Getting the Most from Your Energy Dollar

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ABSTRACT

In today's economy, the cost of energy (electricity and natural gas) has increased at astronomical rates. In less than a decade, electricity has doubled in cost and natural gas risen four-fold. Energy is now a significant cost of operation in any plant or facility, especially in a household budget. Although natural gas costs have dropped some, no one expects prices to return to their pre-2000 rates. High energy costs are with us now and will continue to deplete business profits and income. But it is not all depressing on the energy outlook. There are actions that can be taken to reduce these energy costs. As an energy engineer in the business for 28 years, I will share my thoughts on reducing your energy consumption and lowering your energy bills.

There are five ways to save energy dollars:

(1) Negotiate a better price for your energy commodity.
(2) Reduce energy demand and consumption.
(3) Reschedule energy consumption.
(4) Convert to a different form of energy.
(5) Make your own energy.

Implementing any or a combination of these concepts will help you get the most from your energy dollar.

NEGOTIATING A BETTER PRICE

All industrial and most commercial gas consumers may negotiate a better price in today's marketplace to get more for their energy dollar. In states where electric deregulation is effective, all consumers may change electric energy providers to obtain a better price or service or just out of spite of their existing provider. It is usually just a matter of a paper transaction to change energy suppliers, although it may take a couple months for the paperwork to take effect. Little and usually no change is required in a plant or facility operation. In fact, contracts are based on past usage, and if there is a significant change in consumption, it may affect the contract and commodity price.

Each company must have a strategy in place that is proactive. Exposure to price fluctuations is a major negative in negotiating energy prices in an open market. Consumers must be aware of when their current contract ends and what the likely levels of cost will be for a new contract. Timing is the single most important factor in buying energy. Identifying low price as well as good service are other important considerations. February of 2002 saw the cheapest price for electricity since deregulation began. Some customers were offered prices with five-year deals at 3.8 cents/kWh and turned them down, expecting better deals to occur later, much to their chagrin. NOAA expects the 2006 hurricane season to be similar to last year, so this may have a big impact on present pricing. Short-term yearly contracts may not be good from the standpoint of the typical fluctuations that are likely to occur. A retail electric provider's (REP) strategy is to limit competition through time squeezes on switches and product offerings. Price goes up once you pass the contract deadline. If you have no professional consultant, you allow the REP to frame the contract terms toward the highest price and transfer the risk to you. A good energy strategy is to treat energy purchases as a process, not a task. Evaluate and select multiple REPs, monitor the market daily, be able to execute a contract immediately, and consider long-term (five-year) contracts renewable for an additional year annually.

REDUCE ENERGY DEMAND & CONSUMPTION

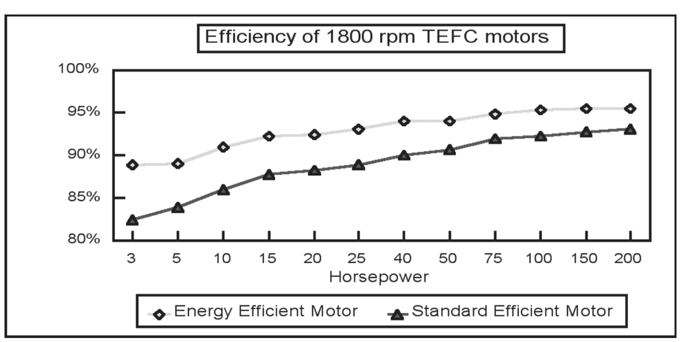
A second strategy to reduce energy cost and get more for your energy dollar is to reduce energy demand and consumption. The most economical way to do this is to *TURN IT OFF*. If the energy using equipment is not needed, it should be turned off. To do this takes education on the part of employees and management. Sometimes a simple sign reminder is sufficient. An incentive plan generally gets the attention and cooperation of everyone. A school has the students receive gold stars whenever they turn off lights in unoccupied classrooms. When they collect a set number of stars, they receive a gift. A company may provide quarterly bonuses if energy use levels are met.

The other major ways to reduce demand and consumption are to replace old inefficient equipment with new high efficiency equipment, and/or reduce the operation time of the equipment. New high efficiency equipment exists in lighting, HVAC, motors, and heating equipment. T-8 and T-5 lighting are now available to replace T-12 fluorescent lamp fixtures and incandescent lamps. The energy savings for a 4-foot, four-lamp fixture (T-12 to T-8) replacement is 52 Watts. The dollar savings for 4,000 hours at 10 ¢/kWh is $20.80 annually. Installed cost is $50 and a 2.4 year payback. Replacing a 65-Watt incandescent flood lamp with a 15-Watt compact fluorescent lamp (CFL), also operating 4,000 hours, will save $20 annually and costs $15 installed; a 3/4-year payback.

When old air conditioning units need replacing, they should be replaced with high efficiency (12 EER and greater) units. The difference between a 9 EER and a 12 EER 20-ton DX unit is 6.7 kWs (0.333 kW/ton). Over 2,500 hour per year full load operation, the annual savings is $1,667; a 2.1-year payback on the differential cost of new compressor units. I have completed a dozen studies on a product which is attached to the freon line. It lowers head and suction pressures and cleans the inside of the coil through cyclonic action. Every study showed a reduction in amperage and kWh of greater than 20 percent. Paybacks ranged between one and two years depending on hours of usage.

Energy efficient motors have increased copper in their windings, use more and thinner laminations of high quality steel in the stator and rotor, minimize the air gap, increase the length of stator and rotor, use a more complex rotor bar designs, and have an improved design to reduce windage and stray load losses. These motors use less electricity—up to 12 percent—compared to the same size standard motor. [1]

Advantages of purchasing a high efficiency motor:



[2]Continuous duty operation (8760 hours per year); 10 ¢/kWh

Motor HP	Efficiency (high/std)	KW Reduction	Annual Savings	Payback (months)
5	89.1/83.9	0.3	$263	4
10	90.9/86.0	0.5	$438	4
25	93.1/88.9	0.9	$788	4
50	94.1/90.6	1.5	$1,314	4
100	95.3/92.3	2.5	$2,190	3
200	95.6/93.1	4.2	$3,679	6

- Better efficiency and power factor over load range.
- Cooler operation and potentially longer life.
- Higher tolerance to voltage unbalance and fluctuations, overload, harmonics, and heat.

Caution: High efficiency motors may run at higher speeds. Energy consumption increases with the cube of the speed.

Many facilities are using old large heating equipment (boilers). Although the rated efficiency of the older boilers verses new boilers (77 percent vs. 85-92 percent) provides significant savings in and of itself, it is the low load time that creates very low efficiency (<30 percent) for a large boiler verses multiple smaller boilers tied together (at low loads, only one of several boilers is operating at near it peak efficiency). At the new higher natural gas costs (double the 2004 level), paybacks are significant, four years or less for replacements. Infrared radiant heater system efficiencies exceed 90 percent because they do not heat the air; instead, they heat the people and objects in the space. Occupants can be comfortable at a lower temperature, and the lower temperatures and lack of forced air circulation means less heat loss through the walls and ceiling.

Similar savings can be obtained on any energy using manufacturing equipment by purchasing high efficiency products instead of standard efficiency units. Electric infrared heating is more efficient than electric strip heating; gas infrared heating is more efficient than straight gas fired heating. Infrared (IR) drying uses electromagnetic waves to produce heat energy directly on the target product; no medium is necessary to transmit the energy. Once the radiant energy is converted to heat at the surface of the product, it is transmitted into the material interior by conduction. Compared to gas-fired convection ovens, infrared ovens reduce floor space 30 percent, gas consumption 50 percent, and warm-up time 85 percent.

Building envelope improvements are another way to reduce energy demand and consumption. Improving insulation, stopping air infiltration, and reflecting radiant energy all help reduce installed air conditioning tonnage and hours of operation of heating and cooling. Infiltration occurs when unconditioned outside air leaks into a building; exfiltration occurs when conditioned air inside the building leaks out. When conditioned air leaks out, it is replaced with outside air that must be conditioned. Infiltration and exfiltration occur through cracks and openings around windows, doors, dampers, and through-the-wall air conditioning units, skylights, and open doors and windows. Excessive air infiltration or exfiltration will result in higher than normal HVAC cooling and heating costs. Each sq. ft. of opening at a 25-degree temperature difference and a wind speed of 10 mph will produce a loss of 2.28 tons of air conditioning. A closed twelve foot wide loading door with a 1/4-inch gap at the bottom leaks over one ton of cooling per hour, not counting the cracks around the sides of the door.

A window film is a polyester film material applied to a window glass surface to partially block solar radiant heat transfer into a building. Advantages of window film are:[3]

- Reflects/Absorbs Heat—39 to 80 percent of total heat impacting on the surface.
- Reduces Light Transmission—95 percent clear to 2 percent blackout.
- Slows Heat Transfer Through Windows—4 to 44 percent of total heat.
- Absorbs Ultraviolet Radiation—95 to 99 percent of total UV radiation.
- Reduces Heat Loss—up to 34 percent heat loss.

Evaporative roof cooling is another technology used to reduce heat gain to the inside of a building. The system consists of pipes with sprinkler heads that spray water directly on the roof surface. The subsequent evaporation of the water produces a cooling effect which reduces the heat transfer though the roof. Control valves are used to turn sprinklers on one section at a time and are timed to wet the roof surface without causing puddles. On a typical 100°F day when the roof temperature can exceed 145°F, evaporative roof cooling can cool a roof down to 90°F. Most systems have a thermostat on the roof that will prevent the sprinklers from operating when the roof temperature is below 90°F.

Energy controls are an invaluable way to reduce operating hours of energy equipment and thereby energy consumption (kWh or MBtu). Occupancy sensors should be used in rooms with little use (rest rooms, warehouse isles, or conference rooms) to turn off lights or raise air conditioning temperature settings when not needed. A restroom with four 4-foot 4-lamp fluorescent T-8 fixtures uses 448 Watts. Assuming operation 18 hours a day, 5 days a week, and 11 ¢/kWh, a sensor reducing the time lights are "ON" by 6 hours a day, the savings is $80 per year and a 1.25-year payback. Timers are a simple method of managing start/stop control at low cost. For residential and offices, set-back thermostats are a good buy to control HVAC energy. The thermostat can be automatically set to different temperatures at different times of day depending on occupancy. They are inexpensive ($35-$50) and generally provide a one-year payback. Caution should exercised when used with heat pumps since they may increase energy use in the heating mode.

Using an energy management system (EMS), intelligent start/stop control on equipment can be achieved, minimizing energy usage while providing optimal control. An EMS may control one or many systems simultaneously. They can reduce demand by duty cycling and/or load shedding as well as energy by the above methods. Other control functions, fire and safety, can also be incorporated into the EMS.

Finally, energy demand and consumption can be reduced by good maintenance. Change filters regularly. Properly adjust belts on fans. Service equipment on a regular schedule. Keep equipment clean. Clean the air conditioning evaporator and condenser coils. Check for leaks of steam, air, and water. Maintain weatherstripping and insulation. Calibrate sensors. Find the cause of a problem, just don't treat the symptom.

RESCHEDULE ENERGY CONSUMPTION

The third way to get the most from your energy dollars is to reschedule energy consumption. The key to this alternative is knowledge. Information is power. Without it, you cannot hope to make intelligent decisions. Know how your facility and its equipment operate; know your schedule. To do this, an energy audit is useful to determine operating parameters (hours, peak demand periods, energy consumption over time, and power factor). With these data, you are now ready to approach the utility and take advantage of curtailable and/or interruptible pricing and time-of-day demand and/or time-of-use energy pricing by adjusting your operation schedule and receiving lower priced electricity and/or natural gas. Having a standby fuel to allow for gas curtailment or a standby electric generator to cover electric interruption provides negotiation power with the utilities.

Adjusting HVAC operation schedules for preheating and precooling with an EMS will lower heating and cooling costs. Adding a thermal storage system shaves the peak electric demand costs from high afternoon rates and moves it to lower evening rates and shifts chiller loads to cooler evening temperatures, improving chiller efficiency. The goal of rescheduling energy is to shift energy loads to take advantage of lower-priced energy and assist in cost negotiations.

CONVERT TO A DIFFERENT ENERGY FORM

A fourth way to get the most of your energy dollars is to convert to a different energy form. You can convert from electricity to natural gas, especially for hot water heating, space heating, and sometimes air conditioning. 11¢/kWh electricity converts to $32.23 per MMBtu. Natural gas sells for approximately $8.00 per MMBtu presently. This is a 4+:1 ratio. Even with equipment efficiency differences, natural gas does the job cheaper. The reverse may also be true in some cases; you can convert from natural gas to electricity in heat treating and air conditioning. Infrared, microwave, and magnetic heating have shown such high efficiencies that in the proper applications, they operate cheaper than heating with natural gas. Some high-efficiency chillers are now available that operate cheaper than most single-effect absorption chillers and some double-effect absorption chillers in the right applications. In other instances, a combination of the two is preferable. Heat pumps with gas backup is an example; electric infrared with gas convection heat is another. Caution—converting energy forms requires a detailed energy analysis to quantify the benefits.

MAKE YOUR OWN ENERGY

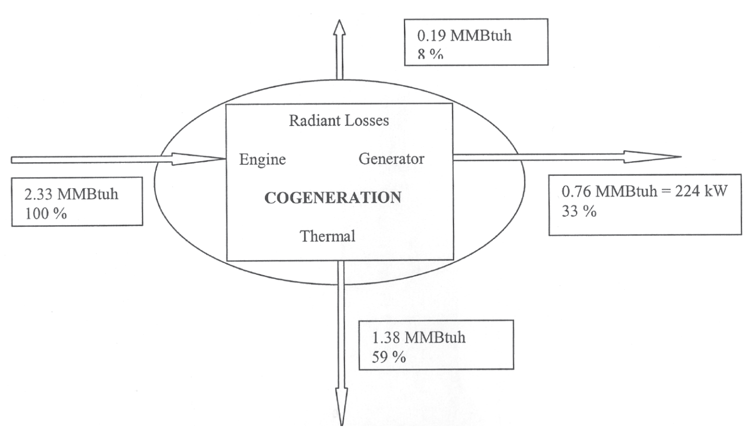
Finally, to get the most of your energy dollar, you can make your own. If you are lucky, you may own your own gas well. But at today's prices, you may want to sell the product instead of using it yourself.

More likely, you would make your own electricity through self-generation by installing a diesel or gas-fired engine or turbine attached to an electric generator. This is economical if a standby or emergency generator must be purchased anyway. The generator can then be used to make electricity when the utility's power is unavailable or it can also be used to generate electricity for sale during utility peak demand periods when the utility is willing to buy it at a profitable price. This type of operation is usually limited to only a few hour a day in the summer. At 160 hours of operation of a 30 percent efficient generator, $8.00 natural gas and 11¢ electricity, self-generation would net $450.

Another situation whereby making your own energy is more economical is combined heat and power (CHP), or cogeneration. This is where one fuel source is used to generate two sources of energy, usually electricity and heat (hot air or hot water or steam). CHP is economical if:

- There is a need for the heat.
- The heat need is coincidence with the electrical need.
- Operation is 18 or more hours per day.
- Fuel price is low (less than $8.00/MCF) and electrical cost is high (over 8.5 ¢/kWh).
- Tax credits or rebates are available.

Following is a CHP schematic which shows an input of 2.33 MMBtuh into a microturbine. As shown by the energy balance, it produces 0.76 MMBtuh or 224 kWh of electricity (33 percent of the total energy output) and simultaneously 1.38 MMBtuh of thermal energy (59 percent) with radiant losses of 0.19 MMBtuh (8 percent).



Using the same data, the economic analysis of this microturbine would be:

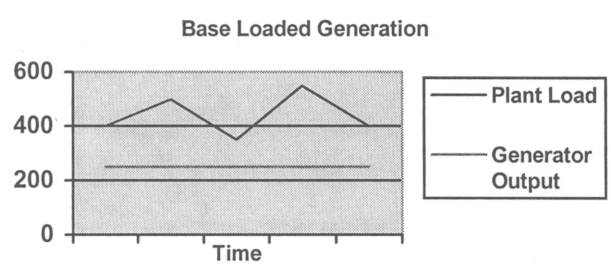
EQUIPMENT DATA			ENERGY DATA		
Generator Size:	224	KW	Gas Rate:	$ 7.00	per MCF
Recoverable Heat:	1.38	MMBH	Cogen Rate:	$ 7.00	per MCF
Fuel Consumption:	2.33	MCFH	Electric Rate:		
Hours of Operation:			Demand:		per KW
Electrical:	5,000	Hours per Year	Months:		Months
Thermal:	5,000	Hours per Year	Energy:	$0.10000	per KWH
Boiler Efficiency:	78	%	% Gas Thermal:	100	%
			% Electric Thermal:		%
Maintenance Cost:	$1.68	per Hour	Chiller Tonnage:		Tons
Estimated Cost:	$336,000	Installed	Chiller Efficiency.:		KW/Ton

AVOIDED ELECTRIC ENERGY COSTS :		
Energy :	Electric Energy Rate * Generator Size * Hours of Electric Operation	
		$112,000
AVOIDED THERMAL ENERGY COSTS :		
Gas Heating :	Gas Rate * Recoverable Heat * Hours of Thermal Operation/Boiler Efficiency	
		$61,699
COGENERATION COSTS :		
Fuel :	Fuel Rate * Consumption/Hour * Hours of Electric Operation	$81,550
Maintenance :	Maintenance Cost/Hour * Hours of Electric Operation	$8,400
COGENERATION SAVINGS PER YEAR :		$ 83,749
Rate of Return	**(ROR):**	24.9%
Net Present Value (NPV):		$ 477,094

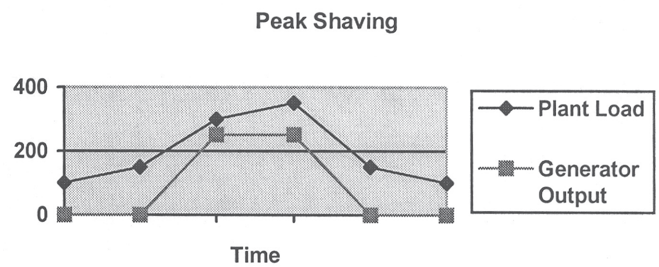
Cogeneration or CHP may operate in either of four different modes.

- Loaded
- Peak Shaving
- Load Following (either electric or heat)
- Stand Alone

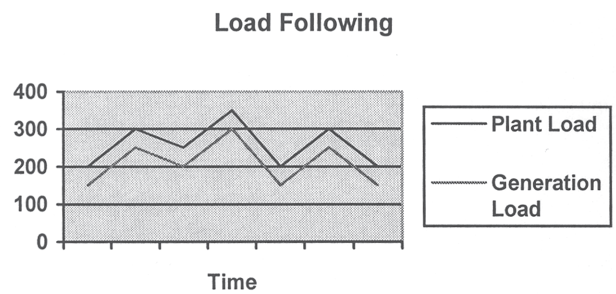
Base loaded generation is generally the simplest and least expensive to operate, although it may make the utility-supplied electricity a bit more expensive.



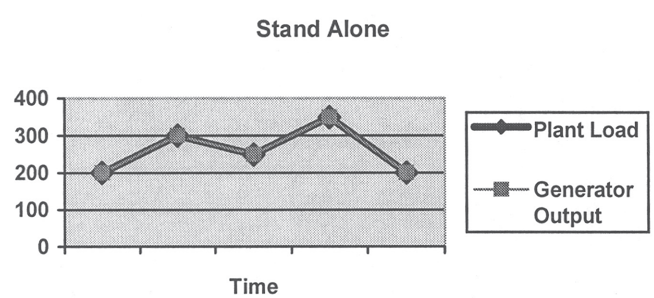
Peak shaving generation is time sensitive. Because it operates only during peak demand periods, there is significantly less operation time. It usually minimizes utility power costs and generation costs.



Load following generation is the most complex and requires sophisticated controls. It can achieve a balance in utility and generation costs and is good with variable loads.



Stand-alone generation can be applied to just a single piece of equipment or the whole plant. It must be synchronous generation since no utility electricity is available. Controls are simple but it does not maximize the use of the generator.



Generation technologies include, in order of cost (lowest to highest): (1) diesel or natural gas engines; (2) steam boiler and turbine; (3) natural gas combustion turbines and microturbines; (4) wind, (5) solar; and (6) fuel cells.

There is a potential for high rewards in generating your own energy, but doing so carries a high risk as well. Generation requires a great amount of study and analysis and is not applicable for everyone.

SUMMARY

There are many resources for negotiating a better price, reducing demand and consumption, rescheduling consumption, converting energy forms, and making your own energy.

Check out these publications and web sites:

- Governmental agencies (DOE, OIT, EPA, SECO).
- Utility companies.
- Energy service companies and engineering firms.
- Equipment vendors.
- Associations (AEE, ASHRAE, IEEE, IGT).

Money is available for any good project, and there are a multitude of opportunities available. The sooner you start, the sooner you will reap the benefits of getting the most from your energy dollar.

References

1. TXU energy fact sheets.
2. TXU energy fact sheets.
3. Llumar Window Film bulletin 08 87 00/CPF.

ABOUT THE AUTHOR

Mr. Phillips is a licensed engineer in the state of Texas and holds certificates as an energy manager, plant engineer, and green building engineer. He graduated from Texas A&M University with a BSME degree and as a distinguished military graduate. He also holds a Master's degree in theology and was a chaplain in the USAR. He has been a teacher and a headmaster in private schools.

Mr. Phillips has worked as an energy engineer for 29 years at Lone Star Gas, TXU, and now as VP of engineering for Independent Energy Alternatives, Inc. He was awarded the 1988 and 2003 Association of Energy Engineers' Region IV Energy Professional award and the 1991 Region IV Energy Engineer award. He is a past president of the North Texas Gas Measurement Association, the North Texas Association of Energy Engineers (NTAEE), and the North Texas Association of Facility Engineers (NTAFE). He is presently a board member of the Dallas Chapter of the Texas Society of Professional Engineers. Mr. Phillips' email is *jpagie@comcast.net*.