Aggregation of Distributed Water Storage Solutions – Lessons from Energy

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Greenleaf Advisors (www.greenleafadvisors.net) has been engaged with Intelligent Generation (www.intelgen.com) in developing the aggregation of distributed energy solutions and delivering those solutions into the wholesale power markets. While the development of networked energy solutions is still in its infancy, the participants and industry structure and infrastructure are rapidly advancing and there may be useful lessons for the water sector. In this brief white paper we share an elementary understanding of the relevant energy marketplace, and comment on its relationship to potential parallel structures and participants in water sectors.

The supply of electricity is generated by both public utilities and private producers and then distributed via the grid by local utility operators (e.g. Com Ed in the Chicago market). Additional sources of generation are provided behind the meter by local generation (e.g. solar on rooftops) that supplies energy to the adjoining building with excess power going onto the grid (receiving credit via net metering in some places). This can create problems for the grid operator who does not control the supply of this distributed power, leading to destabilization of the grid and the power markets that support it. Smarter solutions are being crafted with energy storage (batteries) and associated control devices (e.g. inverters governed by intelligent software in the clouds where a service aggregator directs the assets use). Allocation decisions for the use of those battery assets are based upon such factors as building load demand, battery storage levels, and energy pricing for retail use as well as wholesale energy services (e.g. frequency regulation for grid stabilizing purposes – here the battery is provisioned to supply or receive energy from the grid, as opposed to putting energy onto the grid).

The energy storage units and associated energy system components (i.e. Battery Management Systems, inverters, and integration software) are rapidly evolving and expanding with the growth of renewable energy supplies (e.g. wind and solar). A network of such storage units has the potential to deliver higher performance and efficiency when governed by an algorithm that optimizes several factors such as battery asset life (battery life decreases with deep cycling) and energy pricing, provisioning stored energy to the grid when not needed for the local building load. A network of storage assets can serve as a 'virtual power plant' when all assets are coordinated for efficient delivery. Intelligent Generation holds the patent to this network application and along with select industry partners (e.g. financiers, electrical engineering and solar installation companies) is developing a service that delivers valuable aggregated energy services (see www.intelgen.com/news).

At an historical fundamental level, the electric and water grids have striking parallels. The flow of electricity once it leaves generation sources occurs over a single, monolithic grid that begins with major trunks (transmission lines) and gradually descales through substations and distribution circuits to the end customer. Similarly, on the "generation" (or Supply) side, potable water is distributed through pumping stations and mains that descale to end use. On the collection side, storm and waste water collection occurs at distributed points that eventually scale to a centralized, unified system of mains and centralized treatment plants. Water's equivalent of energy storage exists as different forms of reservoirs, ranging in size from rain barrels to retention ponds to the Great Lakes. However water storage is often 'offline' in that it is shunted off the grid for later drainage or use. In the analogy to electricity, water has both significant advantages and disadvantages to its electric grid counterpart. One of water's primary advantages is that the capability to store the asset (potable water) and the liability (storm and waste water) exists to varying extents. But inherent in this advantage are two significant challenges. The first is that water, unlike electricity, is not fully fungible. An electron from solar energy is the same as an electron from a nuclear power plant. But a potable water supply is not the same as an untreated storm or waste water supply. The second challenge is that storm-water "generation" is intermittent, like solar and wind energy, not dispatachable, like fossil-fuel or nuclear generated electricity. And while stored rain water may not be potable, it can certainly be used for functions like (urban) agriculture, toilets and thermal cooling. The nature of these two challenges suggest that an evolution towards grid networks integrated with storage solutions can be as applicable to water as they are to electricity.

Parallel apparatus exist that can advance networked distributed solutions in the water sector with existing utility infrastructure and entities (potable, storm and waste water distribution and storage). What is needed is the aggregation of distributed market services to the water utilities via enabling the connection and control of the storage asset when it can benefit the utilities' storage and distribution systems as impacted by other sources and demands. As points of comparison between the energy and water sectors - energy capacity constraint relates to water reservoir constraint, grid stability relates to water conveyance capacity/stability, and building energy load demand relates to property storm retention requirements. These assets can be managed in a fashion that does not disrupt service to customers. For optimization, it requires weather forecasting affecting area flows (energy/water) with forecast of local load demands (electricity/stormwater management needs) and storage levels (battery/cistern levels). A further parallel existing when one considers the energy produced by the solar panel with the local supply of water from rainfall.

Pricing/value lessons: When a property owner takes itself off the electrical grid in whole or in part during peak periods it reduces its retail Demand and Capacity charges from that utility. Those charges are set by the customer's usage during peak demand periods, and the Capacity charges are applied every month based upon the peak five hours of annual usage. This is because the utility has to support a system of generation capacity to meet its highest annual demand, which becomes very expensive if only used for a short period. The storage asset begins to pay for itself by reducing usage during peak periods (~30% reduction in annual retail bill). In addition, the grid operator will pay lucrative wholesale power market fees for access to that battery to stabilize the grid at 60 Hertz frequency; for the most part the utility will put as much flow back onto the battery as it takes off for this frequency regulation service. In the water sector, if utilities applied premiums for storm outflows during large events, they could instill market based solutions with intelligent management of their storage assets.

The electricity Frequency Regulation Market is a Dutch auction with all parties receiving the clearing price for the amount they bid. Similarly, one can envision water storage devices being bid into markets that will peak in anticipation of flood events and those with excess capacity to their local demands will have valuable storage to sell. It will require modeling of the water flows in time and space so that the balancing services can be well-forecast to meet the utilities conveyance and storage requirements building upon today's watershed models.

In the regional electrical grid markets the Regional Transmission Organizations are qualifying new players; Intelligent Generation (IG) became a member of PJM in 2012 and is an emerging Software as a Service aggregator. PJM is the largest grid operator in the world with 60 million customers from Illinois to Maryland. IG is focused on serving assets behind the meter to deliver distributed storage solutions in a network fashion; they hold the patents on this ability. Others are entering the market focused on delivering storage at the utility side to provide wholesale power services (e.g. Dayton Power & Light of AES). The aggregation of distributed energy solutions requires a service delivery platform of intelligent software analytics (e.g. IG), financing, association with a willing network of industry participants (e.g. developers, engineering installers, hardware providers), and willing regional utility participants supported by appropriate authorities. With proper alignment of utility rate structures and private markets, similar participants may emerge in the water sector.

More about distributed energy and wholesale power markets can be found via a range of resources and additional lessons perhaps drawn from the emerging distributed energy sector to inform a more intelligent water sector as well. For more information please contact John Andersen at jandersen@greenleafadvisors.net.