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Energy Reduction Techniques

For

Small and Medium Water Systems

Florida Rural Water Association

November 2007

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for

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Introduction to Energy Reduction Strategies

Opportunities for Energy Savings in Water and Wastewater Utilities

Municipal water and wastewater plants and their associated pumping facilities are the most energy intensive systems owned and operated by local governments. These facilities can account for as much as 35% of the energy consumed by the local governments. USEPA studies indicate that as much as 10% of the total energy that is currently consumed can be saved. Generally, the pumping systems are the most logical place to target for energy reductions since every gallon of water passes that through the system represents a significant energy cost, a cost that is magnified by water lost to leaks if left unchecked. . With energy costs approaching $100 a barrel for oil, shortages projected for natural gas and the pressures on the electric power industry to reduce CO_2 emissions from fossil fuels, energy costs are expected to rise in the future.

Significant opportunities exist for energy savings through the incorporation of technical and managerial improvements in water supply and wastewater treatment system operations. These savings are not confined to pumps and motors but to realize optimal energy savings, water efficiency measures must also be included. Excessive water loss results in excess energy consumption. Thus realizing energy savings include the following categories:

Table 1

General Categories of Potential Energy Savings

- Improving the efficiency of pumping systems
- Reducing and managing water leaks
- Incorporating automating control systems
- Improving electrical monitoring and metering programs
- Incorporating effective electrical maintenance programs

These improvements often pay for themselves in months, most do so within a year, and almost all recover their costs within three years.

Identifying Energy Reduction Possibilities

Pumping improvements range from lower cost measures like providing soft starters or variable speed controllers for motors, trimming impellers (when pumps are over-sized) and re-winding motors to higher cost measures like replacing inefficient pumps with efficient ones and installing energy efficient motors.

Management of leaks can save significant quantities of water and the resultant energy used to provide it. Leakage rates can best be lowered using automated controls that can allow reductions in tank levels during many periods of the year when lower operating pressures will be adequate. Reduce pressures in the water distribution system are effective in reducing energy needs, especially at night. Pressure management also minimizes the impact of both undetected system leaks and permissible leaks in buried pipelines.

Increasing the level of automation is often cost effective since critical adjustments can be fined tuned to save water, resultant energy and operation costs while improving service and lengthening the life of equipment. Automation improves the fine tuning ability of all facility process control equipment.

Automation handles operational functions in real time in response to changing situations. Examples include optimizing pressures, turning pumps off and on, feeding chemicals and reducing peak electrical loads. The table below illustrates the benefits to automation when applied to larger water and wastewater treatment plants as part of targeted programs or upgrades. As can be observed savings may approach 20%.

Table 2

Energy Benefits Typically Achievable by Category
Water and Wastewater Plants (from 200 audits by EPRI/HDR, 2003)

Facility	General Category of Energy Reduction Strategy	Cost Savings Realized
Water	Load Shifting	10 – 15%
	VFDs and high efficiency motors	5 to 15%
	Process Optimization and incorporation of SCADA	10 to 20%
Wastewater	Process Optimization	10 to 20%
	Equipment Modifications	10 to 20%

Increased electrical monitoring and metering of the individual system components, operations, and performance is essential in order to trend performance and evaluate energy use. Historical trending helps to identify unacceptable variances and establish performance targets.

Unlike other energy reduction improvements, implementing effective electrical maintenance programs generally do not result in immediate savings of energy but prevent the catastrophic failures of equipment that lead to high costs and inefficient operations.

Management Barriers to Overcome to Achieve Long-Term Energy Efficiency

Lasting change in any utility requires both support and engagement at the senior management and/or administrative level. In the manufacturing sector, energy is largely viewed as a manageable cost, and one that if reduced, translates to reduced production costs and competitive advantage. Thus energy management is viewed as important in improving profits and investments in technology and staff capability are commonly applied. In the private sector, in order to compete successfully in the marketplace competitive advantage goes to the company that successfully incorporates the proven technologies that are readily available. Technologies are prioritized by energy efficiency investments with that have the most rapid payback periods.

In the public sector, the greatest obstacle to large-scale implementation of energy efficiency systems is the lack of focus on energy cost savings potential because of the lack of marketplace pressure. Energy is treated as a fixed cost that must be passed on to the customer. Thus energy efficiency expertise both at the management and technician level is largely absent and there are fewer energy efficiency examples in the public sector to serve as models for implementing energy saving initiatives on any meaningful scale.

Incorporation of efficient energy practices and technologies in the utility sector are typically constrained by one or more of the following four management barriers:

1. Lack of Awareness. Utilities will not implement efficiency changes unless they are convinced of real cost savings. Typically applying energy efficiency techniques to water supply operations are not part of the normal operating daily routine and focusing operators on energy savings are perceived as added tasks with no direct benefit.

2. Aversion to Risk. Deviating from the usual operating routine is associated with risk, real or perceived, such as added burden on staff, extra off-hours response time or problems that can lead to compliance violations or the real possibility of over estimating real savings from new capital outlays. Fear of change has a rational basis and breaking through it requires that the fears be addressed and that the benefits of change clearly outweigh risks.

3. Change May Imply a Problem with the Status Quo. It is not uncommon for staff to be Resistant to new ideas and procedures due to a feeling that suggestions for change Imply criticism of their performance and ability.

4. Financing Efficiency. Operating budgets consist of semi-fixed, short-term financial constraints imposed on operating staff. Even though amortization of initial capital expense may be extremely cost effective the capital outlay is often treated as an operating expense. When properly treated as an amortized capital expense, the utility is still constrained in allocating the up-front funds necessary to finance the project. The risk of achieving future savings is always a barrier to making changes where significant funds are involved. Unless these barriers can be minimized, significant energy reductions are usually not possible.

Barriers to energy efficiency are best realized systematically in three phases. These steps are shown below:

Table 3

Optimizing Energy Efficiency
Using the Three Step Approach

- Educate: Build Management Support and Engagement
- Analyze: Collect Pertinent Data and Perform an Energy Reduction Analysis
- Implement: Prioritize and use the most effective Energy Reduction Measures

Educating and Gaining Management Support and Engagement

Educating utility management that energy reduction improvements measures are a proven low-risk method that increase operating efficiency, productivity, and reliability, while minimizes operating costs, and result in increases in generating revenue is best technique for overcoming the first barrier in achieving success. Managers will generally become believers in water and wastewater system efficiency if the opportunities are presented in these terms, accompanied by examples where the energy reduction measures have been successful.

Engaging senior leadership is an important initial step but only begins the process. The more difficult barrier will be found in the ranks of middle management and in operators that are responsible for operating and maintaining equipment. It is imperative that these employees become supportive and remain engaged in the energy reduction analysis and solution process.

A cost/benefit analysis is the typical technique used to convince decision-makers to make energy reduction investments. The payback analysis is the best financial statistic to use because it answers the question of “how long it will take for improvements to pay for themselves.” It also has the advantage of simplicity when compared to using more sophisticated time-value of money approaches.

Payback periods for typical energy investments are summarized in Table 1. Most measures realize savings in less than two years and cost savings are very seldom realized in time frames that exceed three years.

As illustrated in the table, optimal energy reduction strategies include considerations not just for energy use but also inefficient operating characteristics practiced by the utility. For example, most energy studies target electrical consumption of a pumping unit in terms of the efficiency of how the pump is driven. Matching a pump to the system requirements can generally lead to 10% to 30% in energy savings and adjusting pump speeds to meet the actual conditions using a VFD can add another 10% savings in energy use. These savings will then be compounded when water leaks or water use is reduced using proven supply-side and demand-side water conservation techniques.

Table 4

Typical Payback Periods for Energy Efficiency Improvements
In Water Supply and Wastewater Treatment

Area	Function	Typical Payback Period Ranges (yrs.)
Electricity Rates	Reduce demand during periods of peak electricity demand	0 – 2
Electric Installations	Power factor optimization with capacitors	0.8 – 1.5
	Reduction in voltage imbalance	1 – 1.5
Operations and Maintenance	Routine pump maintenance	2 - 3
	Deep well maintenance and rehabilitation	1 - 2
Production and Distribution	Use automation (telemetry, SCADA, and electronic controllers on modulating valves), to control pressure and output within the networks and to optimize the operation of pumping equipment	0 - 5
	Install Efficient Pumps	1 –2
	Install Energy-Efficient Motors	2 –3
	Replace Pump Impellers	0.5 – 1
	Optimize the distribution networks by sectoring pressure districts, installing variable speed drives and installing valves to regulate pressure	0.5 - 3
Supply-Side Water Management Changes	Perform Water Auditing, Leak Detection and make Meter Efficiency Improvements	1 -2
Demand-Side Water Management Changes	Peak Water Use Disincentive Rates, Irrigation Controls, and inclusion of water saving devices	1 – 2

after Watergy, Alliance to Save Energy, 2007

Use of Energy Audits to Achieve Energy Reductions

The Walk-Through and Desktop Energy Reduction Audit

An energy audit is a detailed investigation of how energy is used in utility facilities. The energy consuming systems are first categorized as lighting, HVAC and utility use. Generally, utility operations where pumps and/or blowers are used will consume in excess of 80% of the energy used. Thus the utility area will have the largest potential to achieve savings on energy improvement investments.

The audit begins with discussions between the energy auditor and key personnel from both the managerial and operations levels of the system. The purpose of these meetings is twofold, to ensure that the decision makers thoroughly understand and are supportive of the process. The other reason is to ensure that relevant facility staff have an adequate understanding of the process since they will be providing the auditor with data and Specifications about the facility are essential to the audit.

After completing the introduction stage, the first step in performing an audit is to conduct a walk-through of the facility. The purpose of the walk-through is to identify how energy consuming equipment is being used and the potentials for savings. The auditor will visit all facilities involved in the project to ascertain the availability of data and system complexity, formulate a data collection strategy, and identify the utility personnel necessary to assist in collecting and compiling data. Once the walk-through is completed, a “desktop audit” can begin by actually collecting and assembling needed data and information.

In the desktop phase, plant energy data, energy bills, unit energy consumption comparisons similar plant equipment units, and brainstorming on how energy might be saved are all considered. This information is compiled and documented to determine if a more in depth audit would be cost effective. In some cases the desktop audit is all that is necessary to achieve the most cost effective gains and many of the findings can be immediately integrated into plant operations. In the desktop phase the purpose of the audit is to identify areas where improvements can achieve immediate energy savings without the need for detailed study and economic analysis. If the desktop phase indicates a high potential for energy savings in many areas, a more detailed audit is necessary.

The Detailed Process Energy Reduction Audit

Detailed process energy reduction audits use the information assembled in the desktop phase to perform a more detailed comprehensive analysis of energy reduction possibilities. In the detailed audit, energy conservation measures (ECMs) are evaluated for applicability and cost effectiveness by plant staff in consultation with outside energy reduction assistance. Regardless of how the audit is conducted, the utility representative should be involved from the preliminary phase to the implementation of the chosen energy reduction improvements. The table below illustrates how the energy audit process proceeds.

Table 6

Comparison of Tasks for Desktop and Detailed Energy Reduction Audit

Step	Task Descriptions	Desktop	Detailed	Purpose of Task
1	Conduct Preliminary Meeting	x	x	Explain Process, Set Objectives, Define timeline, form Team
2	Collect and Assemble Pertinent Data such as electric schedules, electric meter billings, and plant operating data (flows, pressure, dosing, etc.)	x	x	Identify energy use, demand and power factor charges and how the process works
3	Conduct a walk-through of plant facilities	x	x	Identify areas for potential energy reduction
4	Segregate functions by lighting, HVAC and utility use. Create an equipment inventory and determine the percent of energy use by area or process		x	Identify how equipment is metered and used and how equipment consumes energy
5	Develop ECMs and energy reduction implementation strategies, develop cost opinions, compare alternatives		x	More thoroughly develop ECM applications for optimal cost effectiveness
6	Assemble energy reduction data, make recommendations and communicate findings	x	x	Provide specific recommendations to Utility in concise and understandable format
7	Present Final Report and Recommendations to Senior Management	x	x	Answer questions and clarify recommendations and expected ranges of energy savings

After EPRI, Features of Walk-Through and Detailed Process Energy Audits

Checklist – Walk-Through and Desktop Energy Reduction Audit

- Define and map the layout of the system
- Establish goals and benchmarks
- Strengthen capacity of utility staff by providing training where needed
- Perform walk-through
- Collected and assemble process data and information
- Compile information

Collecting Pertinent Data for Use in an Energy Reduction Audit

Collecting and assembling plant operating data is essential in conducting an energy audit. Useful data often includes:

Checklist - Operating Data Collected in a Energy Reduction Audit

- Plant Flows (average and yearly total for at min. two years
- Two years min. electric and/or natural gas utility billings
- Electric Load Profile
- Operating Data such as peak demands and disinfectant levels for water or dissolved oxygen and solids retention time for wastewater
- Pumping records from charts and pump performance curves from O & M Manuals
- Information on how many hours per day the plant is attended and operated and information on staffing
- Design drawings, operating manuals and plant specifications
- Normal operating SOPs for filter backwashing and solids handling
- Utility Schedules and Identification of different tariffs and rates available
- Permits, Permit Conditions and water quality treatment or effluent standards
- Any information on previous energy studies on lighting, pumps or HVAC systems, any test data that may have been collected, and any recommendations provided by contractors or external agencies

Plant operating data can be used as a preliminary screening mechanism to determine how much energy savings can likely be achieved. The table below present's ranges of accepted energy use for water and wastewater systems operations. Plants that operate near the low range will have little potential for energy savings and those that operated near of above the higher ranges will show significant promise for energy reduction.

Table 7

Acceptable Ranges of Energy Consumption for Preliminary Screening For Water and Wastewater Treatment Plants and Categories of Use

Type of Process	Energy Consumption KW-Hrs. / MGD
Wastewater Treatment Plants	
Secondary Lagoon Effluent Disposal	400 – 1,300
Conventional Activated Sludge	1,300 – 2,400
Extended Air and/or Aerobic Digestion	1,800 – 4,000
Water Treatment Plants	
75 psi High Service Pumps	1,100 – 1,400
100 psi High Service Pumps	1,300 – 1,700
125 psi High Service Pumps	1,500 – 1,900

HDR for Wastewater and Surface Water Plants

Table 8

Example Segregation of a Water Treatment Plant Processes In a Energy Audit

PROCESS #	PROCESS NAME
1	Raw Water Pumping
2	Screens
3	Rapid Mixers
4	Flocculation
5	Sedimentation
6	Filtration and Backwash
7	Chemical Treatment
8	Ozonation
9	Disinfection
10	Distribution Pumping
11	Sludge Thickening
12	Sludge Conditioning
13	Sludge Dewatering

Table 9

Example of Water Plant Segmentation in
An Energy Reduction Audit

	PROCESS OR OPERATION												
Electrotechnologies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Well Pumps	X									X			
Water Pumps	X									X			
Traveling Screens		X											
Blowers/Fans						X		X					
Agitators/Mixers			X	X	X		X	X	X			X	
Clarifier Drives					X		X				X		
Sludge Pumps			X	X	X						X	X	X
Process Water Pumps						X	X	X	X				X
Compressors								X					
Chemical Pumps			X			X	X		X			X	
Chemical Mixers			X			X	X					X	
Conveyors		X					X						
Centrifuges											X		X
Belt Filter Press													X
Vacuum Pumps						X							X
Hydraulic Drives													X
Evaporators									X				X
Drainage Pumps	X			X	X				X	X			
Cranes/Hoists	X	X							X	X			
Ozone Generators								X					

Table 10

Example - Energy Use by Plant Segment for an Energy Audit

ITEM/PLANT PRODUCTION	1 MGD	5 MGD	10 MGD	20 MGD	50 MGD	100 MGD
Raw Water Pumping	121	602	1205	2410	6027	12055
Rapid Mixing	41	176	308	616	1540	3080
Flocculation	10	51	90	181	452	904
Sedimentation	14	44	88	175	438	876
Alum Feed System	9	10	10	20	40	80
Polymer Feed System	47	47	47	47	47	47
Lime Feed System	9	11	12	13	15	16
Filter Surface Wash Pumps	8	40	77	153	383	767
Backwash Water Pumps	13	62	123	246	657	1288
Treated Water Pumping	1205	6027	12055	24110	60273	120548
Chlorination	2	2	2	2	4	8
Residual Pumping	4	20	40	80	200	400
Thickened Solids Pumping	N/A	N/A	N/A	123	308	616
Total (kWh/day)	**1,483**	**7,092**	**14,057**	**28,176**	**70,384**	**140,685**

Energy Reduction Strategies for Pumps

The largest use of energy in water treatment and supply and a significant consumer of energy, second only to aeration in wastewater treatment systems is the use of centrifugal pumps. Over the lifetime a typical pump, when all costs to operate and maintain the pump are considered, only 3% of the total lifecycle cost is for the pump is its purchase price and 74% is for the energy that it consumes.

Pumps usually provide significant energy reduction possibilities because inherent in their design is the fact that a system must be over-designed to reach some future or projected build-out. Adjustment can often be fine tuned after 5 to 10 years of operation.

Any system where throttling of water or pumping at excessive head pressures are systems where opportunities for energy savings exist.

A more efficient pump also has the benefit of lower maintenance and downtime costs. The cost advantage of buying energy efficient pumps: even though the purchase price of an efficient pump can be significantly higher than an inefficient one, can be realized in as short as one year.

A common problem in water supply and wastewater treatment pumping systems is for pumps to be too large for the needs of the system. All pumps have a best efficiency point (BEP), the flow rate at which the pump operates with the lowest energy requirement. A pump operating at a flow rate significantly lower than its BEP is wasting a lot of energy and wearing out more frequently than one with a higher efficiency. Wasted energy is lost during the entire lifetime of the pumping unit.

There are options besides switching to a smaller pump such as trimming the impeller, installing a smaller impeller, or reducing the pump speed to better match demand conditions.

Checklist - Data to be Collected on Pumps

- ❑ Pump manufacture's information from O&M Manual and shop drawings
- ❑ Maintenance checks made on pump
- ❑ Identification of total dynamic head (water pressure in the system) via pump test
- ❑ Pumping system efficiency (found on pump curve)
- ❑ Pumping characteristics i.e. starts and stops, hours of use, peak pumping requirements, etc.
- ❑ Optimize pump variables (pressure, flow, peak load, and start and stops.
- ❑ Inspect and clean the impellers and replace as needed.
- ❑ Periodically run the manufacturer's field test on the pumps and check the packing and lubrication of the bearings.
- ❑ Check pumps for excessive heat, leaks, vibration and noise
- ❑ Ensure that the manufacture's regular preventative inspection and maintenance is being performed

Energy Reduction Strategies for Electric Motors

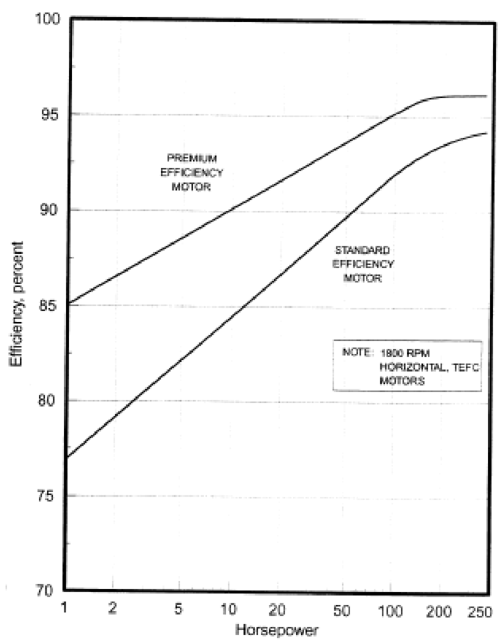
Like pumps, electric motors operate at best efficiency points shown on their operating curve. Providing excess horsepower beyond what is needed results in wasted energy.

Much attention has been paid to newer higher efficiency motors that can provide the necessary horsepower with a reduced energy requirement. Depending on horsepower, high efficiency motors operate from 1% to 10% more efficiently than standard motors. <u>The savings are generally larger on smaller motors because the efficiency improvement is greater on smaller motors that typically operate for longer periods of time</u>.

The figure below illustrates the general energy savings possibilities for premium efficiency 10 HP motor compared to a standard motor that is used for the same application.

Figure 1

Comparison of Energy Efficiency for 10 HP Premium Efficiency Motor



HDR – EPRI Energy Audit Manual

Standard motors should be replaced with premium efficiency motors only when the size and operating conditions yield favorable payback periods. Generally, premium efficiency motors will cost from about 10 to 25% more than standard motors and unless a motor is running at least 8 hours per day, the replacement is usually not cost effective.

When comparing the cost of rewinding an existing motor with the purchase of a new motor, cost difference will highly favor the rewound motor. However, the efficiency of rewound motors is often several percent less than a standard motor that has been wound at the factory, thus the lifecycle costs are not comparable. Additionally, a rewound motor will generally not provide the same service as a rewound motor that will need to be replaced earlier. As we replace older, less efficient motors with more efficient models, savings are often achieved correcting other problems, that is, over sizing and rewind quality.

Many motors are oversized for their applications, and because motor efficiency drops off sharply below about 40% of rated load point. Oversized motors often run far below their nameplate efficiency. Motors should be monitored to determine how close the actual application matches the nameplate.

Table 11

Full Load Current Requirements in Amps
For 3 Phase Motors for 208V, 230V and 460V

HP	208V	230V	480V
5	16.7	15.2	
7.5	24.2	22	
10	30.8	28	14
15	46.2	42	21
20	59.4	54	27
50	143	130	65
75		192	96
100			124
150			180

A fully loaded 10 HP motor would be expected to draw near 31 amps. If the historical amp draw were only 24 amps, the motor is oversized for the application and is likely operating at a very inefficient point on its curve and thus wasting energy as extra heat that may prematurely damage motor windings. In this case, from the table it is obvious that a 7.5 HP would be a better choice. This example illustrates the need to record motor nameplate information, track amperage draw and motor case temperature.

In most cases the change-out opportunity will not be so obvious and a motor application will likely fall between the nominal HP sizes. In these instances a variable speed controller (VFD) provides a method to achieve improved matching. The VFD will provide only the HP necessary to move the applied load. When operated in a range approaching 80% efficiency, the VFD is very energy efficient. VFDs have been used for a number of years, are available from a variety of manufactures and exhibit high reliability.

In addition to the problems with oversized motors, many motors are repaired or rewound more than one time before they are discarded. The fact that they are rewound indicates a likely problem with over sizing resulting in excessive heat buildup. While quality repair practices maintain the efficiency of a motor, it is more likely that a motor's efficiency and life will degrade significantly after a rewind and more so after more than one rewind. The quality of the rewind can be determined by comparing the amp draw of the new motor with the historically recorded amp draw.

Motor repair is an opportunity for proper sizing of the motors and the adoption of replace-instead-of-rewind policies can add energy savings areas that are usually undetected.

The energy efficiency that can be achieved is illustrated in the table below for an 1800 RPM, TEFC Horizontal motor. Note that as the cost of electricity increases the cost savings increase proportionately. Also note that the smaller motors have a shorter payback period than the larger units. Generally speaking the overall payback period will be less than those estimated since the new motor can be properly applied and the motor that it replaces has likely lost efficiency as it has aged. Generally speaking, the payback period for motors 10 HP and below is likely to less than 2 years.

Table 12

Payback Periods for 1800 RPM, TEFC, High Efficiency Motor Operating Running 24 Hours each Day

Electrical Cost Per KWH	$ 0.04	$0.06	$0.08
Horsepower	Payback Period (yrs)		
5	3.7	2.4	1.8
10	3.3	2.2	1.7
20	4.1	2.7	2.0
50	4.7	3.1	2.3
75	4.7	3.1	2.4
100	4.8	3.2	2.4
150	5.4	3.6	2.7

After HDR, Payback Periods for Replacing Standard Motors with Premium Efficiency Motors

To determine the approximate payback period for a motor running less than 24 hours per day, multiply the number of hours that it actually runs times the payback period divided by 24 hours. For example, a 10 HP motor that runs 12 hours each day, with an electrical rate of $0.06 per KWH, would have a payback period of 4.4 years (= 2.2 yrs x 12 hours / 24 hours).

Checklist - Data to be Collected on Electric Motors

Electrical Systems

- Current Power factor
- Sizes of conduit and transformers
- Electrical Consumption as shown on meters and electric bills
- Identification of Peak and off-peak operating loads

Electrical Motors

- Motor nameplate data
- Historic current draw and voltage trends
- Hours and time of day that the motor operates
- Information on Age and Maintenance Performed on the motor
- Any information on where appropriate sizing changes might be made

Electric Energy Tariffs and Load Management

How Electricity is Priced

Electricity is typically billed in two ways: by the quantity of energy used over a period of time, measured in kilowatt-hours (KWH); and by demand, the rate of flow of energy, measured in kilowatts. By choosing when and where to use electricity, facilities can often save as much (or more) money as they could by reducing energy consumption.

Industrial and Commercial Electric Rate Schedules

Because it is costly for electric utilities to provide generating capacity for use during periods of peak electrical demand, they rates are structured to encourage customers to minimize demand during peak periods. Operating facilities may achieve substantial savings simply by selecting a rate schedule that better fits their pattern of electricity use.

Time-of-Use Rates

Time-of-use rates favor off-peak electrical use. Under time-of-use rates, energy and demand charges vary during different block periods of the day. For example, energy charges in the summer may be only five cents per kilowatt-hour with no demand charge between 9:30 p.m. and 8:30 a.m., but increase to nine cents per kilowatt-hour with a demand charge of $10 per kilowatt between noon and 6:00 p.m.

The monthly demand charge is often based upon the highest 15-minute average demand for the month.

Interruptible Rates

Interruptible rates offer users discounts in exchange for a user commitment to reduce demand on request. Water and Wastewater plants and larger pumping facilities are often in an excellent situation to take advantage of these rates since the generators must be run under load periodically and the equipment automatically starts with loss of line power. Interruptible rate requests are relatively infrequent since power companies must maintain significant emergency reserves.

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Power Factor Charges

Power factor, also known as "reactive power" or "kVAR," reflects the extent that current and voltage cycle in phase. Low power factor, such as that caused by induction motors and exacerbated by partly loaded motor, results in excessive current flow. Electric utilities charge extra for low power factor because of the cost of providing the extra current.

Power factor penalties are often the easiest to correct with the addition of capacitors that minimized the reactive power affect.

Power Provider Assistance and Energy Cost Reduction Options

The threat of electrical industry deregulation has resulted in power providers being more attuned to the cost their customer pay for energy. Since the utility is such a large consumer of power, the provider will often provide free services and advice to large users on methods to reduce power consumption and reduce the costs for the power that consumed. These services include power quality monitoring, analysis of current rate applicability for reducing charges, analysis of current metering practices, assistance and may provide recommendations on new pricing options that are not well known.

Effective Energy Conservation Measures (ECMs)

Energy conservation measures consist of proven techniques that result in reductions in energy use usually with increases in operating levels and reliability. The following table illustrates some of the more common ECMs are best applied by asking the following questions.

Checklist - Identifying Opportunities for the Application of ECMs

- ❑ Does the equipment need to run at all?
- ❑ Can the process or equipment achieve the same results at reduced flow or pressure?
- ❑ Can the process be operated for fewer hours?

- Is the equipment properly sized for its loading conditions?
- Will a VFD allow a better match to operating conditions?

Water Efficiency Improvement

Water efficiency strategies are documented in the Florida Rural Water Association's, Water Conservation Techniques for Small and Medium Water Systems. This document provides comprehensive information on eliminating water loss and increasing water efficiency.

Water loss reduction compounds the savings available through energy management techniques. A list of Cities that were assisted in water loss and energy reduction programs that significantly increased the financial gains in combination with energy reduction improvements are included in the Appendix.

Implementing Energy Reduction Recommendations

Preparing Energy Reduction Recommendations

Energy reduction recommendations are prepared in a systematic manner and include the following considerations.

Checklist – Preparation of Energy Reduction Recommendations

- The results of the energy performance monitoring, energy consumption details and system evaluation that was conducted on all facilities that are to be targeted for improvements is included
- A description of the methodology followed in establishing the baseline parameters and the criteria to be followed in for monitoring and adjusting over time is included
- The various types of data collected and their sources is identified
- System maps and the methodology followed for mapping the system is provided
- A list of all efficiency measures identified—including any suggestions for improving operating and maintenance practices are prioritized according to the pay-back-period or highest rate of return on investment is provided
- A suggested monitoring and verification plan to track progress during implementation of conservation measures is provided
- Performance targets and benchmarks against which to evaluate progress are established
  Performance measures have been set relative to existing baseline data and the monitoring system(s) necessary to measure them are included
- Operating staff have been adequately trained in the any new procedures and technologies.

Energy Reduction Benchmarking with Neighboring Facilities

The benchmarking process allows a facility's personnel to compare the operation of their facility energy use information with similar plants in order to determine how efficient the facility is operating. Benchmarking provides the operator to exposure to new methods and technologies that allow the energy reductions to reach higher level of savings than those previously identified. In addition, benchmarking is a good tool to notify personnel that some condition in the plant has suddenly changed or that the plant is operating unusually.

References:

Information from a variety of sources was used in preparing this document. Much of the information came from *EPRI's Energy Audit Manual for Water and Wastewater Facilities* and Watergy's, Energy Efficiency in Municipal Water Supply and Wastewater Treatment, Rural Water Association's documents and working experiences in assisting utilities in energy management planning as part of the Florida State Revolving Fund program was also used in preparing the document.

This document is intended as a guideline to be used in assisting small water utilities in developing more efficient energy use practices and can be obtained free of charge from the Florida Rural Water Association Web Site at: http://www.frwa.net.

Appendix

1. **Examples of Energy Efficiencies Achieved as a Result of Water Loss Reduction Florida Rural Water Association**

    1. Gonzales
    2. Eustis
    3. Palatka
    4. South Bay
    5. Trenton

<u>FLORIDA RURAL WATER ASSOCIATION</u>

Imbedded energy cost savings as a result of water loss reduction

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Gonzales =
              (Current Average)    (Water Loss Reduction)
              (KWH/MG)           X   (MG) =   1604    X   12.487600

          KW Saved    X     KWH Rate   =  Energy Saved
          20,034      X     $0.35      =  $701.19 Per Year

              Ten Year Payback   =  $7,011.90


Eustis =

              (Current Average)    (Water Loss Reduction)
              (KWH/MG)           X   (MG)  = 1013.33   X   70.028470

          KW Saved    X     KWH Rate   =  Energy Saved
          70,961.95   X     .07        =  $4,967.34 Per Year

              Ten Year Payback   =  $49,673.40


Palatka =

              (Current Average)    (Water Loss Reduction)
              (KWH/MG)           X   (MG)  =  KW Saved

          KW Saved  X     KWH Rate  =  Energy Saved Per Year

          Energy Saved Per Year  X    10 Years     =   10 Year Savings
               997   X   219    =    218,343
          218,343    X   .062   = $ 13,537.27
       13,537.27     X    10    = $135,372.70
```

City of South Bay =

(Current Average) (Water Loss Reduction)
(KWH/MG) X (MG) = 985.7 X 27.594

KW Saved X KWH Rate = Energy Saved Per Year

27,199 X .067 = $1822.33

Ten Year Payback = $18,223.30

Trenton =

(Current Average) (Water Loss Reduction)
(KWH/MG) X (MG) = KW Saved

KW Saved X KWH Rate = Energy Saved Per Year

Energy Saved Per Year X 10 Years = 10 Year Savings

1260.03 for two months
x 6 for full year

7560.18 Yearly Loss after Leak Detection

(20,991.229 - 7560.18)
910.458 X 13.431049 X .057 X 10 = $6970.19