Rebuild Michigan

Energy Services

# Introductory Energy Evaluation

## Superior County
## Superior, Michigan

Prepared by:

Brandy J. Minikey - Staff Engineer

Energy Office
Michigan Department of
Labor & Economic Growth
611 W Ottawa – Fourth Floor
P.O. Box 30221
Lansing, MI 48909
Phone: (517) 241-8235
Fax: (517) 241-6229

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# Executive Summary

On November 12, 2003, a walk-through audit was conducted in the Superior County buildings to identify opportunities for reducing energy consumption and costs. The walk-through of each building consisted of a visual inspection of electrical, mechanical and HVAC equipment, temperature controls, and lighting. An analysis was also made of the buildings' energy use based on information obtained for each facility.

From the results of this Introductory Energy Evaluation, a Comprehensive Technical Energy Analysis (CTEA) conducted by a qualified engineering firm is recommended as your next step. A summary of energy conservation opportunities (ECOs) is included in this report. Although your maintenance and technology staff can readily implement some of the listed ECOs such as timers and computer software, other ECOs require a more significant investment and should be appropriately analyzed. Among major ECOs, heating and cooling system modifications, an energy management system, water conservation measures, motor replacements and lighting seem to be cost-effective. A professional engineer can best determine the cost, savings and payback for any number or combination of ECOs through a Comprehensive Technical Energy Analysis (CTEA).

Assistance in hiring a qualified engineering firm to conduct a CTEA and in locating funding for the implementation of ECOs is available through the Energy Office. There are 59 consulting firms that have been pre-qualified to perform Technical Energy Analyses under Rebuild Michigan Energy Services. *There is a cost for this phase of the program,* and the cost can vary depending on the consulting firm. You may want to request bids from 3-5 firms on the list.

***The Michigan Energy Office offers two financial assistance options for the TEA step: an incentive that will cover up to 50% of the TEA cost and an interest-free 18-month loan to cover the remaining cost of your TEA.***

The State of Michigan's Energy Office will review the engineering study before it is finalized, provide feedback, and monitor the utility bills for one year after the ECOs are installed to account for the actual energy savings achieved. Troubleshooting will also be provided if savings are lower than expected

# Energy Use Analysis

The total cost of energy over the past year at Superior County buildings included in this report was $1,745,218. Electricity accounted for 62% of the total cost at $1,088,514. Natural gas was responsible for the remaining 38% of the total at $656,704.

Using monthly utility bills for the past year, the Energy Use Index (EUI) in Btu per square foot per year (Btu/sq.ft./year) was calculated for each building. Figure 1 on the next page graphs the EUI for each building compared to the average EUI for similar buildings in Michigan. Energy use in Btu/sq.ft./year for each building is shown as the combined natural gas (yellow bar) and electricity energy use (blue bar).

As shown in Figure 1, all of the Superior County buildings, except the Health Dept. and Downtown Office, have higher EUI's than the average for similar Michigan buildings. Even though the Downtown Office building is below the Michigan average there is opportunity to save additional dollars by completing recommended efficiency measures. The Health Department also appears to be below the Michigan average however this is because there is no steam usage reported for this building. Once the new condensate meters are added and accurate steam use can be recorded then an accurate assessment of this building can be made. A high EUI in the above mentioned buildings could be the result of building envelope infiltration, over ventilating areas, over heating, inefficient equipment and lighting.

Figure 2 is a graph of the total energy cost per square foot per year ($/sq.ft./year), or Energy Cost Index (ECI), for each building compared to the average ECI for similar buildings in Michigan. The Superior County buildings are all over the Michigan average. both gas consumption (over heating due to envelope infiltration and no nightly temperature set-backs) and primarily electric consumption (air conditioning, lighting, and motors that run continuously) can result in higher costs per square foot.

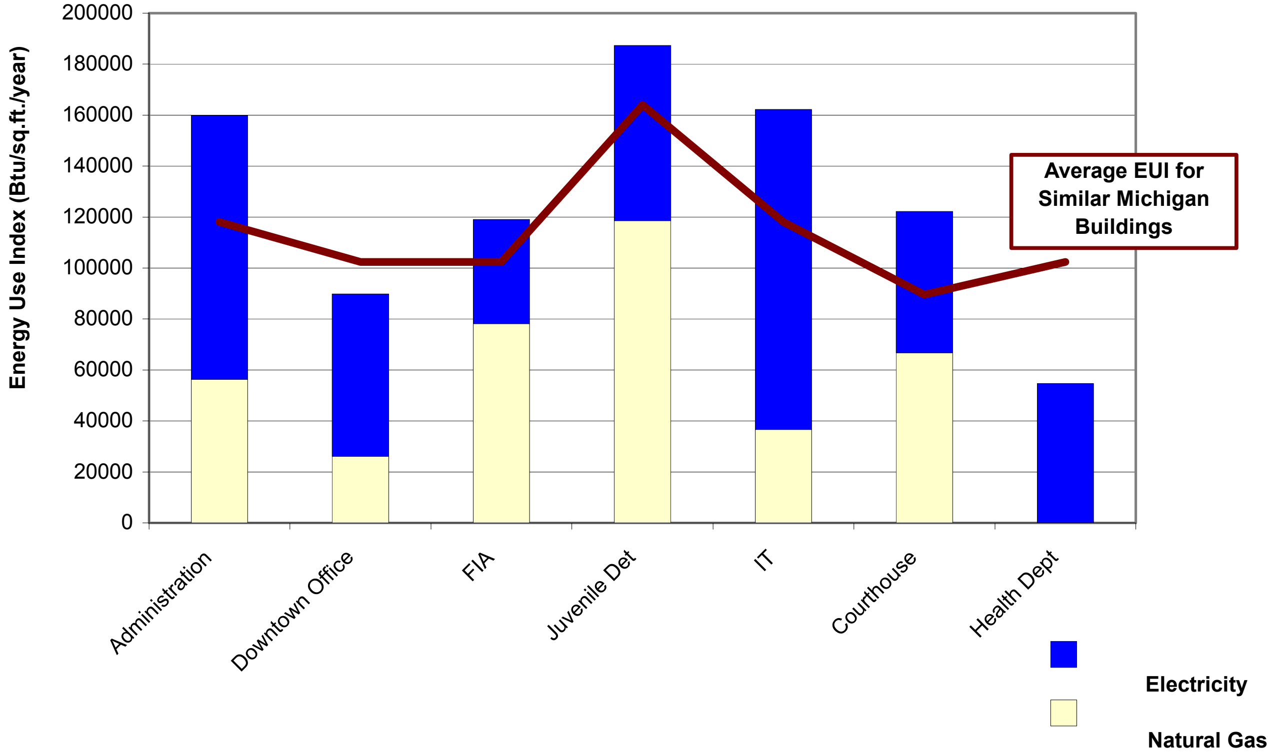
**Your Energy Cost Savings Potential**

Using the information in figure 2, it could be concluded that if the Administration, Downtown Office, FIA, Juvenile Detention, and the Health Department's energy usage were reduced to the Michigan average, annual savings of more than $440,000 would be possible. If the majority of the ECM's from this report were implemented, it is likely that these buildings will consume less than the average for Michigan buildings, making the annual savings potential even higher.

From information obtained during the walk-through, it is estimated that there is potential for lowering both energy use and cost per square foot in all of the buildings. Heating and cooling system modifications, an energy management system, water conservation measures, motor replacements and lighting appear to offer the most cost-effective energy saving opportunities, but many of the low-cost ECOs listed could also provide good savings.

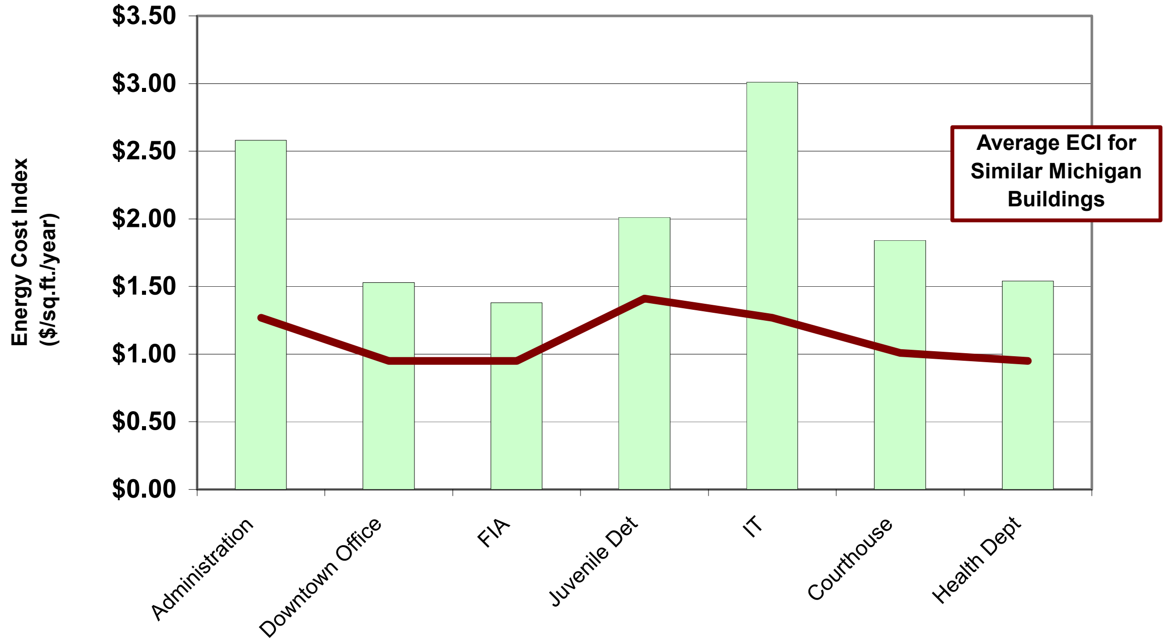
*NOTE: Appendix A contains individual energy consumption profiles for each building.*

# Figure 1 - Energy Use Index (EUI) Benchmark




| Name of Building | Natural Gas Use (Btu / sq.ft. / year) | Electricity Use (Btu / sq.ft. / year) | Total EUI (Btu / sq.ft. / year) | Average EUI for Similar Building |
|---|---|---|---|---|
| Administration | 56,379 | 103,408 | **159,787** | **118,057** |
| Downtown Office | 26,146 | 63,671 | **89,817** | **102,378** |
| FIA | 78,187 | 40,865 | **119,052** | **102,378** |
| Juvenile Det | 118,589 | 68,739 | **187,328** | **164,039** |
| IT | 36,652 | 125,621 | **162,273** | **118,057** |
| Courthouse | 66,718 | 55,526 | **122,244** | **89,539** |
| Health Dept | 0 | 54,684 | **54,684** | **102,378** |

## Figure 2 - Energy Cost Index (ECI) Benchmark




| Name of Building | Natural Gas Cost ($ / sq.ft. / year) | Electricity Cost ($ / sq.ft. / year) | Total ECI ($ / sq.ft. / year) | Average ECI for Similar Building |
|---|---|---|---|---|
| Administration | $0.78 | $1.80 | **$2.58** | **$1.27** |
| Downtown Office | $0.36 | $1.17 | **$1.53** | **$0.95** |
| FIA | $0.48 | $0.90 | **$1.38** | **$0.95** |
| Juvenile Det | $0.73 | $1.28 | **$2.01** | **$1.41** |
| IT | $0.48 | $2.53 | **$3.01** | **$1.27** |
| Courthouse | $0.92 | $0.92 | **$1.84** | **$1.01** |
| Health Dept | $0.61 | $0.93 | **$1.54** | **$0.95** |

# Summary of Your Energy Conservation Opportunities

| Energy Conservation Opportunity (ECO) | Applicable Building | ECO Additional Benefits |
|---|---|---|
| 1) **LED Exit Sign Lighting**<br>Complete replacement of exit signs with LED units. LED retrofit lamps can be used in some fixtures, while others may need to be replaced with LED fixtures. 75%-95% savings are possible for exit sign lighting. | All Buildings | Reduce maintenance…<br>LED exit signs and retrofit lamps have 25-year life cycles. |
| 2) **Occupancy Sensors**<br>Use occupancy sensors to control lighting and exhaust fans. Rooms with irregular use, restrooms, storage areas and offices usually are the best possibilities. | All Buildings | |
| 3) **T8 Fluorescent Lighting (with electronic ballasts)**<br>Replace/retrofit standard T12 fluorescent light fixtures with T8 fluorescent fixtures. A minimum savings of 30% on lighting can be achieved. | Administration<br>FIA<br>Health Dept<br>Downtown Office<br>Juvenile Detention | Improve visual acuity; often can *increase* lighting levels; improve student performance |
| 4) **Timer for Water Heating Circulator Pump**<br>Install timer on circulator pump to shut off domestic water heating loop during unoccupied building hours. | Administration<br>Health Dept. | Reduce pump motor maintenance. |
| 5) **Water Conservation**<br>Install low flow kits in toilet and waterless urinals to save 20-60%. Replace faucet aerators with low flow 1.0-gpm aerators to save at least 50%. | Administration<br>FIA<br>Health Dept<br>Downtown Office<br>IT | Water heating system size can be reduced; shower quality often improved. |
| 6) **Adjust Cooling Temperature**<br>Consider a review of current cooling temperatures in comparison to recommended levels. Substantial energy savings *may* be achieved (for *FREE*) by adjusting thermostats in all buildings. | All Buildings | |
| 7) **Adjust Heating Temperature**<br>Consider a review of current heating temperatures in comparison to recommended levels. Substantial energy savings can often be achieved (for *FREE*) by adjusting thermostats or energy management systems. | All Buildings | |
| 8) **Energy Management System**<br>Install an energy management system (EMS) with day-night heating temperature control to allow overnight setback and control heating/cooling system operation. | Administration<br>FIA<br>Downtown Office<br>IT<br>Juvenile Detention | Improve comfort, control, air quality and ventilation; extend equipment life. |
| 9) **Cogged V-Belts**<br>Replace standard v-belts with cogged v-belts for HVAC air handlers and air compressors. | Administration<br>FIA<br>Health Dept<br>Juvenile Detention | |
| 10) **Pipe and Condensate Tank Insulation**<br>Add pipe insulation to hot water and steam piping in all Mechanical rooms and long lengths of pipe. Also add insulation to the Condensate tank to reduce the amount of heat loss into the boiler room. | Administration<br>FIA, Health Dept<br>Downtown Office<br>IT<br>Juvenile Detention | Improved workplace safety by avoiding hot surfaces.<br><br>Improved conditions in the boiler room. |

| Energy Conservation Opportunity (ECO) | Applicable Building | ECO Additional Benefits |
|---|---|---|
| **11) Steam Trap Maintenance**<br>Inspect and repair/replace any faulty steam traps in boiler system. Also adapt a yearly maintenance program. | Administration<br>FIA, Health Dept<br>Downtown Office<br>IT<br>Courthouse | Improve comfort and heating system control. |
| **12) Demand Controlled Ventilation with $CO_2$ Monitoring**<br>Reduce over-ventilation at applicable locations with intermittent occupancy. Most useful in large areas that are irregularly occupied. | Courthouse | |
| **13) Variable Frequency Drives**<br>adjust fan or pump motor speeds according to building occupancy schedules | Downtown Office<br>Administration | |
| **14) Drinking Fountain Timers**<br>Control plug-in drinking fountain operation with a 24-hour plug-in timer. | All Buildings | Extend equipment life. |
| **15) Upgrade Pop Machines**<br>Disconnect lamps and ballasts inside pop machine, or consider installing power controllers activated by occupancy sensors. Investigate new styles of vending machines that have these features built in. | All Buildings | Reduce pop machine cooling load; extend equipment life. |
| ***) Enable Computer Power-Down Feature**<br>Check your computers to make sure the power-down feature is activated. | All Buildings | Extend equipment life. |
| ***) ENERGY STAR Appliances, Computers, Office Equip.**<br>Be sure to specify new appliances, computers and office equipment with U.S. EPA ENERGY STAR rating. | All Buildings | |
| ***) Premium Efficiency Motors**<br>When replacing pump, air handler fan or other motors, be sure to specify premium efficiency motors… any additional cost will be recovered quickly in energy savings. | All Buildings | Improve power quality. |
| ***) High Efficiency Transformers** | All Buildings | |
| ***) Roof Insulation**<br>When roof replacement becomes necessary, be sure to specify two-inches (minimum) rigid foam insulation… additional cost will be recovered in energy savings. | Administration<br>FIA, Health Dept<br>Downtown Office, IT<br>Juvenile Detention | Improve comfort. |

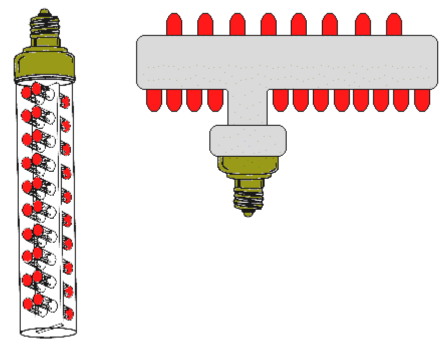
***  ECO for future consideration when replacement is necessary.**

# Discussion of Energy Conservation Opportunities

The individual ECOs from the Summary of Energy Conservation Opportunities are discussed below. The energy savings for most ECOs will likely pay for the implementation cost in less than six years… sometimes much less. ECOs involving major building improvements (windows, doors, wall insulation, etc.), sophisticated energy management systems or HVAC system replacements will require an engineering study to determine cost-effectiveness.

## ECO # 1: LED Exit Sign Lighting

The development of light emitting diodes (LEDs) has allowed the replacement of exit sign lighting with a more energy efficient alternative. Multiple LEDs, properly configured, produce equivalent lighting and consume 95% less electricity than incandescent bulbs and 75% less than energy-efficient compact fluorescent lamps. A major benefit is the 25-year life cycle rating of LEDs… they virtually *eliminate* exit sign maintenance.



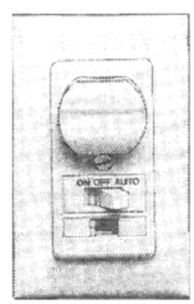
Some lamps can be replaced with LED retrofit lamps that draw only 1-2 watts each. These are screw-in conversions, so installation is quick and easy… rewiring is not necessary. If converting an existing exit sign is not possible, it may be cost-effective to replace it completely with a new LED exit sign fixture.

Consider replacing any remaining incandescent and compact fluorescent fixtures with LED fixtures for immediate energy and maintenance savings.

## ECO # 2: Occupancy Sensors

Motion and temperature can be used to indicate occupancy. When there are no occupants in the area being monitored, the lights will be turned off by the sensors.

*Passive infrared* sensors react to changes in heat, such as the pattern created by a moving person. The control must have an unobstructed view of the building area being scanned... doors, partitions, stairways, etc. will block motion detection and reduce its effectiveness. The best applications for passive infrared occupancy sensors are open spaces with a clear view of the area being monitored.



**Passive Infrared Occupancy Sensor (replaces wall switch)**

*Ultrasonic* sensors transmit sound above the range of human hearing and monitor the time it takes for the sound waves to return. A break in the pattern caused by any motion in the area triggers the control. Ultrasonic sensors can see around obstructions and are best for areas with cabinets and shelving, restrooms and open areas requiring 360-degree coverage.

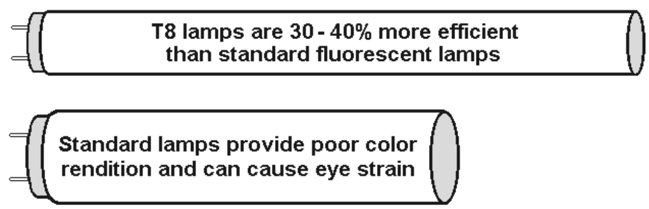
| BUILDING AREA | SAVINGS |
|---|---|
| Offices | 25 to 50% |
| Classrooms | 20 to 25% |
| Rest Rooms | 30 to 75% |
| Storage Areas | 45 to 65% |

Some occupancy sensors utilize *both* passive infrared and ultrasonic technology, but are usually more expensive. They can be used to control one lamp, one fixture or many fixtures. The table on the left provides typical savings achievable for specific building areas, as determined by EPA studies, with the average savings being 60%.

Throughout the buildings, consider the use of occupancy sensors to control bathroom lighting and exhaust fans. Bathroom exhaust fans are often times overlooked and run round-the-clock, causing higher heating loads and greater electrical usage. Other rooms with irregular use like storage areas, certain offices or classrooms are good possibilities, too. You may have to experiment with several types of sensors at several different room locations to find the best fit for your situation. A qualified lighting engineer can help determine the best occupancy sensor solution for your buildings.

## ECO # 3: T8 Fluorescent Lighting (with electronic ballasts)

The new T8 fluorescent lamps, powered by electronic ballasts, use *30-40% less* energy than standard T12 fluorescent lamps. T8 lamps are available in common lengths, but 4-foot T8s are most popular. Fixtures with 8-foot lamps can often be retrofitted with 4-foot lamps (end to end)… they're more stable, less expensive and have a 33% longer life than the 8-foot lamps.



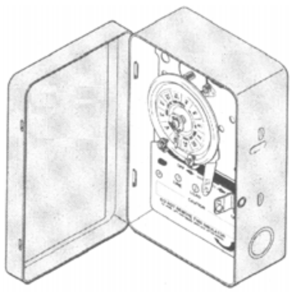

In most cases, older fixtures are replaced with new high efficiency fixtures pre-wired with T8 lamps and electronic ballasts. However, when existing fixtures are in good condition, it is possible to replace just the ballast(s) and lamps.

Besides energy efficiency, T8 fluorescent lighting provides higher quality illumination. Color rendition is better and there is no detectable *flicker* (often exhibited by standard fluorescent fixtures). As a result, visual acuity is improved. There are even studies showing increased student performance under T8 lighting.

Consider replacement of T12 fluorescent lighting with T8 fluorescent lighting at all Superior County Buildings. Immediate replacement of older T-12 fixtures that still utilize magnetic ballasts will provide substantial energy savings. A detailed lighting audit would be very beneficial to determine the financial benefits of this measure. There is a high potential for significant savings in your county; the sooner the project is completed the sooner the savings will be realized.

## ECO # 4: Timer for Water Heating Circulator Pump

Circulator pumps regularly operate twenty-four hours a day and the domestic water heating system has to cycle more frequently to maintain temperature. Shutting down circulator pumps overnight or whenever the building is unoccupied (for at least 6 hours) is recommended. Electricity savings are gained by shutting down the pump, but over 50% of the *total* savings are directly due to reduced water heater cycling.

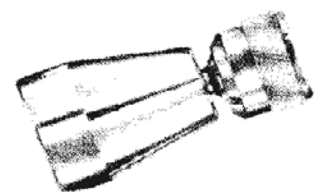

Electro-mechanical Timer

Electro-mechanical timers are the typical choice for controlling hot water circulator pumps. They do, however, need to be hard-wired into the circuit. If the pump plugs directly into a wall outlet, a lower cost option is a 24-hour plug-in timer. Either way, the savings will usually justify the cost.

## ECO # 5: Water Conservation

***Low Flow Showerheads (1.5-gallons per minute)***

Low flow showerheads that use only 1.5-gallons per minute (gpm) can often reduce shower water consumption by more than 50%. Studies show that even a 0.25-gpm reduction is cost-effective to implement in most cases. The best units reduce water flow but increase water velocity to produce a sufficient spray. Acceptance and satisfaction is very high with premium-grade low flow showerheads.


1.5-gpm Low Flow Showerhead

***Low Flow Kits for Toilets and Urinals***

To conserve water in schools or public buildings with older bathroom facilities, low flow or water use reduction kits can be installed in toilet and urinal flush valves. Low flow kits reduce the amount of water required to flush a typical toilet or urinal by 0.5-1.5 gallons per flush. The kits are inexpensive (less than $25) and available at most plumbing supply companies. Low flow toilet kits would make sense for Superior County buildings, also see waterless urinals below.

***Low Flow Faucet Moderators (1.0-gallon per minute)***

Low flow faucet moderators can reduce water use through faucets substantially for a water/sewer cost savings. In the case of hot water, an energy savings can be achieved, too. Good moderators maintain adequate pressure and the effect of a full stream of water while reducing the flow rate (a 50-75% reduction is possible). They are easy to install and cost about $3 each (premium-grade moderators).


1.0-gpm Moderator for Bathroom Faucet

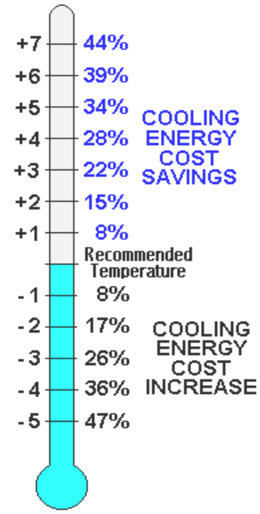
***Waterless Urinals***

Water free Systems are environmentally friendly and cost efficient. They offer a variety of urinal models, all designed to accommodate a revolutionary cartridge. These urinals require absolutely no water. Each cartridge saves more than 9,000 gallons of water. As a result of not using water you will also reduce your sewer

expenses by lowering the volume of waste. Waterless urinals also offer a more sanitary "hands free" usage and are less susceptible to vandalism.

## ECO # 6: Adjust Cooling Temperature

Temperature requirements for school buildings vary with occupancy schedules and the type of activities being conducted. For example, the recommended cooling temperature for classrooms and offices is 76°F when the building is occupied. Higher settings are often possible in corridors, storage areas, restrooms and gymnasiums, while lower settings are usually necessary for computer rooms. When air conditioning a school building, you should try to keep the cooling temperature at the highest possible setting while still maintaining comfort. As the graphic on the right illustrates, the savings can be quite significant for this measure. For example, it can cost up to *36% more* to cool offices and classrooms to 72°F rather than 76°F.

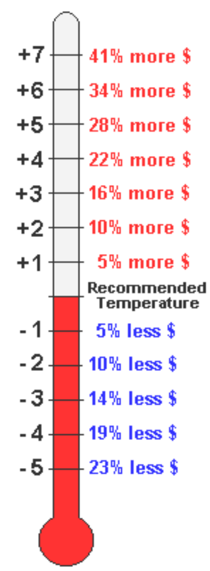



| BUILDING AREA | Recommended Temperature °F |
|---|---|
| Classrooms, Offices | 76 ° F |
| Cafeterias, Auditoriums | 76 ° F |
| Computer Rooms | 74 ° F |
| Restrooms | 78 ° F |
| Gymnasiums | 78 ° F |
| Corridors | 80 ° F |
| Storage Rooms | 82 ° F |

Recommended cooling temperatures for various building areas during occupied hours are shown on the left. (Ideally, the air conditioning should be shut off when the building is unoccupied, but studies have shown that over half of the savings available are achieved with just a 5-degree increase… even minor temperature increases during unoccupied hours can produce a good savings).

## ECO # 7: Adjust Heating Temperature

Heating requirements in buildings will vary with the type of activity being conducted. For example, the recommended heating temperature for classrooms and offices is 68°F. However, cooler levels are often possible in other areas such as computer rooms, corridors and gymnasiums. Generally speaking, you should try to keep the temperature at the lowest possible level while still maintaining comfort for occupants. As the graphic on the right illustrates, the savings can be quite significant for this measure. For example, it can cost up to 22% more to heat a building area to 72°F rather than the recommended setting of 68°F. Likewise, you could save up to 14% by dialing down from 68°F to 65°F.




| BUILDING AREA | Recommended Temperature °F |
|---|---|
| Classrooms, Offices | 68 ° F |
| Cafeterias, Auditoriums | 68 ° F |
| Computer Rooms, Shop | 65 ° F |
| Restrooms | 65 ° F |
| Corridors | 62 ° F |
| Gymnasiums | 55 ° F |
| Storage Rooms | 55 ° F |

Recommended heating temperatures for various building areas are shown on the left. The temperatures apply to occupied building hours; a reduction to 55°F is recommended when building areas are unoccupied. Studies show that over half of the savings available are achieved in the first 5-degree setback… even a minor temperature setback during unoccupied building hours can produce a substantial savings.

You may want to consider reviewing current heating temperatures in comparison to recommended levels. Significant energy savings can often be achieved for *FREE* by adjusting thermostats or energy management systems. Also, consider lowering the temperature in large rooms that have irregular occupancy when they are not in use.

## ECO # 8: Energy Management System (EMS)

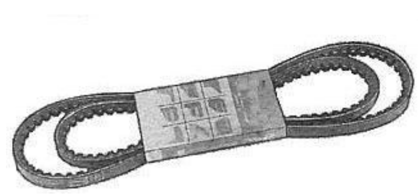
Controlling energy usage in county buildings can be a difficult undertaking, depending on the type of activity that is being conducted at the facility. Normally, there are several energy systems operating at the same time such as lighting, space heating/cooling and water heating. Attempting to control these systems manually is generally difficult, inefficient and costly. If the systems are fairly complex, energy efficient control is often beyond the capabilities of clock thermostats, timers and other simple programmable devices. An energy management system (EMS) could be the best option for energy efficient and cost effective operation under these circumstances.

There is a wide variety of EMS equipment on the market. Basic models are available that control building temperatures and the heating, ventilation and air conditioning (HVAC) system. More advanced EMS units can control and monitor building operations and provide computer printouts of almost unlimited options regarding energy use by each system. A *central* EMS can do this for multiple buildings… energy use can be monitored and controlled for all buildings from a central location.

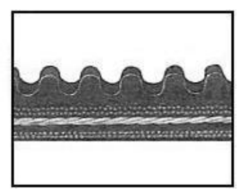
At Superior County, an energy management system (EMS) to control day-night heating temperature allowing overnight setback (now operating at constant temp 24 hours/day in most building areas) and heating system operation (reset for boilers, air handler run time, fresh air, etc.) would appear to be very cost-effective.

## ECO # 9: Cogged V-Belts

Motors and belts are commonly utilized for heating, ventilating and air-conditioning (HVAC) systems and air compressors. One of the natural inefficiencies in these systems is the *slip* that occurs between a standard v-belt and the sheaves on which it is mounted. This reduces power transmission from the motor to the equipment being driven. Studies show that replacing standard v-belts with cogged v-belts can reduce slip and improve system efficiency by as much as 8%.



COGGED V-BELT



Cogged v-belts cost a little more than standard v-belts but they also have longer life cycles, which more than offsets the extra cost. The energy savings produced by improved system efficiency often pay for the cost of installing cogged v-belts in a matter of months.

At the Administration, FIA, Juvinile Detention and Health buildings, you should consider replacement of standard v-belts with cogged v-belts on HVAC system air handlers.

## ECO # 10: Pipe and Condensate Tank Insulation

Uninsulated heating pipes and condensate receiving tanks were observed during the walkthrough in the Superior County Buildings. This causes the load on the heating system to increase and the energy consumed for heating and cooling is increased. Some areas of the building could even be difficult to heat comfortably. The cost to insulate the heating pipes will quickly pay in energy savings. The boiler room will also be more comfortable in the winter time if insulation is added to the bare pipes because the unnecessary heating of the room will not be taking place.

## ECO # 11: Steam Trap Maintenance

A steam system has steam traps to remove air, carbon dioxide and condensate from the pipe distribution system while holding in the useful steam to heat the building. A failed trap can block steam distribution to some areas of the system and cause severe heating problems (lack of heat in these areas). Or, it could fail in the open position, allowing steam to pass through the system without releasing its full heating potential. This can cause overheating in building areas the return steam lines pass through. Either situation will reduce the overall efficiency of the heating system and increase energy costs.

National surveys estimate that 15-60% of the steam traps now in use have failed. For this reason, annual testing of steam traps by a licensed HVAC contractor/technician is recommended and is usually very cost effective. Detection and replacement cost of one failed trap can pay for itself in energy savings in a matter of months. Inspection and repair/replacement of any faulty steam traps in the boiler system at all Superior County buildings that are steam heated should be strongly considered.

## ECO # 12: Demand Controlled Ventilation with Carbon Dioxide Monitoring

Carbon dioxide is exhaled from building occupants; concentrations rise as occupancy levels increase. Carbon dioxide levels correlate with other bio-effluents such as odors, particulates, bacteria, and perfumes. Monitoring carbon dioxide levels helps facilitate ventilation decisions that allow occupant comfort and energy savings balance. Carbon dioxide amount exhaled by occupants is diluted with outdoor ventilation air introduced by mechanical ventilation and air leakage. If outdoor air carbon dioxide concentrations are known, the difference between indoor and outdoor carbon dioxide concentrations can provide outdoor air amount indication that is being introduced to a space on a cfm per person basis. Carbon dioxide control is officially accepted by American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE); interpretation IC 62-1989-27 was passed which clarifies its use to modulate ventilation based on actual versus design occupancy.

When a building is designed, the outdoor ventilation air delivered to interior spaces is based on providing outdoor ventilation air to meet building full occupancy requirements. For a classroom this would be 15 cfm per person times the space design occupancy at delivery system ventilation effectiveness. This ventilation rate is maintained during all occupied hours resulting in unnecessary over-ventilation during intermittent occupancy. Demand-controlled ventilation (DCV) using carbon dioxide can save energy by reducing ventilation when occupancy is below full occupancy assumed by original designers. Ventilation rates can track occupancy more closely with DCV using carbon dioxide.

Actual energy savings is dependent on how variable space occupancy is. If a classroom is fully occupied all day such as in elementary schools, and ventilation system is properly sized, savings will be small. If moderate variation takes place, such as one or two unoccupied periods and two or three periods below full occupancy, ventilation rates of 30% to 50% are possible without compromising per person ventilation requirements. Auditoriums, meeting and conference rooms, and classrooms are candidates for DCV since occupancy varies in these applications. Payback is usually less than two years. Consider DCV at the Courthouse to reduce the amount of over-ventilation in unused courtrooms.

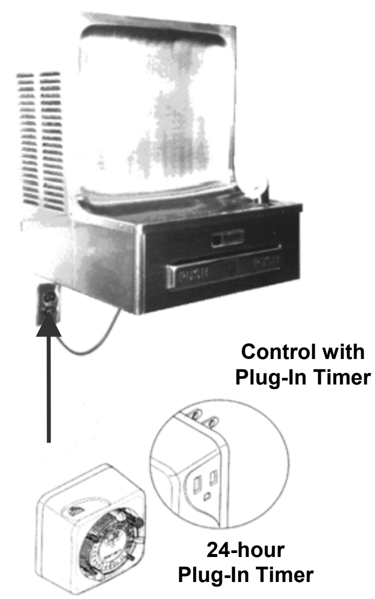
## ECO # 13: Variable Frequency Drives (VFDs)

Variable frequency drives (VFDs), or *freq-drives*, adjust fan or pump motor speeds according to building occupancy schedules, and can achieve a significant energy savings during unoccupied or reduced occupancy periods. The soft-start feature of freq-drives reduces wear and tear on motors and can extend their life.

VFDs are sophisticated electrical devices that require considerable technical experience for proper design. Power quality deterioration (i.e. power factor, harmonic distortion), motor stress and vibration damage can result from poor design. New premium efficiency motors are often necessary, too, depending on the application. VFD design is best left to qualified engineers.

## ECO # 14: Drinking Fountain Timer

Drinking fountains are often refrigerated types that keep chilled water available on a continuous basis. Much of the time, these units can be modified to save energy consumed by the compressor to refrigerate the water. Overnight or during periods the building is unoccupied, the drinking fountain can be turned off (chilling of water during winter months is often unnecessary, too). Because a drinking fountain can cost as much to operate as a small refrigerator over the course of one year, the savings potential for turning it off when possible makes this measure worth consideration, especially if your facility has several units.




Short of shutting off power to the drinking fountain permanently, the best option is to install a timer to control hours of operation to coincide with building hours. An inexpensive 24-hour *plug-in timer* can be installed if a drinking fountain is the plug-in type. (For wired drinking fountains, individual timers have to be wired into each unit… usually, the savings *will not* justify the cost).

## ECO # 15: Upgrade Pop Machines

Refrigerated pop machines operate 24 hours/day, often with display lighting operating continuously. The lighting produces heat, which adds to the load on the compressor, increasing refrigeration cost. Disconnecting the ballast and lamps can save up to $100 per year!


During periods the building is unoccupied, a pop machine can be turned off. With an operating cost greater than that of a large refrigerator, the savings potential for turning it off whenever possible is significant. There is now a power controller available that is activated by an occupancy sensor that will shut the machine down when the area is unoccupied (primarily overnight). This device will not shut the machine down while the compressor is cycling (which can be harmful) and is approved by several of the major soft drink companies. The payback for power controllers is generally in the 1-2 year range.

*NOTE: Consult vendor before implementing this measure.*

## ECO (Future): Enable Computer Power-Down Feature

The majority of computers manufactured in the past five years have power-down capability, which usually needs to be activated. All computers purchased in the last five years should be checked for this feature and activated, if necessary. When purchasing computer equipment, the U.S. EPA Energy Star standards should be specified. Upon delivery of the equipment, the power-down feature should be activated.

Software titled "EZ Save" is now available, which allows administrators to enable power management strategies and change computer and monitor settings from central servers. There is also software available titled "EZ WIZARD" which can be used for decentralized stations, which are web based. Software is free and can be downloaded from http://www.energystar.gov/powermanagement.

## ECO (Future): ENERGY STAR Appliances, Computers & Office Equipment

Energy costs associated with electrical plug loads should be minimized where possible. Plug loads are electrical devices plugged into the building's electrical system and generally include things like appliances, computers, printers and office equipment such as fax machines and copiers. When purchasing appliances, computers and office equipment, the U.S. EPA ENERGY STAR standards should be specified. Manufacturers are required to meet certain energy efficiency criteria before they can label a product with the ENERGY STAR emblem, so these products represent your best energy saving value. To view Energy Star requirements and products visit the Energy Star website at: www.energystar.gov.

## ECO (Future): Premium Efficiency Motors

Using better quality steel, larger conductors with lower electrical resistance, improved bearings and low-loss fan designs, the new premium efficiency motors can save up to 10% over standard models. If existing motors are old or poorly maintained (or both), the savings can be greater.

Motors need to be properly sized for maximum efficiency. When considering replacement, it is important to make sure that the new motor is sized correctly for the job. A motor that is too large for the task at hand will be inefficient and more costly to operate.

Finally, premium efficiency motors have higher power factors. This is especially important when trying to prevent penalty charges (due to low power factor) from being assessed on your electric bill. Correcting power factor is also an easier task when equipment, like a premium efficiency motor, has a higher rating to begin with.

When replacing pump, air handler fan or other motors, be sure to specify premium efficiency motors. Any additional expense will be recovered quickly in energy savings.

## ECO (Future): High Efficiency Transformers

A transformer converts power from one voltage to another. Electricity is converted by passing a current from one electric winding set to another through a magnetized core. The conversion levels are dictated by the winding turn ratios. Reducing core losses, which occur when the core is magnetized and de-magnetized during operation, can increase transformer efficiency. Core losses occur whenever transformer is energized and do not vary with load. Amorphous iron, a recently available European material, is made of rapidly cooled molten metal alloy and reduces core losses by 70% when compared to conventional steel cores. Coil (load) loss, a function of winding resistance, which varies with transformer load, can also be reduced which occurs in primary and secondary transformer coils. Most coils are aluminum-wound which reduces electricity from 480 to 208 and 120 volts. Copper windings, a better conductor which results in lower electrical losses (and less unwanted heat) minimize transformer full-load losses and may permit smaller cores. Also, larger diameter copper wires can reduce transformer losses by allowing more electric current to flow more easily.

Sizing transformers to meet loading also influences efficiency. Greatly oversized transformers are inefficient. Core losses continue whenever transformers are energized, therefore transformer sizing is critical. Maximum transformer efficiencies can be obtained when average loading is in 60 to 80% range. During transformer replacement, evaluate total life-cycle cost, since unit service life will be approximately 30 years. Request transformer core and coil losses from manufacturer to calculate losses at proposed loading levels. A small increase in purchase price will usually secure a unit with lower operating costs and a short investment payback period.

A detailed engineering analysis would be required to determine increased transformer efficiency payback.

## ECO (Future) : Roof Insulation

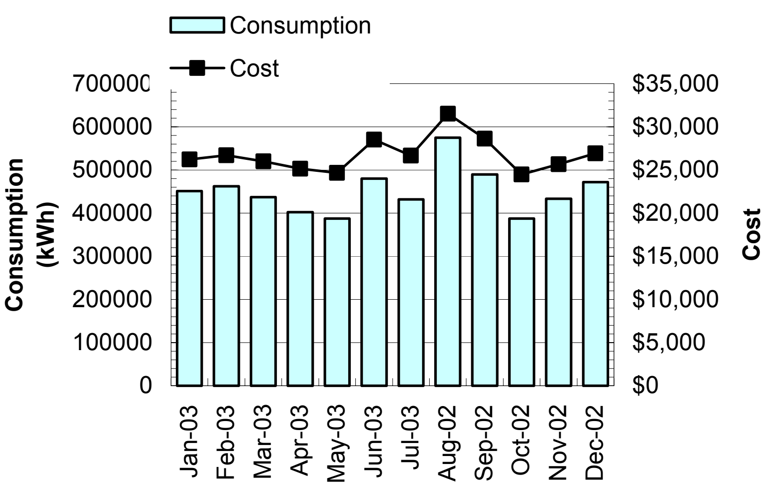
Since warm air rises, it is important to make sure the roof area is adequately insulated. When the roof at any of the buildings is scheduled for replacement, it would be wise to install at least two inches of rigid foam beneath the new membrane. Due to the expense, this method is rarely considered until re-roofing is necessary. However, the additional expense of the insulation will be recovered quickly in energy savings.

# Appendix A: Energy Consumption Profiles

# Administration

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 178,505 | **Wall Construction** | block/marble/glass | **Heating** | Steam loop |
| **Year Built** | 1966 | **Roof Construction** | EPDM | **Cooling** | (2) Absorption Units, (1) C.To |
| **Additions** | | **Windows** | Single Pane | **Distribution** | rad. Perimeter, forced air |
| **DHW** | Heat Exchanger | **Interior Lighting** | T-12 | **Temp Cont.** | pneu, manual t-stats |
| | | **Exterior Lighting** | HPS, photo | **Other** | |

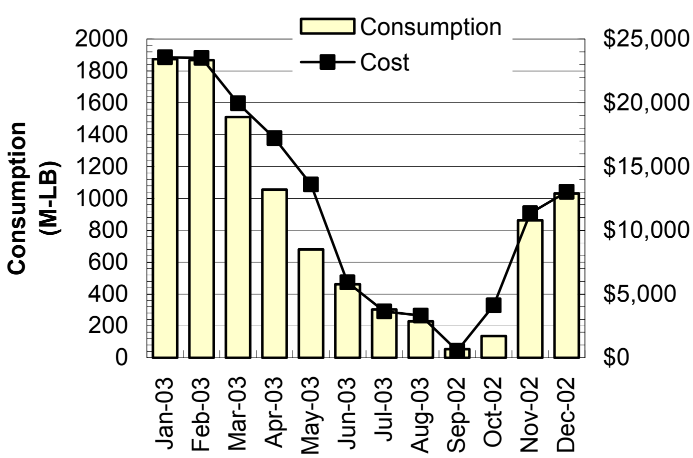
**Electricity Consumption Profile**




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 451,200 | $26,236 |
| Feb-03 | 462,000 | $26,691 |
| Mar-03 | 436,800 | $25,983 |
| Apr-03 | 402,000 | $25,154 |
| May-03 | 387,600 | $24,676 |
| Jun-03 | 480,000 | $28,526 |
| Jul-03 | 432,000 | $26,661 |
| Aug-02 | 574,800 | $31,506 |
| Sep-02 | 489,600 | $28,638 |
| Oct-02 | 387,600 | $24,474 |
| Nov-02 | 433,200 | $25,652 |
| Dec-02 | 471,600 | $26,939 |
| **Totals:** | **5,408,400** | **$321,135** |

Cost/sq.ft.: $1.80 per sq.ft./yr.
**Elec EUI: 103,408 BTU/sq.ft.**
Avg. Cost: $0.059 /kWh

**Steam Consumption Profile**



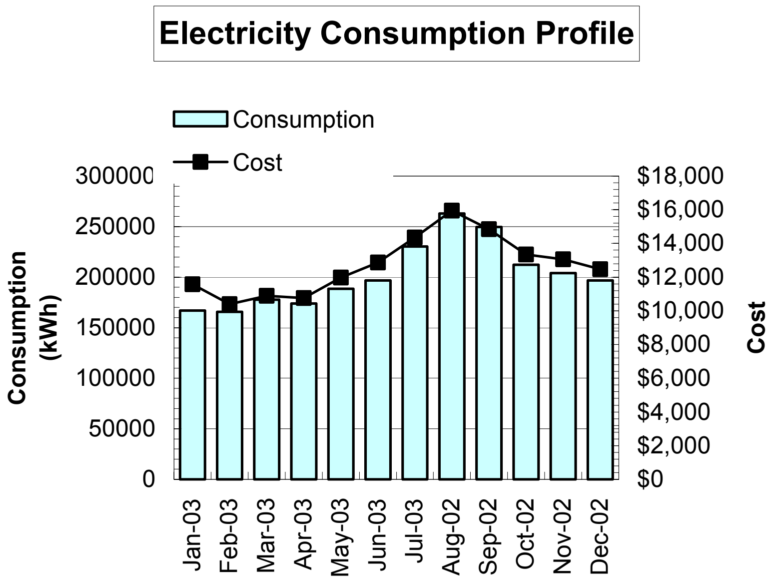

| Month | M-LB | Cost |
|---|---|---|
| Jan-03 | 1,873 | $23,575 |
| Feb-03 | 1,867 | $23,515 |
| Mar-03 | 1,510 | $19,963 |
| Apr-03 | 1,056 | $17,237 |
| May-03 | 680 | $13,597 |
| Jun-03 | 462 | $5,919 |
| Jul-03 | 303 | $3,624 |
| Aug-03 | 228 | $3,321 |
| Sep-02 | 54 | $547 |
| Oct-02 | 136 | $4,108 |
| Nov-02 | 863 | $11,341 |
| Dec-02 | 1,032 | $13,023 |
| **Totals:** | **10,064** | **$139,770** |

Cost/sq.ft.: $0.78 per sq.ft./yr.
**Steam EUI: 56,379 BTU/sq.ft.**
Avg. Cost: $13.888 / M-LB

**Annual Utility Cost = $460,906**
**Total Cost / sq.ft. = $2.58**
**Combined EUI = 159,788**

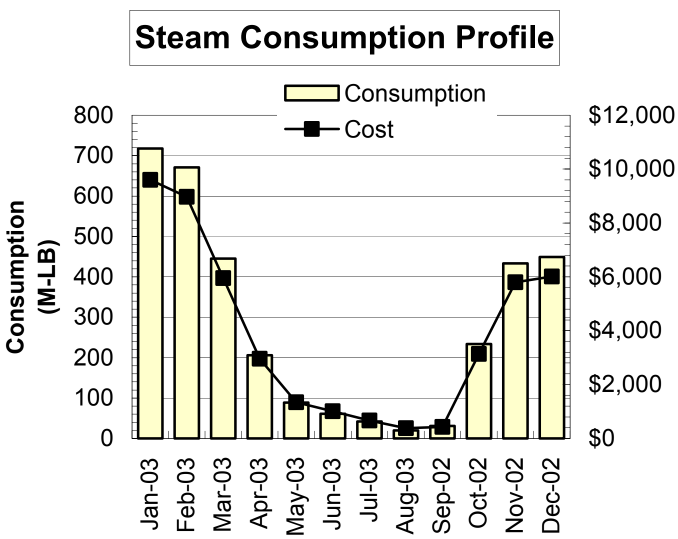
# Downtown Office

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 130,000 | **Wall Construction** | brick and block | **Heating** | steam from steam Loop |
| **Year Built** | 1976 | **Roof Construction** | EPDM | **Cooling** | Cooling tower |
| **Additions** | | **Windows** | sgl pane | **Distribution** | Forced air w/ re-heats |
| **DHW** | Heat exchanger | **Interior Lighting** | T-12, T-8 | **Temp Cont.** | pneu controls, manual t-stats |
| | | **Exterior Lighting** | Metal Halides | **Other** | |




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 166,800 | $11,566 |
| Feb-03 | 165,600 | $10,388 |
| Mar-03 | 177,600 | $10,890 |
| Apr-03 | 174,000 | $10,756 |
| May-03 | 188,400 | $11,970 |
| Jun-03 | 196,800 | $12,870 |
| Jul-03 | 230,400 | $14,346 |
| Aug-02 | 262,800 | $15,953 |
| Sep-02 | 249,600 | $14,847 |
| Oct-02 | 212,400 | $13,346 |
| Nov-02 | 204,000 | $13,054 |
| Dec-02 | 196,800 | $12,478 |
| **Totals:** | **2,425,200** | **$152,465** |

Cost/sq.ft.: $1.17 per sq.ft./yr.
**Elec EUI: 63,671 BTU/sq.ft.**
Avg. Cost: $0.063 /kWh




| Month | M-LB | Cost |
|---|---|---|
| Jan-03 | 718 | $9,600 |
| Feb-03 | 671 | $8,972 |
| Mar-03 | 445 | $5,954 |
| Apr-03 | 206 | $2,956 |
| May-03 | 89 | $1,343 |
| Jun-03 | 61 | $1,009 |
| Jul-03 | 42 | $660 |
| Aug-03 | 20 | $375 |
| Sep-02 | 31 | $425 |
| Oct-02 | 234 | $3,136 |
| Nov-02 | 433 | $5,794 |
| Dec-02 | 449 | $6,007 |
| **Totals:** | **3,399** | **$46,230** |

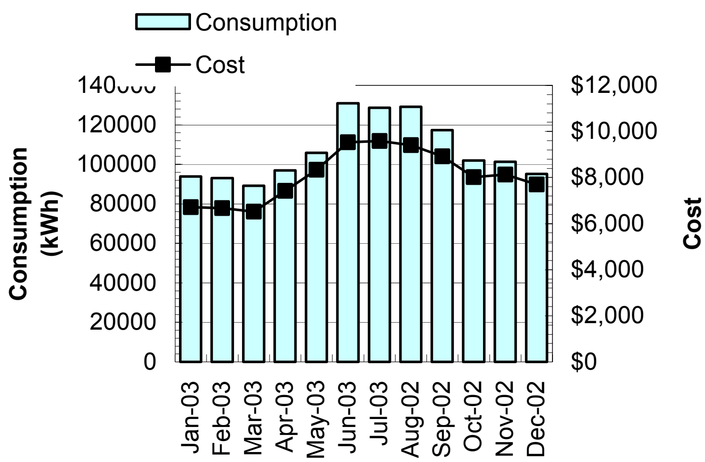
Cost/sq.ft.: $0.36 per sq.ft./yr.
**Steam EUI: 26,146 BTU/sq.ft.**
Avg. Cost: $13.601 / M-LB

**Annual Utility Cost = $198,695**
**Total Cost / sq.ft. = $1.53**
**Combined EUI = 89,817**

# FIA Building

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 107,237 | **Wall Construction** | brick and block | **Heating** | 1976 Steam boiler |
| **Year Built** | 1932 | **Roof Construction** | EPDM/Built up | **Cooling** | (8) DX units |
| **Additions** | | **Windows** | sgl pane | **Distribution** | forced air and radiant |
| **DHW** | (2) tank type gas | **Interior Lighting** | T-12 and inc | **Temp Cont.** | pneu, day/night setting |
| | | **Exterior Lighting** | HPS | **Other** | |

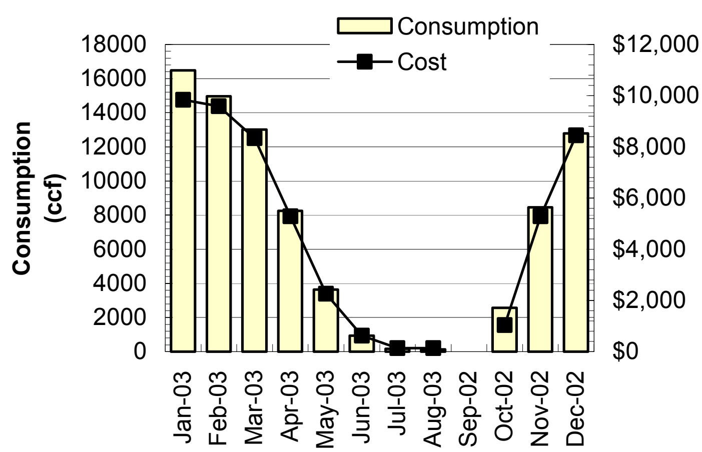
## Electricity Consumption Profile




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 93,936 | $6,711 |
| Feb-03 | 93,112 | $6,670 |
| Mar-03 | 89,198 | $6,523 |
| Apr-03 | 97,026 | $7,428 |
| May-03 | 105,884 | $8,336 |
| Jun-03 | 131,016 | $9,537 |
| Jul-03 | 128,750 | $9,584 |
| Aug-02 | 129,162 | $9,406 |
| Sep-02 | 117,420 | $8,917 |
| Oct-02 | 101,970 | $8,016 |
| Nov-02 | 101,352 | $8,133 |
| Dec-02 | 95,172 | $7,700 |
| **Totals:** | **1,283,998** | **$96,962** |

Cost/sq.ft.: $0.90 per sq.ft./yr.
**Elec EUI: 40,865 BTU/sq.ft.**
Avg. Cost: $0.076 /kWh

## Natural Gas Consumption Profile



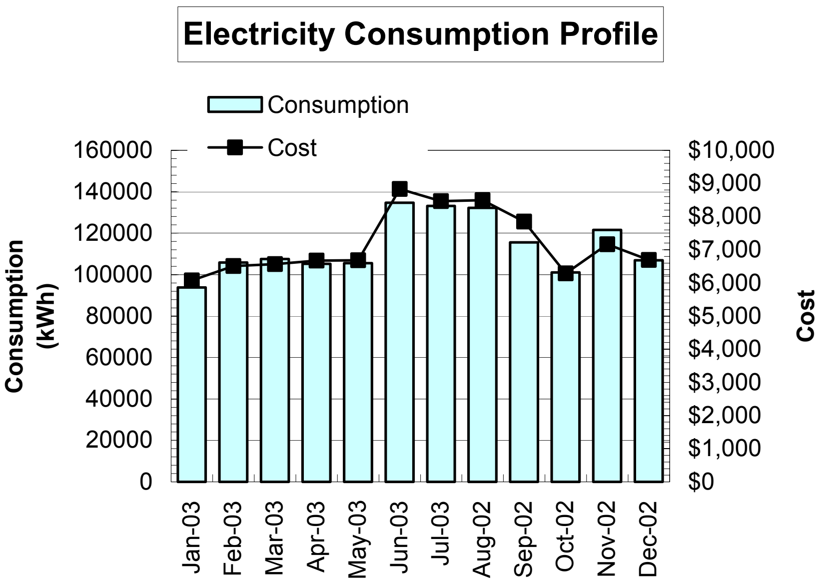

| Month | ccf | Cost |
|---|---|---|
| Jan-03 | 16,486 | $9,837 |
| Feb-03 | 14,965 | $9,582 |
| Mar-03 | 13,009 | $8,332 |
| Apr-03 | 8,246 | $5,287 |
| May-03 | 3,630 | $2,261 |
| Jun-03 | 936 | $628 |
| Jul-03 | 160 | $139 |
| Aug-03 | 140 | $136 |
| Sep-02 | | |
| Oct-02 | 2,573 | $1,035 |
| Nov-02 | 8,465 | $5,282 |
| Dec-02 | 12,793 | $8,455 |
| **Totals:** | **81,403** | **$50,973** |

Cost/sq.ft.: $0.48 per sq.ft./yr.
**Gas EUI: 78,187 BTU/sq.ft.**
Avg. Cost: $0.626 / ccf

**Annual Utility Cost = $147,936**
**Total Cost / sq.ft. = $1.38**
**Combined EUI = 119,052**

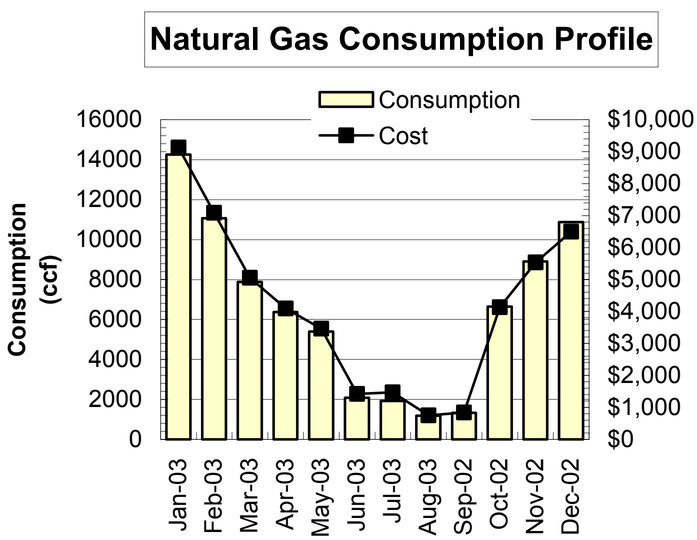
# Juvenile Detention

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 67,685 | **Wall Construction** | brick and block | **Heating** | (2) 1962 HW Boilers |
| **Year Built** | 1965 | **Roof Construction** | EPDM/Built up | **Cooling** | (8) DX Rooftop units |
| **Additions** | | **Windows** | dbl | **Distribution** | Forced air and radiant |
| **DHW** | 1968 HW boiler | **Interior Lighting** | t-12, T-8, MH | **Temp Cont.** | pneu, manual t-stats |
| | also 1998 boiler/storage unit | **Exterior Lighting** | HPS | **Other** | |




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 93,760 | $6,076 |
| Feb-03 | 105,920 | $6,509 |
| Mar-03 | 107,520 | $6,571 |
| Apr-03 | 105,280 | $6,670 |
| May-03 | 105,600 | $6,683 |
| Jun-03 | 134,720 | $8,834 |
| Jul-03 | 133,120 | $8,468 |
| Aug-02 | 132,160 | $8,494 |
| Sep-02 | 115,520 | $7,850 |
| Oct-02 | 101,120 | $6,286 |
| Nov-02 | 121,600 | $7,166 |
| Dec-02 | 106,880 | $6,695 |
| **Totals:** | **1,363,200** | **$86,301** |

| | | |
|---|---|---|
| Cost/sq.ft.: | $1.28 | per sq.ft./yr. |
| **Elec EUI:** | **68,739** | **BTU/sq.ft.** |
| Avg. Cost: | $0.063 | /kWh |



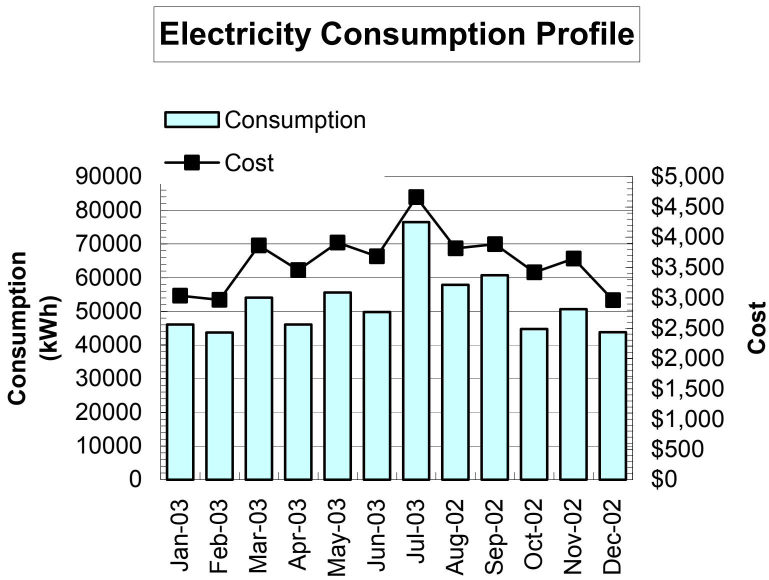

| Month | ccf | Cost |
|---|---|---|
| Jan-03 | 14,254 | $9,127 |
| Feb-03 | 11,070 | $7,092 |
| Mar-03 | 7,881 | $5,053 |
| Apr-03 | 6,374 | $4,090 |
| May-03 | 5,397 | $3,465 |
| Jun-03 | 2,077 | $1,425 |
| Jul-03 | 1,928 | $1,474 |
| Aug-03 | 1,188 | $751 |
| Sep-02 | 1,336 | $843 |
| Oct-02 | 6,640 | $4,130 |
| Nov-02 | 8,905 | $5,534 |
| Dec-02 | 10,879 | $6,497 |
| **Totals:** | **77,929** | **$49,482** |

| | | |
|---|---|---|
| Cost/sq.ft.: | $0.73 | per sq.ft./yr. |
| **Gas EUI:** | **118,589** | **BTU/sq.ft.** |
| Avg. Cost: | $0.635 | / ccf |

**Annual Utility Cost = $135,783**
**Total Cost / sq.ft. = $2.01**
**Combined EUI = 187,328**

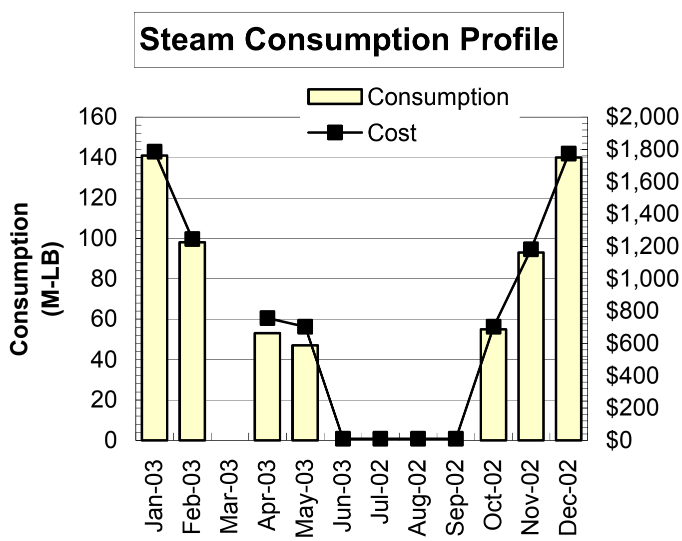
# IT Building

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 17,107 | **Wall Construction** | Brick and Block | **Heating** | Steam from steam loop |
| **Year Built** | 1966 | **Roof Construction** | EPDM | **Cooling** | 50 Ton Reciprocating Chiller |
| **Additions** | | **Windows** | dbl pane | **Distribution** | Forced air w/ reheats |
| **DHW** | tank type, gas | **Interior Lighting** | T-8 | **Temp Cont.** | pneu, manual t-stats |
| | | **Exterior Lighting** | HPS | **Other** | County Main HUB |




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 46,072 | $3,037 |
| Feb-03 | 43,679 | $2,969 |
| Mar-03 | 54,052 | $3,866 |
| Apr-03 | 46,130 | $3,460 |
| May-03 | 55,585 | $3,913 |
| Jun-03 | 49,775 | $3,688 |
| Jul-03 | 76,541 | $4,662 |
| Aug-02 | 57,902 | $3,817 |
| Sep-02 | 60,691 | $3,887 |
| Oct-02 | 44,806 | $3,421 |
| Nov-02 | 50,629 | $3,646 |
| Dec-02 | 43,791 | $2,961 |
| **Totals:** | **629,653** | **$43,325** |

Cost/sq.ft.: $2.53 per sq.ft./yr.
**Elec EUI: 125,621 BTU/sq.ft.**
Avg. Cost: $0.069 /kWh




| Month | M-LB | Cost |
|---|---|---|
| Jan-03 | 141 | $1,787 |
| Feb-03 | 98 | $1,245 |
| Mar-03 | | |
| Apr-03 | 53 | $757 |
| May-03 | 47 | $702 |
| Jun-03 | 0 | $10 |
| Jul-02 | 0 | $10 |
| Aug-02 | 0 | $10 |
| Sep-02 | 0 | $10 |
| Oct-02 | 55 | $703 |
| Nov-02 | 93 | $1,182 |
| Dec-02 | 140 | $1,774 |
| **Totals:** | **627** | **$8,189** |

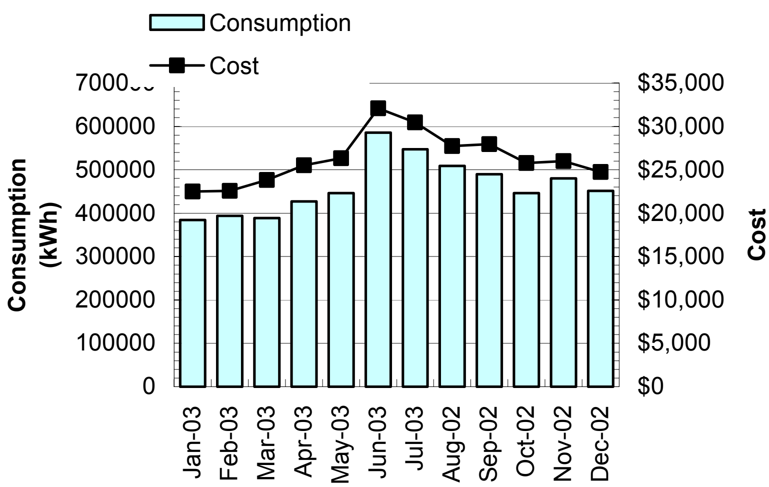
Cost/sq.ft.: $0.48 per sq.ft./yr.
**Steam EUI: 36,652 BTU/sq.ft.**
Avg. Cost: $13.060 / M-LB

**Annual Utility Cost = $51,514**
**Total Cost / sq.ft. = $3.01**
**Combined EUI = 162,273**

# Superior County Courthouse

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 341,049 | **Wall Construction** | Brick and Block | **Heating** | Steam from Steam loop |
| **Year Built** | 2001 | **Roof Construction** | EPDM | **Cooling** | (3) towers, centravac, absorb |
| **Additions** | | **Windows** | dbl pane w/ low-e | **Distribution** | AHU's, w/ VSD's |
| **DHW** | Heat exchanger | **Interior Lighting** | T5 and T-8 | **Temp Cont.** | DDC |
| | | **Exterior Lighting** | HPS | **Other** | |

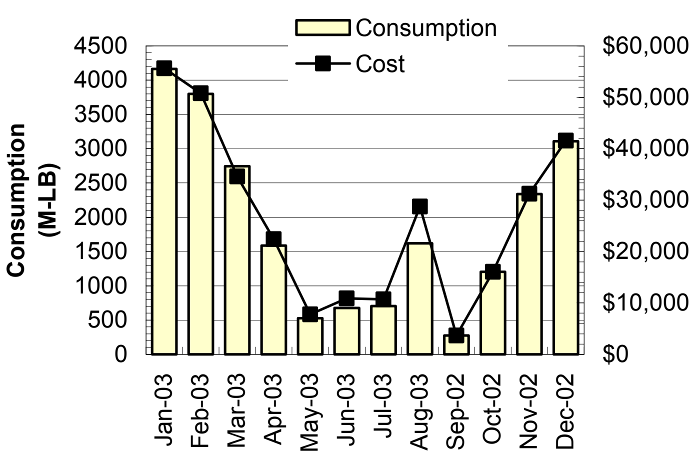
**Electricity Consumption Profile**




| Month | kWh | Cost |
|---|---|---|
| Jan-03 | 384,000 | $22,484 |
| Feb-03 | 393,600 | $22,553 |
| Mar-03 | 388,800 | $23,843 |
| Apr-03 | 427,200 | $25,517 |
| May-03 | 446,069 | $26,319 |
| Jun-03 | 585,600 | $32,071 |
| Jul-03 | 547,200 | $30,457 |
| Aug-02 | 508,800 | $27,725 |
| Sep-02 | 489,600 | $27,966 |
| Oct-02 | 446,400 | $25,764 |
| Nov-02 | 480,000 | $25,985 |
| Dec-02 | 451,200 | $24,748 |
| **Totals:** | **5,548,469** | **$315,433** |

Cost/sq.ft.: $0.92 per sq.ft./yr.
**Elec EUI: 55,526 BTU/sq.ft.**
Avg. Cost: $0.057 /kWh

**Steam Consumption Profile**




| Month | M-LB | Cost |
|---|---|---|
| Jan-03 | 4,165 | $55,638 |
| Feb-03 | 3,802 | $50,790 |
| Mar-03 | 2,745 | $34,597 |
| Apr-03 | 1,588 | $22,380 |
| May-03 | 527 | $7,771 |
| Jun-03 | 678 | $10,884 |
| Jul-03 | 704 | $10,695 |
| Aug-03 | 1,618 | $28,765 |
| Sep-02 | 275 | $3,684 |
| Oct-02 | 1,203 | $16,078 |
| Nov-02 | 2,338 | $31,237 |
| Dec-02 | 3,111 | $41,561 |
| **Totals:** | **22,754** | **$314,080** |

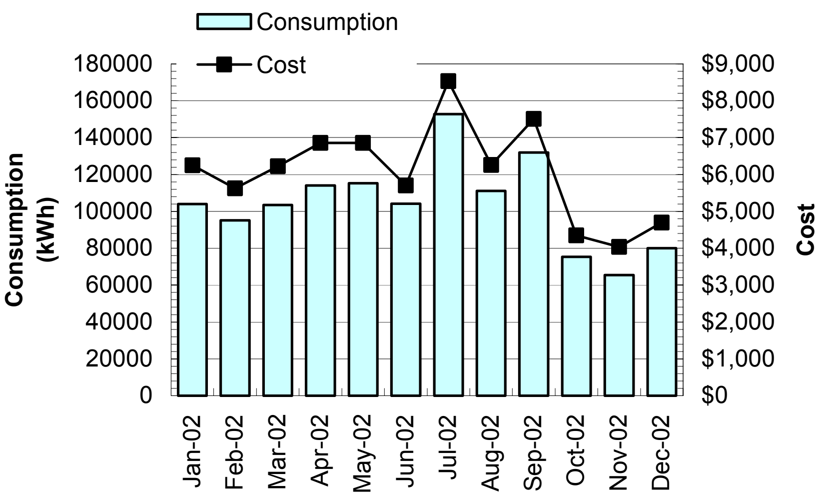
Cost/sq.ft.: $0.92 per sq.ft./yr.
**Steam EUI: 66,718 BTU/sq.ft.**
Avg. Cost: $13.803 / M-LB

**Annual Utility Cost = $629,513**
**Total Cost / sq.ft. = $1.85**
**Combined EUI = 122,243**

# Health Department

| | | | | | |
|---|---|---|---|---|---|
| **Square Ft** | 78,185 | **Wall Construction** | Brick and Block | **Heating** | Steam supplied by power pla |
| **Year Built** | 1976 | **Roof Construction** | EPDM | **Cooling** | (1) screw Compressor unit |
| **Additions** | | **Windows** | dbl Pane | **Distribution** | Forced air and radiant |
| **DHW** | From Steam | **Interior Lighting** | T-12 and T-8 | **Temp Cont.** | DDC |
| | | **Exterior Lighting** | HPS, Timers | **Other** | |

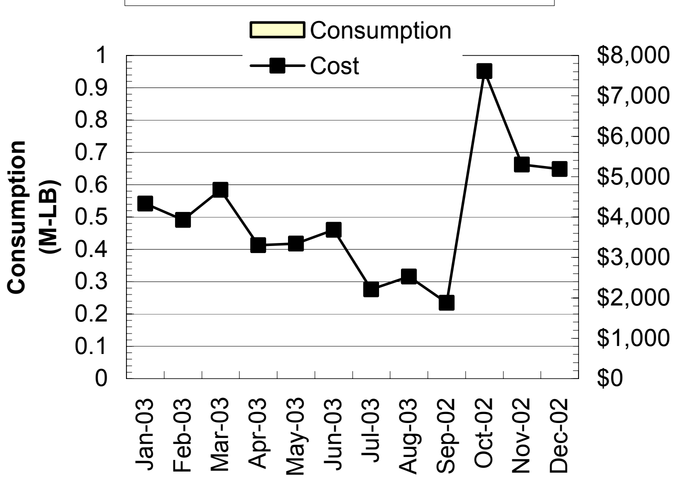
**Electricity Consumption Profile**




| Month | kWh | Cost |
|---|---|---|
| Jan-02 | 104,000 | $6,251 |
| Feb-02 | 95,100 | $5,626 |
| Mar-02 | 103,500 | $6,226 |
| Apr-02 | 114,100 | $6,857 |
| May-02 | 115,300 | $6,858 |
| Jun-02 | 104,100 | $5,701 |
| Jul-02 | 152,800 | $8,534 |
| Aug-02 | 111,100 | $6,260 |
| Sep-02 | 131,900 | $7,504 |
| Oct-02 | 75,300 | $4,350 |
| Nov-02 | 65,500 | $4,034 |
| Dec-02 | 80,000 | $4,693 |
| **Totals:** | **1,252,700** | **$72,893** |

| | | |
|---|---|---|
| Cost/sq.ft.: | $0.93 | per sq.ft./yr. |
| **Elec EUI:** | **54,684** | **BTU/sq.ft.** |
| Avg. Cost: | $0.058 | /kWh |

**Steam Consumption Profile**




| Month | M-LB | Cost |
|---|---|---|
| Jan-03 | Information not available | $4,333 |
| Feb-03 | | $3,928 |
| Mar-03 | | $4,677 |
| Apr-03 | | $3,304 |
| May-03 | | $3,343 |
| Jun-03 | | $3,687 |
| Jul-03 | | $2,214 |
| Aug-03 | | $2,525 |
| Sep-02 | | $1,877 |
| Oct-02 | | $7,609 |
| Nov-02 | | $5,295 |
| Dec-02 | | $5,188 |
| **Totals:** | **0** | **$47,980** |

| | | |
|---|---|---|
| Cost/sq.ft.: | $0.61 | per sq.ft./yr. |
| **Steam EUI:** | **0** | **BTU/sq.ft.** |
| Avg. Cost: | #DIV/0! | / M-LB |

**Annual Utility Cost = $120,874**
**Total Cost / sq.ft. = $1.55**
**Combined EUI = 54,684**