Project Nexus, Water and Energy Integration for the Future

By John Benson

April, 2022

1. Introduction

It's impossible. How do a take a state with a land area of 163,696 square miles, most of which is covered by mountains, deserts and large metropolitan areas, 2/3rds of the remaining area is incredibly arid with frequent droughts, and turn it into the most productive agricultural state in the Union? Then take the man-made resource that made this happen, make it more efficient. Oh yes, and also make it generate 13 gigawatts of renewable power. Your hints are the pictures below:

And this is not a blue-sky idea by some dreamer. A major state agency has funded a pilot and the pilot will be hosted by a large water/irrigation and power utility. A large California University is supporting this project.

2. The Concept

A new study published in the journal Nature Sustainability reports that covering the 4,000 miles of California's open canals with solar panels could reduce evaporation and save upwards of 63 billion gallons of water annually, while providing approximately 13 gigawatts of renewable power for the state.[1]

The study, conducted by researchers from the University of California, Merced and UC Santa Cruz, explored the interconnected nature and costs of moving water across the state – the water/energy nexus. It revealed that there are numerous compounding advantages to be gained by mounting solar panels over open water canals when compared to conventional ground-mounted solar systems, including added efficiency resulting from a shading/ cooling effect.

"We were surprised by the significant evaporation savings, which we project to be as much as 82%," said Dr. Brandi McKuin, report lead author. "That amount of water can make a significant difference in water-short regions." Because the solar panels shade the canals from direct sunlight, McKuin added, they can not only mitigate evaporation but also curtail the growth of aquatic weeds and reduce maintenance costs, while the evaporation that does occur actually cools the panels, thereby increasing their efficiency in converting sunlight to electricity.

[1] Solar aquagrid, https://solaraquagrid.com/

The study estimates that, for California, the resulting annual savings in maintenance costs could be as much as $40,000 per mile of canal. In addition, the retirement of old diesel pumps and generators in favor of solar arrays would contribute to cleaner air in California's Central Valley, which suffers from among the worst air quality in the nation. Report co-author Roger Bales, Distinguished Professor of Engineering at UC Merced, comments "What is most compelling about this study is when you tally up the multiple benefits. Solar over canals represents the sort of shift in thinking that California and the world need as we transition our economy and infrastructure to a fossil-free, sustainable future." The analysis shows that adding solar coverings above canals that run across 'already disturbed land' means developers can avoid protracted environmental permitting and right-of-way issues so systems can be deployed more quickly and cost effectively.

3. The Pilot

At its February 8, 2022 board meeting, Turlock Irrigation District (TID) announced Project Nexus, a pilot project to build solar panel canopies over a portion of TID's existing canals to operate and research a truly innovative, multi-benefit, water-energy nexus project that can further California's push toward water and climate resiliency.[2]

Project Nexus, a public-private-academic partnership among TID, the Department of Water Resources (DWR), Solar AquaGrid, and the University of California, Merced, could contribute to a more water resilient future for California and position the State to meet its ambitious clean energy goals. The first ever solar panel over canal development in the United States, the Project will assess reduction of water evaporation resulting from mid-day shade and wind mitigation; improvements to water quality through reduced vegetative growth; reduction in canal maintenance through reduced vegetative growth; and generation of renewable electricity.

Groundbreaking on Project Nexus is scheduled for this fall, with project completion expected in 2024 at multiple locations throughout the TID service territory in California's Central Valley. The project will use existing TID infrastructure on already-disturbed land to keep costs low and efficiency high while supporting the region's sustainable farming tradition. Additionally, energy storage will be installed to study how storage facilities can support the local electric grid when solar generation is suboptimal due to cloud cover. The $20 million project is funded by the state of California.

4. The Team

4.1. TID

Turlock Irrigation District (TID) was an old customer of mine in my Landis & Gyr Systems days. Turlock is a city of about 75,000 about 50 miles east of San Jose. This city is in Stanislaus County in the California Central Valley.

Established in 1887, the Turlock Irrigation District (TID) was the first irrigation district in the state. Today it is one of only four in California that also provides electric retail energy directly to homes, farms, and businesses. Organized under the Wright Act, the District

[2] TID Press Release, "Turlock Irrigation District selected to pilot first-in-the-nation water-energy nexus project involving solar panels over canals," Feb 9, 2022, https://www.tid.org/wp-content/uploads/2022/02/TID-ProjectNexus-PressRelease_final.pdf

operates under the provisions of the California Water Code as a special district. TID is governed by a five-member, locally-elected Board of Directors.[3]

TID delivers irrigation water through over 250 miles of a gravity-fed canal system that irrigates approximately 150,000 acres of farmland. In addition, TID owns and operates an integrated and diverse electric generation, transmission and distribution system that serves more than 103,000 customer accounts within a 662 square-mile area. TID is one of seven Balancing Authorities in California and operates independently within the Western United States power grid. A Balancing Authority performs a balancing function in which customers' usage and resources are matched on a moment-by-moment basis.

4.2. DWR

DWR manages California's water resources, systems, and infrastructure, including the State Water Project (SWP, see below), in a responsible, sustainable way.[4]

Our responsibilities and duties include:

- *Preventing and responding to floods, droughts, and catastrophic events*
- *Informing and educating the public on water issues*
- *Developing scientific solutions*
- *Restoring habitats*
- *Planning for future water needs, climate change impacts, and flood protection*
- *Constructing and maintaining facilities*
- *Generating power*
- *Ensuring public safety*
- *Providing recreational opportunities*

***The California State Water Project (SWP)** is a multi-purpose water storage and delivery system that extends more than 705 miles -- two-thirds the length of California. A collection of canals, pipelines, reservoirs, and hydroelectric power facilities delivers clean water to 27 million Californians, 750,000 acres of farmland, and businesses throughout our state.*

Planned, built, operated and maintained by DWR, the SWP is the nation's largest state-owned water and power generator and user-financed water system. The project is considered an engineering marvel that has helped fuel California's population boom and economic prosperity since its initial construction.

For the last 20 years, the California State Water Project's average water is 34 percent for agricultural and 66 percent for residential, municipal, and industrial.

4.3. UC Merced

UC Merced opened Sept. 5, 2005, as the newest campus in the University of California system and the first American research university of the 21st century. Situated near Yosemite National Park, the campus significantly expands access to the UC system for

[3] TID Quick Reference Guide, https://www.tid.org/news-and-resources/publications/quick-reference-guides/
[4] California Department of Water Resources, What We Do, https://water.ca.gov/What-We-Do

students throughout the state, with a special mission to increase college-going rates among students in the San Joaquin Valley. It also serves as a major base of advanced research, a model of sustainable design and construction, and a stimulus to economic growth and diversification throughout the region. As of the 2019-20 academic year, UC Merced had more than 8,800 undergraduate and graduate students.[5]

4.4. Solar Aquagrid

Solar AquaGrid LLC is a project development, engineering and design group based in Marin County, California. The firm is dedicated to accelerating adoption of innovative solutions to address our water/energy nexus and is currently guiding development of pilot projects to provide large-scale solar shading over canals across the American West.[1]

5. The Study

Covering the 4,000 miles of California's water canals could save billions of gallons of water and generate renewable power for the state every year, according to a new study.[6]

The study was published in the journal Nature Sustainability. Professors Roger Bales, Joshua Viers and Tapan Pathak authored the paper with researchers Andrew Zumkehr, Jenny Ta and Elliot Campbell in collaboration with UC Water and postdoctoral researcher Brandi McKuin of UC Santa Cruz, an alumna of UC Merced.

The research explores the interconnected nature and costs of moving water across the state. It tested the thesis that by erecting a modular system of solar shading panels over California's exposed aqueducts, the state can reduce evaporative water loss and provide a variety of benefits when compared to conventional ground-mounted solar systems. The Solar AquaGrid study was underwritten by NRG Energy, with development support from the Bay Area agency Citizen Group.

Results show a savings of 63 billion gallons of water annually, which is comparable to the amount needed to irrigate 50,000 acres of farmland or meet the residential water needs of more than 2 million people. And the 13 gigawatts of solar power the solar panels would generate each year would equal about one sixth of the state's current installed capacity — roughly half the projected new capacity needed by 2030 to meet the state's greenhouse gas emission-reduction goals.

[5] About UC Merced, https://www.ucmerced.edu/about
[6] McKuin, Brandi L, Zumkehr, Andrew, Ta, Jenny, et al., "Energy and water co-benefits from covering canals with solar panels," 2021, https://escholarship.org/content/qt8cj5j07p/qt8cj5j07p.pdf