cost and payback period for premium efficient and EPACT efficient motors are listed below. The given price differences are estimates based on list prices. Motors can normally be purchased from vendors at prices much lower than list price.

Motor size (HP)	Estimated Premium Efficiency	Minimum EPACT* Efficiency	Purchase Cost Difference	Energy Cost Savings	Payback Period (years)
3	89.5	86.5	$40	$26	1.5
5	89.5	87.5	$43	$29	1.5
7.5	91.7	88.5	$55	$67	0.8

The decision to replace a motor with an EPACT efficiency motor, a premium efficiency motor, or have it rewound can be more easily made if a motor survey is conducted and if life cycle costs between the alternatives are considered. The motor survey should include the voltage, current, power factor, and operating speed under typical operating conditions per motor. Begin the survey by concentrating on motors that exceed minimum size and operating duration criteria that include:

- Three-phase NEMA design B motor
- Non-specialty motor
- 10 to 600 HP
- At least 2000 hours per year of operation
- Constant load (not intermittent, cyclic, or fluctuating)
- Older or rewound standard efficiency motors

Use the above information along with the program MotorMaster 3.0, which is available for free download from http://www.oit.doe.gov/bestpractices/software_databases/software.shtml. Divide your motors into three categories:

- **Replace Immediately – Motors Offering Rapid Payback through Energy Savings, Improved Reliability, or Utility Rebates.** These include motors that run continuously (typically 8000 or more hours a year), are currently inefficient (including oversized motors), must be reliable, or are covered by attractive utility rebate programs. Order an efficient replacement motor soon and install it at the next available opportunity, such as during a scheduled downtime.

- **Replace at Time of Failure –** Motors with Intermediate Payback. When these motors fail, you will want to replace them with an energy-efficient model. Now is the time to contact motor dealers to review the efficiency and prices of available motors. After identifying the most cost-effective replacement model you must decide whether to purchase it and keep it on hand as a spare, or wait to purchase it until existing motor fails. This choice depends on how quickly an energy-efficient motor can be obtained through suppliers, how quickly a failed motor must be replaced, and how many motors of the same size and type are used in your facility.

- **Leave Present Situation as is –** Motors with Extended Payback. These motors are already reasonably efficient or are used less than 2000 hours each year. They can be rewound or replaced with a similar motor.

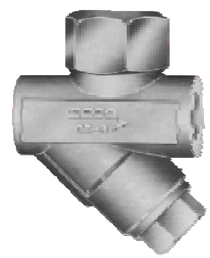
Steam Trap Maintenance

There are many types of steam traps, since there are many different types of applications. Each type of trap has a range of applications for which it is best suited. All traps can be divided into two groups regarding their operation mode: continuous flow and intermittent flow traps. Continuous flow traps will continuously discharge condensate. These are float, thermostatic and fixed orifice traps. Intermittent traps will cycle open and closed. These traps are the thermodynamic, inverted bucket and bimetallic.

The following table contains a listing of several different types of steam traps as well as the pros and cons of each trap and their mechanical operation. It should be noted that these are not the only configurations for each type of trap, but the most common.

Float and Thermostatic (F&T)

Inverted Bucket



Thermodynamic

Ball Float

Characteristic	Inverted Bucket	F&T	Disc	Thermostatic
Method of Operation	Intermittent	Continuous	Intermittent	Intermittent
Energy Conservation	Excellent	Good	Poor	Fair
Resistance to Wear	Excellent	Good	Poor	Fair
Corrosion Resistance	Excellent	Good	Excellent	Good
Resistance to Hydraulic Shock	Excellent	Poor	Excellent	Poor
Vents Air and CO2 at Steam Temp	Yes	No	No	No
Ability to Vent Air at Low Pressures	Poor	Excellent	NR	Good
Ability to Handle Start-Up Air Loads	Fair	Excellent	Poor	Excellent
Operation Against Back Pressure	Excellent	Excellent	Pair	Excellent
Resistance to Damage Due to Freezing	Good	Poor	Good	Good
Ability to Purge System	Excellent	Fair	Excellent	Good
Performance on Light Loads	Excellent	Excellent	Poor	Excellent
Response to Slugs of Condensate	Immediate	Immediate	Delayed	Delayed
Ability to Handle Dirt	Excellent	Poor	Poor	Fair
Physical Size	Large	Large	Small	Small
Ability to Handle Flash Steam	Fair	Poor	Poor	Poor
Mechanical Failure (Open/Closed)	Open	Closed	Open	Open/Closed

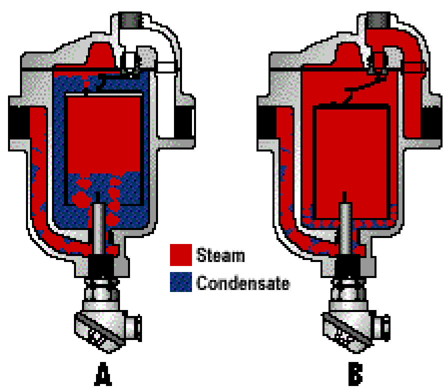
There are four main categories of online trap inspection: thermal, visual, acoustic and electronic.

Thermal inspection relies on upstream/downstream temperature variations in a trap. It includes infrared testing (temperature measurement with an infrared gun – usually when the trap is not easily accessible), pyrometer and color change testing (heat sensitive crayons or paints that change color when temperature rises above a predetermined level).

Acoustic methods use one of various forms of listening devices such as stethoscopes, screwdrivers and ultrasonic instruments. Generally, they are more reliable, but require a presence of a properly trained inspector.

Visual - The simplest way to determine the operational status of a trap is to observe trap discharge. One can often determine if a trap is blowing live steam or if it is not properly draining condensate by opening the trap and observing its discharge.

Electronic testing uses a multiple sensing probe inserted into the bottom of the steam trap (see figure below). The probe detects the presence of condensate and determines the temperature. Data can be processed thorough a PC or PLC and transmitted by modem to any location.



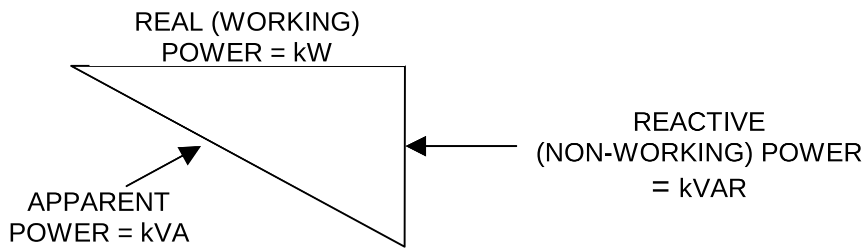
Good record keeping is essential. To begin with, traps should be tagged and mapped. A mapping and tagging system will assure that these traps are maintained. There are many ways to systematize data and to keep records. The result should be useful records such as cost analysis of the work performed. Also, analytic ability is needed to determine the status of all the traps within a system including those failed, blocked, leaking, out of service or operating well. Take advantage of one of software packages that are available on the Internet. For example, free software can be downloaded from the following web site**:**
http://www.armstrong-intl.com/products/traps/stsoftware.html

Ideally, a survey will be conducted by in-house trained inspectors who will routinely inspect their steam traps. However, even in plants that have trained inspectors, steam traps often are neglected due to the lack of manpower for surveys. In these situations, plants can benefit from using professional services.

Power Factor

The diagram below helps to explain what power factor is and why an electric utility is concerned with your facility's power factor.

$$PF = \frac{kW}{kVA}$$



Power Factor is the ratio of **Real Power**, measured in kilowatts (kW) to **Apparent Power**, measured in kilovolt-amps (kVA).

- **Apparent Power** is the amount of power provided to your facility by the electric utility.
- **Reactive Power** is non-working power, and is measured in kVARs. Inductive loads (e.g. transformers, electric motors, and high intensity discharge lighting) are a major portion of the power consumed in industrial facilities, and they require current to create a magnetic field. The current used to create the magnetic field is required to operate the device, but does not produce work.
- **Real Power** is the work done by the device, and is measured in kW.

If your facility draws **100** kW Real Power and **100** kVAR Reactive (magnetizing) Power, then your utility must provide your facility with Apparent Power of **142** kVA. The power factor is 70%, which means that only 70% of the current provided by the electrical utility is being used to produce useful work.[14]

[14] Reducing Power Factor Cost, US Department of Energy Fact Sheet #