What you know can

Large transmission pumps are major energy consumers. Black & Veatch

The water and wastewater industry consumes approximately 7% of the electricity generated in the world, according to the U.S. Department of Energy. Since electricity costs often are one of the largest operation and maintenance costs for water and wastewater utilities, they merit substantial scrutiny. But anyone who has ever tried to understand the intricacies of an electricity bill or wondered how to manage rising electricity costs in an age of stagnant or declining budgets knows it can be difficult to implement cost-cutting strategies.

save you

Understanding your options for purchasing electricity is the first step toward managing costs more effectively

Travis Moore and Jeffrey Buxton

The good news is many utility managers have found ways to cut their electricity costs with little or no capital investment. Large consumers of electricity often are afforded a variety of options for purchasing electricity from their local electric utilities. Options for pricing and the corresponding opportunities for cost reduction generally increase with increased energy consumption. Managers who understand how electricity is priced and purchased and who know their alternatives can identify and take advantage of opportunities to reduce energy costs.

Pricing components

Electricity pricing in regulated electric utilities can appear to take many forms, but understanding key elements and their role in electrical tariffs facilitates understanding even the most complicated bill. Common tariffs may include some or all of the following charges.

Basic charges

The **energy charge** is for the total amount of energy in kilowatt-hours (kWh) used in a facility over the billing period. The total energy consumed during the billing period is multiplied by the price per kilowatt-hour to calculate the cost of the energy consumed.

The **demand charge** is based on the peak power demand in kilowatts measured during the billing period. Demand is measured as the amount of power required during a given period of time – typically 15, 30, or 60 minutes. Demand reflects the maximum amount of power that the electric utility needs to be able to provide at any given time. The peak demand during the billing period is multiplied by the demand charge to calculate the demand cost.

Ancillary charges

Customer, facility, or billing charges are flat fees that cover the electric utility's costs for meter reading, bill preparation, and other administrative expenses. They are independent of power demand or energy consumption.

The **power factor charge** is derived from how effectively the delivered current is converted into useful work. The power factor is stated as a percentage, with 100% being most effective. Facilities with power factors less than a defined threshold may incur surcharges from their electric utilities based on the total amount of energy consumed and facility power factor.

Fuel, transportation, or other charges account for variable operating costs incurred by the electric utility in the process of generating electricity. They may be shown on the bill, or they may be included in the energy charge. These charges typically are applied per kilowatt-hour of energy consumption and may fluctuate monthly or seasonally.

Tariffs or rate schedules

The basic pricing components can be combined to produce a variety of possible tariffs. Electric utilities commonly offer multiple tariffs for a variety of types of customers, but customers are not always notified when new or modified tariffs become available. An electric utility customer representative can assist in reviewing an up-to-date list of the tariff options that are available.

Understanding the available tariffs and the facility's electricity use patterns can help water and wastewater utility managers select the most cost-effective tariff. Many utilities have achieved significant cost savings by simply changing to a tariff that better matches their electricity use patterns.

A **flat tariff** has no demand charge. Energy is charged by the quantity used plus any applicable ancillary charges.

A **demand tariff** uses both demand charges and energy charges, along with applicable ancillary charges, to calculate the total bill. The demand charge may be calculated based on the maximum demand each month, or it may be calculated using a ratchet clause. A ratchet clause uses the maximum demand from a rolling window of up to 12 billing periods to calculate demand cost for a given billing period. A maximum demand in a billing period that exceeds the previous maximum within the rolling window will establish a new billed demand, and the rolling window resets (see Figure 1, below).

Figure 1. New maximum demand results in higher demand charge

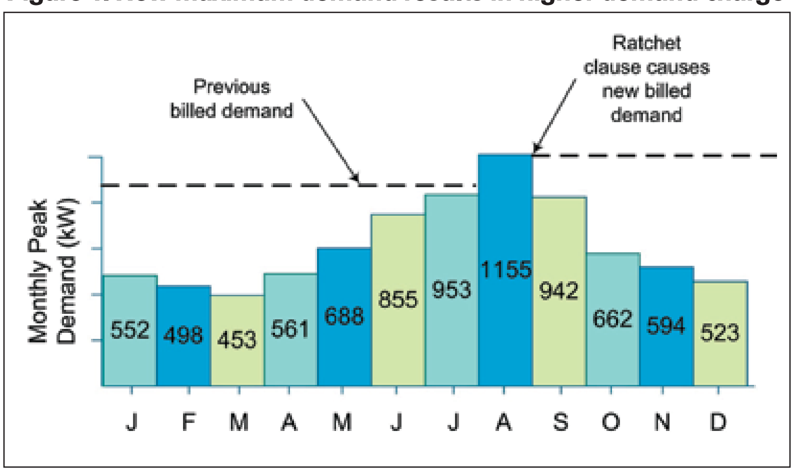


Table 1. Examples of demand and time-of-use tariffs

	Tariff*		
	Power and light	**Power and light with time-of-use**	**Large power and light with time-of-use**
Charge	*Annual maximum demand > 400 kW*	*Annual maximum demand > 400 kW*	*Annual energy >15,000,000 kWh*
Customer charge (per month)	$135	$135	$135
Summer demand (per kW per month)	$10.65	$5.95	$5.55
Winter demand (per kW per month)	$5.95		
On-peak summer energy (per kWh per month)	$0.0410	$0.1670	$0.1620
Off-peak summer energy (per kWh per month)		$0.0370	$0.0340
Winter energy (per kWh per month)		$0.0370	$0.0340

Summer = June–October.
Summer peak: 2 p.m.–7 p.m. (5 hours).
Summer off-peak: 7 p.m.–2 p.m. (19 hours).
Winter: November–May.
*These tariffs do not use a ratchet clause.

Time-of-use (TOU) tariffs apply different energy and demand charges to different parts of the day or year to account for the electric utility's varying cost of supplying electric service. Energy TOU rates can vary seasonally (summer/winter), daily (peak/shoulder-peak/off-peak), or both (summer peak/off-peak, winter; see Table 1, above, and Figure 2, below).

Interruptible tariffs, also known as "curtailment" or "customer generator" rates, are arrangements whereby the customer agrees to reduce or interrupt plant electrical loads upon short notice from the electric utility during periods of high electrical system demand, such as during particularly hot summer days. In return, the electric utility offers lower demand charges to compensate the customer. Many water and wastewater utilities use onsite engine-generators to supply adequate energy to the facility during periods of electric interruption or curtailment.

Example: untreated water transmission pumping station

This simplified example demonstrates how selection of tariff and adjustments in operating philosophy can yield cost savings in a very short time with no capital investment.

Scenario. An untreated water transmission pump station transfers water from a regional reservoir to a lake near the water treatment plant of a midsize city. The lake supplies water to the plant. The pipeline was sized during design for a maximum capacity of 150,000 m^3/d (40 mgd). Water demand, which has not yet reached maximum pipeline capacity, is commonly 114,000 m^3/d (30 mgd) in the summer and 57,000 m^3/d (15 mgd) in the winter.

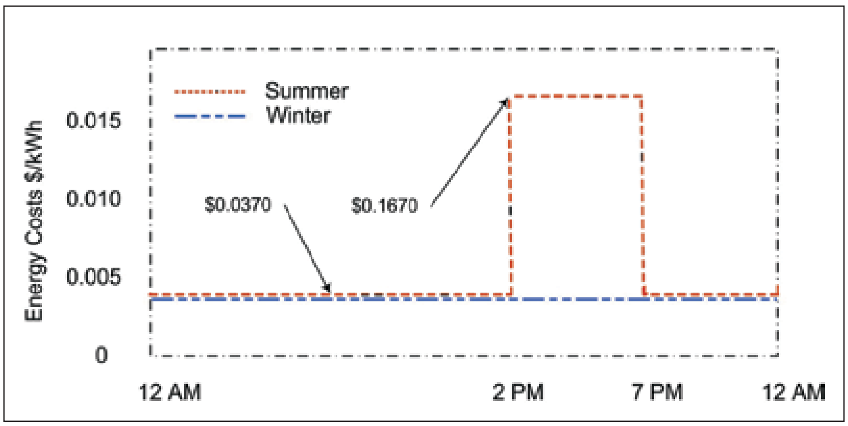
Current operation. Each day the pump station operators review the lake level and previous day's water withdrawals from the lake and plan how much water to pump to the lake the next day. They strive to minimize demand costs by pumping the planned volume of water at a constant rate over 24 hours.

Tariffs. The pump station has the three tariffs available from the local electric utility, as shown in Table 1 (above). The pump station currently uses the power and light (PL) TOU tariff. The large power and light (LPL) TOU tariff recently has become available because growth in water demand has pushed the pump station's annual energy consumption over the 15 million-kWh threshold. The available tariffs do not have a ratchet clause, so the demand cost is billed according to the maximum demand each month.

Analysis. Monthly electric costs were compared for the three available tariffs when pumping 114,000 m^3/d (30 mgd) in the summer and 57,000 m^3/d (15 mgd) in the winter. Adjusting the summer pumping plan to transfer the required volume of water during the 19-hour off-peak period with no pumping during peak times also was analyzed. In all combinations, the required amount of water was pumped at a constant rate through the pumping period so that the maximum power demand matched the instantaneous power demand. For illustrative purposes, this example assumes that the same volume of water was pumped each day of the month in both summer and winter variations. Monthly summer and winter pumping costs for the various combinations are summarized in tables 2 and 3 (p. 37).

Results. Changing the summer pumping plan to pump only during off-peak hours enabled monthly savings of 34% using the current PL-TOU tariff. The higher demand cost in this pumping schedule was more than offset

Figure 2. Seasonal variations for PL-TOU tariff



PL-TOU = power and light time-of-use.

Table 2. Summer pumping combinations

Combination	Tariff	Customer charge	Demand	Energy	Total monthly cost
30 mgd, 24-hr pumping	PL	$135	$13,947	$39,302	$53,384
	PL-TOU	$135	$7792	$61,429	$69,356
	LPL-TOU	$135	$7268	$58,154	$65,557
30 mgd, 19-hr pumping	PL	$135	$17,617	$39,302	$57,054
	PL-TOU	$135	$9842	$35,468	$45,455
	LPL-TOU	$135	$9181	$32,592	$41,908

PL = power and light.
PL-TOU = power and light time-of-use.
LPL-TOU = large power and light time-of-use.

Table 3. Winter pumping combinations

Combination	Tariff	Customer charge	Demand	Energy	Total monthly cost
15 mgd, 24-hr pumping	PL	$135	$3896	$19,651	$23,682
	PL-TOU	$135	$3896	$17,734	$21,765
	LPL-TOU	$135	$3634	$16,296	$20,065
15 mgd, 19-hr pumping	PL	$135	$4921	$19,651	$24,707
	PL-TOU	$135	$4921	$17,734	$22,790
	LPL-TOU	$135	$4590	$16,296	$21,021

PL = power and light.
PL-TOU = power and light time-of-use.
LPL-TOU = large power and light time-of-use.

by the lower off-peak energy costs. The most cost-effective winter pumping method was to maintain the 24-hour pumping schedule because there were no peak/off-peak winter rates. Costs using the newly available LPL-TOU tariff were lower than the other two tariffs for all pumping combinations. Switching from the PL-TOU tariff to the LPL-TOU tariff and using 19-hour pumping saves 40% in the summer months and 8% in the winter months with 24-hour pumping. This example shows that major cost savings can be obtained by understanding the available tariffs and adjusting facility operation.

Automation, smart metering, and the future

Although the situation examined in the example illustrates a good case for managing demand and overall electricity costs, such opportunities may not be as readily available to all utilities. Demand costs may be higher relative to energy costs. Individual utilities may have less control over when equipment must run. In these situations, utilizing automation and control systems may hold the key to greater control of energy costs.

Plant control and energy management systems can be implemented or configured to help improve overall energy costs. These can be as simple as basic metering and monitoring of real-time and cumulative energy usage in the facility. Operators who know the energy usage at any point in time can make more insightful decisions about efficient equipment operation. More capable control systems can monitor energy usage and the electricity prices in effect at a given moment and advise operators when to turn machinery on or off. The most complete control systems can examine the current electricity price, historic energy demand, and many physical operating factors for a given system and seek the least expensive operating strategy in real time. Such systems may operate on

How to save costs

Review tariffs and compare them against facilities' electricity use patterns. Evolution of electric tariffs and expansions to a facility may have caused a currently used tariff to be less cost-effective than an alternative tariff. As electricity needs increase, so do purchasing options.

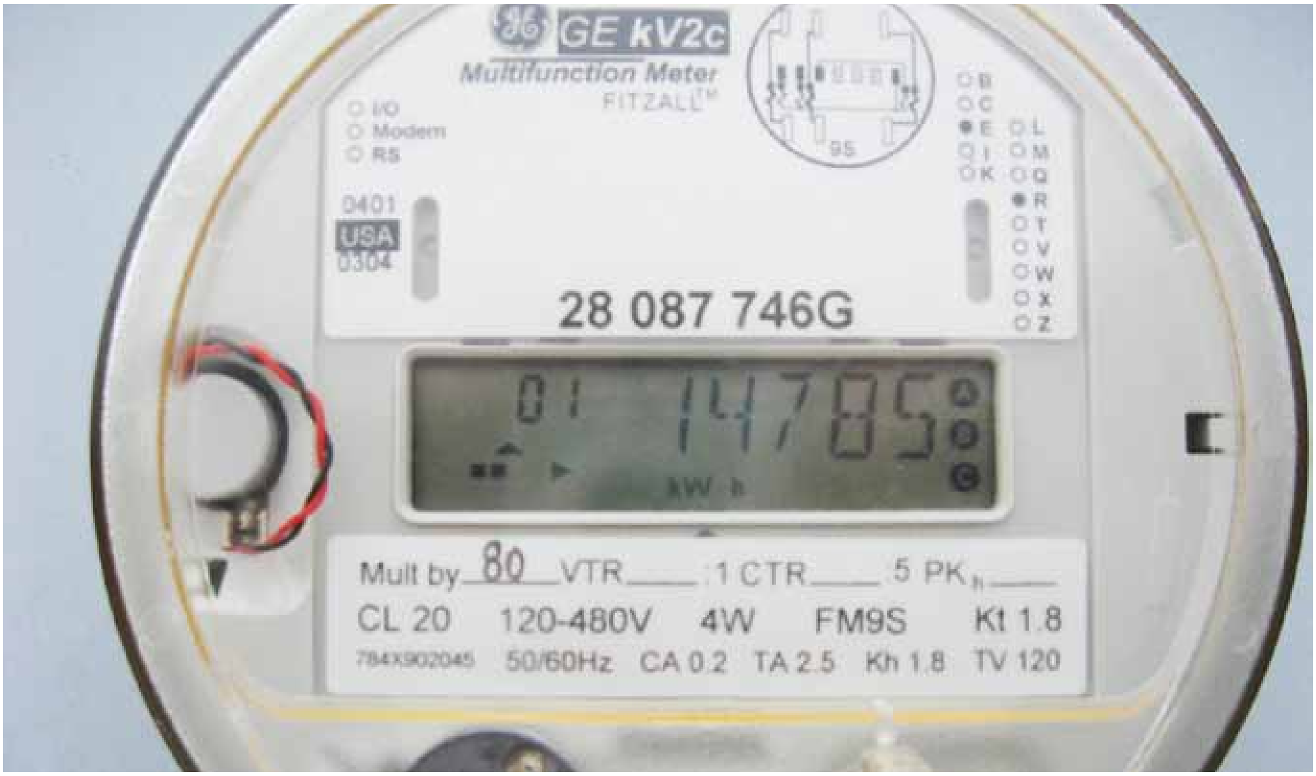
Schedule major equipment operation for off-peak times whenever possible if you have a time-of-use tariff. Avoid routine motor testing during peak hours. Use water storage opportunities within the system to limit large pump operation to off-peak hours.

Manage demand costs by using the smallest, most efficient equipment available and staggering operation of large machines. Train operators and use plant control systems to help monitor real-time demand and operate flexible or discretionary processes during periods of low demand.

Monitor the power factor and make corrections if it's low. Capacitors and other power factor correction devices have relatively low costs and can provide payback in a short period of time. More efficient operation of an electrical system and reduced losses are additional benefits of power factor improvement.

Investigate interruptible tariffs. If the facility can tolerate short-term reduced operation or if it has onsite generation capability, the cost savings from an interruptible tariff may offset the effort and expense of operating and maintaining the generator.

Talk with electric utility representatives to keep up-to-date on current tariffs and energy-efficiency and incentive programs. Annually reviewing a facility's electric tariff and bills with an electric utility representative or engineering consultant will help you understand all tariff elements and determine if there is a tariff better suited for a specific situation. Many electric utilities will change the applied tariff for little or no cost.



Electric meters measure power demand, energy consumption, and time of use. Black & Veatch

autopilot, with operators overseeing overall system operation.

Many electricity tariffs available today have pricing systems that vary seasonally and in specific hour increments on a daily basis. Tariff sheets can be used to program treatment plant control systems that consider the electricity price at a given moment.

Real-time pricing of electricity is being tested in some regulated electric utilities. It may not be long before this method of pricing electricity becomes a reality. Tariff and pricing options will continue to expand as electric utilities begin to embrace smart metering and as electric industry deregulation progresses. The electric utility soon may be able to provide real-time pricing, consumption, and demand information. This may create additional opportunities for electricity users, who may then be able to see and consider the instantaneous price of electricity to optimize operational decisions.

When energy management moves to a real-time basis, choosing between consumption and conservation then can be made in real-time as well. This will dramatically amplify the opportunities available from improved monitoring and more automated system controls. Further expanding this opportunity will be increased choices available to the operator in response to varying energy prices. These will include shifting the time and rate of production, conservation and demand reduction in non-production facilities, alternative or self-generation resources, and energy storage.

In this new world, a well-designed plant and energy management control system will become an integral part of taking advantage of new tariff structures and an overall energy management strategy.

Time to take control

Managing the cost of electricity can seem complex. But some basic steps – beginning with close inspection of a facility's electric bill – can lead to reduced electrical costs with little or no capital investment. Considering the potential future impact of changes in the way that electricity will be priced and billed, as well as beginning to use plant and energy management control systems as a key part of an overall energy management strategy, will help utilities navigate times of rising energy costs and shrinking budgets.

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