California Independent System Operator Corporation – Eric Schmitt, Vice President Operations

Panel 2:
Integrating Water and Energy Operations, Policy and Planning: Lessons Learned and Remaining Challenges

Background – the current landscape

Of the roughly 14,000 MW of capacity from nearly 400 hydroelectric plants in the state, the CAISO dispatches a little over 60 percent:

Pacific Gas &Electric hydroelectric (about 4,940 MW):
16 Northern California river basins
100+ reservoirs
Includes pumped storage operations at Helms

Southern California Edison hydroelectric (about 1,195 MW):
90% of SCE hydro is from Big Creek project (upper San Joaquin above Fresno)
Includes pumped storage at Eastwood
Other plants near Bishop and on the Kern River
Small hydro in San Bernardino Mountains
SCE also receives energy from Hoover Dam (not included in above total)

San Diego Gas & Electric hydroelectric (about 45 MW):
Lake Hodges 40 MW pumped storage facility
Area plans include developing larger pumped storage

California Department of Water Resources hydroelectric (about 2,300 MW):
Does not include pump-back generation at Castaic dispatched by LADWP.

Hydroelectric power plant types include:

- Larger, dispatchable, reservoir-based power plants and project chains (in series where discharge of one plant is intake for the next) along major rivers.
  - Quick start, flexible response, usually long run times available due to reservoir capacities
- Pumped-back storage facilities (may be combined with other reservoir projects) either on rivers or aqueducts.
  - Provides generation and demand alternatively, can be moderate delay transferring from generation to pump, some have shorter duration runs due to smaller reservoirs
- Run-of-the-river smaller hydro for whatever water is flowing in the river that can be diverted for non-consumptive use (all the water returns to the river).
  - Considered renewable but generally not dispatchable

- Larger projects may also include smaller projects to capture power from water diverted for required deliveries for aqueducts or required fish life releases, etc.
    - Not dispatchable

Dispatchable hydro plants are very responsive and among the most flexible and reliable. This makes hydroelectric generation ideal for use integrating variable energy resources… *PROVIDED* there is adequate water.

California's aqueducts are examples of historic water and energy pairing

California electric and water (aqueduct) operations have been very closely tied. The California Department of Water Resources (CDWR) aqueduct system is a great example of combining the benefits and operating capabilities of water and electric operations. This system has pumping stations necessary to lift water over mountain ranges (and which consume a great deal of energy) as well as substantial amounts of generation that capture the energy in moving water to meet the energy needs of the aqueduct. The system also includes pumped-storage facilities. That means that the aqueduct generally meets its energy needs and, to the degree there is operational flexibility in water operations, that flexibility can be transferred to the electric operations as needed; and vice-versa. Beyond meeting the needs of water operations, generation or pump-load could be dispatched or operated in an emergency to benefit the electric system and energy costs could reflect provision of this flexibility.

Similarly, the Metropolitan Water District aqueduct from the Colorado River into southern California offers operating flexibility in both its pumping and generation.

Hydroelectric generation provides electric operations with flexibility in the form of dispatchable, quick start generation. Pumping and pumped storage provide similar flexibility when that electric demand can be dispatched as needed or triggered to trip off in an emergency without significant impact on the general public, thereby allowing greater transfer capability on existing electric transmission facilities.

Retrofitting older pumps with more efficient and possible expansion of facilities to handle higher capacities would enhance the potential benefits to both electric and water operations.

Drought impacts

A drought impacts hydroelectric facilities less than consumptive uses ("drinking" water, agricultural, commercial and industrial). This is because except for the temporary storage in reservoirs prior to use, hydroelectric generation does not consume water, but only passes it through. And if reservoirs have adequate water available, the impact to power generation may be minimal. But to the degree there is less water available overall combined with less storage in reservoirs (such as during a prolonged drought over several years), there would be less water available to generate electricity. Because of this, moderate droughts or droughts of shorter duration do not significantly impact power production. But very serious droughts and especially droughts lasting more than two successive years can have greater impacts on hydroelectric generation.

Thermal power plants also use water (*i.e.*, either fresh or reclaimed[1]) for plant processes including cooling and emissions control. If there were a very serious drought over several years that affected not only rivers and reservoirs but also ground water, even thermal plants could be impacted.

This year's drought (combined with last year's) is very serious and is having an impact on the overall amount of energy provided by hydroelectric facilities. There is a reduction of energy available from hydro generation but not a complete loss[2]. Although serious, the drought has not been so severe as to impact thermal plants. Given the amount of energy produced by hydroelectric facilities as compared to what is normally produced by other sources in California, the current drought is not causing system-wide reliability issues on the CAISO-controlled grid.

Other resources are available to make up for the losses of hydroelectric generation due to the drought. So, this year's drought is not as threatening for the power system as it is for agriculture and other uses. This underscores the value of having other generation available when hydroelectric resources are impacted by drought. And it's better yet if that other generation is efficient and operationally flexible.

Statewide drought planning has included:

- Close participation with state energy agencies and the State Water Resources Control Board as a subgroup to the Governor's Drought Task Force
- Outreach to generation plants to assure consideration of drought impacts on operations
- Extreme scenario planning with higher than expected demand, higher generator outages, higher de-rates from hydro resources and lower imported power to assure reliability

Water-Energy Nexus lessons learned applied to current and future needs

<u>Key take-away:</u>

Increasing operational flexibility through integrated planning and operational strategies has served both electric and water systems well and should be especially maximized in the future as the need for flexibility increases.

- Water projects that include operational flexibility can also provide electric system flexibility to the advantage of both. Even small municipal water systems may be able to provide some flexibility in their time-of-use for energy and benefit either from market mechanisms or rate restructuring that includes incentives based on

[1] Does not include ocean water used for cooling at coastal "once through cooling" plants
[2] The California ISO 2014 Summer Assessment provides a scenario for a drought-based reduction of approximately 22% to the hydroelectric peak output available for use during summer 2014.

time-of-use. This would provide electric system flexibility and greater cost efficiencies for both parties.

- Projects that expand existing capacities of aqueducts have the potential to benefit both electric and water operations.

- Using less water saves energy… In the U.S., one estimate is that the energy used to pump, heat, chill, treat and pressurize water was about 8 percent of total energy used nationally. Projects that save water also save energy.

- Using water before energy can be produced misses an opportunity (such as agricultural diversions upstream of a hydroelectric project).

- Reclaimed water systems have potential of saving energy and providing operational flexibility that benefit both water and electric operations. Reclaimed water is the least energy intensive.

- Similarly, greater use of localized gray water systems for irrigation save water and energy and expanding stimulus for after-market installations benefit both systems.

- Water storage facilities enable greater use of off peak pumping with corresponding energy and cost savings, and electric flexibility increases.

- Water treatment facilities may be ideal locations for renewable energy, especially solar. Additionally, these facilities may be able to provide some load shifting to provide some flexibility. (Note: Otay treatment facility is an example in San Diego that has a 0.945 MW solar installation.)

- Waste water treatment facilities may similarly provide energy opportunities, including methane power recovery installations and time-of use-operations.

- Projects such as desalination plants[3] that were too costly based only on water supply reliability may be more feasible if designed to provide energy benefits, which are factored in to the overall cost (*e.g.*, the reduced amount of energy to transport water from longer distances in lieu of producing water locally near users). Designs that enable flexible operations and local product storage to maximize time-of-use opportunities add to the operational flexibility. And further benefit could be obtained from installing solar generation at available space as feasible. Desalination is the most energy intensive source of water.

[3] A new desalination plant at Carlsbad is scheduled to be completed in 2016. 15 desalinization projects are proposed along the California Coast from Los Angeles to San Francisco Bay.

- Increasing combined planning efforts for electric and water system infrastructure development and subsequent operations may yield initial and ongoing efficiencies and operational flexibility.

<u>The Duck Chart</u>

This chart shows the forecasted need for flexibility in operations as variable energy such as solar and wind resources are increasingly available. The chart shows the net demand remaining to be served by conventional resources after the demand being served by solar and wind resources have been "netted" out. It is clear that a combination of flexible energy resources (like hydroelectric generation) and responsive demand (able to vary the amount and timing of energy use) will be needed to "flatten" this curve.