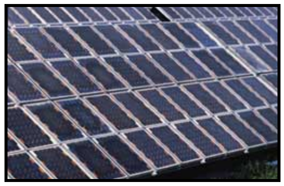
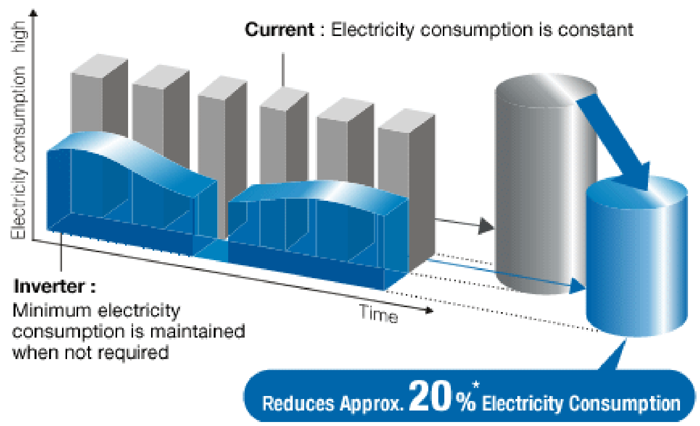
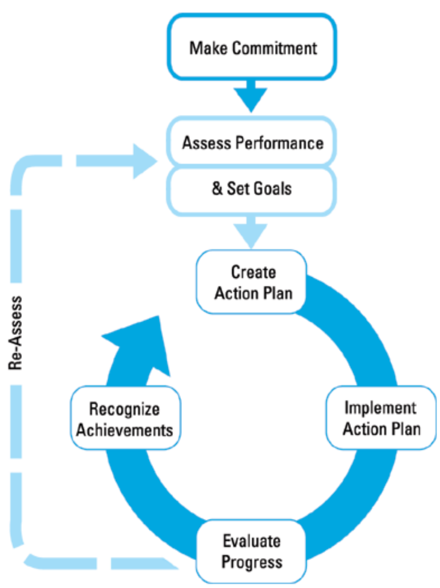


FACT & INFORMATION SHEETS

A service of the Purchase Area Development District





FACT & INFORMATION SHEETS
ENERGY MANAGEMENT: FACT & INFORMATION SHEETS

CONTENT PAGE

FACT & INFORMATION SHEETS

U.S. Department of Energy
Energy Efficiency and Renewable Energy

DISCLAIMER

The contents of this booklet are offered as a guide. The Purchase Area Development District and the U.S. Department of Energy as well as all technical or informational sources referred to in this booklet do not:

- Make any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this booklet, or that the use of any information, apparatus, method, or process disclosed in this booklet may not infringe on privately owned rights
- Assume any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method or process disclosed in this booklet.

The booklet does not reflect official views or policy of the above mentioned institutions. Mention of trade names or commercial products does not constitute endorsement or recommendation of use.

TECHNOLOGY FACT SHEETS

1. Energy-Efficient Appliances

Commercial and residential refrigeration and clothes washer appliances represent significant opportunities for reducing energy consumption through the application of commercially available energy efficient technology. Refrigeration counts for a significant portion of residential and commercial energy use. In the average American household, the refrigerator can account for as much as 15 percent of a home=s total energy usage.

Primary energy usage in the commercial refrigeration sector is estimated to be one quad, or about 91 billion kilo-watt hours (kWh), including consideration of generation, transmission and distribution losses. Primary energy savings in the range of 30 percent are possible with energy efficient refrigeration technology.

Automatic clothes washers are one of the highest end-uses of water in today=s homes. Americans wash about 35 billion loads of laundry annually in the U. S., consuming 2.6 percent of the total residential energy use. The clothes washer uses a relatively small amount of energy to operate the motor and controls. Much more energy is consumed to heat the water used by the washer and to dry clothes once they have been washed. Consequently, washers that have low hot water requirements and have effective spin cycles to remove moisture from the clothing (thereby reducing the energy needed by the dryer) are more efficient.

1.1 Residential Refrigerators

Refrigerators are the single biggest power consumer in most households. Due to government regulations and market demand, these appliances have become increasingly more energy efficient over the last 25 years. Energy efficiency measures for refrigerators include better insulation, more efficient compressors, improved heat transfer surfaces, and more precise temperature and defrost mechanisms. Federal law requires that EnergyGuide labels be placed on all new refrigerators. These labels will tell you how much electricity in kilowatt-hours (kWh) a particular model uses in one year. Also, the most energy efficient products are designated with the ENERGY STAR label.

1.2 Commercial Reach-in Refrigerators and Freezers

Reach-in refrigerators and freezers are used primarily in food-service establishments such as restaurants and cafeterias and in grocery and convenience stores. The common reach-in refrigerator is available in 10 to 75 cubic feet of capacity, the industry average being 50 cubic feet. The energy efficiency features of reach-in refrigerators and freezers are associated with high efficiency fan motors and compressors as well as non-electric anti-sweat heating. Energy efficient models typically have payback periods less than three years, and less than two years in some cases. And a new commercially available high-efficiency model, recently developed with DOE funding, achieves a 68 percent reduction in energy use without any price premium.

1.3 Refrigerated Vending Machines

Refrigerated vending machines are primarily purchased by beverage distributors and placed in a variety of locations at no cost to the property owner. However, the property owner does pay for the electricity to operate these machines. Since the purchaser does not pay operating costs, there is little incentive to purchase efficient machines, and most vending machines are inefficient as a result. The same efficiency measures use in residential refrigerators could be applied to vending machines.

1.4 Clothes Washers Background

Conventional clothes washers use about 40 gallons of water B water weighing more than 300 pounds B to wash a load of clothes which typically may weigh only 7 pounds. U. S. homes wash about one load per day, making automatic clothes washers one of the highest end-uses of water in today=s homes.

About 35 billion loads of laundry are washed annually in the U. S. consuming 2.6 percent of the total residential energy use. Only a relatively small amount of energy is used by the clothes washer itself to operate the motor and controls. A much larger component is in the energy needed to heat the water used by the washer and in the energy needed to dry clothes once they have been washed.

1.5 Horizontal- and Vertical-Axis Washers

Horizontal-axis (H-axis) washers are front loading washers while vertical-axis (V-axis) washers load from the top. Although H-axis washers have been more efficient historically, new V-axis washers have similar performance, and models meeting government ENERGY STAR qualifications are available for both types. H-axis washers have been more popular in Europe but are gaining popularity in the American market.

Instead of suspending clothes in a tub of water for washing and rinsing as vertical-axis (v-axis) washers do, h-axis washers tumble the wash load repeatedly through a small pool of water at the bottom of the tub to produce the needed agitation. Efficient washers include energy efficient motors, faster spins cycles to remove moisture from the clothing (thereby reducing the energy needed by the dryer), and sensors that regulate the volume of hot water based on the size of the clothes load.

1.6 Energy Savings

Refrigerators made to meet the latest DOE standards will cut consumers' energy costs by 30 percent compared to the previous (1993) standards. A new refrigerator with an ENERGY STAR label will save between $35 and $70 annually compared to the models designed 10 years ago. This adds up to between $525 and $1050 over the average 15- to 20-year life of the unit.

With reach-in refrigerators, primary energy usage reductions of about 50 percent, representing 27 trillion Btu, are possible with a typical payback period of two years. With reach-in freezers, primary energy usage reductions of about 40 percent, representing 29 trillion Btu, are possible. Reductions of 30 percent are realizable with a two-year payback period through the use of high efficiency compressors and non-electric anti-sweat heating technology. Additional energy saving features can achieve further reductions of 10 percent with a five-year payback.

For refrigerated vending machines, primary energy usage reductions of about 32 percent, representing 45 trillion Btu, are possible with a payback period of two years or less.

Efficient washers can provide close to 38 percent water and 58 percent energy savings. Complete replacement of inefficient washers with highly efficient ones could save over 500 billion gallons of water and over 150 trillion Btu of energy annually in the U.S.

1.7 Emissions

Buildings and their appliances use 36 percent of the nation’s energy, and are also responsible for 36 percent of U. S. emissions of carbon dioxide produced by human activities. If most U. S. households change over to high-efficiency clothes washers by 2010, U. S. carbon emissions will be reduced by 28 million metric tons of carbon per year. If Americans replace their aging refrigerators with these new efficient ones by 2010, they would reduce carbon dioxide emissions by 48 million metric tons per year.

2. Improved HVAC Systems

Heating, ventilation and air conditioning (HVAC) systems account for 40% to 60% of the energy used in U.S. commercial and residential buildings. Proven technologies and design concepts, along with energy efficient HVAC technologies will allow these services to be provided with significant energy savings and lower lifecycle costs.

HVAC systems also have a significant effect on the health, comfort, and productivity of occupants. Issues including user discomfort, improper ventilation, and poor indoor air quality are linked to HVAC system design and operation and can be corrected by improved mechanical and ventilation systems. As with lighting systems, the productivity gains from a well designed and implemented HVAC system can result in savings that are many times the energy savings alone.

2.1 Design Decisions

The best HVAC design considers all the interrelated building systems while addressing indoor air quality, energy consumption, and environmental benefit. Upgrading an existing HVAC system should only be undertaken after improvements to a building's lighting, insulation and office equipment have already been made. These improvements will substantially reduce the load and will consequently affect the design of the HVAC system.

Optimizing the design and benefits requires that your mechanical system designer and your architect address major issues early in the schematic design phase and work closely together throughout the design process. It is also essential that you implement well-thought-out commissioning processes and routine preventative maintenance programs.

2.2 Highlighted Technologies

The following highlighted technologies allow substantial energy savings from HVAC systems:

2.2.1 Energy Efficient Unitary Air Conditioners

Air conditioners account for about 12% of the energy used in commercial buildings, and are the largest contributor to peak electricity demand in hot weather. Unitary air conditioners are the most common type of air conditioner for residential and smaller commercial buildings. Newer, high efficiency models exceed federal standards for energy efficiency by 20% and have lifecycle costs that are 14% lower than standard models.

New AC units are required by the Federal Trade Commission to include a label describing the unit's energy efficiency rating, and the most energy efficient units receive the Energy Star label from the Environmental Protection Agency. In addition to reducing average energy consumption, unitary air conditioners also reduce peak demand for electricity. A portion of peak electricity demand is often met by diesel generators, which produce extremely high levels of NOx emissions.

2.2.2 Residential Furnaces and Boilers

Although older forced-air and hot water boiler systems had efficiencies in the range of 56% to 70%, modern heating systems can achieve efficiencies as high as 97%, converting nearly all the fuel to useful heat for the home. Conservation efforts and a new high-efficiency heating system can often cut fuel bills and furnace's pollution output in half.

2.2.3 Heat Pump Water Heater (HPWH)

Heat Pump Water Heaters are 2 to 3 times more efficient than conventional water heaters because they transport heat from a source (e.g., outside air or air inside a building) rather than producing it by combusting gas or using electric resistance elements. Commercial HPWH systems have installed costs that are several times that of gas or electric water heaters; however their lifecycle costs can be significantly lower because of their greatly reduced operating costs. The HPWH becomes increasingly attractive in building applications where energy costs are high, and where there is a steady demand for hot water.

The most cost effective use of a Heat Pump Water Heater is when the heat is removed from a source that would normally be removed by the HVAC system. With this design, the simple payback is less than 1 year.

2.2.4 Ceiling Fans

The movement of air by a ceiling fan creates a wind-chill effect that makes a room feel cooler. In temperate climates or during moderately hot weather, the use of ceiling fans can compensate for air-conditioning. For hotter temperatures where air conditioning is required, a ceiling fan can allow the thermostat to be raised about 4°F with no reduction in comfort. However, most ceiling fans use inefficient motors and blade designs. A major manufacturer recently introduced an improved design which consumes 40% less electricity. This alternative has a return on investment up to 30% and a simple payback 3 ½ years.

2.3 Energy Savings
The largest energy savings from upgrading a building's HVAC system are attributable to a decrease in the system size made possible by prior implementation of other measures (e.g. improved lighting, insulation, and energy efficient office equipment) that reduce the need for HVAC services. HVAC upgrades that improve comfort and air quality while reducing HVAC energy consumption 40 percent or more are possible.

2.4 Emissions Reductions
Improved HVAC systems reduce emissions of greenhouse gases roughly in proportion with energy savings. Upgrading a single residential furnace or boiler from 56% to 90% efficiency in a cold-climate will save 1.5 tons of carbon dioxide emissions each year if you heat with gas, or 2.5 tons if you heat with oil.

2.5 Websites

DOE Buildings:	http://www.eren.doe.gov/buildings
Unitary AC:	http://www.pnl.gov/uac/welcome.stm
	http://www.eren.doe.gov/femp/procurement/pdfs/uac.pdf
	http://www.cee1.org/com/hecac/Com_HVAC_spec.pdf
Furnaces:	http://www.eren.doe.gov/buildings/heatcool_furnace.html
Heat Pump WH:	http://www.eren.doe.gov/femp/prodtech/10_comm.html
	http://www.cee1.org/resrc/facts/hecac-fx.php3
Ceiling Fans:	http://yosemite1.epa.gov/estar/consumers.nsf/content/ceilingfan.htm
	http://www.nrel.gov/docs/fy01osti/29513.pdf
Screening & Design Tools	http://www.eren.doe.gov/buildings/tools_directory/ (Under Materials, Components, Equipment and Systems/HVAC equipment and systems)

3. Improved Lighting
In the U.S. commercial sector, lighting accounts for approximately 26% of the electricity consumed in commercial buildings and represents approximately $22 billion in annual expenditures. An additional 10% of electricity consumed in buildings is for air conditioning to counter the heat generated by electric lights.

Energy efficient lighting requires only about one third the energy of standard incandescent lighting. It represents the most cost-effective energy efficiency opportunity available to the commercial sector. Converting to energy efficient lighting can reduce a company's energy expenses for lighting by up to 70%, depending on the lighting technologies and practices being replaced. The return on investment for lighting retrofits is typically greater than 30% with a simple payback within three years.

Whether retrofitting, remodeling, or constructing a new building, good lighting design is the key to minimizing energy costs for lighting. Besides incorporating efficient technology, effective lighting design considers the illumination needs based on different uses of floor space, incorporates natural lighting, and provides workspace occupants flexibility in controlling light levels.

3.1 Technologies
Conventional incandescent lamps are the least efficient lighting option. They convert only about 10% of the energy into light while transforming the rest into heat. Commercially available energy efficient lighting technologies include daylighting, fluorescent lamps, and high intensity discharge lamps. Solid-state lighting is a promising advanced technology under development. These technologies are discussed below.

The use of natural light for illuminating interior space is referred to as **daylighting.** When properly designed and effectively integrated with a building's electric lighting system, sunlight can offer significant energy savings benefits over traditional incandescent or fluorescent lighting. The building's air conditioning requirements are also reduced because less heat is generated by electric lights. Besides window design, daylighting options include advanced skylights, clerestories, reflecting surfaces, light shelves, and light pipes.

Conventional **fluorescent lamps** with magnetic ballasts consume about one-third the energy required for incandescent lamps. **Energy efficient fluorescent lamps** combine smaller diameter fluorescent bulbs with electronic ballasts. They require only about two-thirds of the energy required for conventional fluorescent lamps.

Small-diameter fluorescent lamps folded for compactness are called **compact fluorescent lamps** (CFLs). They last up to 10 times longer than incandescent lamps, and they use about one-fourth the energy, producing 90% less heat. Even smaller fluorescent lamps, **sub-compact fluorescents**, are designed to replace incandescent lamps in standard fixtures. **Recessed can fluorescents** are compact fluorescent lamps in air-tight recessed cans designed to replace incandescent recessed can lighting.

DOE is currently aggregating volume purchases of sub-compact fluorescents and recessed can fluorescents by commercial entities in order to encourage production volumes necessary for them to become market competitive.

Interested companies can refer to:
for sub-compacts: http://www.eren.doe.gov/buildings/emergingtech/pdfs/lightbulbs.pdf
for recessed cans: http://www.pnl.gov/cfldownlights/index.html

The **compact fluorescent torchiere lamps** are recommended as an energy efficient alternative for halogen torchiere lamps (floor lamps). The energy-efficient torchiere gives off approximately 50% more light while consuming only one quarter the energy of a halogen torchiere. Compact Fluorescent torchiere lamps are also much safer than halogen torchieres because halogen torchieres have a bulb temperature of 1000 °F compared to 100 °F for compact fluorescent torchiere lamps.

The **high intensity discharge** (HID) lamps are a very compact light source. A single 100-watt HID lamp, for example, provides as much light as a 500-watt incandescent lamp or a 160-watt, four-lamp fluorescent fixture. The HID lamp, however, is approximately the size of a common 100-watt incandescent bulb. HID lamps are typically used when high levels of light are required over large areas and when energy efficiency and/or long life are desired. These areas include gymnasiums, large public areas, warehouses, outdoor activity areas, roadways, parking lots, and pathways. More recently, however, HID sources, especially metal halide, have been used in small retail and residential environments.

The U.S. DOE is currently sponsoring the development of **solid-state lighting** for general illumination. Unlike incandescent and fluorescent lamps, solid-state lighting creates light without producing heat. A semi-conducting material converts electricity directly into light, which makes the light very energy efficient. Solid-state lighting is currently used commercially for some applications but requires further development to be suitable for general illumination.

3.2 Benefits

Advanced lighting technologies like fluorescent and high intensity discharge lamps are several times more energy efficient that traditional incandescent lights. The return on investment of replacing incandescent bulbs with fluorescent ones is often greater than 30%. In addition, the use of daylighting can provide full spectrum, natural light without the use of any electricity.

These efficient lighting alternatives last 5 to 13 times longer than traditional incandescent lights, reducing inconvenience and maintenance costs. Also, studies indicate increased worker productivity from well designed lighting.

3.3 Energy Savings

Automated energy saving calculators are found at
http://www.eren.doe.gov/buildings/forms/light.cgi
and
http://www.eren.doe.gov/femp/procurement/calc-index.html

Table 1 shows the energy savings per year of a compact fluorescent light bulb compared to an incandescent bulb producing an equivalent amount of light.

Incandescent (watts)	Fluorescent (watts)	Kilowatt-hours saved/year	Financial Savings/year
60	15	180	$18
75	20	220	$22
100	25	300	$30

Table 1:
Annual energy savings due to replacing an incandescent bulb with a compact fluorescent bulb
(Assumes that the bulb is used for 4000 hours/year and electricity costs 10¢/kWh)

3.4 Emissions

Lighting is responsible for 450 million tons of U.S. CO_2 emissions per year. Because of their advantages over traditional incandescent bulbs, advanced lighting technologies can potentially make a significant dent in the US's CO_2 emissions. A single compact fluorescent light prevents the emissions of 8-16 pounds of acid-rain causing sulfur dioxide and 1000-2000 pounds of carbon dioxide. Large-scale, national implementation of advanced lighting could reduce carbon dioxide emissions by hundreds of millions of tons per year.

3.5 Websites

DOE Buildings: http://www.eren.doe.gov/buildings
Daylighting: http://cfdev.iimage.com/bts/design/integratedbuilding/passivedaylighting.cfm.
Fouorescents: http://www.pnl.gov/techguide/23.htm.
Recessed Cans: http://www.pnl.gov/cfldownlights/about.html.
Torchierres: http://eetd.lbl.gov/BTP/cfloverview.html
http://eande.lbl.gov/BTP/torchiere.html
HID Lamps: http://www.peco.com/comed/library/pdfs/ce_high_intensity_lamps.pdf.
Design & Screening Tools: http://www.eren.doe.gov/buildings/tools_directory/

4. Combined Heat and Power

Combined heat and power "CHP" systems produce electricity or mechanical power and capture recoverable "waste" heat from power generation technologies for cooling, dehumidification, steam, hot water, or additional power generation. CHP systems are highly efficient; as much as 80 percent of the fuel input can be converted into usable energy. CHP systems also greatly reduce the amount of heat, carbon, NOx, and SOx released into the atmosphere. CHP systems could reduce annual greenhouse emissions by at least 16 million metric tons of carbon dioxide per year if goals to double U.S. installed capacity by 2010 are met.

4.1 Energy Savings

Energy savings are realized by using the thermal energy produced during onsite power generation to meet onsite thermal or additional power loads. Conventionally a facility would draw electricity from the grid, which has a national average generation efficiency of 32% and transmission and distribution line losses of 7-9%. This translates into an overall delivered efficiency around 25%. A facility would also need to produce steam or hot water (i.e. a natural gas-fired boiler with a thermal efficiency exceeding 85%).

Characteristic	Grid Power and Boiler Heat	Onsite Combined Heat and Power
Electrical	▪ 32% HHV efficiency (U.S. average) ▪ 7-9% line losses	▪ 20-40% HHV efficiency ▪ No line losses
Thermal (Boiler)	▪ 85% HHV efficiency	▪ Waste heat recovery
Overall fuel use efficiency	▪ 45%	▪ 55-80%

The above example demonstrates that CHP systems can double the fuel use efficiency of using grid power and a boiler. Consider the fact that a 5 MW CHP system with 75% heat recovery efficiency operating 6,500 hours a year would use approximately 100 billion BTU/year less than separate heat and power system with 45% efficiency.

4.2 Emissions

Emissions benefits of CHP systems depend on local conditions including the fuel used for both the CHP system and the separate heat and power system. Emissions benefits are highest when a natural gas-fired CHP system is compared against a coal-fired separate heat and power system. The example below compares systems which both use natural gas therefore emissions reductions could be much greater for other systems.

Characteristic	Separate Heat and Power [1]	CHP System [2]
Nitrogen Oxides	0.00124lbs/kWh	0.00050 lbs/kWh
Sulfur Dioxide	0.00003 lbs/kWh	0.00001 lbs/kWh
Carbon Dioxide	1.20 lbs/kWh	0.5 lbs/kWh

1 Solar Turbines *Taurus 60* Gen Set. Natural gas fired. Efficiency is 29.35%. Boiler is natural gas fired with efficiency of 85%.
2 CHP system with 75% heat recovery efficiency.

If you assume 6,500 hours of operation per year, the CHP system will emit approximately 2,925 pounds/year less carbon dioxide than a separate heat and power system.

4.3 Applications

The industrial sector offers the greatest potential for near-term growth. Currently the majority of CHP systems are installed in the industrial sector, predominately in the petroleum refining, petrochemical, and pulp and paper industries.

Advanced reciprocating engines and combustion turbines and new technologies like microturbines and in the future fuel cells combined with heat recovery, absorption cooling, desiccant dehumidification and other thermally activated technologies means that CHP is becoming increasingly economically attractive for industrial facilities and is now being considered for commercial and institutional buildings.

This involves the installation of a system that generates part of or all of the building's electricity and thermal requirements (such as cooling, heating, hot water, and dehumidification).

4.4 Technology Calculator

Description	Cost *
Capital cost of unit	$1,148/kW
Fuel cost	$0.017/kWh
Maintenance cost	$0.0059/kWh
Total cost of generating power	$0.023/kWh

* "Small Gas Turbine Technology Characterization – Peer Review Draft", Report for NREL, November 2002, Energy and Environmental Analysis (Energy Nexus Group). Actual costs may vary widely and are affected by site requirements and conditions, regional price variations, and environmental and other local permitting requirements. Fuel costs based on $5MMBTU and a 5MW gas turbine.

4.5 Related Websites

www.epa.gov/chp
www.uschpa.org
www.nemw.org
www.districtenergy.org
www.aceee.org/chp
www.cogeneration.org
www.chpcentermw.org
www.rci.rutgers.edu/%7Ejonflrty/cogeneration.htm
www.energy.rochester.edu
www.cogen.org

DOE Website:
www.eren.doe.gov/der/chp

4.6 Screening and Design Tools

Name	Website	Cost
Cogeneration Ready Reckoner–Industrial CHP/Cogen	www.eren.doe.gov/der/chp/chp-eval2.html	Free
RECIPRO –Small reciprocating engine applications only	www.thermoflow.com	$1,500
BCHP Screening Tool –CHP in buildings	www.bchp.org/finance-economic.html#screen	TBD-Currently in Beta test
Building Energy Analyzer –CHP in buildings	www.interenergysoftware.com	Est. $500 -$700
D-Gen Pro –CHP in buildings	http://archenergy.com/dgenpro/default.htm	$895
Heatmap CHP –Detailed CHP system design simulation	www.energy.wsu.edu/software/HEATMAP	$4,000 (also requires AutoCad)
GT Pro –Detailed gas turbine CHP system design tool	www.thermoflow.com	$7,000

5. Resources for Whole Building Design

The process of creating high-performance commercial and residential buildings is different from the conventional design/build process. Traditionally, the energy efficiency of building components and subsystems has been analyzed and optimized separately. This approach fails to optimize the energy efficiency of the whole system. In order to optimize a building's energy efficiency, designers must adopt a systems engineering approach that considers the interaction of building components.

5.1 Approach

Whole-building design considers all building components and systems during the design phase and integrates them to work together efficiently. Because all the systems are interrelated, it is essential that the design team be fully integrated from the ***beginning*** of the process. The building design team can include architects, engineers, building occupants and owners, as well as specialists in areas such as indoor air quality, materials and energy use. The whole-building philosophy considers site, energy, materials, indoor air quality, acoustics, natural resources, and their interrelationships.

A building that is constructed using whole building design techniques requires more initial planning and collaboration of different stakeholders, but the end result is a building that is more comfortable, energy efficient, and cost-effective.

In order to use the whole-building design philosophy it is recommend that:

- Members of the entire design team are identified before beginning the design process. All those who can influence the building design and how it is constructed should be represented on the design team, including architects, engineers, building owners and occupants, and specialists in areas such as indoor air quality, materials, and energy use. The breadth and aggressiveness of the design goals will determine who should be on this team.
- Architects and engineers with green building design experience are selected.
- A design charrette process (a charrette is a workshop for generating and discussing ideas in the planning and design process) should be used to increase collaboration between members of the design team. Design charrettes can take several days and allow participants to propose and consider many different ideas, address organizational differences, reduce adversity, verify decisions, and expedite the design process.

- Use LEED (Leadership in Energy and Environmental Design) national green building standard as a framework for assessing building performance and meeting sustainability goals.
- Use standardized protocols like the International Performance Measurement and Verification Protocol to measure building performance.
- Develop a strategy to implement the building-commissioning process to insure that the building is operating to its design specifications.
- Use lifecycle cost assessment tools rather than just initial costs.
- Design for worker comfort. Research has demonstrated that workers are more productive in well-designed buildings and the cost savings from increased productivity can dwarf the building's energy savings.

5.2 Energy Savings and Emissions Reductions

Buildings based on the whole-building design approach can use less than half of the energy and produce less than half of the emissions of a comparable conventional building.

5.3 Other Benefits

Buildings based on the whole-building design approach can provide greater comfort to the building's occupants than conventional buildings. Increased worker productivity can lead to savings many times the building's energy savings.

5.4 Websites

Whole building design:
http://cfdev.iimage.com/bts/design/wholebuilding/index.cfm
Whole Building design guide:
http://www.wbdg.org
Building America Program:
http://www.eren.doe.gov/buildings/building_america/
International Performance Measurement & Verification Protocol:
http://www.ipmvp.org
LEED home page:
http://www.usgbc.org/LEED/LEED_main.asp
Energy Star Building Manual:
http://yosemite1.epa.gov/Estar/business.nsf/content/business_resources_upgradebuilding.htm
Building benchmarking:
http://eber.ed.ornl.gov/benchmark/bench.htm
Software tools for buildings:
http://www.eren.doe.gov/buildings/tools_directory/
Green building design software:
http://www.buildinggreen.com/ecommerce/cat.jsp?s=7
Sustainable building technical manual:
http://www.sustainable.doe.gov/pdf/sbt.pdf

6. Software and Training

Industrial equipment like motors, pumps, compressed air systems and steam systems are large energy consumers, with their lifetime energy costs often exceeding their initial capital costs by several times. However, selection of these components is often based on their initial costs. In addition, the components are often oversized for their intended function and thus not optimized for energy efficiency.

Although energy costs are often only a fraction of cost of labor and capital, every dollar of energy saved goes directly to the company's bottom line. In order to facilitate the industry's adoption of energy saving equipment, The Office of Industrial Technologies has developed a range of technical software and training programs to help plant operators save energy with return on investment often exceeding 50%. The software packages and training courses for each component are described below:

6.1 Motors

Motor driven equipment accounts for 64% of the electricity consumed in the U.S. industrial sector.

Software	Training
MotorMaster+: MotorMaster+3.0 is a software program that analyzes motor and motor system efficiency. Designed for utility auditors, industrial plant energy coordinators, and consulting engineers, MotorMaster+3.0 is used to identify inefficient or oversized facility motors and compute the energy and demand savings associated with selection of a replacement energy-efficient model.	**Electric Motor Systems Workshop – 1-day** This course provides an understanding of electric motor systems management, including evaluation and selection of optimum motor based on application requirements and economic analysis. Techniques for developing motor tracking systems, and guidelines for motor repair are also covered. The Motor Systems Workshop includes information on the use of the MotorMaster+ software, with demonstration of the basic functions and applications of the tool.
ASDMaster: This adjustable speed drive evaluation methodology and application software program, developed by the Electric Power Research Institute & the Bonneville Power Administration, helps a plant or operations professional determine the economic feasibility of an ASD application, predict how much electrical energy may be saved by using an Adjustable Speed Drive (ASD), and highlight key systems where ASDs can successfully be applied	**Adjustable Speed Drive Application — 1-day workshop** This course examines how an adjustable speed drive (ASD) functions and explains common ASD configurations. It also covers common problems encountered with ASDs, along with their symptoms and solutions. During the course, participants learn how to use ASDMaster software to identify potential ASD applications and to assist in preparing bid specifications. Participants receive summary information about how the software works and several sample case studies, and learn which questions a user should ask when designing an ASD system.

6.2 Pumps

Improving Pump systems can potentially save 5% of the total motor system energy use by the manufacturing sector.

Software	Training
Pumping System Assessment Tool (PSAT): The Pumping System Assessment Tool helps industrial users assess the efficiency of pumping system operations relying on field measurements of flow rate, head, and either motor power or current to perform the assessment. PSAT uses achievable pump performance data from Hydraulic Institute standards and motor performance from the MotorMaster+ database to calculate potential energy and associated costs savings.	**Pump System Assessment — 1-day workshop** The workshop covers practical issues involved in field measurements of fluid and electrical data and presents the Pump System Assessment Tool (PSAT) used to assess the performance of pump systems. The workshop teaches how the software functions, what data is required, how the software should be used when measured data are not available, and what the assessment results mean. **Qualified Pump System Specialist — 2-day workshop and qualifying exam.** This course is designed for pumping system professionals who wish to use the software when performing plant assessments of industrial pumping systems.

6.3 Compressed Air Systems

Improving compressed air systems can potentially save up to 2.7% of the total motor system energy use by the manufacturing sector.

Software	Training
AirMaster+: AirMaster+ provides comprehensive information on assessing compressed air systems, including modeling, existing and future system upgrades, and evaluating savings and effectiveness of energy efficiency measures.	**Qualified AIRMaster Specialist — 2½-day workshop and qualifying exam.** This course is designed for compressed air professionals who wish to use the software when performing plant assessments of industrial compressed air systems. **Compressed Air Challenge Workshops — 1-day and 2-day**. The 1-day, Fundamentals of Compressed Air Systems workshop introduces compressed air systems and teaches approaches for cutting costs and tailoring a compressed air system management action plan for your plant. The 2 day Advanced Management of Compressed Air Systems Workshop shows how to develop a system profile and address point-of-use issues.

6.4 Process Heating

Process heating systems supply heat to most manufacturing processes; these systems consume about 17% of U.S industrial energy.

Software	Training
Process Heating Assessment and Survey Tool (PHAST) This tool can be used to survey furnaces, to identify major energy using equipment, to prioritize improvement opportunities, and assess available methods that can be used to reduce energy consumption in an industrial plant.	**Process Heating Systems Optimization — 1-day Workshop** This workshop includes an introduction to process heating and process heating equipment such as furnaces, ovens, dryers, heaters, kilns etc. used by the industry. It includes discussion of combustion and other heating methods, heat transfer in furnaces, heat containment, waste heat recovery, commonly used process heating controls and emission reduction related to process heating.

6.5 Steam Systems

Steam accounts for $21 billion per year of U.S. manufacturing energy costs. Increasing the efficiency of a plant's steam system can significantly increase a company's bottom line.

Software	Training
Steam System Assessment Tool The Steam System Assessment Tool (SSAT) allows users to assess potential savings from individualized steam-system improvements. Users input data about their plant's conditions, and the SSAT generates results detailing the energy, cost, and emissions savings that various improvements could achieve.	**Steam System Improvement — 1-day workshop** This course covers steam generation, utilization, leaks, and distribution. Participants discover how to obtain optimum steam generation efficiency from plant boilers and learn about steam utilization, including multi-pressure system operation and balancing. The training course helps operators reduce losses in their steam system by learning more about operation, selection, and testing of steam traps. The course also investigates the distribution system and focuses on heat loss and condensate return issues.

Software	Training
Steam System Scoping Tool. This tool is designed to help steam system energy managers and operations personnel for large industrial plants. This tool can be used to evaluate steam system operations against identified best practices. **3E Plus** This Microsoft Windows(R) based software can be used to assess potential steam system improvements that can result from appropriate insulation for piping, valves and tanks.	**Certified Insulation Energy Appraiser — 2-day Workshop** The National Insulation Association (NIA) offers training on how to conduct an insulation energy appraisal using 3EPlus Software. Industry professionals who take the 2-day training and pass a certifying exam are recognized by the NIA as Certified Insulation Energy Appraisers.

Notes

Notes

Notes

Notes

Energy Tips – Compressed Air

Compressed Air Tip Sheet #3 • December 2000

Suggested Actions

- Fixing leaks once is not enough. Incorporate a leak prevention program into your facility's operations. It should include identification and tagging, tracking, repair, verification, and employee involvement. Set a reasonable target for cost-effective leak reduction—5-10% of total system flow is typical for industrial facilities.
- Once leaks are repaired, re-evaluate your compressed air system supply. Work with a compressed air systems specialist to adjust compressor controls. Also look at alternatives to some compressed air uses. If a compressor can be turned off, benefits include cost savings and a system backup.

References

Improving Compressed Air System Performance: A Sourcebook for the Industry, Motor Challenge and Compressed Air Challenge, April 1998.

Training

- *Fundamentals of Compressed Air Systems* - 1 day
- *Advanced Management of Compressed Air Systems* - 2 days

Offered by the Compressed Air Challenge. Call the Industrial Technologies Clearinghouse or visit the BestPractices Web site (www.oit.doe.gov/bestpractices) for the latest schedule and locations.

For additional information on industrial energy efficiency measures, contact the Industrial Technologies Clearinghouse at (800) 862-2086.

Minimize Compressed Air Leaks

Leaks are a significant source of wasted energy in a compressed air system, often wasting as much as 20-30% of the compressor's output. Compressed air leaks can also contribute to problems with system operations, including:

- Fluctuating system pressure, which can cause air tools and other air-operated equipment to function less efficiently, possibly affecting production
- Excess compressor capacity, resulting in higher than necessary costs
- Decreased service life and increased maintenance of supply equipment (including the compressor package) due to unnecessary cycling and increased run time.

Although leaks can occur in any part of the system, the most common problem areas are: couplings, hoses, tubes, fittings, pipe joints, quick disconnects, FRLs (filter, regulator, and lubricator), condensate traps, valves, flanges, packings, thread sealants, and point of use devices. Leakage rates are a function of the supply pressure in an uncontrolled system and increase with higher system pressures. Leakage rates are also proportional to the square of the orifice diameter. (See table below.)

Leakage rates[a] (cfm) for different supply pressures and approximately equivalent orifice sizes[b]

Pressure (psig)	Orifice Diameter (inches)					
	1/64	1/32	1/16	1/8	1/4	3/8
70	0.3	1.2	4.8	19.2	76.7	173
80	0.33	1.3	5.4	21.4	85.7	193
90	0.37	1.5	5.9	23.8	94.8	213
100	0.41	1.6	6.5	26.0	104	234
125	0.49	2.0	7.9	31.6	126	284

[a] For well-rounded orifices, multiply the values by 0.97, and for sharp-edged orifices, multiply the values by 0.61.

[b] Used with permission from *Fundamentals of Compressed Air Systems Training* offered by the Compressed Air Challenge™.

Leak Detection

The best way to detect leaks is to use an ultrasonic acoustic detector, which can recognize high frequency hissing sounds associated with air leaks. These portable units are very easy to use. Costs and sensitivities vary, so test before you buy. A simpler method is to apply soapy water with a paintbrush to suspect areas. Although reliable, this method can be time consuming and messy.

Example

A chemical plant undertook a leak prevention program following a compressed air audit at their facility. Leaks, approximately equivalent to different orifice sizes, were found as follows: 100 leaks of 1/32" at 90 psig, 50 leaks of 1/16" at 90 psig, and 10 leaks of 1/4" at 100 psig. Calculate the annual cost savings if these leaks were eliminated. Assume 7000 annual operating hours, an aggregate electric rate of $0.05/kWh, and compressed air generation requirement of approximately 18 kW/100 cfm.

Cost savings = # of leaks x leakage rate (cfm) x kW/cfm x # of hours x $/kWh

Using values of the leakage rates from the above table and assuming sharp-edged orifices:

Cost savings from 1/32" leaks = 100 x 1.5 x 0.61 x 0.18 x 7000 x 0.05 = $5,765
Cost savings from 1/16" leaks = 50 x 5.9 x 0.61 x 0.18 x 7000 x 0.05 = $11,337
Cost savings from 1/4" leaks = 10 x 104 x 0.61 x 0.18 x 7000 x 0.05 = $39,967

Total cost savings from eliminating these leaks = $57,069

Note that the savings from the elimination of just 10 leaks of 1/4" account for almost 70% of the overall savings. As leaks are identified, it is important to prioritize them and fix the largest ones first.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy and resource intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.oit.doe.gov/bestpractices** or by contacting the Industrial Technologies Clearinghouse at **800-862-2086** or via email at **clearinghouse@ee.doe.gov.**

BestPractices is part of the Industrial Technologies Program's Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

Peter Salmon-Cox
Industrial Technologies Program
Phone: (202) 586-2380
Fax: (202) 586-6507
Peter.Salmon-Cox@hq.doe.gov
www.oit.doe.gov/bestpractices

Industrial Technologies
Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov

Visit our home page at www.oit.doe.gov

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

DOE/GO-102000-0988
December 2000
Compressed Air Tip Sheet #3

Energy Tips – Steam

Steam Tip Sheet #2 • March 2002

Insulate Steam Distribution and Condensate Return Lines

Uninsulated steam distribution and condensate return lines are a constant source of wasted energy. The table shows typical heat loss from uninsulated steam distribution lines. Insulation can typically reduce energy losses by 90% and help ensure proper steam pressure at plant equipment. Any surface over 120°F should be insulated, including boiler surfaces, steam and condensate return piping, and fittings.

Insulation frequently becomes damaged or is removed and never replaced during steam system repair. Damaged or wet insulation should be repaired or immediately replaced to avoid compromising the insulating value. Eliminate sources of moisture prior to insulation replacement. Causes of wet insulation include leaking valves, external pipe leaks, tube leaks, or leaks from adjacent equipment. After steam lines are insulated, changes in heat flows can influence other parts of the steam system.

Heat Loss per 100 feet of Uninsulated Steam Line

Distribution Line Diameter (inches)	Heat Loss per 100 feet of Uninsulated Steam Line (MMBtu/yr)			
	Steam Pressure (psig)			
	15	**150**	**300**	**600**
1	140	285	375	495
2	235	480	630	840
4	415	850	1,120	1,500
8	740	1,540	2,030	2,725
12	1,055	2,200	2,910	3,920

Based on horizontal steel pipe, 75°F ambient air, no wind velocity, and 8,760 operating hr/yr.

Example

In a plant where the value of steam is $4.50/MMBtu, a survey of the steam system identified 1,120 feet of bare 1-inch diameter steam line, and 175 feet of bare 2-inch line both operating at 150 psig. An additional 250 feet of bare 4-inch diameter line operating at 15 psig was found. From the table, the quantity of heat lost per year is:

1-inch line: 1,120 feet x 285 MMBtu/yr per 100 ft = 3,192 MMBtu/yr
2-inch line: 175 feet x 480 MMBtu/yr per 100 ft = 840 MMBtu/yr
4-inch line: 250 feet x 415 MMBtu/yr per 100 ft = 1,037 MMBtu/yr
Total Heat Loss = 5,069 MMBtu/yr

The annual operating cost savings from installing 90% efficient insulation is:

0.90 x $4.50/MMBtu x 5,069 MMBtu/yr = $20,530

Suggested Actions

Conduct a survey of your steam distribution and condensate return piping, install insulation, and start to save.

Insulation Optimization Software Available

The North American Insulation Manufacturers Association has developed a software package (3EPlus) that determines the optimum thickness for a wide variety of insulating materials. Outputs include the simple payback period, surface heat loss, and surface temperature for each specified insulation thickness. 3EPlus is available at no cost through the Information Clearinghouse.

Use Insulating Jackets

Removable insulating jackets are available for valves, flanges, steam traps, and other fittings. Remember that a 6-inch gate valve may have over 6 square feet of surface area from which to radiate heat.

Adapted from an Energy TIPS fact sheet that was originally published by the Industrial Energy Extension Service of Georgia Tech. For additional information on industrial energy efficiency measures, contact the Industrial Technologies Clearinghouse at (800) 862-2086.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy and resource intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.oit.doe.gov/bestpractices** or by contacting the Industrial Technologies Clearinghouse at **800-862-2086** or via email at **clearinghouse@ee.doe.gov.**

BestPractices is part of the Industrial Technologies Program's Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

Peter Salmon-Cox
Industrial Technologies Program
Phone: (202) 586-2380
Fax: (202) 586-6507
Peter.Salmon-Cox@hq.doe.gov
www.oit.doe.gov/bestpractices

Industrial Technologies
Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

DOE/GO-102002-1504
March 2002
Steam Tip Sheet #2

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Energy Tips – Motors

Motor Tip Sheet #1 • December 1999

Suggested Actions

1. Compute annual and life-cycle cost for systems before making an engineering design decision.
2. In systems dominated by friction head, always evaluate pumping costs for a couple of different pipe sizes and try to accommodate pipe size with the lowest overall life-cycle cost.
3. Look for ways to reduce friction factor. If your application permits, the use of plastic or epoxy-coated steel pipes can reduce friction factor by more than 40%, proportionately reducing your pumping costs.

References and Footnotes

1. Xenergy Inc., *United States Industrial Motor Systems Market Opportunities Assessment,* prepared for the U.S. Department of Energy, December 1998.
2. Mohinder K. Nayyar, *Piping Handbook*, McGraw-Hill Publications, New York, 1998.
3. Hydraulic Institute, *Engineering Data Book*, Second Edition, New Jersey, 1990.
4. *Improving Pumping System Performance: A Sourcebook for Industry*, Motor Challenge and Hydraulic Institute, January 1999.
5. *Pumping System Optimization*, Training workshop offered by the U.S. Department of Energy. Call (800) 862-2086 for more information.

For additional information on industrial energy efficiency measures, contact the Industrial Technologies Clearinghouse at (800) 862-2086.

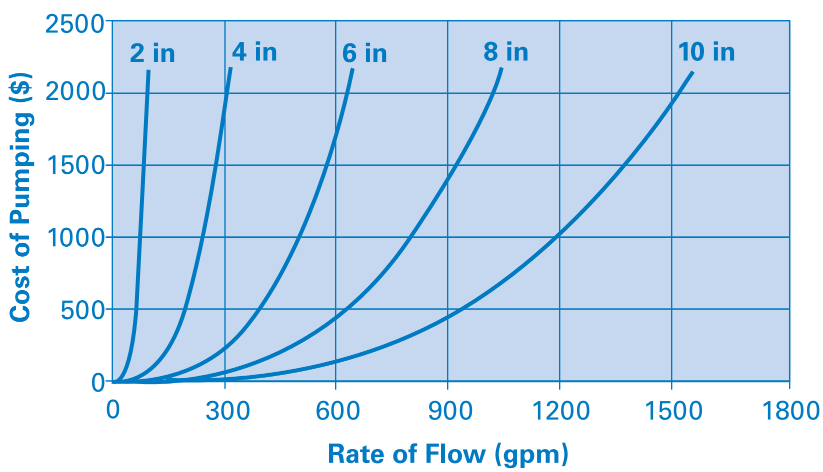
Reduce Pumping Costs through Optimum Pipe Sizing

All industrial facilities have a network of piping that carries water or other liquids. According to the U.S. Department of Energy study[1], 16% of a typical facility's electricity costs are for its pumping systems.

The power consumed to overcome the static head in a pumping system varies linearly with flow and very little can be done to reduce the static component of the system requirement. On the other hand, several energy and money-saving opportunities exist to reduce the power required to overcome the friction component of the pumping system.

The frictional power required is dependent on rate of flow, pipe size (diameter), overall length of the pipe, pipe characteristics (surface roughness, material, etc.) and properties of the liquid being pumped. The figure below shows the annual water pumping cost (frictional power only) for 1000 ft. of pipe length for different pipe sizes and rates of flow.

Annual Water Pumping Cost for 1000 Feet of Pipe of Different Sizes



Based on 1000 ft. for clean iron and steel pipes (schedule 40) for pumping 70°F water. Electricity rate—0.05 $/kWh and 8,760 operating hours annually. Combined pump and motor efficiency—70%.

Example

A pumping facility has 10,000 ft. of piping to carry 600 gpm of water continuously to storage tanks. Determine the annual pumping costs associated with different pipe sizes.

From the figure above, for 600 gpm:	6 inch pipe:	($1690/1000ft.) x 10,000 ft. =	$16,900
	8 inch pipe:	($425/1000 ft.) x 10,000 ft. =	$4,250
	10 inch pipe:	($140/1000 ft.) x 10,000 ft. =	$1,400

After calculating the energy costs, one should calculate the installation and maintenence costs for the different pipe sizes. Although the up-front cost of a larger pipe size may be higher, it may still provide the most cost-effective solution due to the large reduction in the initial pump and operating costs.

General Equation for Estimating Frictional Pumping Costs

$$\text{Cost (\$)} = \frac{1}{1705}\,\text{(Friction Factor)}\,\frac{\text{(Flow in gpm)}^3\,\text{(Pipe length in ft.)}}{\text{(Pipe inner diameter in inches)}^5}\,\frac{\text{(\# of hours)(\$/kWh)}}{\text{(Combined pump and motor efficiency as a percent)}}$$

Where the *Friction Factor*, based on the pipe roughness, pipe diameter, and the Reynolds number, can be obtained from engineering handbooks.[2,3] For most applications, the value of this friction factor will be between 0.015 and 0.0225.

About DOE's Industrial Technologies Program

The Industrial Technologies Program, through partnerships with industry, government, and non-governmental organizations, develops and delivers advanced energy efficiency, renewable energy, and pollution prevention technologies for industrial applications. The Industrial Technologies Program is part of the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

The Industrial Technologies Program encourages industry-wide efforts to boost resource productivity through a strategy called Industries of the Future (IOF). IOF focuses on the following nine energy and resource intensive industries:

- Agriculture
- Aluminum
- Chemicals
- Forest Products
- Glass
- Metal Casting
- Mining
- Petroleum
- Steel

The Industrial Technologies Program and its BestPractices activities offer a wide variety of resources to industrial partners that cover motor, steam, compressed air, and process heating systems. For example, BestPractices software can help you decide whether to replace or rewind motors (MotorMaster+), assess the efficiency of pumping systems (PSAT), compressed air systems (AirMaster+), steam systems (Steam Scoping Tool), or determine optimal insulation thickness for pipes and pressure vessels (3E Plus). Training is available to help you or your staff learn how to use these software programs and learn more about industrial systems. Workshops are held around the country on topics such as "Capturing the Value of Steam Efficiency," "Fundamentals and Advanced Management of Compressed Air Systems," and "Motor System Management." Available technical publications range from case studies and tip sheets to sourcebooks and market assessments. The *Energy Matters* newsletter, for example, provides timely articles and information on comprehensive energy systems for industry. You can access these resources and more by visiting the BestPractices Web site at **www.oit.doe.gov/bestpractices** or by contacting the Industrial Technologies Clearinghouse at **800-862-2086** or via email at **clearinghouse@ee.doe.gov.**

BestPractices is part of the Industrial Technologies Program's Industries of the Future strategy, which helps the country's most energy-intensive industries improve their competitiveness. BestPractices brings together the best-available and emerging technologies and practices to help companies begin improving energy efficiency, environmental performance, and productivity right now.

BestPractices focuses on plant systems, where significant efficiency improvements and savings can be achieved. Industry gains easy access to near-term and long-term solutions for improving the performance of motor, steam, compressed air, and process heating systems. In addition, the Industrial Assessment Centers provide comprehensive industrial energy evaluations to small and medium-size manufacturers.

For Additional Information, Please Contact:

Peter Salmon-Cox
Industrial Technologies Program
Phone: (202) 586-2380
Fax: (202) 586-6507
Peter.Salmon-Cox@hq.doe.gov
www.oit.doe.gov/bestpractices

Industrial Technologies
Clearinghouse
Phone: (800) 862-2086
Fax: (360) 586-8303
clearinghouse@ee.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Industrial Technologies Program
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

DOE/GO-10099-879
December 1999
Motor Tip Sheet #1