Guidelines

003
March 2012

Use Occupancy/Light Sensors and Timers to Reduce Electricity Use

Background/Rationale:

Many businesses and organizations have rooms within their facilities which are used intermittently, such as break rooms, conference rooms, guest rooms or public restrooms. They may also offer snacks or beverages via vending machines or may perform functions which occur on a predetermined, timed basis, such as heating motor blocks for a fleet of vehicles. Any business seeking to make operations more sustainable should consider installing occupancy sensors, light sensors, vendor misers and timers in key areas to reduce electricity and/or natural gas use related to lighting and heating/cooling. Increased use of natural daylight wherever/whenever possible will also help reduce use of electricity for lighting. Using these devices will, in turn, indirectly help reduce greenhouse gas (GHG) emissions related to energy generation and any adverse environmental impact associated with excess emissions.

Some improvements may be relatively simple and inexpensive to implement, while others may be more complex and require assistance from experienced professionals. The material contained in these guidelines is intended for use by persons who have a basic level of technical training/competence and familiarity with source reduction concepts and strategies.

Step 1: Assess the Current Situation/Define the Scope of the Situation

1.a. Collect and analyze information about current operations, including but not limited to:

- identify key sources of information (see Appendix 1, Example 2)
    - the environmental cause champion
    - maintenance, facility, and/or shop supervisor(s)
    - purchasing or accounts payable personnel
    - key suppliers/vendors
    - business representatives at local utility
- collect pertinent documents and information (see Appendix 1, all examples)
    - policies/procedures related to use of lights and thermostats:
        - formal/informal guidelines/expectations regarding proper/improper use
        - environmental controls of any kind (e.g. thermostat covers) already in use
    - maintenance records, equipment specifications and guides, manufacturer's user manuals and equipment nameplate information
    - utility bills identifying billing rates and energy usage
- keep track of, document and distinguish between key assumptions, known or reported data, and information which is calculated (see Appendix 1, all examples)
- conduct use and cost analyses by observing, interviewing staff, reviewing existing information and developing supplemental data (see Appendix 1, Examples 1, 3 and 4)
    - verify number and type of intermittently used rooms or devices and days/hours of operation or occupancy rates (see Appendix 1, Example 1)

- determine sizes of rooms, presence of windows, wattage capacity, traffic flow/usage patterns
- count number and type of fixtures/bulbs currently used for lighting (see Appendix 1, Example 1)
- calculate total kWh/year used and cost of electricity for constant use of lights in identified spaces
  - calculate utility usage and costs per room or per function for constant use throughout operating hours, which may then be aggregated in different ways to support recommendations for alternatives (e.g., for most frequently used areas, for specific zones/floors/wings, functions, etc.) (see Appendix 1, Example 3)
  - use tools such as Watts Up Pro, Kill A Watt, or a data logging light meter to measure electricity usage (watts of power and kilowatt hours) and light available (see Appendix 1, Example 4)
- calculate total kWh/year used and cost of kWh/Btu's for constant use of heat/cooling in identified spaces
  - calculate utility usage and costs per room or per function for constant use throughout operating hours, which may then be aggregated in different ways to support recommendations for alternatives (e.g., for most frequently used areas, for specific zones/floors/wings, functions, etc.) (see Appendix 1, Examples 2)
- estimate expected life of materials/equipment and replacement costs anticipated with constant use
  - estimate maintenance time needed for changing bulbs and calculate costs based on average hourly wage for maintenance staff

➢ conduct life cycle assessment using reference material cited below to determine global warming potential impact of greenhouse gas emissions associated with kWh use and/or costs saved (see Appendix 3)

1.b. Conduct necessary research and calculations using the following references:

The following references are use to help calculate energy waste and to identify potential strategies for improving efficiency:

➢ *Engine Block Heater Fact Sheet*, Missoula City-County Air Quality Advisory Council, available online at: http://www.co.missoula.mt.us/airquality/AirQualityTopics/TransportationAndBuiltEnv/vehiclestransportation.htm

➢ *Air Quality* article with information about benefits of engine block heaters by American Lung Association, available online at: http://www.lung.org/associations/states/alaska/local-programs/air-quality/

➢ *National Idle Reduction Campaign*, USEPA, information about three types of block/compartment heaters available online at: http://epa.gov/cleanschoolbus/antiidling.htm

➢ Information about programmable thermostats available online at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TH and http://www.fypower.org/ind/tools/products_results.html?id=100133

- Information about energy efficiency and vending machines is available online at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=VMC and http://www.p2pays.org/energy/Vending.pdf
- Information about daylight harvesting sensors available online at: http://www.esource.com/esource/getpub/public/pdf/cec/CEC-TB-36_Daylighting.pdf

The following reference(s) are used to calculate life cycle impact on greenhouse gas emissions for the wastes to be reduced as well as for the net impact of implementing alternative practices:

- *Economic Input-Output Life Cycle Assessment (EIO-LCA)*, US 2002 Industry Benchmark model, Green Design Institute, Carnegie Mellon University, 2012, available online at: http://www.eiolca.net

Step 2: Identify Feasible P2 Opportunities

2.1. In General:

- research several models of occupancy/light sensors and/or timers and include relevant vendor information (the vendor information included in these guidelines is for example only)
- keep track of, document and distinguish between key assumptions, known or reported data, and information which is calculated
- include a thorough cost analysis, comparing suggested modifications with current practices, and use a chart to compare current to proposed costs
  - be specific on the “unit” for application, i.e. which rooms or functions to modify
  - verify utility rate per kWh/Btu
  - calculate capital costs for installation of sensors/timers: equipment and labor
  - calculate pay back periods for return on investment
- watch for hidden costs: peak energy fees, sales tax, expected life of equipment, other installation considerations
- identify how to monitor/measure impact, e.g. monitor savings, expenditures related to utility usage, follow up survey to determine user satisfaction

2.2. Selected strategies to consider, including techniques and calculations to perform:

- install occupancy sensors in select rooms (see Appendix 2, Examples 1a-1b))
  - emphasize cost savings, ease of implementation and adaptability of devices
  - calculate payback period, including equipment and labor costs
  - provide detailed calculations and summarize costs/savings in table
- install light switch reminders (see Appendix 2, Example 1b)
  - provide low tech/low cost alternative to new equipment
- use vending machine controls (see Appendix 2, Example 2)
  - emphasize cost savings
  - suggest a vendor and provide background information on vendor
  - calculate simple payback period
- use thermostat controls (see Appendix 2, Example 3)
  - analyze billing information provided by client to determine costs
- install timers on vehicle engine block heaters (see Appendix 2, Example 4)
  - provide detailed calculations and summarize costs/savings in table
- calculate life cycle impact on greenhouse gas emissions compared to current processes (see Appendix 3 for examples)

Step 3: Identify Barriers to and Benefits of Implementation for Each Opportunity

After analyzing the frequency of use of workspaces and identifying feasible opportunities for realizing savings, you will want to make as strong a business case as possible for making changes to include the use of occupancy sensors, light sensors, and/or timers.

Based on experiences over the past 15 years, the P3 program has found that simple projects with thorough documentation and short pay back periods or projects with compelling cost and environmental savings have a greater likelihood of being implemented. For example, suggestions for installing sensors in infrequently used rooms and/or timers which save unnecessary use for high utility draw functions are more likely to be implemented. Installing sensors or timers is typically easily and quickly accomplished and can be expanded to additional areas as savings are proven and employees adjust to the change. In addition, there may be tax and/or utility company incentives for energy efficiency projects like these.

On the other hand, suggestions which are high cost with long payback periods, have complex implementation logistics, or are not adequately researched or quantified are typically not implemented. For example, projects which require costly rewiring or for which a cost/benefit analysis has not been fully documented or potential vendors have not been identified are unlikely to be implemented. Interestingly, even though the savings may be well documented, this opportunity involves changing employee behavior and perception of safety and may not be implemented due to the employee concerns. Employers are typically sensitive to employees' perceptions.

Specific to sensors and timers, benefits are decreased solid waste related to extended life of bulbs or devices, decreased maintenance time/costs related to replacement, decreased electricity/natural gas use, and increased employee awareness of environmental stewardship. Perceived barriers include capital costs, including installation logistics, and convenience and safety concerns. See Appendix 2 for examples of implemented P2 sensor/timer suggestions from the Nebraska intern program. These are annotated to make it clear what information is needed to perform these calculations for a different facility and to explain why some suggestions were implemented and others were not.

Common Barriers:

Beliefs & Attitudes

- resistance to change—employees set in ways and enjoy convenience of having areas constantly lit, of having control over heating/cooling settings, or of having devices ready at full power for use around the clock
- fear of risks involved related to health/safety, logistics related to devices failing to work properly
- other/higher strategic priorities—the company may have other issues is sees as more important to address in the short run
- misinformation or lack of understanding about the full costs related to continual utility use:
  - related labor time/costs for maintenance

- full costs of production of electricity/natural gas and the impact on greenhouse gas emissions
- that small efforts can yield measurable results
- how certain practices affect the environment

Costs and Investments

- capital investment for purchasing/installing occupancy sensors/timers

Technical Issues: What to Do and How

- lack of knowledge/skills re: what needs to be done/how to implement the suggestion
- amount of different/conflicting vendor information available can overwhelm
- concern re: managing logistics and process changes

Common Direct and Indirect Benefits:

Company Image

- improves aesthetics of the working environment
- demonstrates social responsibility and best management practices; improves/develops a positive public image, sets an example/sets pace for the industry

Cost Savings

- reduces costs and improves efficiency:
- reduces maintenance required

Education

- educates employees and general public in efficiency and responsibility when information is posted about the change and why it was made

Environmental Impact

- reduces impact of on the environment:
    - reduces amount of harmful wastes generated/expelled
    - reduces use of natural resources/raw materials
    - conserves/preserves/provides clean environment/quality of life for future generations

Step 4: Make the Business Case for Change

4.1. Develop a written report for submission to decision makers.

- include a thorough waste assessment with process descriptions, flow charts and material balance representations.
- outline specific P2 Opportunities/Suggestions with the following information:
  - recommended action
  - brief summary of current operations
  - cost of implementing recommendation: don't forget to consider labor costs and savings in your economic analyses.
  - summary of benefits:
    - potential cost savings ($)
    - waste reduction(s)
    - simple payback
    - indirect benefits: safety, risk/liability reduction, GHG reductions, etc.
- always identify how to monitor/measure impact for future analysis
- incentives to Change: Conclude the report with a summary of the benefits to be realized from implementing the recommendations made. Stress environmental stewardship. Call for action!
  - see Appendix 2 for examples of similar projects which have been implemented.
  - you may want to reference previous successes in similar businesses as a selling point.

4.2. Make an oral presentation to summarize your findings and call to action:

- focus on pertinent details of waste assessment and P2 opportunities
- make it interesting yet include sufficient technical detail to be convincing and make the business case for change—include a picture of the product/change in action
- develop a final "impact" slide with table of metrics—call for action/change
- allow time for question/answer period

4.3. Advocate for change based on metrics/facts and environmental ethic:

- use informal interactions to establish trust in your abilities and to build a foundation for change
- use written report and formal presentation to communicate your findings and provide the formal information/rationale for implementing recommendations
- emphasize sustainability (triple bottom line) and preserving resources for future generations—energy conservation and the relationship to greenhouse gas emissions is particularly important for compressed air system operations

4.4. Report potential Greenhouse Gas (GHG) emission reductions as an important indirect benefit:

- include in written report and oral presentation
- include explanation of why GHG emissions are relevant/of concern to all businesses
- calculate potential carbon dioxide equivalent (CO_2e) emission reductions for each recommendation
- include an Appendix in written report documenting calculations
  - see Appendix 3 for details and an example of calculations for electric hand dyers

See Appendix 4 for additional tips for making the business case for change.

Appendix 1
Example Waste Assessments for Installing Sensors/Timers

Note: *Several examples of waste assessments related to utility use in areas where sensors/timers might be applicable are included below. Each of these addresses one or more of the steps needed to accomplish a thorough assessment. In these examples, we have attempted to clarify for the reader what information is known or reported, what is logically assumed, and what has been calculated. This is embodied within the example narrative for easy reference. In an actual report, many of these details would likely be in attached appendices so as not to interrupt the flow of the report.*

Example #1: Determination of Energy Use and Costs for Lighting in One Restroom
(adapted from report by Kayleigh Peters, 2008)

Generally, personnel at the facility exhibit a high level of environmental awareness. Managing and monitoring waste in an environmentally conscientious manner is a priority for the hospital. Based on information gathered during a brief site visit, several calculations were made (outlined below) to determine the amount of electricity used per year in visitor and staff restrooms. The facility may want to conduct a more thorough study of actual lighting costs and quantities to obtain more exact metrics.

Calculations for Annual Energy Use in Restrooms

Known Values:

Energy Cost:	\$0.055 / kWh
No. of Bathrooms:	1
No. of Fixtures:	8
No. of Bulbs/Fixture:	4
Current Bulb Type:	Fluorescent
Current Bulb Power:	32 Watts (reported by facility staff)

Assumptions:

Hrs. of Operation:	3,744/year
Vacancy Rate:	60% (observed and confirmed by facility staff)

Calculations:

Total Number of Bulbs per Bathroom:

$$\frac{8\ fixtures}{bathroom} \times \frac{4\ bulbs}{fixture} \times 1\ bathroom = 32\ bulbs$$

Energy Demand:

$$\frac{32\ bulbs}{bathroom} \times \frac{32\ W}{bulb} \times \frac{kW}{1000\ W} = 1.024\ kW$$

Energy Consumption:

$$\frac{3744\ hours}{year} \times 1.024\ kW = 3834\ kWh/year$$

Annual Cost:

$$\frac{3834\ kWh}{year} \times \frac{\$0.06}{kWh} = \$230/year$$

Unnecessary use/costs at 60% Vacancy:

$$\$230/year \times 0.60 = \$138/year$$

Example #2: Evaluation of Timing Related Issues in Electricity Use for Entire Facility
(adapted from report by Chris New & Kayleigh Peters, 2008)

Figure 1 below shows the plant's electrical energy consumption and demand profile. The average price for electricity is $0.049/kWh. The facility used approximately 7,000,000 kWh/year, with a maximum peak demand in December, 2007 of 4,900 kW. There are two items worth noting. First, while consumption is rather steady, demand shows significant variability. As can be seen by comparing Figures 1 and 2 (below), this variability seems to be only loosely associated with production (Figure 2). Thus, there may be an opportunity to reduce demand charges and therefore, the cost of electricity, by analyzing and managing the components of electrical demand, especially timing of maximum electrical use. Second, while peak demand typically occurs in the summer months (possibly from air conditioning), the winter peak suggests that (1) there is also electrical heat in the facility and/or (2) the load from the plant simply dwarfs that of office air conditioning.

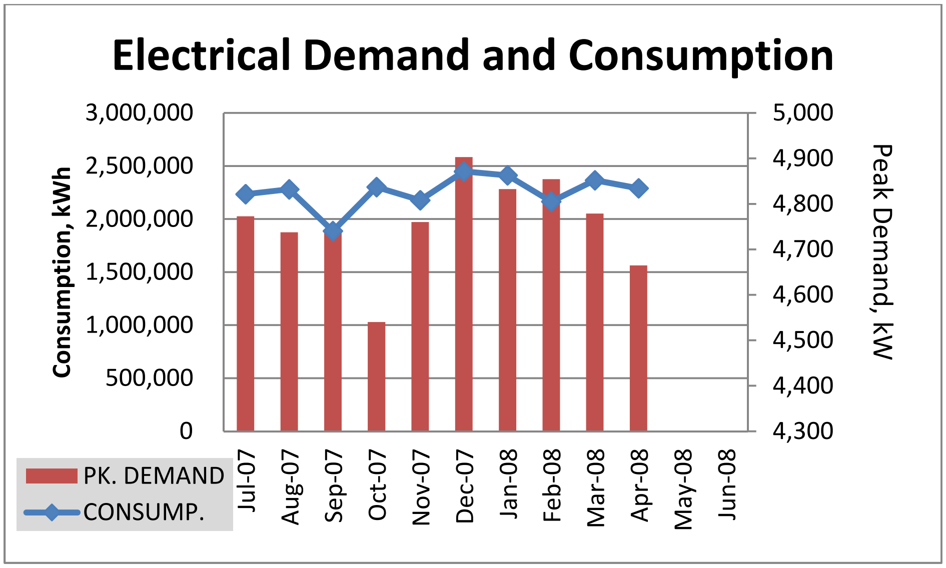


Figure 1. Electrical Energy Profile

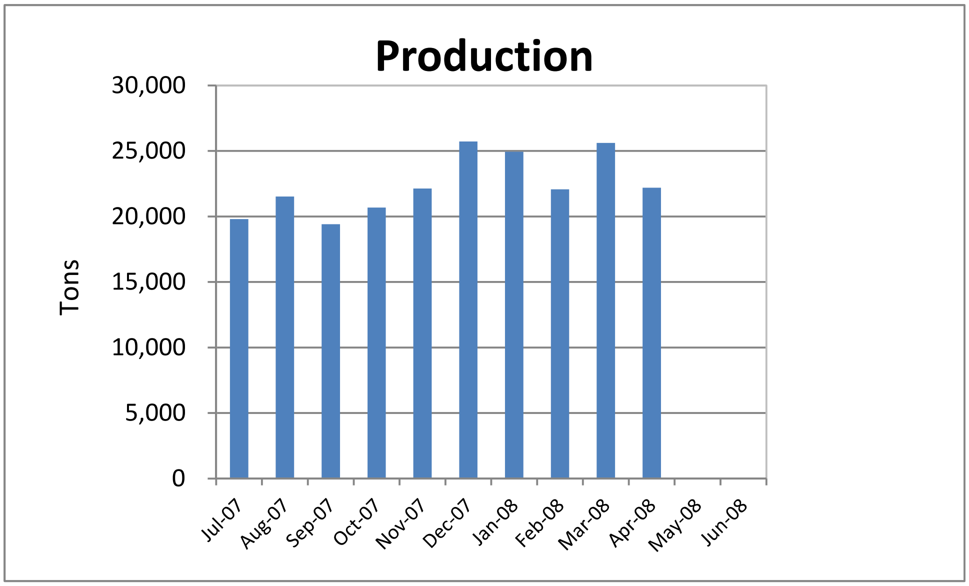


Figure 2. Production

Example #3: Determination of Energy Use for Specific Appliance (Engine Blocks) using estimation of time of use (adapted from report by Kathleen Johnson, 2008)

Currently the facility uses engine block heaters for school buses during the winter months (approximately November 1 to April 1) to ensure start-ups in the morning. Drivers plug the buses in upon returning from their routes in the afternoon and allow them to charge overnight until 7 a.m. The buses are left plugged in during the weekends and over the two-week winter break. Calculations are provided below to demonstrate estimating energy usage based on time engine blocks used. Calculations shown below reveal that during the winter months, bus heating contributes up to 90%, or 403,000 kWh of the overall facility electricity use of 450,000 kWh.

Energy Use Calculations Based on Time Engine Blocks Used

Assumptions:

Buses charged during 5-month time frame and over winter break (20 weeks)
Buses charged 14 hours for 5 days (5 PM – 7 AM)
Buses charged 24 hours for 2 days (over the weekend)
1500 W energy demand per block heater (reported by facility staff)
$0.05 per kWh
All 114 buses in the fleet are charged

Calculations:

Current energy use:

$$(1.5\ kW) \times (118\ hours)/week \times (20\ weeks)/year \times 114\ buses = \sim 403{,}000\ kWh/year$$

Current energy cost: $403{,}00\frac{kWh}{year} \times \frac{\$0.05}{kWh} = \sim \$20{,}000/year$

Example #4: Determination of Energy Use for Specific Appliance (Vending Machine) using Measurement Tool (Data Logger)

The facility currently has 10 lighted vending machines in its lunchroom area that operate 25 hours a day, 7 days a week. As is typical for vending machines, each of these machines are plugged into standard 120V AC wall sockets via a flexible cord. A data logging electricity meter, Watts Up PRO was plugged into the wall socket and the vending machine into it to record the energy usage over time. This WattsUp Pro Monitor provided the cumulative watt hours used by the machine. Calculations are provided below to demonstrate estimating energy usage based on extrapolating results from this data logger.

Energy Use Calculations Based on Extrapolation from Data Logger

Assumptions:

Data logger (e.g. Watts Up Pro) was installed on 1 vending machine for 4 months (Nov-Feb)
Result: 2790 kWh used Nov-Feb
4 months trial results can be extrapolated to 12 month actual use
$0.05 per kWh
All 10 vending machines have the same energy use

Calculations:

Trial energy use: 2790 kWh X (12 months/4months) X 10 machines = ~ 83,7000 kWh

5 month energy cost: $83{,}700\frac{kWh}{year} \times \frac{\$0.05}{kWh} = \sim \$4{,}200/year$

Appendix 2
Examples of P2 Opportunities for Sensors/Timers

Note: *Several examples opportunities for reducing utility use with sensors and timers are included below. Each of these addresses a different way to improve practices and achieve direct and/or indirect savings and each uses different techniques for encouraging implementation (highlighted at the beginning of each example). In these examples, calculations are embodied within the narrative for easy reference, although in an actual report, these would likely be in appendices at the end so as not to interrupt the flow of the report.*

Area #1: Install Occupancy Sensors

Example #1a: **Install occupancy sensors in select rooms** (adapted from report by Lauren Swadener, 2010)

The choice of an occupancy sensor depends on the area in which it will be installed. Some of the factors are the area of the room, if there are any windows, how much wattage it carries, and the amount of traffic going in and out of the room. The average price of a sensor from Grainger is about $100 but this can be much lower for a smaller room or a little bit more for a larger room with more wattage. Benefits of installing sensors include:

- They are relatively inexpensive.
- They take no more than half an hour to install.
- They are easy to operate and adaptable to different spaces: some have timer settings ranging from 30 seconds to 30 minutes; some have a switch which can be used in case there are complications with the sensor.

The assumptions used when calculating the *costs* and benefits of the sensors are as follows:

- A maintenance employee receives $40/hour including benefits.
- It takes 30 minutes to install one sensor.
- Each bulb operates on 40W. This does not take into account the energy use of the ballasts.
- $100/sensor is the conservative price used in the cost analysis calculations

Table 1 below summarizes the costs and savings for installing select sensors along with their respective payback periods. Only a select number of offices and conference rooms were taken into account in this study. There are many other places throughout the business to implement this opportunity. An example of detailed calculations the conference rooms is also shown below.

Table 1: Costs and Savings for Installing Select Occupancy Sensors

Location	Number of Sensors	Daily Hour Savings	Yearly Savings (kWh)	Cost of Sensors	Yearly Savings ($)	Payback Period
Conference Rooms	4	7	3,500	$480	$200	2.5 yr
Sample Office	1	5	400	$120	$25	5.2 yr
Women's Restrooms	6	19	10,500	$720	$600	1.2 yr
Men's Restrooms	6	19	11,600	$720	$650	1.1 yr
Break Rooms	4	12	23,800	$480	$1,330	4.3 mo.
Total	21	62	50,000	$2,520	**$2,800**	**0.9 mo.**

Conference Rooms

Assuming originally no lights are shut off in conference rooms during 8am-5pm

Operation Hours Per Year				
9	x	5	=	45
		52		wks
	=	2340		hrs/yr

Current T-12 Fluorescent Lighting in Conference Rooms										
Fixture Type	# of Bulbs	Watts Per Bulb		Operation Hours Per Year		$ Rate per kWh		Conversion to kWh		Annual Operation Cost
4 Bulb	48	40	x	2340	x	0.056	/	1000	=	$ 251.60
						Total kWh/yr	=	**4,492.80**		**$ 251.60**
						Total kWh/yr =		**4,492.80**		
						Total cost =		**$ 251.60**		

Cost analysis for sensors				
$ 100	/sensor			
4	sensors =	$	400.00	
Time install/sensor			0.5	hr
Maintenance Pay		$	40.00	hr
Total Initial Cost		**$**	**480.00**	

Operation Hours Per Year				
2	x	5	=	10
		52		weeks
	=	520		hours/yr

Operating with Sensors using Current T-12 Fluorescent Lighting in Conference Rooms										
Fixture Type	# of Bulbs	Watts Per Bulb		Operation Hours Per Year		$ Rate per kWh		Conversion to kWh		Annual Operation Cost
4 Bulb	48	40	x	520	x	0.056	/	1000	=	$ 55.91
						Total kWh/yr	=	**998.40**		**$ 55.91**
						Total kWh/yr =		**998.40**		
						Total cost =		**$ 55.91**		

Savings from Sensors Every Year	
$195.69	**dollars/yr**
3,494.40	**kWh/yr**

Payback Period (yrs)	=	**2.5**

Implementation Status: Not yet reassessed to determine impact.

In another large manufacturing facility, the recommendation to install occupancy sensors in community areas like restrooms and the cafeteria was implemented immediately and is being expanded within the facility. The intern worked with a lighting specialist to recommend that the company have sensors installed. The lights are no longer on 24 hours a day, which has saved 75,000 kWh/yr, accounting for over $2,635 savings annually. The initial cost was $2,662, so the payback was a little greater than a year. Aside from saving energy, employees have an increased awareness of energy use and it gives the facility a better image among employees.

Key Barriers/Benefits: Potential waste and savings were well documented. Implementing the recommendation will be straightforward and simple. The implementation cost is reasonable. The payback period is relatively short. The facility will save on operating costs, energy consumption, and related environmental impact on an ongoing basis.

Example #1b: **Comparison between installing motion detectors or light switch reminders in selected areas** (adapted from report by Chris New/Kayleigh Peters, 2008)

There are two options to address the issue of lights left on in unoccupied offices. The less expensive option is to purchase light switch reminder labels and adhere them to all switches in offices, conference rooms and bathrooms. Studies have shown that labels will decrease light usage and related energy consumption by 15%. A more expensive option is to install motion detectors. The initial cost is higher and the payback period longer, however, this is a more permanent solution that will save more energy and costs on an ongoing basis. The State of North Carolina's published guide for calculating the savings from light switch reminders and occupancy sensors provides the basis for the savings calculations summarized in Table 1 below.

Table 1. Costs and Savings for Motion Sensors and Light Switch Reminders

P2 Recommendation	Cost	Estimated Annual Savings	Estimated Payback (yr)
Install Motion Sensors	$1,000	12,300 kWh/$600	2.0
or Light Switch Reminders	$70	7,100 kWh /$300	0.2

Implementation Status: Implemented (adapted from report by Amanda Schlender, 2009)
This recommendation was made primarily for the office area of the plant, but staff are working to implement it in the entire plant where feasible in two phases. Installing the sensors for Phase I had an initial cost of $230,000. Savings in addition to annual savings on electricity include tax rebates and rebates from the electric company. Thus far, the plant has received one-time savings of $44,000 from rebates, and will have $50,000 in annual electricity savings for Phase I. Staff estimates that Phase II will result in additional savings of $54,000 annually.

Key Barriers/Benefits: Potential waste and savings were well documented and the company chose to implement the installation even more widespread than suggested. The implementation cost was reasonable. The payback period was relatively short. The facility will save on operating costs, energy consumption, and related environmental impact on an ongoing basis.

Example #2: **Use Vending Machine Controls** (adapted from report by Kara Scheel, 2011)

Vending Machines would use less electricity with the installation of an occupancy sensor, specifically a VendingMiser®. Vending machine lights are currently on for 24 hours a day and have been measured to use a total of 16,000 kWh per year. The VendingMiser® automatically powers down the machine when the area around the machine is vacant by use of an occupancy sensor, and repowers the cooling system at one to three hour intervals to ensure the product stays cold. It simply plugs into the wall so there is virtually no installation process. Due to reduced running time, the VendingMiser® also provides for a longer lasting machine and less maintenance for an approximate savings of $40-$80 per machine per year. Energy consumption is reduced by 46% according to the vendor (see vendor information below), resulting in an annual energy savings of **7000 kWh** and **$600**. Each VendingMiser® cost around $170 each. The payback period is around 1 year. Along with energy reduction, the GHG emission would be reduced by **7 MT CO2e** per year (see calculations in Appendix 3).

VendingMiser Vendor Information

VendingMiser®

ENERGY MANAGEMENT SYSTEM
For Refrigerated Vending Machines

Improve the profitability of your existing cold drink machines. Vending Miser® puts you on a cost-effective refresher course for energy savings and conservation.

VendingMiser cuts energy costs down to size

VendingMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes either on the wall or on the vending machine. It's that easy.

With VendingMiser there's no need to have new machines to achieve maximum energy savings resulting in a reduction in operating costs and greenhouse gas emissions. When equipped with the VendingMiser, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR® qualified machines.

Power play

Compatible with all types of cold drink vending machines, the VendingMiser uses a Passive Infrared Sensor (PIR) to power down the machine when the area surrounding it is vacant. Then it monitors the room's temperature and automatically re-powers the cooling system at one- to three-hour intervals, independent of sales, to ensure that the product stays cold.

This Miser runs the bank

For a series of up to four machines, VendingMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

Refresher course

VendingMiser's microcontroller will never power down the machine while the compressor is running, eliminating compressor short-cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability. Maintenance savings is generated through reduced running time of vendor components – estimated at $40 - $80 per year, per machine. The VendingMiser has been tested and accepted for use by major bottlers.

VendingMiser reduces energy consumption an average of 46%—typically $150 per machine.

Vending Miser offers...

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Early return on investment
- Environmental benefits

VendingMiser can also control other cooled product vending machines, such as refrigerated candy machines.

VendingMiser Technical Specifications

Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Vending Machines: Any machine, except those containing perishable goods such as dairy products

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to three hours, dynamically adjusted, based on ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Regulatory Approvals
Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79

Other energy-saving products offered by USA Technologies include VM2IQ™, CoolerMiser™, SnackMiser™ and PlugMiser™.

GSA Schedule Contract GS-35F-0031R

ENERGY STAR PARTNER

USA TECHNOLOGIES

For more information about VendingMiser by USA Technologies: 888.521.6982 www.usatech.com

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?
Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?
Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?
Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?
Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and will typically save up to 35% energy use.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Vending Machines:	Any machine, except those containing perishable goods such as dairy products.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to three hours, dynamically adjusted, based on ambient temperature

DIMENSIONS

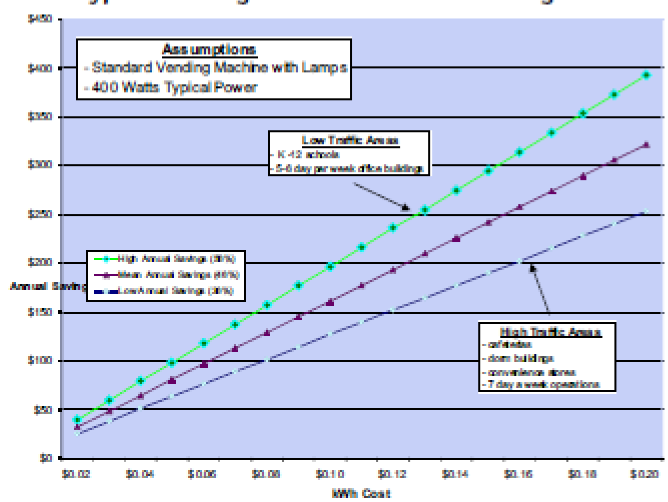
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

UL LISTED   UL LISTED

Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

For more information about VendingMiser by USA Technologies: 888.521.6982 www.usatech.com

Implementation Status: Not yet reassessed to determine impact.

Example #3: **Use Thermostat Controls** (adapted from report by Kayleigh Peters, 2008)

As energy costs increase, temperature management is becoming a priority for businesses. Regulating the temperature on a thermostat to conserve energy can reduce heating and cooling costs between 5 to 15%. Based on information and documentation provided by the client, twelve months of electric utility bills were analyzed to determine potential savings from setting the thermostat for air conditioning (A/C) two degrees higher.

The calculations below show the assumptions and methods used to estimate savings for a single month (May 2007 was used as a test month), which was then repeated to estimate annual savings. Implementing a two degree temperature setback can save 29,000 kWh and $1,447 (5% of annual costs) per year in reduced energy consumption (see Table 1 below).

Thermostat Management Calculations

Known Values:

From May 2007 bill (see table below):

--180,000 kWh used

--$3,618 usage charge

--378 kW demand

--$4,158 demand charge

Assumptions:

Demand peaks June – September

Demand minimizes January – March

May '07 is used as test month

For 2° temperature increase, assume annual A/C cost reduced by conservative 5%

Calculations: (Using May '07 as the example calculation)

Cost per kWh in May '07:

$$\frac{Usage\ Charge}{Usage} = \frac{\$3{,}618}{180{,}000\ kWh} = \$0.0201\ per\ kWh$$

Cost per kW in May '07:

$$\frac{Demand\ Charge}{Demand} = \frac{\$4{,}158}{378\ kW} = \$11\ per\ kW$$

Total Cost in May '07: $\$3{,}618 + \$4{,}158 = \$7{,}776$

Total Cost per kWh in May '07:

$$\frac{Total\ Cost}{Usage} = \frac{\$7{,}776}{180{,}000\ kWh} = \$0.0432\ per\ kWh$$

Average Off Peak Usage (January – March, from table of billing information):

$$\frac{142{,}800\ kWh + 145{,}800\ kWh + 108{,}600\ kWh}{3\ months} = 132{,}400\ kWh$$

Average Off Peak Demand (January – March):

$$\frac{299.4\ kW + 324\ kW + 334.8\ kW}{3\ months} = 319\ kW$$

A/C Consumption in May '07:

$$Total\ Month\ Usage - Avg\ Off\ Peak\ Usage = 180{,}000\ kWh - 132{,}400\ kWh = 47{,}600\ kWh$$

A/C Demand in May '07:

$$Total\ Month\ Demand - Avg\ Off\ Peak\ Demand = 378\ kW - 319\ kW = 59\ kW$$

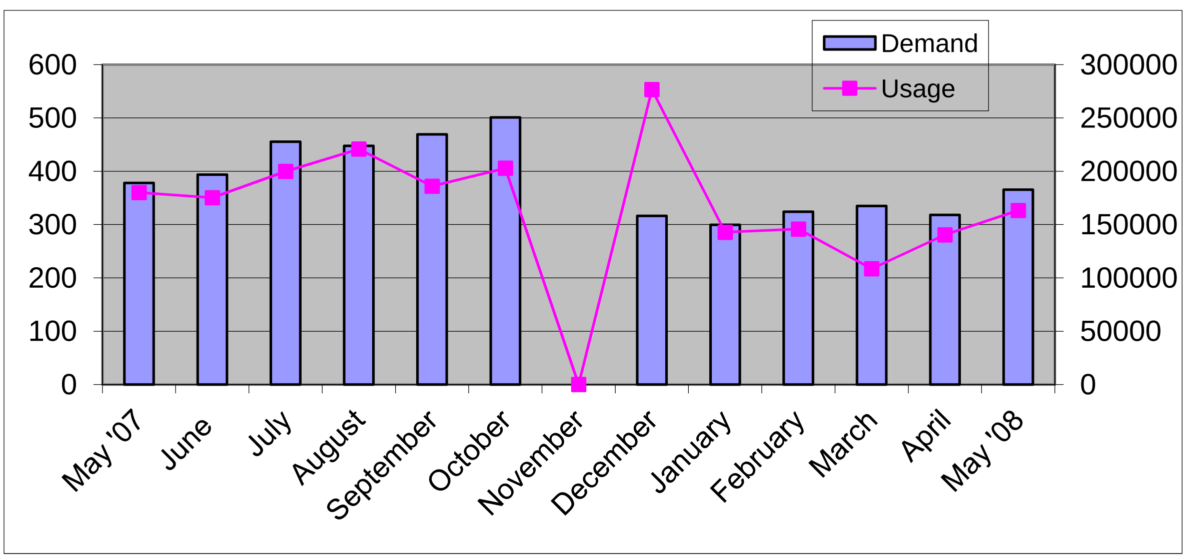
A/C Cost in May '07:

$$47{,}600\ kWh \times \frac{\$0.0432}{kWh} = \$2{,}056.32$$

Cost Savings for 2° temperature increase = .05% X $2056 = ~ $100 for May

Table 1. Analysis of electric utility bills for one year.

Month	Usage	Demand	Usage Chg	Dem Chg	$/kWh	$/kW	Tot Cost ($)	Tot $/kWh	A/C Cost
May '07	180000	378	3618	4158	0.0201	11.00	7,776	0.0432	2056.32
June	175200	393.6	3528	6553	0.0201	16.65	10,081	0.0575	2462.71
July	199800	455.4	3989	7582	0.0200	16.65	11,571	0.0579	3903.33
August	220800	447.6	4382	7452	0.0198	16.65	11,834	0.0536	4737.89
September	186000	469.2	3730	7812	0.0201	16.65	11,542	0.0621	3326.08
October	202800	501	4045	8341	0.0199	16.65	12,386	0.0611	4299.68
November	0	0	0	0	0	0	0	0	0
December	276600	316.2	5426	4332	0.0196	13.70	9,758	0.0353	5087.14
January	142800	299.4	2922	4332	0.0205	14.47	7,254	0.0508	528.30
February	145800	324	2978	4332	0.0204	13.37	7,310	0.0501	671.84
March	108600	334.8	2282	4332	0.0210	12.94	6,614	0.0609	0.00
April	140400	318	2877	4332	0.0205	13.62	7,209	0.0513	410.77
May '08	163200	365.4	3304	4421	0.0202	12.10	7,725	0.0473	1457.90



Total=
$28941.96
x 5%
$ 1,447.10

Implementation Status: **Not Implemented** (adapted from report by Eric Farrow, 2009)
This practice has not been implemented. The central heating ventilation and air conditioning (HVAC) system is computer controlled for the majority of the facility. Multiple building additions to the facility complicate efficient thermostat management. Currently, the most feasible thermostat management policy allows for individual office thermostats to be controlled by the respective occupants. *Because of the potential for a substantial cost savings, the facility was urged to reconsider better thermostat management.*

Key Barriers/Benefits: Potential waste and savings were well documented. No implementation costs or vendor information were supplied and thus no payback period was calculated. The facility can potentially save a modest amount on operating costs, energy consumption, and related environmental impact on an ongoing basis. However, staff member resistance to change and concern regarding comfort impeded implementation.

Example #4: Install timers on the bus engine block heaters to reduce energy consumption
(adapted from report by Kate Johnson, 2008)

Currently the school Transportation Services uses engine block heaters for school buses during the winter months (approximately November 1 to April 1) to ensure start-ups in the morning. By installing a timer on the bus engine block heater circuits, they can reduce the amount of electricity being used during the winter months. The Shop Supervisor suggested that only 4 hours of heating would be required to aid the engine start-up, which is consistent with information provided by environmental health experts in air quality. Table 3 below compares the current practice of heating the bus engines with the suggested practice if a timer is installed.

Table 3. Alternatives for Bus Heating during Winter Months

	Hrs/week charging	Number of Weeks	Buses Charging	kWh Consumed per 5 Months	Cost per 5 Months	Comments
Current	118	20	114	403,560	$20,200	Charge 14 hr per day, 24 hr per day weekend
With Timers	20	18	110	59,400	$3,000	Charge 4 hr per day, off weekend, off break (2 weeks)
Savings	98 (83%)			344,160 (85%)	$17,200 (85%)	

Currently, the school system leaves the buses plugged in for 14 hours a day and 48 hours over the weekend, spending approximately **$20,000** during the winter months. By installing the timers, Transportation Services can reduce electricity costs in the winter months to as little as **$3,000** and save up to **$17,000/year** in electricity costs. Assuming a **$2,000 installation cost** for timers on 8 circuits and including labor, the payback period for implementing this opportunity would be as short as **1.4 months**. The cost analysis is outlined below.

Cost Analysis of Installing Engine Heater Timers

Known Values:
$175 per timer circuit capital cost
8 circuits to be installed
$20,200 current annual energy cost

Assumptions:
$75 per circuit labor cost for installation
$3,000 annual energy cost with timers

Calculations:

Initial Investment:

$$\frac{\$175 + \$75}{circuit} \times 8\ circuits = \$2{,}000$$

Payback Period:

$$\frac{\$2{,}000}{\frac{\$20{,}200}{year} - \frac{\$3{,}000}{year}} = 1.4\ months$$

In addition to reducing electricity bills, Transportation Services would be reducing greenhouse gas emissions from electrical generation. Using the timers has additional benefits such as setting a standard for other maintenance shops that use engine block heaters which improves Transportation Service's public image.

Implementation Status: **Not yet reassessed to determine impact.**

Key Barriers/Benefits: Potential waste and savings were well documented. Implementing the recommendation will be straightforward and simple. The implementation cost is reasonable. The payback period is relatively short. The facility will save on operating costs, energy consumption, and related environmental impact on an ongoing basis.

Appendix 3
Greenhouse Gas Reductions Explanation and Calculations

Relevance of Greenhouse Gas Emission Estimates
This issue is an increasingly important one for business decision makers as it relates to regulations, stakeholder interests and day-to-day business operations and energy use.

There are several important dimensions of analysis for any pollution prevention opportunity. One is certainly direct environmental impact (e.g. reductions in solid or hazardous waste, water use, air pollution, or energy use). Another important dimension is cost. Yet another is the intangible (not quantifiable) impact, such as reduced liability, increased worker safety/satisfaction, or improved corporate image. A final important dimension is indirectly estimating the impact on greenhouse gas (GHG) emissions that can be achieved by implementing any given pollution prevention opportunity.

GHGs include a number of different gases such as carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and water vapor. These gases contribute to the "greenhouse effect" in the Earth's atmosphere. While GHGs make the planet warm enough to be habitable, an excessive amount of these gases is believed to be building up in the atmosphere and causing the average global temperature to rise, leading to climate change and instability. A significant spike in GHG concentrations in the atmosphere has occurred since the industrial revolution, pointing to the man-made nature of this change. This is why a new emphasis, and discussion of possible regulations, has been placed on reducing GHG emissions in all parts of our society, including government, business and industry.

The most widely recognized unit for measuring GHG emissions is carbon dioxide equivalent (CO2e). Each of the GHGs has a different capacity to heat the earth's atmosphere, called its global warming potential (GWP). Carbon dioxide (CO2) has a GWP of 1, so in order to standardize reporting, when GHG emissions are calculated, they are reported as equivalent to a given volume of CO2.

Reductions in GHG emissions can be estimated using a variety of calculation tools and computer models. The direct environmental/cost benefits estimated or realized are used as quantified input for these calculations, therefore the resulting GHG emission reduction estimates are considered indirect benefits. Some commonly used tools are listed below:

--Nationally recognized conversion factors from the U.S. Department of Energy and the American Water Works Association are used to estimate GHG emissions for electricity, natural gas, and water use. For example, kilowatt-hours (kWh) of electricity used can be converted to GHG emissions using a factor of 1.404 pounds CO2 e per kWh.

--Another tool to determine GHG emissions related to solid waste, is the EPA's WAste Reduction Model (WARM). This online calculator uses a life-cycle approach to determine the change in GHG emissions caused by alternative end-of-life waste management decisions or disposal methods for a number of different kinds of wastes. For example, using the weight of a solid waste diverted from a landfill and recycled, an approximate reduction in GHG can be calculated. WARM is periodically updated and new material types are added by the EPA as new information from climate change research becomes available.

--Another model used to estimate GHG reductions is the Economic Input Output Life Cycle Assessment (EIO-LCA) developed by researchers at Carnegie Mellon University. This model provides a useful approximation of GHG reductions through the full life-cycle production of a material or chemical, based on the cost savings from reductions in use. For example, if a business reduces its lubricating oil purchases by $50,000, the EIO-LCA estimates the GHG emissions to produce that oil through the mining, extracting, refining, packaging and delivery (to list a few) steps in the process of getting that oil to the end user.

--Recycled Content (ReCon) Tool: EPA created the ReCon Tool to help companies and individuals estimate life-cycle greenhouse gas (GHG) emissions and energy impacts from purchasing and/or manufacturing materials with varying degrees of post-consumer recycled content.

When using one of these models to estimate GHG emission reductions for a client, always provide an explanation of which model was used, why, what assumptions were applied, and the importance of reducing GHG emissions as a business and global sustainability strategy. Two examples of Appendices documenting GHG emissions reductions related to the use of occupancy sensors follows.

Example1; Greenhouse Gas Calculations for Use of Occupancy Sensors

The Carnegie-Mellon Economic Input-Output Life Cycle Assessment Model was used to estimate the reduction of CO2 equivalent greenhouse gas emissions related to the reduced use of electricity as a result of using occupancy sensors. The following steps were taken: .

1. Go to http://www.eiolca.net/cgi-bin/dft/use.pl
2. Select US 2002 (428) in step 1.
3. In Step 2 select Mining and Utilities for the Broad Sector Group and Power Generation and Supply for the Detailed Sector.
4. In Step 3 input the amount of money saved by **electricity costs** in **millions of dollars**. In this example about **$2,800 would be save by installing occupancy sensors**. The amount entered was 0.0028 in the "Amount of economic activity for this sector".
5. In Step 4 "Greenhouse Gases" was then selected for the category of results to display.
6. Click "Run the Model".

1 Choose a model:

Your current model is the **US 2002 Benchmark**, which is a **Producer Price** Model. (Show more details) (Hide details)

US 2002 (428)

2 Select industry and sector:

Search for a sector by keyword:

Search

Or browse for a sector below:

Mining and Utilities

Pow er generation and supply

3 Select the amount of economic activity for this sector:

.0028 Million Dollars (Show more details) (Hide details)

4 Select the category of results to display:

Greenhouse Gases (Show more details) (Hide details)

5 Run the model:

The table received in this example can be seen below. The total tons of CO_2 equivalents for all sectors is 26.2.

	Sector	**Total t CO2e**	**CO2 Fossil t CO2e**	**CO2 Process t CO2e**	**CH4 t CO2e**	**N2O t CO2e**	**HFC/PFCs t CO2e**
	Total for all sectors	*26.2*	*24.9*	*0.088*	*0.967*	*0.158*	*0.161*
221100	Power generation and supply	24.7	24.3	0	0.067	0.151	0.157
212100	Coal mining	0.643	0.072	0	0.570	0	0
211000	Oil and gas extraction	0.361	0.102	0.066	0.193	0	0
486000	Pipeline transportation	0.188	0.086	0.000	0.102	0	0
482000	Rail transportation	0.073	0.073	0	0	0	0
324110	Petroleum refineries	0.056	0.055	0	0.000	0	0
484000	Truck transportation	0.026	0.026	0	0	0	0
230301	Nonresidential maintenance and repair	0.025	0.025	0	0	0	0
331110	Iron and steel mills	0.021	0.008	0.013	0.000	0	0
221200	Natural gas distribution	0.020	0.002	0	0.019	0	0

Example 2: Greenhouse Calculations for Vending Machine Controls

The use of electricity from coal fire plants releases air pollutants in the form of greenhouse gases. Greenhouse gases released into the atmosphere trap heat and hold heat it in, having effects on the climate. Reducing the amount of greenhouse gases emitted into our atmosphere is essential to the quality of the environment.

Assumptions:

--Installation of occupancy sensors would save 7000 kWh/year of electricity
--GHG conversion based on Nebraska conversion factor
--All annual saving are caused by the reduction in energy use
--2.104 lb CO2E/kWh (based on EPA GHG Calculator)

Calculations: $\frac{7000\ kWh/yr\ X\ 2.104\ lb\ CO2e\ per\ kWh}{2{,}204.6\ lb\ per\ metric\ ton} = 6.68\ MTCO2e/year\ \approx 7\ MTCO2e/yr$

Sources:

--U.S. EPA, Clean Energy. "eGRID 2007 Version 1.1." February 2009. Downloadable ZIP file: eGRID20071_1year05_aggregation.xls, tab NRL05 and US05. (http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html#download)
--US EPA, Downloadable Document: "Unit Conversions, Emissions Factors, and Other Reference Data, 2004." Table I, Page 1.
http://www.epa.gov/climatechange/emissions/downloads/emissionsfactorsbrochure2004.pdf

Appendix 4
Tips for Making the Business Case for Change

Tip # 1: Writing an Executive Summary

An executive summary is a brief overview of a report designed to give readers a quick preview of its contents. Its purpose is to consolidate the principal points of a document in one place. After reading the summary, your audience should understand the main points you are making and your evidence for those points without having to read every part of your report in full. It is called an executive summary because the audience is usually someone who makes funding, personnel, or policy decisions and needs information quickly and efficiently in order to make decisions and respond appropriately.

Guidelines:

An executive summary should communicate independently of the report. It should stand on its own as a complete document.

It should explain why you wrote the report, emphasize your conclusions or recommendations, and include only the essential or most significant information to support those conclusions.

Use subtitles, bullets, tables, selective bolding or other types of organizational structure to add clarity to your summary

It should be concise—about 10% of the length of the full report.

It should be organized according to the sequence of information presented in the full report. Don't introduce any new information that is not in your report.

To help with organizing the executive summary, after you have written the full report, find key words; words that enumerate (first, next, finally); words that express causation (therefore, consequently); words that signal essentials (basically, central, leading, principal, major); and contrast (however, similarly, less likely).

Read the completed summary with fresh eyes. Check spelling, grammar, punctuation, details, and content. Ask someone else to read it.

Tip #2: Technical Writing Tips

Use these tips as a **checklist** as you prepare your report.

- **Proof reading.** Write your report, let it sit, then proof read it for grammar, jargon, clarity, multiple meanings, and technical correctness before submittal. Re-read the report from the recipient's point of view. Reading the report aloud may help.
- **Figures and tables.** Refer to each figure and table in the text prior to inserting it. Always place the figure or table in the report soon after you have referred to it. Include a title and number for all figures and tables, capitalizing the title when referring to a specific table or figure, e.g., "All of the wastes generated by the shop are listed in Table 1
- **Transitions.** Provide brief transition sentences between sections of the report and before a bulleted list to explain what the list consists of and how it is organized.
- **Parallel construction.** Use parallel construction in all numbered or bulleted lists. For example, all items should be a complete sentence or none should be; or all items might begin with an active verb, e.g., "use," "change," "remove" or a noun, like this list.
- **Format.** A general format/outline has been suggested, although this may need to be modified to address a client's requests. Generally you should:
  - Move from generalities to specifics, in each section and across the report as a whole.
  - Use page numbers.
  - Keep section headings with the narrative that follows at page breaks.
  - Rarely split a table across two pages.
- **Abbreviations.** On first use, spell the term out completely, followed by the abbreviation in parentheses. For example, "Volatile Organic Compounds (VOCs) are another waste that could be minimized." Subsequently, just the abbreviation is sufficient unless it is used at the beginning of a sentence. Never start a sentence with an abbreviation or a numeral.
- **Professional tone.**
  - Avoid slang, informal terminology (inexpensive vs. cheap), or imprecise (there, that, it) language.
  - Be careful how you word suggestions. Avoid making recommendations outside of your area and level of expertise in source reduction and waste minimization.
  - Use tact and be positive in your conclusions. Remember a reader likes to be complimented, but can see through phoniness.
  - Be careful to confirm your information if you state it as a fact; or cite your source, e.g., "According to Mr. Jones, Plant Engineer, . ." or state that the information is a potential based on xyz assumptions.
- **Common errors.**
  - i.e. vs. e.g.: i.e. means "that is" or "in other words," and e.g. means "for example."
  - compliment vs. complement: a compliment is a nice comment, and a complement is a part of a whole
  - how many vs. how much: how many can be counted, and how much is uncountable, e.g., how many bottles of water vs. how much water.
  - policies vs. procedures vs. practices: policies are formal written positions or statements about some issue; procedures are written directives aimed at accomplishing a task or complying with a policy; practices are typically informal steps people take, which may or may not follow written policies and procedures

Tip #3: General Recommendations

General recommendations are made to help a company establish the culture and infrastructure needed to establish and sustain a commitment to source reduction and sustainability. Examples of commonly made general recommendations include:

1. A pollution prevention policy statement should be generated and periodically updated by management to formally reflect management's commitment to incorporating pollution prevention in the company's operations. Some examples of formal policy statements follow:

> *This company is committed to continued excellence, leadership, and stewardship in protecting the environment. Environmental policy is a primary management responsibility, as well as the responsibility of every employee.*
>
> *The corporate objective is to reduce waste and achieve minimal adverse impact on the air, water, and land through excellence in environmental control.*
>
> *Minimizing or eliminating the generation of hazardous waste is a prime consideration in process design and plant operations and is viewed by management as having a priority as high as safety, yield, and loss prevention.*

2. To further implement the corporate pollution prevention policy, one or more "cause champions" should be selected to lead the pollution prevention program and overcome the resistance present when changes are made to existing operations. These "cause champions" may include a project manager, an environmental coordinator, or anyone else dedicated to implementing the pollution prevention ideal and company policy. These individuals must be given authority by management to carry out the policy.

3. Input from employees should be considered, encouraged, and valued. Since the employees must deal with the waste, they may have insight into how a specific pollution prevention opportunity may be implemented. Many companies offer incentives to employees who suggest innovations to minimize or reduce waste generation.

4. Goals should be established to help implement and track the progress of the corporate pollution prevention policy. Specific, quantitative goals should be set that are acceptable to those willing to work to achieve them, flexible to changing requirements, and achievable with a practical level of effort. To document the progress of the pollution prevention goals, a waste accounting system should be used.