Water Energy Symbiosis for Grid Reliability

There is growing recognition that the water and energy utility sectors are linked. Water-related energy use consumes nearly 20% of California's electricity, 30% of its natural gas, and 88 billion gallons of diesel fuel annually. These numbers are expected to grow in the future. California's water and wastewater agencies spend more than $500 million each year on energy consumption. When water utilities reduce their energy use, they see lower operating costs, reduced climate impact, a reduced carbon footprint, and improved sustainability of the water infrastructure.

The energy industry is facing real challenges due to regulatory initiatives aimed at "greening" the electric power system. These initiatives include increasing the Renewable Portfolio Standard from 20% to 33% and beyond, reducing air toxins, and retiring power plants that utilize once-through-cooling technology. With the closure of the San Onofre Nuclear Generating Station (SONGS) Southern California is expecting even more strain on the power grid. Customer-based "preferred" resources can have a vital place in supporting grid reliability. Future energy supply will be less predictable, more distributed at customer sites, and more remote where large scale technology is deployed. With the proliferation of "smart technology", electricity usage can be more controllable, price responsive, condition sensitive, and predictable.

The energy industry needs environmentally responsible solutions as renewable energy becomes more prevalent. Strict reliability criteria are in place requiring grid operators to maintain continuous balance between customers' electricity demand and generation supply. Traditionally, this equilibrium has been secured by fast-responding fossil-fueled generation. Balancing the grid becomes more difficult with the proliferation of renewable energy sources due to their inherent variability. Greenfield generation, transmission, and distribution assets are more difficult to get permitted and financed, especially in populated areas. Using distributed and flexible customer resources becomes increasingly important to provide firming power. Flexible customer resources can provide fast ramping and smoothing capabilities and it is important to examine the barriers to entry present in the current paradigm.

Currently, discussions around water energy nexus focus on energy use at water facilities, primarily energy efficiency and lower overall energy use. Energy audits are being performed around the country that typically results in a list of capital projects aimed at improving efficiency. While load reduction is a commendable step toward achieving a reduced energy footprint at water facilities, much more can be done to achieve a true water-energy symbiosis. For water and wastewater utilities, the amount of flexibility in energy use could be significant.

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It is estimated that each water or wastewater utility has between 0.5 and 3 MW of flexible load and there are 24 of these agencies in San Diego County alone.

The water industry can modulate its energy usage in response to the energy industry's grid requirements by leveraging the excess capacity and inherent operational flexibility in the water assets. Water and wastewater utilities construct facilities to support a 30-year-forward planning horizon resulting in excess capacity that can be used as a form of energy storage. Water conservation has delayed the progress toward full utilization of water assets resulting in even greater available capacity. Water utility operators are currently managing their energy use by reacting to the current time-of-use programs. However, they have the capability to manage water operations on projected or real-time basis, by storing and releasing water or modulating the control of water and wastewater treatment processes. This creates energy storage and firming products through management of processes and discrete devices, resulting in grid-firming services such as single-direction fast ramping (up or down) or modulation in small increments around a predetermined set point, known as area regulation. Water assets are also geographically distributed, offering a unique resource that can be deployed in support of overall or local reliability needs.

In piped water systems, pumps filling reservoirs can speed up or down in response to grid requirements. Where variable drives are not present, a combination of pumps can be turned on and off to achieve a similar effect. In treatment plants, unit processes can be operated over a broader, more flexible range while remaining within process boundary limits and meeting the water quality end objectives. Combined with forecast information this affords significant agility without compromising process quality.

While automation and metering is required, smart instrumentation and controls, such as SCADA, already exist in most water facilities. This can help water and wastewater utilities become distributed energy resources that respond to the grid operator reliability signal. Tying the existing control systems at the water facilities to grid operations through a precise controller is the next step. Full integration with the needs of the grid can be achieved to allow the energy industry to treat water facilities as virtual power plants that can be called upon when required. Unpopular water rate hikes can be mitigated when water utilities leverage their existing investment in capital assets for revenue streams created by providing energy firming services. As the energy supply mix changes, participation by water utilities can become financially significant when providing firming power and flexible energy response that benefits grid reliability.

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