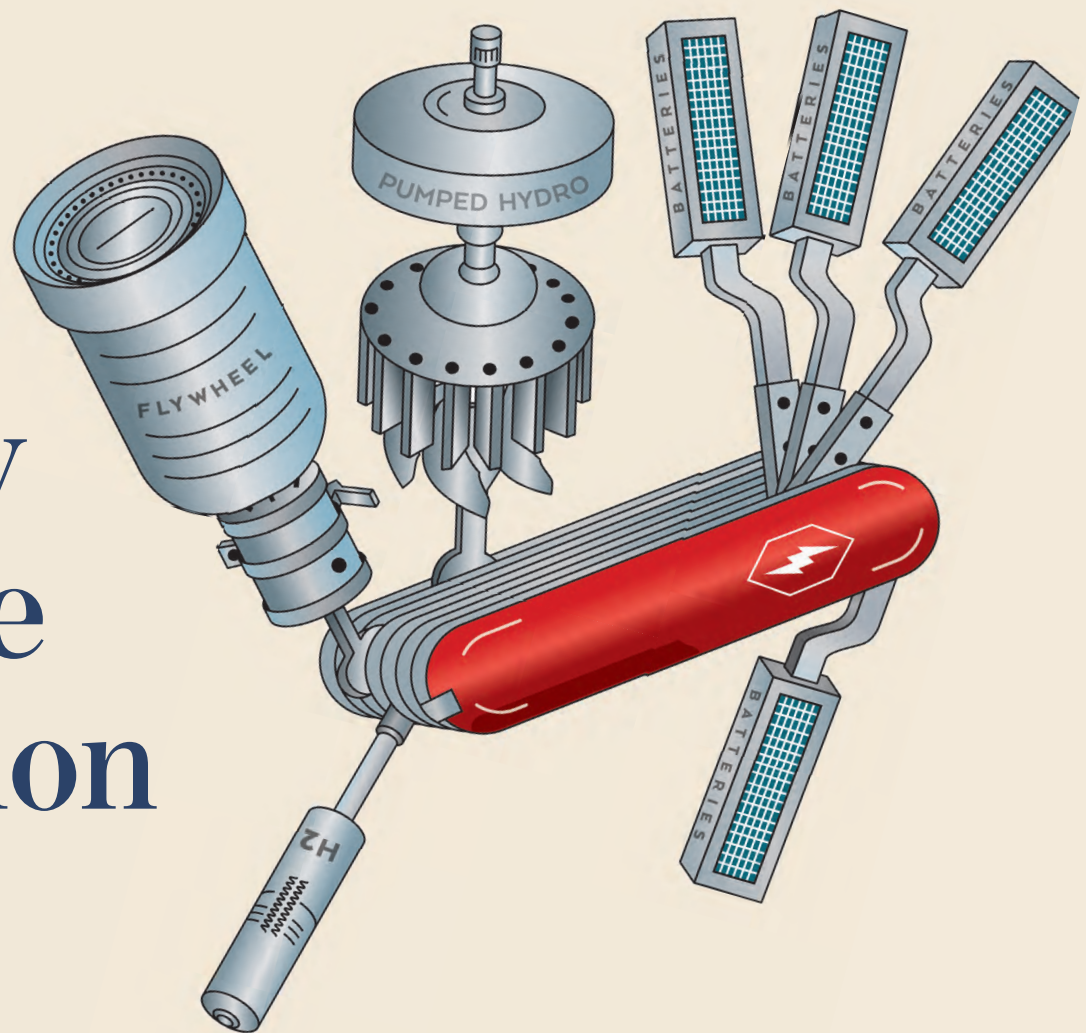


# CALIFORNIA Water & Power

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## Energy Storage Evolution

No one size fits all



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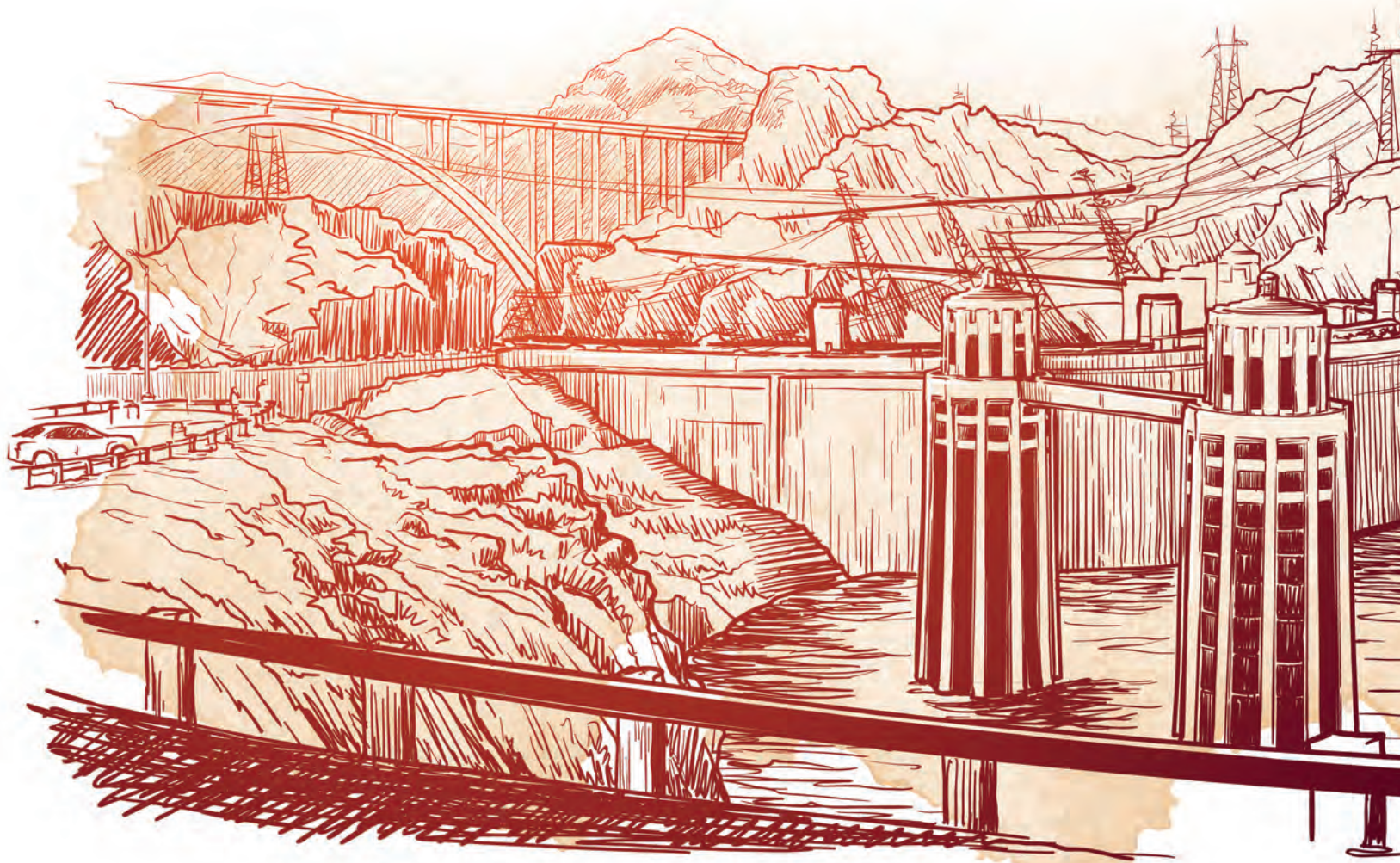
# Energy Storage Evolution

*By John Egan*

**POU leaders weigh costs, benefits and performance**

**S**ome experts have called energy storage a versatile “Swiss Army knife” group of technologies that could help California efficiently use more carbon-free energy while continuing to maintain a high level of reliability for customers. Like the many tools that splay from a utility knife, energy storage projects come in many shapes and sizes, with varying price tags and operational tradeoffs.

In the Golden State, battery energy storage systems have garnered the lion's share of funding, managerial attention and media coverage, although there are other types of viable storage systems, too.





CMUA spoke with five executives from publicly owned utilities in California to hear what they're thinking about the technology, costs, safety issues and other topics relating to energy storage systems—battery systems in particular. While recognizing there are many potential benefits of utility-scale energy storage systems, several leaders also flagged potential concerns, such as permitting, end-of-life disposal and scant operational history.

In the rapidly evolving market for energy storage, many POU leaders are moving forward but proceeding cautiously with a posture similar to the adage *trust but verify*. Nico Procos, general manager of Alameda Municipal Power, acknowledges utilities tend to be risk-averse.

"We want to be sure something will work before we sign on," Procos said.

Steve Zurn, general manager for Glendale Water & Power, has a similarly guarded attitude.

"I'm trying to be practical and pragmatic," Zurn explained. "Let's say I'm a centrist leaning toward enthusiasm."

### Costs are still high

Battery storage costs have decreased by about 50 percent the past few years. A recent report from the Electric Power Research Institute predicted battery energy storage could be cost effective by 2021 or 2022.

Nevertheless, echoing the concerns of several other executives, Procos noted the price of battery energy storage projects is still too high.

"I'm supportive of new technologies," Procos said. "The price for battery energy storage is not there yet, though it is moving in the right direction."

In 2018, Alameda investigated standalone solar generation and a solar-plus-storage hybrid package as part of a process managed by the Northern California Power Agency. For Alameda, 2.5 megawatts of solar generation penciled out at an affordable and competitive \$72 per megawatt-hour over 20 years. When that same amount of solar generation was paired with battery storage, the cost ballooned to between \$172 to \$259 per MWh. Alameda committed to the next step with standalone solar generation and decided to wait to add storage.

Because front-of-the-meter battery storage is not expected to be cost effective for several more years, SMUD is initially focusing on storage behind the meter, at a customer's premise, with an eye on more options in the future, said Paul Lau, SMUD's chief of grid strategy and operations.

Anton Tokarev / Dreamstime

*The Los Angeles Department of Water & Power has a bold plan to potentially convert the Hoover Dam into a massive pumped storage facility, essentially making the upper reservoir at Hoover Dam a giant battery.*

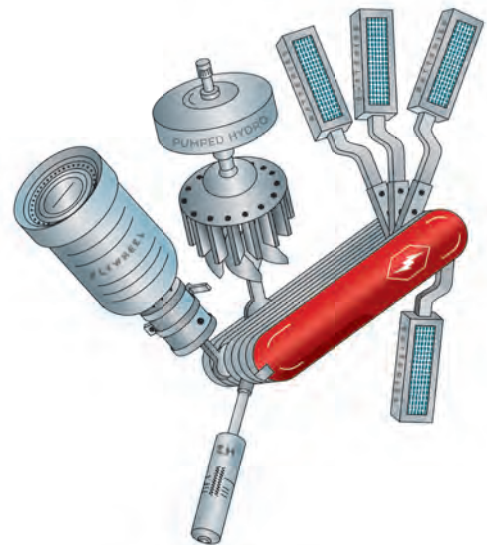


Illustration by David Miller

*Like the many tools that splay from a Swiss Army knife, energy storage projects come in many shapes and size.*

### The energy-water nexus is a factor

Water and electric issues continue to be deeply intertwined in California. The water industry consumes about 20 percent of the state's electricity. Hydropower generates a sizable percentage of the state's electricity. Water and power utilities face distinct but interrelated challenges.

Irvine Ranch Water District partnered with Southern California Edison and Advanced Microgrid Solutions to install a total of 6.25 MW of lithium-ion batteries at six of the water district's facilities. Approximately half the batteries are operating. The remaining were scheduled to be activated by year-end 2018.

IRWD, which serves about 400,000 customers across 180 square miles in Orange County, will shave about \$500,000 off its annual \$14 million electric bill by using the batteries, explained Paul Cook, the water district's general manager.

"That's a healthy chunk of change," Cook said.

The water district's peak electric demand is 26 MW. It used about 116 MWh of electricity in 2017.

SCE will use the batteries





**“AS LARGE USERS, WATER UTILITIES HAVE A ROLE TO PLAY IN MEETING THESE MANDATES. STORAGE COULD HELP FIX THE STATE’S ‘DUCK CURVE’ PROBLEM AND CURTAIL NEGATIVE PRICING FOR RENEWABLES.”**

**—IRVINE RANCH WATER DISTRICT  
GENERAL MANAGER PAUL COOK**

installed by AMS to reduce its peak load during the day. The batteries are charged at night and used during peak demand periods to relieve stress on the grid.

“Achieving the mandate of 100 percent carbon-free electricity and greenhouse-gas reductions will fall on all utilities as well as their customers,” Cook said. “As large users, water utilities have a role to play in meeting these mandates. Storage could help fix the state’s ‘duck curve’ problem and curtail negative pricing for renewables.”

### **Safety is an ongoing concern**

As companies tinker with battery chemistry to improve density and performance, there could be an impact on safety. Several executives noted the buildup of highly flammable hydrogen gas in lithium ion batteries is a particular concern. Hydrogen-fueled fires burn so hot that some fire departments let the fire burn out rather than try to extinguish it.

“Safety is critical,” said Reiko Kerr, senior assistant general manager of power systems at the Los Angeles Department of Water & Power, regarding battery energy storage. “There is a backfeed potential during outages when storage is paired with other distributed energy resources. Battery storage manufacturers continue to tweak the software, but our employees’ safety is critical.”

Several sources also noted that lithium ion batteries, which contain cobalt or other rare-earth minerals, can create toxic waste. And what do you do when the batteries are

depleted, typically within 10 years?

“You can’t just throw them into a landfill,” Kerr noted. “I am confident that a process will be worked out, but for now that standard simply doesn’t exist.”

Janice Lin, executive director of the California Energy Storage Alliance said there are recycling programs in place, particularly for lithium ion batteries that are specific to each manufacturer. For utility-scale projects, the end-of-life disposal typically is built into a project’s total cost, she said.

### **Operations must be seamless**

As with any new technology, electric utilities and water agencies must continue to deliver exceptional reliability.

“We provide a vital service and we are unwilling to accept tradeoffs involving lower reliability,” Irvine Ranch’s Cook said. “Operationally, if there is a problem (with the batteries), we want to know how fast we could switch back to grid power.”

The utility invested in its electric infrastructure to integrate the batteries and isolate them if there is a need to work on the system.

“We were particularly concerned over potential safety and lockout issues,” Cook said.

Working with SCE and AMS, a solution was found.

In a separate project, LADWP brought online in October one of the state’s largest battery-storage projects at its Beacon site. Built by Doosan GridTech, the 20 MW/25 MVA/10 MWh lithium-ion system

### **BATTERIES NOT THE ONLY OPTION**

The term “energy storage” often seems synonymous with batteries. This is because lithium ion batteries account for at least 90 percent of the energy storage market—according to new research from Massachusetts Institute of Technology—are used widely in consumer electronics and have come down in cost. Batteries, however, are but one of many energy storage options. Other technologies include:

- **Hydrogen.** Electricity can be used to split water molecules to create hydrogen, which can be stored and used later to produce electricity.

- **Flywheel.** A mechanical form of storage in which electricity is used to spin a mass around an axis that is connected to a generator.

- **Compressed air.** Uses excess electricity or electricity at times of low demand to compress air, which is stored and can later be released to spin generating turbines to create electricity.

- **Pumped-hydro.** Uses electricity to move water from a lower reservoir into an upper reservoir. The stored water can later be released through generating turbines to produce electricity at times when the value of the energy is high.

connects to a dedicated 34.5-kV breaker in the Beacon Collector Station.

In addition to stabilizing local photovoltaic generation, the direct connection to the substation allows LADWP’s grid operations to manage the Beacon Energy Storage System in accordance with daily needs of the grid.

The \$19 million Beacon Energy Storage System is LADWP’s first utility-scale battery energy storage project, installed alongside new solar photovoltaic power plants totaling 570 MW in the Mojave Desert, about 230 miles northeast of downtown Los Angeles. LADWP is contracting for an additional 490 MW of solar PV in the immediate area.





IRVINE RANCH WATER DISTRICT

*Irvine Ranch Water District partnered with Southern California Edison and Advanced Microgrid Solutions to install 6.25 megawatts of lithium-ion batteries at six of the water district's facilities.*

LADWP's Kerr recalled that shortly after Christmas 2016, the sun disappeared and it rained for a week around Los Angeles, depriving the utility of about 1,300 MW of daily solar generation. Executives are mindful the utility should provide reliable and low-cost electric power in an environmentally responsible manner. LADWP is committed to have a plan in place for scenarios when the sun doesn't shine and the wind doesn't blow for an extended period of time.

"It always comes down to an operator's confidence that electricity from batteries will be there when it's needed," Glendale's Zurn said. "With a gas turbine, you know you can have power flowing so many minutes after you flip the switch. There's a solid track record of performance. Batteries are not there yet."

Although energy storage is a newer

technology, Lin noted that grid-scale projects are performing as expected, or even exceeding expectations.

"A battery system may not have the same longevity as a pumped-hydro system, but the economics should be baked into the project lifecycle," Lin added. "When these [energy] projects are sold, they have performance warranties from credible companies. Like components from any power plant, they need to be replaced and maintained over time."

#### **New targets are driving adoption of energy storage**

New California laws, which include setting the goal to reach 100 percent carbon-free power by 2045, encourage utilities to take a closer look at battery energy storage projects.

Regulators have pushed for more storage for years. A 2013 decision by the California Public Utilities

Commission (CPUC) directing investor-owned utilities to procure or install 1,325 MW of cost-effective energy storage by 2020 doesn't directly affect California POU's, but it has a significant impact on the state's market for battery storage. Lin said that after recent moves in November 2018, the CPUC has approved more than 1,500 MW of energy storage capacity in California—about half of that is already installed.

The CPUC has eased the way for deployment of more storage by offering up to \$423 million in self-generation incentives for energy storage projects. That has accelerated the industry's march toward a future where energy storage projects are more than a novelty.

Operational changes in the state's power business play a critical role in the deployment of energy storage systems. The closure of the San

Onofre nuclear power plant and the planned closure of the Diablo Canyon nuclear facility mean nuclear soon will be out of the picture. Similarly, the leak at the Aliso Canyon natural gas storage facility in 2015-2016 created concern about the state's ability to reliably supply fuel for its gas-fired generation.

California POU's can select from a variety of energy-storage technologies in the market, ranging from pumped-hydro storage to flywheels to compressed air to batteries. Right now, battery energy storage has captured much of the interest and investment, although LADWP has discussed a plan to turn the Hoover Dam into a \$3 billion pumped-hydro storage project—see sidebars “Batteries Not the Only Option” and “Pumped-Hydro Storage Projects.”

### A measured march forward

Although there is no shortage of concerns about energy storage among the POU leaders CMUA interviewed, there also was unanimity that storage will play an indispensable role in meeting the 100 percent carbon-free requirements of California's Senate Bill 100.

Storage can offset the intermittency of renewable resources such as solar and wind. Storage also could help lower the peak in the state's “duck curve.” How the batteries are recharged—with gas power or renewables—will determine if storage reduces or increases greenhouse gas emissions from the power sector.

There are clear indicators that energy storage is of growing interest to California POU's. Glendale Water & Power, for example, is investigating options to repower its Grayson power plant, an aging gas-fired facility. Most of the units at Grayson were built between 40 and 77 years ago.

“There are a lot of uncertainties about the future of Grayson, but I can say storage is a virtual certainty,” Zurn said.

In a mid-2018 request for proposals issued by GWP for options at Grayson, energy storage projects were the largest single category of bids submitted.

## PUMPED-HYDRO STORAGE PROJECTS

With a decarbonizing electricity business and the West perennially coping with drought, pumped-storage projects would seem to be the ideal win-win solution. Carbon-free electricity is generated by water from an upper reservoir falling on a turbine. Water is then pumped from the lower reservoir back to the upper reservoir chiefly using renewable power to be used again and again.

Federal legislation signed in October may provide a boost to pumped-storage projects under development by lengthening the duration of preliminary permits issued by the Federal Energy Regulatory Commission. The new law, named the Water Resources Development Act, extended the duration of a FERC preliminary permit for pumped-storage projects to four years.

Pumped-storage facilities, which have operated in the U.S. for nearly a century, are the original energy storage projects, said Reiko Kerr, senior assistant GM of power systems at Los Angeles Department of Water & Power. There is more than 22,000 MW of pumped storage generation across the U.S., according to the National Hydropower Association. But few new projects have been built in recent years.

Uncertainties about electric load and the high cost of pumped storage projects work against large pumped-storage projects, Kerr noted.

LADWP has a bold plan to potentially convert the Hoover Dam into a giant pumped storage facility. The project, with a preliminary estimate of \$3 billion, would turn Lake Mead, the upper reservoir at

Hoover Dam, into a giant battery.

A proposed water pipeline and pump station would be powered by solar and wind energy. The water, which runs once through the turbines at the dam, would be pumped back to Lake Mead, where it could generate more electricity. Key to the project's success would be no negative impacts to current operations of the dam.

Separately, the San Diego County Water Authority in late October received a preliminary permit from FERC for a 500 MW, \$1.5 billion pumped storage project about 20 miles northeast of downtown San Diego, said Gary Bousquet, a senior engineering manager at SDCWA.

If a contract can be reached with a developer, hopefully by late 2019, construction could start around 2026, and the facility could be operating by 2030. The project has been under development for about a decade.

“We're still in the very early study stage with the San Vicente Energy Storage Facility,” Bousquet said. “But it's clear that increased use of intermittent resources means you need to do something to store that energy for when the sun doesn't shine and the wind doesn't blow.”

With regular maintenance, pumped storage projects can operate for 80 to 100 years—an important advantage over battery storage projects, where the batteries have to be replaced every 10 years or so.

Another proposal in California—the Eagle Mountain Hydroelectric Pumped Storage Project—has been under development for 25 years and remains unlicensed. This \$2.6 billion, 1,300-MW project is scheduled to be built by NextEra in east Riverside County near the Joshua Tree National Park.

Energy storage is a game changer for the power sector in many ways, said Lin, who lauded the technology's ability to make all other energy resources run more efficiently, and consequently make significant cost savings possible.

“Its flexibility and modularity gives you a new tool in the toolkit, especially for local resource adequacy, and the ability to ‘island’ portions of the grid if you need to, in instances where you need to shut

down the grid when it's very windy,” said Lin.

Speaking about storage, Alameda's Procos said, “It's always good to have another tool in the toolbox, but these need to be viable options. I think it's a little unwise to count on batteries to solve all the problems we will face.”

LADWP's Kerr spoke for many POU's when she said, “We want to be a fast follower, not a first adopter. The devil's always in the details.” **CWP**