



DEEP DIVE

Getting to 100% zero emissions in California: Beyond CAISO's eight-solution menu

The state's IOUs are on track for 50% renewables by 2020, but the goal is 100% clean energy by 2045 and there are still unanswered questions on how to reach it.

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The path to 100% emissions-free energy by 2045 in California is not completely carved, and answers are still forthcoming.

Most of the state's load serving entities (LSEs) required to meet the SB 100 mandate of 60% renewables by 2030 have met their 2017 interim requirement of 27%, according to the California Public Utilities Commission's (CPUC) latest annual RPS report. California's three dominant investor-owned utilities (IOUs) have reached 33% renewables and are on track for 50% by 2020.

But reaching the 2045 zero emissions goal — also part of SB 100 — will require a wide range of changes, including reducing reliance on natural gas in the power sector and on gasoline-fueled vehicles in the transportation sector.

California's grid operator has not taken on the 100% emissions-free goal yet because the CPUC's integrated resource planning (IRP) process "has not reviewed the implementation of SB 100," California Independent System Operator (CAISO) spokesperson

Anne Gonzalez told Utility Dive. A "preferred system plan" is expected some time in the first quarter of 2019.

The CPUC's IRP process has not addressed technical needs for 60% renewables, but has studied "amounts near 57%, which gets us close," Gonzalez said. CAISO has an eight-solution menu for meeting the "current and future renewable energy goals" that includes more distributed energy resources (DER) and demand response, time-of-use rates, transportation electrification and a regional grid.

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Arne Olsen
Senior Partner, E3

Zero emission ambitions

One set of potential answers for moving toward California's zero-emission ambitions can be found in ten scenarios described in an Energy and Environmental Economics (E3) paper prepared for the California Energy Commission (CEC). The scenarios include high levels of energy efficiency, renewables and transportation electrification, but vary on biofuels and building electrification.

The E3 paper was commissioned by the CEC before SB 100 was passed. Its scenarios represent initial and not complete or final assessments of what may be needed for a 100% zero emissions economy.

"Simulations show up to 90% of California's power can come from a combination of wind, solar, batteries and geothermal," E3 Senior Partner Arne Olsen told Utility Dive. "Beyond 90%, it gets

difficult and expensive."

The E3 paper's "four pillars" of deep, economy-wide decarbonization provide some, though incomplete, clarity on what will be needed. Echoing and expanding on items in CAISO's menu of solutions, they call for economy-wide electrification with renewable generation and energy efficiency, moving to low-carbon — eventually zero-carbon — fuels, and eliminating non-combustion emissions from soils and forests, manufacturing, and livestock agriculture.

There is widespread agreement that all these elements must be addressed to achieve the 100% zero emissions economy foreseen by SB 100. And power system consultant Lorenzo Kristov, who has led efforts at CAISO, the CEC and Rocky Mountain Institute (RMI) to integrate higher levels of renewables and distributed generation, said there is another facet few others have considered: how system architecture can optimize coordination of the transmission and distribution systems.

The big picture

CAISO has been studying management of high renewables penetration for a decade and implementing solutions to cope with overgeneration, according to a 2017 presentation by Renewables Integration VP Mark Rothleder.

California's power industry is being transformed by its renewables objectives, according to Rothleder. The state has an installed wind capacity of 6,087 MW, an installed utility-scale solar capacity of almost 10,000 MW and an estimated 5,000-plus MW of behind-the-meter solar capacity.

CAISO expects an estimated 4,000 MW of new grid-connected renewables by 2020 along with potentially 4,000 MW of behind-the-meter solar. Another 10,000 MW to 15,000 MW of

renewables is likely by 2030, Rothleder reported. This growth in zero-emission resources could make achieving the SB 100 goals easier if CAISO can maintain a reliable system.

But the impact of the Duck Curve, caused by midday solar overgeneration that fades just as peak electricity demand rises, is worsening. The size and speed of today's ramp are what was originally expected in the early 2020s. But the fossil fuel peaker plants used now to cope with this must be eliminated to reach SB 100 goals.

CAISO sees the challenge as an opportunity to integrate zero-emission resources through advanced grid management solutions, according to Rothleder. Price signals and rate design can minimize overgeneration, and demand response and battery storage can flatten the peak. Better operational tools, better forecasting and a regional market can use zero-emissions generation more efficiently.

The E3 study confirms the importance of the CAISO solutions to reaching the 100% zero-emissions by 2045 goal, but offers a higher-level view. Its broad emissions mitigation scenarios model combinations of emissions reduction strategies and assess key technologies, including 'reach' technologies, like advanced biofuels and electric heavy duty vehicles, which are "not widely commercialized" but could mitigate emissions "currently difficult to address."

Getting to the needed deep and economy-wide decarbonization will require scaling up technologies now in the market like energy efficiency and renewables, and aggressively pursuing "at least one 'reach' technology," according to E3.

E3's most important contribution to the discussion of reaching 100% zero emissions may be its questions about costs and risks. Market transformation will come from higher carbon prices in

California's cap and trade and low-carbon fuel standard programs that increase costs to customers. Incentives and policy can lower those costs, but if the prices are too low, they may fail to spur the needed transformations.

The report focuses on a "High Electrification" scenario that is "lower-cost, lower-risk" than other scenarios but still includes the needed high levels of energy efficiency, renewables-generated power for building and transportation electrification as well as some biomethane delivered through existing natural gas pipelines. But it faces "implementation challenges" due to costs that could compromise consumer acceptance, E3 said.

Consumers face "significant" upfront costs from adopting new technologies that could challenge the appeal of long-term or societal savings, the report adds. This makes individual decisions, like whether to buy solar panels or an EV, the "pivotal" factor in California's effort.

Electrification of the rest

"There are many ways to get California to 60% renewables and deep decarbonization, but the first one is a more diverse energy mix with something besides more solar," PaulosAnalysis Principal Ben Paulos told Utility Dive.

Geothermal, biopower and out-of-state wind are suitable because they have different generation profiles and will not add to renewables overgeneration, he said. Their costs are higher than the utility-scale solar and wind now dominating least-cost, best-fit renewables solicitations, "but integration will cost less because batteries to integrate low-cost solar are still expensive."

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produce the cheapest, cleanest, most reliable resource mix."

Ben Paulos

Principal, PaulosAnalysis

Targeted energy efficiency is an under-recognized solution, Paulos added. "It is already the least-cost option and targeting it to reduce the evening demand peak would make it even more valuable."

The goal of energy policy is "to create competition between technologies on as level a playing field as possible and to be open to solutions," he said. "Regulators and policymakers should allow interchangeable technologies to compete to produce the cheapest, cleanest, most reliable resource mix."

Transportation electrification will also be essential to meeting SB 100's 2045 goal because a zero-emissions grid will replace fossil fuel emissions-generating gasoline-powered vehicles, Hewlett Foundation Environmental Program Officer Anand Gopal told Utility Dive. Doing so will require "something like 10 million ZEVs on the road by 2030," said Gopal, who coauthored a report on the future of EVs in California. Currently, the state has a 1.5 million zero emission vehicles (ZEVs) by 2025 and 5 million by 2030 goal.

The rapidly falling price of batteries is driving adequate market growth, but any policy that targets 10 million ZEVs "means more significant new loads on the grid," which "would likely cluster at certain times of the day."

To accommodate the EV charging spikes, more storage would be needed and upgrades to the distribution system would be necessary as well, he said.

Gopal expects EV driver response to smart charging programs and rates to eliminate "only 10% to 15% of the stationary storage needed."

The current 1.3 GW California storage mandate could support the 60% renewables by 2030 mandate, but adding 5 million ZEVs would require another 200 MW of storage, Gopal estimated. The load from 10 million ZEVs would, according to his rough estimate, more than double that to about 450 MW.

That said, the biggest barrier to transportation electrification is getting the charging infrastructure in place and the most critical step is upgrading the distribution system, he added.

The system piece

Only a rethinking of California's grid architecture will allow a 100% zero-emissions power system, independent consultant on electric system policy, structure and market design Kristov told Utility Dive.

There is a complementarity between the bottom up development of DER on the distribution system and the bulk system that moves renewable energy over large areas, he said.

"The missing piece in California's [renewables integration] policy is a structured partnership between state level policymakers and local governments," he said. This is needed because the building and transportation electrification that will replace natural gas-powered heating and cooling with power from a 100% zero emissions grid will largely come through urban planning for "massive DER growth" at the distribution system level.

The state should support funding and coordination of community-level best practices that align city and county actions

with state renewable and emission reduction goals, Kristov said.

To integrate all the pieces needed to achieve the SB 100 zero emissions by 2045 goal, communities and Community Choice Aggregators (CCAs) can partner with IOU distribution companies working at the wider service territory level, he said.

"The power system should be re-envisioned as a layered architecture," Kristov said. The question to be answered by California's work to decarbonize is whether there should be central optimization of all DER by CAISO or coordination of DER at the transmission-distribution interface by a distribution system operator (DSO).

"With a DSO coordinating DER, the bulk system does not need control over the local activity and the loss of top down control does not mean chaos," he added.

"The traditional central control approach is not sustainable in the long term because grid defection will get cheaper, and constrained local communities will have no choice but to municipalize or go off-grid."

Lorenzo Kristov

*Electric System Policy, Structure and Market Design
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There is a predisposition toward top-down planning and control, Kristov said. But to achieve the system integration of distributed and central station renewables needed to eliminate emissions from all sectors of its economy, California needs "a statewide vision" of resilient communities. This includes

recognition of CCAs and municipal and cooperative utilities, as the energy arms of local governments, and recognition of IOUs as the providers of distribution services.

A state policy framework that targets SB 100's 2045 goal can reinforce those relationships through incentives and directives that align local interests with state policies, he said. "The traditional central control approach is not sustainable in the long term because grid defection will get cheaper, and constrained local communities will have no choice but to municipalize or go off-grid."

That would likely leave in place some reliance on natural gas in the power sector and fossil fuel-powered vehicles in the transportation sector, delaying the economy-wide integration of zero-emissions efforts needed to reach SB 100's 2045 goal.

The only way to avoid "massive stranded investments" and preserve a "coherent" system is to "integrate from the bottom up and from the top down and allow local communities a substantive role," Kristov said. "But local communities' perspectives can be too narrow, which is why state objectives and local perspectives must be aligned."