

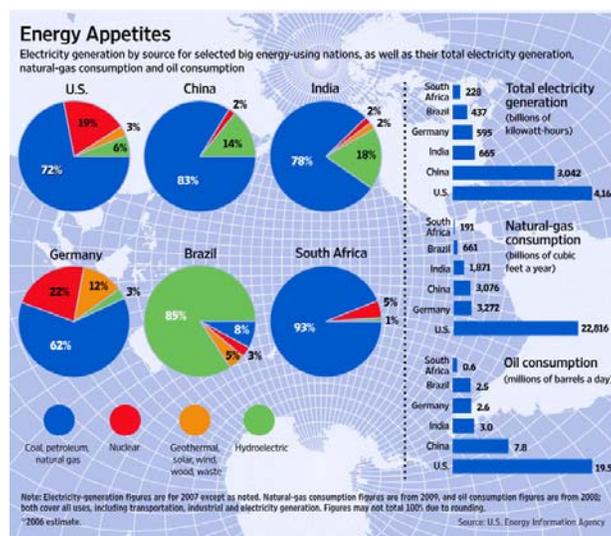
EM – 1 White Paper
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OMNI
OMNI Professional Environmental
Research Triangle Park, NC

Pharmaceutical manufacturing operations are increasingly examining and reducing their energy usage and the resulting emissions in order to cut costs, to satisfy corporate goals and regulatory requirements, and to remain competitive. By leveraging process automation and power system assets, pharma/biotech manufacturers can better measure, monitor, and manage energy consumption by individual loads, machines and lines.

Global energy demand is projected to increase by 35% by 2030 (in 20-years) as developing nations modernize and expand their economic output. In China alone, over 200 million people are expected to migrate from rural to urban areas during this 20-year timeframe – increasing their energy consumption in the process. Automobiles, other transportation vehicles, power plants, industrial facilities, and commercial & residential buildings not only consume energy, but these sources also emit air, water & solid waste pollutants.

The bulk of our energy, both domestically and internationally, is derived from three fossil fuels: coal, oil, and natural gas. The United States imports most of its petroleum from unfriendly nations, which creates issues of national security and economic instability. This fuel is also subject to price volatility, supply disruptions, environmental spills, and increasing costs of exploration. An “oil gap” is expected to begin within 5 to 10 years, wherein demand will exceed supply, and this gap will continue to grow over time.



Consensus estimates of proven and undiscovered petroleum reserves indicate roughly a 45-year remaining supply of this fuel. Similar estimates of proven and undiscovered natural gas reserves indicate approximately a 65-year supply.

Options for dealing with these problems of burgeoning demand and dwindling supplies are limited. The options most often considered are the following:

- Hoarding & stockpiling of petroleum (the U.S. already does this to some extent).
- Diversification of energy supply sources (renewable, biomass, nuclear, etc.)
- Demand restraints (i.e., lowering standards of living)
- Sustainable development (dramatic changes in current practices), and
- Energy efficiency.

A recent study by McKinsey & Associates found that energy efficiency is essentially a “free lunch”. That is, the cost savings resulting from the reduced energy expenditures will in many cases pay for the required changes in equipment, procedures, and processes and pay added dividends into the future.

There are numerous opportunities to reduce energy consumption and realize energy cost savings in most facilities, including those in the pharmaceutical industry.

Energy audits identify changes and upgrades ranging from investing in variable-frequency drives, to shifting time-of-day equipment operation to off-peak hours, to potential cost savings related to improving compressed air systems. Installing power monitors to continuously collect usage data to be measured against the appropriate benchmarks allows facility managers and engineers to find hidden energy costs, eliminate waste, improve reliability, and identify opportunities for significant cost reductions. In most plants, the primary savings will come from 10 key systems.

Some of these opportunities are low-cost or no-cost changes. For example, turning off meters that should not be on or installing occupancy sensors. These types of changes can reduce annual energy costs by as much as 5 to 10 percent and can have very quick payback.

Energy cost reductions of as much as 15 to 30 percent usually call for investments in higher-cost measures and capital improvement projects. Examples of this would include lighting upgrades, replacing windows with more efficient models, upgrading insulation, replacing motors, replacing chillers, etc.

Modern automation technology can play a key role in achieving energy cost reductions while maintaining employee comfort, improving process reliability, and maintaining production quality & quantities. Yet, many existing controls were designed to protect the equipment and the employees and to maintain the proper functioning of the equipment & systems. Modifying these controls to

reduce energy consumption and provide energy efficiency, while continuing to preserve their primary functions, is a challenging undertaking.

Some of these challenges & opportunities include the following:

Energy Accounting

Energy accounting is fundamental to achieving best energy management practices. The key steps to successful energy accounting are the following:

- 1.) Tracking energy usage. You can't manage what you don't monitor.
- 2.) Creating baselines for your facilities. Establish a reference point prior to energy management practice implementation. Compare energy performance from new initiatives with the baseline.
- 3.) Benchmarking sets standards that serve as a basis for evaluation or comparison. Benchmarks can be set at the corporate level or among individual buildings.
- 4.) Reporting energy performance and any other information to all interested parties at least once a year. Analysis of these reports will affect decisions about current and future initiatives.

Supply Side Management

The term "supply side management" refers to the type of measures that concern managing utility bills.

Common opportunities for savings include:

- Turn off unnecessary meters - Meters that need to be turned off can arise following construction projects or when the use of a space changes.
- Close/change accounts that are on unfavorable rates - An increase or decrease in use of space or a change of square footage are warning signs for accounts that may be on unfavorable rates.
- Correct billing errors – Common billing errors include incorrect billing of peak demand and estimated bills that do not get corrected.

Operations and Maintenance

	ENERGY STAR® 2000	1995 CBECS* (Top 25%)	1995 CBECS* (Bottom 25%)
Economizers	70%	30%	75%
Variable Speed Drives	55%	20%	45%
Variable Air Volume Heating and Cooling Systems	70%	35%	65%
Energy Management Control Systems	80%	25%	55%
Motion Sensors	60%	10%	20%

Source: *Energy Performance Pitfalls, Building Operations Management*, p.43,
March 2000

*CBECS – Commercial Building Energy Consumption Survey

This table shows ratings for buildings from three different categories. Buildings that were awarded ENERGY STAR® labels in 2000, and buildings that were rated in the top 25 percent and bottom 25 percent in the commercial building energy consumption survey (CBECS) data collected in 1995.

Although ENERGY STAR buildings tend to have the best technologies - economizers; variable speed drives; variable air volume heating and cooling systems; energy management control systems; motion sensors that turn off lights - the top 25 percent of the buildings from the CBECS survey most often did not have these.

CBECS also found that most often the bottom 25 percent were more likely to have some of these features.

What can we take from these results? ***Operations and maintenance are far more important in determining the energy performance of a building than whether or not the building features what is considered to be “best technologies.”***

The Federal Energy Management Operations and Maintenance Best Practices Guide reported, “*It has been estimated that O&M programs targeting energy efficiency can save 5 percent to 20 percent on energy bills without a significant capital investment.*” Other studies report cost reductions in the same range.

“Building recommissioning” or “building retro-commissioning” is a highly recommended practice for energy efficiency initiatives. Normally, independent party is contracted to evaluate all of the equipment and system operations with regard to energy usage, indoor air quality, safety and comfort.

Building Recommissioning or Retro-Commissioning

Is my building a good candidate?

Selection Criteria

- ✓ Reasonably modern building control system
- ✓ Not suffering from deferred maintenance
- ✓ Not anticipating major capital improvements in the near future
- ✓ Chronic maintenance issues or high energy usage

This is particularly valuable with complex systems and system interactions. The contractor examines all of the set points, air movement and temperature as well as any performance issues that have been reported.

Building recommissioning usually pays for itself through energy cost reductions within two to three years once the corrective action has been taken.

Some automation systems have claimed similar savings through continuous re-commissioning of key facility systems.

Life Cycle Costing

The life cycle cost of a piece of equipment is sometimes called the “cost of ownership.” Integrating life cycle costing into the decision-making process is essential to effective energy management.

Life Cycle Costing

Cost of Ownership

- Method used to incorporate information about operational costs, maintenance costs, durability and scrap value into decisions about new equipment purchase
- Can be applied to anything: lighting, motors, controls, major HVAC equipment, etc.

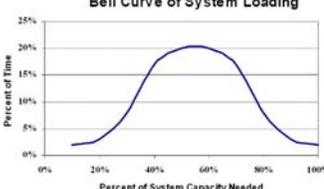
The time frame used depends on the project. It may range from as little as 10 years for lighting to as much as 30 years for HVAC systems.

For contacts that can help you locate resources that provide information on how to use life cycle costing, see the references at the end of this paper.

HVAC Systems

A large percentage of the total energy usage of buildings in North Carolina goes to heating, ventilation and air conditioning (HVAC). The rest goes to lighting, computers, process equipment, and other energy loads. Therefore, HVAC systems usually merit special attention.

Following the manufacturer's recommendations regarding maintenance and repair for HVAC equipment in your buildings is the obvious first step.

HVAC (Heating, Ventilation and Air Conditioning)	HVAC - Fans and Pumps
<ul style="list-style-type: none">➤ Install ground-source heat pump hybrid systems with cooling towers for extreme hot weather➤ Install modular condensing boilers➤ Install air-cooled chillers with EER>10 and water-cooled chillers with EER>11.9➤ Dual-duct outside air delivery and demand-controlled ventilation	<ul style="list-style-type: none">➤ Install variable speed drives on fans and pumps so speed can vary with changing outside conditions <p style="text-align: center;">Bell Curve of System Loading</p>  <p>The graph shows a bell-shaped curve representing the distribution of system loading. The x-axis is labeled 'Percent of System Capacity Needed' and ranges from 0% to 100% in 20% increments. The y-axis is labeled 'Percent of Time' and ranges from 0% to 25% in 5% increments. The curve starts near 0% at 0% capacity, rises to a peak of approximately 20% at 50% capacity, and then falls back to near 0% at 100% capacity.</p>

For smaller office buildings, a ground-source heat pump hybrid system with a cooling tower that handles the load in extremely hot weather is an example of the best technologies available. Modular condensing boilers for heating is another best technology. These remove the sensible and latent heat from the exhaust gasses, losing the least amount of heat of any heating system using gas. They can be up to 97 percent efficient.

Air-cooled chillers should have an EER above 10 on newer systems. Also consider independent outdoor air-delivery systems and under-floor delivery systems. Demand-controlled ventilation uses either occupancy sensors or carbon dioxide sensors to reduce flow to unoccupied rooms.

All of the equipment in a building is sized for the worst-case scenario of hot or cold weather. Since these conditions exist typically under 3 percent of the time, as shown in the bell curve graphic, energy is wasted most of the time unless the speed of the pumps and fans that serve central systems are varied.

There are different types of controls to vary the speed of the motors. The most common is called the “variable frequency drive” or VFD, because it works by dropping the frequency of the alternating current.

The term “*economizers*” refers to using outdoor air to provide free cooling to the inside of the building.

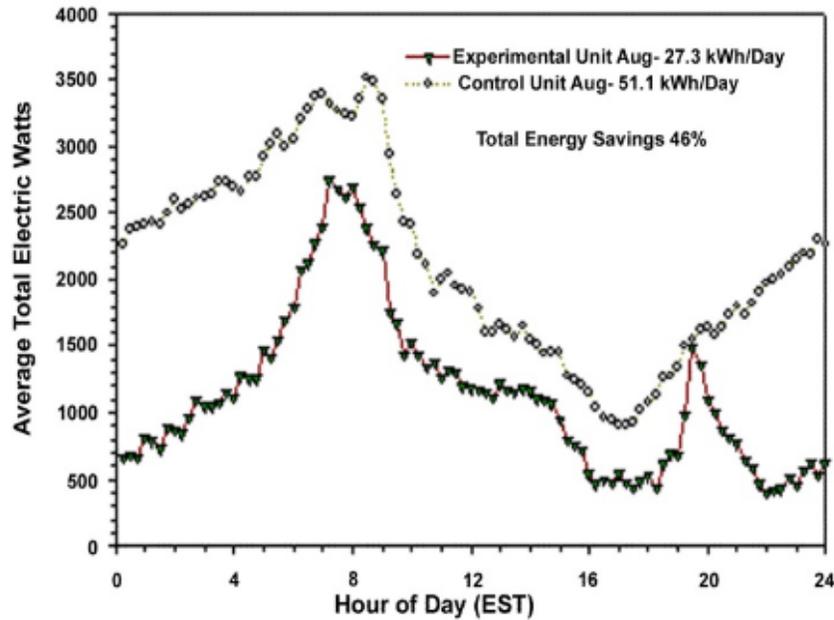
“*Enthalpy*” of air refers to a quality that incorporates air temperature and relative humidity. When the enthalpy of the outside air is less than that of the inside air, and there is a need to cool the building, you would prefer to use the outside air to cool the building rather than chillers or air conditioners. This requires a special set of ducts, dampers and controls, which require regular maintenance but can save up to 20 percent on cooling costs.

It’s important to keep these systems simple. In the Southeast it is also important to be sure that your system is set up to measure enthalpy and not simply temperature. (In drier climates, economizers work well by measuring dry bulb temperatures.) Economizers are not recommended for DX systems.

Scheduling, Setbacks & Re-Sets

Scheduling is a low- or no-cost opportunity for energy savings. Of course, scheduling can be manual or automated. Installing better controls for HVAC and lighting is generally a good, relatively low-cost first step for reducing energy usage.

Also, working with building occupants is important. For example, simply issuing an office policy that says that only certain parts of each office building will be heated and cooled after-hours to accommodate after-work programs can achieve savings at virtually no cost.



The electric demand profile shown provides a snapshot of the benefits of scheduling. Observe the no-cost energy savings achieved between the hours of 8 p.m. and 6 a.m.

Energy used during non-business hours represents the largest opportunity for energy savings. Thermostatic setbacks or ventilation setbacks can be a major component.

By lowering the thermostatic settings for nighttime, weekend and holiday hours, either manually or through automatic controls, the savings can be substantial -- as much as 40 percent. Often this can be done by turning off air-handling units, especially in core areas, but be careful of mold and indoor air quality issues. Another opportunity for low-cost energy savings on central heating and cooling equipment is known as “temperature resets.” The basic idea is to adjust the temperature of the chilled or hot water that circulates through the building based on a higher or lower load in the building.

For example, if the temperature is cool outside but the building still needs to be cooled, the water temperature in the chilled water loop can be increased, which causes the chiller to work less hard but still carries the cooling load of the building.

Rule of Thumb		
	Summer/Chiller	Winter/Boiler
Savings	1.5% / °F increase	1% / °F decrease

The rule of thumb is for each degree increased in the chilled water loop temperature; about 1.5 percent of the energy usage is reduced.

For hot water loops that heat the building, savings of about 1 percent for every degree decreased in boiling water temperature can be achieved. This can be done with mixing valves, instead of actually decreasing the boiler setting. In some cases automatic controls are set up to do this based on outdoor temperature only or sometimes based on loads from the building and outside temperature together.

Be careful of humidity control when variable frequency drives are used on chilled water pumps. As is the case with economizers, when implementing temperature resets, be cautious of humidity issues that can cause mold and indoor air quality issues.

Lighting

The newer fluorescent lighting such as Super-T8 lamps with instant-start ballast outperform T12 systems by 81 percent and older T8 systems by 31 percent. High-output, 28W T8 lighting may also be a viable option for energy savings.

Technology	Mean Efficacy (Lumens/Watt)	Rated Hours of Life (Hrs)	Percentage Improvement in Efficacy (%)	
			34W T12	Reg. T8
Magnetic 34W T12 with energy-saving ballast	54	15,000	-	-
Generic 32W T8 with instant-start ballast	75	15,000	39	-
Reduced wattage - T8 30W with instant-start ballast	82	18,000	52	9
Reduced wattage - T8 28W with instant-start ballast	85	10,000	57	13
32W Super-T8 with programmed-start ballast	92	20,000	70	23
32W Super-T8 with instant-start ballast	98	30,000	81	31
28W T8	104	30,000	93	39

Lighting improvements made over the last 10 years have brought revolutionary increases in efficiency. Check the pricing on the different lamps and ballasts. It may be that for little or no cost, more efficient lighting could be installed as lamps and ballasts need to be replaced. Bulk relamping often makes good economic sense as well.



LED signs last 25 years and use 2 to 4 watts



Old exit signs can be replaced or the bulbs can be replaced with light-emitting diode (LED) replacement kits. The energy savings is significant, and the reduced maintenance pays for the replacement quickly.

Replacing one 100W incandescent light with a compact fluorescent lamp (CFL) saves about 500 pounds of coal from being burned. The life of the compact fluorescent lamp is usually about 10,000 hours and yields up to \$25 in annual savings.

Here are some additional examples as follows:

There are now T8 fluorescent fixtures designed for ceilings up to 45 feet high. They may have six or eight lamps depending on the ceiling height.

High output T-8 fixtures for high bay applications.



LED parking lot and parking garage lighting.

For example, a company called SportLite provides another type of lighting fixture with eight compact fluorescent lights on separate switching so that lighting levels can be adjusted.

Flat, wall-mounted LEDs are available for garages and parking lots.

Adapting automation technology to lighting issues is also a possibility. For example, adjusting lighting levels to ambient conditions can both increase comfort and save energy. Lighting controls, such as daylight sensing, dimming fluorescents, computer-based control programs and demand-response lighting controls, reduce lighting levels to minimize billed peak demand for cost savings. Again, it is important to work with building occupants.

However, be aware there is a plethora of misleading marketing in the lighting area. So, it is important to look at actual technical data – not just marketing claims such as “full spectrum lighting”, which means nothing.

Motors

Motors are another area of opportunity of energy management.

Planning is essential when considering motors in energy management. When a motor goes out, assess the alternatives and the logistics of installing the most efficient and appropriate replacement. In many cases, a more efficient motor may be larger, or a smaller motor may be appropriate to correct oversizing.

Having a written policy requiring life cycle costing of motors is also a good idea.



Variable speed drives on pumps and fans pay for themselves in under five years in some cases. Your utility company also may subsidize this equipment.

Building Envelope

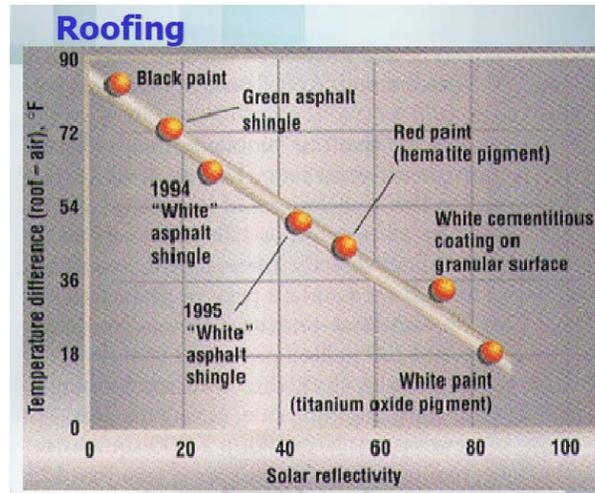
The building envelope represents another opportunity for energy savings.

A building with leaky windows and doors will use significantly more energy and can cause comfort complaints.

- **Leaky windows and doors will use significantly more energy**
- **Periodically check insulation**



Check insulation periodically - particularly after insulation has been installed/reinstalled to make sure the work was done properly. An R-value of about 38 is recommended for roof insulation; walls should be about 20; and floors about 17.



A reflective roof can reduce roof heat gain by as much as 77 percent and cause rooftop units (RTUs) to run more efficiently.

Review of Energy Efficiency Opportunities

- Supply Side Management
- Energy Accounting
- Operations and Maintenance
- Scheduling
- HVAC
- Economizers
- Setbacks
- Temperature Resets
- Lighting (upgrading)
- Motors (planning)
- Building Envelope (maintaining)

Proper use of IT tools such as web-based reporting, trending graphics, and dashboard tools helps to predict the effect of process, facility and operational changes on energy consumption, and to enhance the overall efficiency of plant utility usage. Examples and case studies will be included in the presentation to show how these tools and techniques were used to save billions of utility dollars and to achieve energy productivity improvements of up to 60%.

SIDE BAR ISSUES

(Basic Terms & Concepts)

Your electric bill will be calculated using two basic energy units: kilowatt (kW) and kilowatt-hour (kWh). A watt (W) is an electrical unit of power. A **kilowatt (kW)** is the unit of power equivalent to 1,000 watts of electrical demand.

Electrical energy is reflected as the amount of watts multiplied by the number of hours in use. The **kilowatt-hour (kWh)** is the basic unit used to measure electrical energy consumption. It is the amount of energy consumed when 1,000 watts (or one kilowatt) runs for one hour.

The **demand period** is the time interval during which flow of electricity is measured (usually in 15-, 30- or 60-minute increments depending on rate structure) by the utility company.

The **peak demand component** of an electrical bill is the highest average demand over any demand period in the billing period. The peak demand is reset to zero "0" each time the meter is read. Peak demand is measured in kilowatts.

Electric load factor (ELF) indicates if peak demand is high for the facility. The ELF is the amount of kilowatts on your bill, divided by the hours in the whole billing period, multiplied by your peak demand in kilowatts.

The electrical demand profile over a 24-hour period shows the average demand at different times of the day throughout the entire month. An **electric demand (or "load") profile** may be available from your utility company if you ask for it.

Natural gas units of measurement include the following:

Btu: British thermal unit.

MMBtu: million British thermal unit.

Btu/hr: British thermal unit per hour.

CCF: hundred cubic feet (10 CCF = 1 MMBtu).

Dekatherm (dth): 1 dth = 1 MMBtu or approximately 10 CCF.

Natural gas is typically billed using CCF, MMBtu or dth.

Equipment nameplates, such as those found on a boiler or rooftop-heating unit, most often refer to the heating capacity in units of Btu/hr.

Some units are typically shown on an equipment nameplate. These units may be used to rate the equipment's capacity or load.

Horsepower (hp) is a unit of power essentially equivalent to 745.6 watts.

Motor hp equals 2,545 Btu per hour.

Boiler hp is a different unit altogether. This is equivalent to 33,475 Btu per hour.

A **cooling ton** refers to the amount of energy required to melt one ton of ice in one hour and is equivalent to 12,000 Btu per hour.

One **kilowatt equals 3,412.3 Btu per hour.**

It is important to understand the difference between **capacity**, which is the equipment output, and the **equipment energy usage**. Capacity refers to the work done by a motor, or the heating and cooling provided by the heating, ventilation and air conditioning (HVAC) equipment. However, you are billed for the energy *usage* of the equipment. For this you need to apply an efficiency factor.

Sometimes examining your energy loads makes more sense if you can put them all in to one unit. Converting the ratings of all of the energy using equipment to Btu/hr units will allow you to see the relative impact of lighting, heating, cooling, ventilation and other loads in the building.

Some efficiency terms include the following:

The general definition of “**efficiency**” is the work done divided by the work put into the system. Remember, “work out” over “work in,” where both of these are stated in the same units. Efficiency is usually expressed as a percentage.

Efficacy is a measure of performance using different units. Examples of efficacy ratings are lumens per watt for lighting or kilowatts per ton for chillers or air conditioners.

Coefficient of performance (COP) is the measurement of how efficiently a heating or cooling system (particularly a heat pump in its heating mode and a chiller in its cooling mode) will operate at a single outdoor temperature condition.

When applied to heating modes for heat pumps, the outdoor temperature condition is usually 47 degrees Fahrenheit (47°F). *The higher the COP, the more efficient the system.*

COP can be calculated by two different methods. For heat pumps, divide the Btu of heat produced by the heat pump by the Btu equivalent of electricity that is required to produce the heat.

➤ **Coefficient of Performance (COP)**

- ✓ Measurement of how efficiently a heating or cooling system operates at a single outdoor temperature condition
 - Temperature condition for heat pumps = 47°F

➤ **Methods to calculate COP**

Heat Pump	Chiller
$\frac{\text{Btu of heat produced (47°F)}}{\text{Btu of electricity used (47°F)}}$	$\frac{3.516}{\text{kW/ton}}$

This formula is stated: Btu of heat produced (47°F) over Btu of electricity used (47°F). In a typical system, for every Btu of electricity the system uses, it will produce a little more than 3 Btu of cooling when the outdoor temperature is 47°F.

The formula most frequently used to determine chiller efficiency is 3.516 divided by the number of kilowatts per ton (kW/ton) used by the system. This formula is stated: 3.516 over kW/ton.

Energy efficiency ratio (EER) measures how efficiently a cooling system will operate when the outdoor temperature is at a specific level (usually 95°F). A higher EER means the system is more efficient. The term EER is most commonly used when referring to window and unitary air conditioners and heat pumps, as well as water-source and geothermal heat pumps.

The formula for calculating EER is: Btu/hr of cooling at 95°F over watts used at 95°F.

For example, if you have a window air conditioner that draws 1,500 watts of electricity to produce 12,000 Btu per hour of cooling when the outdoor temperature is 95°F, it would have an EER of 8.0 (12,000 divided by 1,500). A unit drawing 1,200 watts to produce the same amount of cooling would have an EER of 10 and would be more energy efficient.

It may be necessary to compare equipment efficiencies if they are rated differently. The **EER rating can be converted to an equivalent COP rating** by dividing by the conversion factor for Btu to watt-hour (Wh), which is 3,412 Btu per watt-hour.

Seasonal energy efficiency ratio (SEER) measures how efficiently a residential central cooling system (air conditioner or heat pump) will operate over an entire cooling season, as opposed to a single outdoor temperature.

As with EER, a higher SEER reflects a more efficient cooling system.

SEER is calculated based on the total amount of cooling (in Btu) the system will provide over the entire season divided by the total number of watt-hours it will consume. The formula is stated as seasonal Btu of cooling over seasonal watt-hours used.

By federal law, every central split cooling system manufactured in the United States must have a seasonal energy efficiency ratio of at least 13.0. This became effective in 2006. For high-efficiency equipment, look for those with a SEER greater than 14.0.

Heating seasonal performance factor (HSPF) is the measurement of how efficiently all residential and some commercial heat pumps will operate in their heating mode over an entire normal heating season.

The higher the HSPF, the more efficient the system. HSPF is determined by dividing the total number of Btu of heat produced over the heating season by the total number of watt-hours of electricity that is required to produce that heat. The formula is stated as Btu of heat produced throughout the heating season over watt-hours of electricity used throughout the heating season.

Most heat pumps have HSPFs in the 7.0 to 8.0 range, meaning they operate with seasonal efficiencies anywhere from 205 to 234 percent. To convert the HSPF number into a percentage, divide the HSPF by 3,412 (the number of Btu in one watt-hour of electricity). That means, for every Btu of energy used over the entire heating season, these systems will put out anywhere from 2.05 to 2.34 Btu of heat.

Electric furnaces have nominal efficiencies of 97 percent (for each Btu of electricity, they put out 0.97 Btu of heat). Newer gas furnaces have efficiency ratings of about 80 to 97 percent (for each Btu of gas, they put out 0.8 to 0.97 Btu of heat). By comparison, heat pumps use far less energy for the same heating capacity as electric and new gas furnaces.

When purchasing new equipment, **look for an HSPF greater than 9.0** for high-efficiency.

Annual fuel utilization efficiency (AFUE) measures how efficiently a gas furnace or boiler will operate over an entire heating season. The AFUE is expressed as a percentage of the amount of energy consumed by the system that is actually converted to useful heat.

For example, a 90 percent AFUE means that for every Btu of gas used over the heating season, the system will provide 0.9 Btu of heat. The higher the AFUE, the more efficient the system. Federal law requires most gas furnaces manufactured and sold in the United States to have minimum AFUEs of 78 percent. Gas furnaces and boilers now on the market have AFUEs as high as 97 percent.

When purchasing new equipment, ***look for an AFUE greater than 92 percent*** for high-efficiency.

Some basic energy accounting terms include the following:

The ***Energy Use Index (EUI)*** allows you to compare the energy performance of buildings. To create the EUI, convert all of the gas and electric energy units used for each building into Btu. The EUI units are generally expressed as Btu per square foot per year (Btu/ft²/year).

The ***Energy Cost Index (ECI)*** is another way to compare energy performance among buildings and is generally expressed as cost per square foot per year. However, the ECI is a less reliable way of comparing energy performance among buildings unless the buildings are on the exact same gas and electric rate structure. For example, even with buildings in the same corporate fleet, the ECI may produce misleading results if the buildings do not have the same gas and electric rate structure. The same applies when trying to make comparisons among different buildings.

Divide the EUI or ECI by the building's square footage of heated/air-conditioned space to establish a normalized energy use number. Energy use can also be normalized by dividing other factors, such as number of employees or weather adjustment factors.

Electricity is predominantly produced by burning coal at power plants. ***Each 1 to 1.25 kWh used at a facility amounts to one pound of coal being burned somewhere at a power plant*** and all of the associated emissions attributed to that coal burning.

For example, if you replaced 10 T12 fluorescent fixtures with Super-T8s (four lamps per fixture), you would essentially reduce the amount of coal burned at the utility plant by about 100 pounds per year.

Electric utility plants are one of the major contributors to carbon dioxide and greenhouse gas emissions in the United States.

Organizations usually take the following three actions to implement effective energy management:

- 1.) Appoint an energy manager.
- 2.) Establish an energy team.
- 3.) Create and implement an energy policy.

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