A smart grid for water utilities?

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The electric industry, with government backing in some cases, is developing and deploying smart grid technologies that collect frequent data from customers' meters as well as continuously monitoring and controlling the distribution system. The smart grid is being promoted as a way of increasing the efficiency and reliability of electric power generation and delivery, as well as addressing energy independence, environmental and global warming issues, increased economic productivity, and national security. What affect will this have on water utilities?

Smart grid is an aggregate term applied to a collection of technologies, including smart meters and meter reading equipment, wide area monitoring systems, dynamic line evaluation, electromagnetic signature measurement and analysis, time-of-use and real time pricing tools, advanced switches and cables, radio communications technology, and digital protective relays. Smart grid includes databases and applications to store and analyse huge volumes of distribution and consumption information, provide it to utility staff and customers to help them manage delivery and usage, and detect anomalies and tampering.

The smart grid concept also represents a change in philosophy and the business model for a utility's relationship with customers and other stakeholders. In the old model, a utility simply produced energy, delivering it over a transmission and distribution network to customers. In the new model, the utility and its customers become partners in managing the supply/demand relationship. Smart grid provides the technologies to enable this relationship.

Using advanced metering infrastructure (AMI) and smart meters, which record how electricity is used at different times of the day and regularly communicate with the utility, electric utilities can set prices which track costs (including operating, purchased power or marginal capacity) that vary by time of day, increasing the price of electricity used during high demand periods, and decreasing it during low demand periods. Consumers can respond to that information by adjusting their electricity demands accordingly, reducing demand during peak usage periods, or buying appliances that can respond to such information.

For water utilities, there are major parallels with electricity production, delivery and customer service, as well as significant differences. Although there are major differences between water and electric service, water utilities experience many of the same circumstances and issues that drive electric utilities, including the need to hold costs down while maintaining system reliability, intense capital requirements, the need for conservation, environmental concerns and staffing issues.

Moreover, water and wastewater utilities spend major parts of their operating costs on electricity. Most of this is for running pump motors, which adds the dimension of reactive power. Energy costs for water and wastewater can be one-third of a municipality's total energy bill. Drinking water and wastewater systems in the United States spend about US$4 billion a year on energy to pump, treat, deliver, collect and clean water. Water and wastewater utilities account for an estimated 75 billion kWh of overall US electricity demand, and loads are expected to increase by 20% over the next 15 years due to increased populations and more stringent regulations. While water utilities have more flexibility than electric utilities in product storage, many are subject to high peak demands that require pumping when the cost of electricity is high. So, water and wastewater utilities stand to be impacted by the advent of smart grid technology.

The advent of smart grid for electric utilities raises questions for water utility managers:

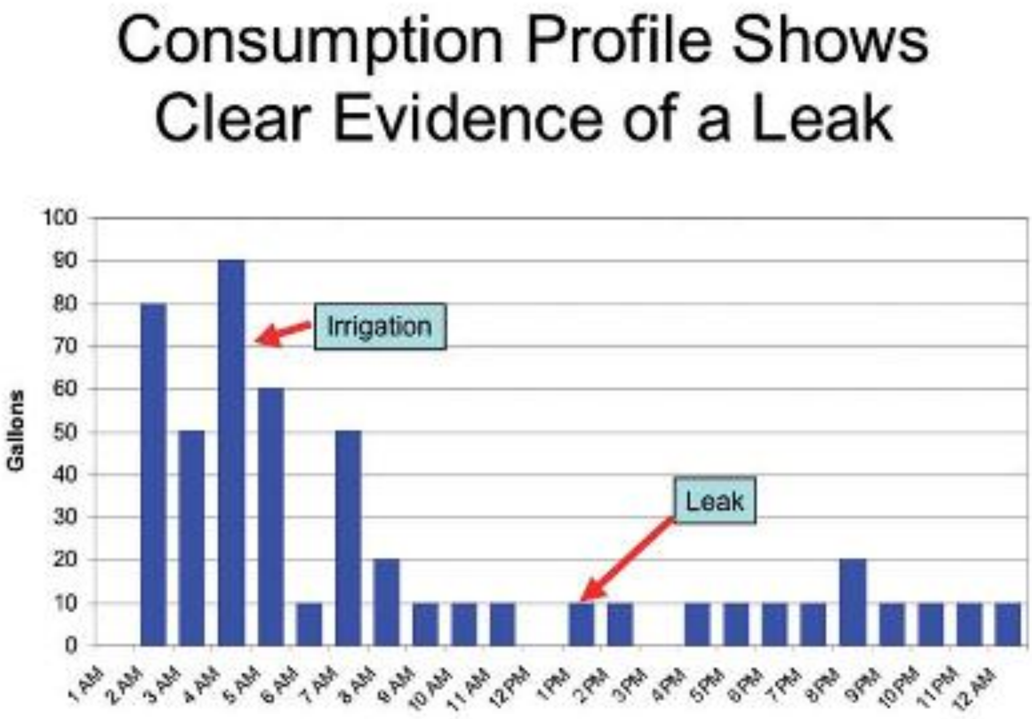
- How will smart grid affect water utilities' energy use and operating costs?
- What smart grid technologies are now or will be available to water utilities?
- What aspects of the smart grid business model are applicable to water utilities?

To a much greater extent than water supplies, the electric grid is characterised by interconnections between the distribution systems of regional utilities. While generally providing more reliability and price stability, this situation also contributed to historic regional blackouts. (Smart grid technologies should reduce such vulnerability to "weak links" in the grid.)

As droughts tend to be regional, and demand for water is growing in many areas, water utility distribution systems are likely to be more interconnected over time. For example, a succession of studies reinforces the conclusion that the Colorado River, a critical source of water for seven states (all of which have growing demands), is oversubscribed. Interconnections between major river basins, and desalinisation facilities built to reallocate water to distant utilities, are under consideration.

While electricity cannot be stored to any great degree, water can be stored in raw or treated reservoirs, or in tanks at customers' premises. Electric utility operators think in terms of 1 minute, 15 minute and hourly windows when managing the transmission and distribution system, and when measuring and pricing consumption, while water utility operators think in terms of hourly or daily or weekly peaks.

However, for both water and electric utilities, providing peaking capacity with facilities that aren't used much is expensive. The better the load factor, the better the economics of production and delivery. There are savings and efficiency gains as well as environmental benefits if the utility can reshape its customers' demand profiles seasonally or daily. If a water utility imposed an alternate day sprinkling ban, the load factor would be reduced even if the same volume of water was consumed.



Detailed consumer consumption profile illustrating a leak.

Water utilities can use smart metering to monitor and enforce alternate day sprinkling bans. Water utilities can establish seasonal or daily time-of- use or peak load pricing, as well as tiered pricing for water budgets. Such pricing is already being established in California and at other utilities around the world, particularly in drier areas. Smart metering provides the information to help customers respond to such price signals prior to receiving the bill.

In principle, a water utility could send load control signals to irrigation controllers and other devices, just as electric utilities would send control signals to air conditioners and other equipment to shut off or avoid turning on during certain periods.

By using demand management techniques, a water utility could reduce the amount of water it needs to put into pressure system storage (for example, in elevated tanks); this is conceptually equivalent to electric utilities reducing the amount of spinning reserve that they have to keep on line.

WHAT DOES SMART GRID LOOK LIKE FOR WATER UTILITIES?

Water utilities will be subject to more sophisticated pricing and demand side management by their electricity providers. Smart grid vendors will adapt electric smart grid technologies, particularly AMI and meter data management systems, and market them to the water utility market along with new business models. Regulators will encourage water utilities to adopt electric utility business models. Their effect will impact water utility production, distribution and customer service.

On the production side:

- Water utilities will increasingly be subject to real time pricing from electric utilities, and will implement increasingly sophisticated energy management protocols for their motors and pumps.
- Some water utilities may in turn impose peaking surcharges on some customers, particularly those with high volume consumption, high peak to average usage ratios, and peaks that coincide with system peaks.
- Water utilities located where solar radiation and wind resources are high will increasingly deploy renewable energy system at their facilities (think solar panels covering ground tanks and sedimentation basins, and wind turbines at the ends of the basins). Power from these (and even standby generators) will be sold into the grid.

In distribution system operations:

- Water utilities will consider collaboration with energy utilities for communications infrastructure and database systems to support AMI.
- Sensors distributed throughout the distribution system will monitor acoustically for small leaks before they become large ones, and leaks that don't appear on the surface.
- Other sensors will be placed on the distribution system, or at meter locations, to monitor pressure. Data from these devices will be integrated with SCADA systems.
- Utilities will routinely perform mass balances of pumping districts or pressure zones, measuring all the water going into a pressure district and all the water going through customers' meters over the same time period. For example, all the meters may be read around midnight on one Sunday and the same time the next week, and compared to data on production and change in storage. This will help identify nonrevenue water losses.

On the customer side of the business:

- The same systems that enable electric utilities to read customers' meters frequently (e.g., hourly) are now being deployed in the water industry. Consumption data from customers' meters will be sampled at least daily and perhaps several times per day, even hourly. This data will be available to customers at web sites. Boston Water and Sewer Commission, the District of Columbia Water and Sewer Authority and many other utilities already provide this information. The utility can provide customers access to recent usage and cost information prior to billing. Customers may come to expect such service from water utilities.

- Water utilities will adopt meter data management systems to maintain all the consumption data. These will be integrated with billing systems and other information systems, such as asset management systems. They will store information about customers, including lot size, irrigable area, number of bathrooms, household population, the presence of swimming pools and irrigation systems, etc., to establish individual water budgets and rates based on these budgets.
- AMI will be used to manage and monitor conservation programmes, including limitations on outdoor water use.
- AMI will be increasingly used to monitor for tampering and theft of service close to real time, and unauthorised usage when a service has been shut off.
- The AMI system will monitor backflow, both "mini" events that might signal marginal pressure, and larger events that could indicate significant problems, like cross connections or main breaks.
- Utilities will increasingly adopt programmes to notify customers proactively about potential leaks or high consumption before they receive a high bill.
- Water utilities will begin deploying AMI-based service line shut-off valves that can be remotely closed or opened from the utility's office. This is similar to the auto-shutoff capability of electric smart meters.
- Water utilities will move from a high reliance on the supply management business model; demand management is increasing seen as a complement to supply management.
- As more water utilities and their customers implement recycled and non-potable water distribution systems, cross connection and backflow control and monitoring will become increasingly important. AMI is being considered as a tool for backflow monitoring.

- Water conservation programmes will become more sophisticated with the availability of consumption profiles. Feedback on the effectiveness of programmes and devices will be more immediately. The programmes can be "turned on or off" and adjusted, depending on supply situations.

Smart grid approaches tailored to the water utility industry will enable utilities to reshape demand to avoid expensive peak production or purchase, extend the life of generation and transmission capacity, avoid or postpone new construction, reduce operating costs, increase customer service levels, and enhance distribution system reliability.

Smart Energy International