
A REGIONAL POWER MARKET FOR THE WEST

Risks and Benefits



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I.

Executive Summary

FORMAL regional electricity markets, known as regional transmission organizations (RTOs) or independent system operators (ISOs), have become common in most of the United States, but until now, utilities and regulators in the Western US have resisted creating one. Only the California Independent System Operator (CAISO) has a competitive regional market in the West, serving primarily California customers. The rest of the region is divided into a patchwork of individual utility balancing authorities.



With the growth of renewable energy and aggressive goals to decarbonize the power system in California, parties are taking a new look at whether a regional power market would help integrate more variable wind and solar energy in order to avoid curtailment and reduce reliance on natural gas for power generation.

The debate, which has been going on literally for decades, has been put high on the agenda by Governor Jerry Brown, who sees it as critical for meeting climate goals. The election of President Donald Trump, who has proven to be antagonistic to California's policies across the board, may add a new element of risk, since the Federal Energy Regulatory Commission (FERC) – an independent agency but one whose commissioners are appointed by the president – will need to approve the rules and governance of a regional market. Recent actions by the US Department of Energy to prop up at-risk coal and nuclear plants on reliability and “national security” grounds are also causing concerns, though they have been rejected by FERC so far.

The proposed vehicle for expanding CAISO into a regional entity is Assembly Bill 813, which has been pending in the legislature for nearly two years. Proponents of the bill, primarily clean energy industry and environmental groups, emphasize the technical and economic merits of a regional grid. They say it would increase the state's ability to develop renewable energy and cut carbon emissions at the lowest cost. The smaller group of opponents, chiefly labor groups plus the Sierra Club and TURN, emphasize potential risks to governance and the loss of renewable energy construction jobs to other states.

This paper attempts to capture the debate as objectively as possible, to help policymakers understand a deeply complicated set of legal, economic, and technical issues. The paper has a substantial amount of background about how electricity markets function, how they are regulated, and what is happening with the California power grid.

The main focus, though, is on the debate for and against regionalization. To simplify the debate, this brief focuses on the key arguments on each side.

The Case For Regionalization

Regionalization has a large number of supporters, including Governor Brown, CAISO, and members of two coalitions, the Fix The Grid Coalition and Secure California's Energy Future, made up primarily of clean energy industry and environmental groups. They cite the following arguments in favor of a regional RTO.

1. Easier Integration of Renewables

A bigger, more liquid, and transparent market would enable easier integration of wind and solar power, and help meet the state's renewable energy and climate goals at the least cost. It would allow California solar to be exported rather than curtailed, and enable access to a greater variety of excellent resources, such as wind energy in Wyoming, Montana and New Mexico.

2. Manage and Use Existing Transmission Better

A Western RTO would enable more efficient use of existing transmission lines, through increased transparency and competition. Eliminating duplicative transmission fees would lower costs. It would also create a more unified and efficient process for planning and allocating costs from transmission lines that cross state borders, which are currently regulated by individual states. By weighing all options across the region, only the most necessary new lines would be built.

3. Reduce Operational Costs

As shown by the \$330 million saved to date by the CAISO's Energy Imbalance Market (EIM), shared operations in a Western RTO can cut operational expenses. Utilities can share reserves, reducing the number of power plants they need to keep on standby. A bigger pool also reduces the variability caused by demand and by wind and solar power, smoothing it out over a larger number of customers and geographic area.

4. Improve Competition, Choice, and Consumer Savings, Growing Jobs

A transparent regional market would facilitate greater competition between generators, which would help cut utility bills. One study found that savings could rise to \$1.5 billion per year for California consumers by 2030. Lower power costs would spur job creation across the economy.

5. Put Competitive Pressure on Coal-fired Plants

A regional market will also increase pressure on the least competitive power plants, which are often the oldest and least efficient. In competitive markets in other parts of the country, older coal plants are retiring in large numbers in the face of lower cost natural gas, wind, and solar power. The West's excellent wind and solar resources will be strong competitors with existing coal and natural gas power plants, including some in California, helping reduce local pollution in-state.

The Case Against Regionalization

Opponents to regionalization include labor unions, the Sierra Club, The Utility Reform Network (TURN), and some municipal utilities.

1. Governance

The current CAISO board is appointed by the governor and approved by the state Senate, though it is a non-profit corporation, not a state agency. CAISO has a strong connection to state policies and coordinates with state energy and environmental agencies. A regional RTO would have a board strictly independent of all stakeholders, including policymakers, with state regulators represented on an advisory committee. Opponents of regionalization fear this would decrease control by state policymakers.

2. It Could Undermine California Policies

An independent regional RTO would have to consider the policy needs of any Western states whose utilities join, rather than working solely with California. Opponents fear this would compromise state policies, and expose California to attacks from other states and to greater scrutiny by FERC.

3. It Could Increase Sales by Regional Coal Plants

California imports about nine percent of total demand from coal plants in other states. While coal has been in decline nationally, opponents say a regional power market could help these old coal plants, and drive up carbon emissions. They fear that Trump Administration proposals to prop up uncompetitive coal plants would be more likely to succeed in a regional RTO.

4. It Could Shift Construction Jobs to Other States

California's renewable portfolio standard (RPS) requires at least 75 percent of renewable electricity to be delivered directly into the CAISO grid, meaning it must be located in or near CAISO. Expanding the RTO to a broader region would make more out-of-state projects eligible, thus shifting construction jobs to other states.

5. There are Other Ways to Integrate Renewables

While opponents of a Western RTO concede that a regional grid could help integrate renewables, they argue that California has many other ways to do that, using distributed energy resources like rooftop solar, energy storage systems, controllable demand (known as demand response), and electric vehicles that can be tapped to provide grid services when they are plugged in. They argue that relying more on distributed energy than on regionalization could improve reliability, create more jobs in California, and capitalize on the state's competitive advantage in advanced technology.

Tradeoffs and Takeaways

Not all of these arguments are equal or deserving of the same consideration. Some, such as fears of what FERC or the Trump Administration may do in the future, are speculative, so cannot be proven one way or another.

But all of the issues raised involve tradeoffs and options that will require further decisions down the road.

Key takeaways include:

1. JOBS: A regional RTO would facilitate regional development of renewables, which could mean construction jobs happening in other states to meet California's needs. However, those projects, especially wind farms, would lower the cost of electricity for all Californians and create a more diverse energy supply, which would ease integration.

Research shows that cheaper electricity would lower costs for business, creating a much larger number of jobs across the California economy. Lower costs come from developing the best resources in the region, rather than restricting development to California. On the whole, studies say that regionalization would lead to greater job growth in California.

2. GOVERNANCE: There is a perception that moving from a state RTO to a regional RTO would mean state policymakers would be giving up control.

It is true that a regional RTO would need to have a staff and board that were fully independent, from both market participants and from policymakers. The point of independence is to insulate the regional market from political interference and control by market participants.

But CAISO, despite having a board appointed by the governor, is already independent from stakeholders. Because it has been responsive to state policy goals, some people think of it as a state agency, regulated by state policymakers. But it is not, and hasn't been for almost two decades. A regional RTO, just like CAISO, would have to operate under a framework of FERC orders and federal law that require cooperation, free trade, and fair competition.

3. THREATS TO POLICY: Threats to California state policies are the same whether or not the state is part of a regional RTO. FERC already has jurisdiction over CAISO and interstate electricity sales. Most legal challenges to clean energy policy happen under interstate commerce rules, not under RTO or FERC rules. FERC must follow federal law and all decisions are subject to appeal to the courts.

The primary goal of federal law and FERC policies is to facilitate competition, as a way to ensure “just and reasonable” rates. State policies that don’t interfere with competition are unlikely to run afoul of FERC challenges. Clean energy policies, like RPS, can be crafted to be compatible with federal rules.

4. INTEGRATING RENEWABLES: There are no technical absolutes about how renewable energy can be integrated. Bulk solutions, such as transmission lines and regional markets, are the traditional way to manage the variability of wind and solar. Distributed energy resources, like batteries and demand response, can also be used to integrate renewables, and they are increasingly affordable and capable.

A bulk approach is still a lower cost option than one that relies heavily on distributed energy, but the two need not be mutually exclusive. Most distributed energy resources are in their infancy, and wide-scale adoption will take time, based on current costs and trends. Unfortunately, a distributed-intensive scenario was not included under the SB350 studies mandated by the state to investigate a western RTO, nor has it been adequately studied by other agencies, labs, universities, or think tanks. A detailed study should be undertaken to better understand the potential of distributed energy to help decarbonize the grid reliably and affordably.

Given the benefits of both bulk and distributed approaches, it is likely that a high-renewables future will include more of both.

5. MORE, OR LESS, COAL?: Coal power is in decline across the country, and especially in competitive markets. The argument that coal would thrive in a regional RTO relies largely on market failures and poor decisions by regulators, and on the threat of future action to undermine competitive markets – not on the presence of greater regional competition. Given the enormous amount of high quality renewable energy resources across the West, and the relatively small amount of coal power plants, it is hard to envision coal succeeding in a truly competitive market, so long as rules do not unfairly favor incumbent or obsolete technologies.

Conclusion

There is strong agreement in California about clean energy and climate policies, but not on the vexing question of whether a regional power grid would be a good, or necessary, way to reach those goals. Support for regionalization is strong, but concerns remain.

With clean energy technologies becoming the most competitive options, their growth may well be best served by a larger and more independent power market. Proponents argue that these trends are unstoppable, and a formal regional market will simply accelerate the domination of wind and solar in the Western power system. Opponents counter that a regional market will disconnect state policy from market operations, enhance federal moves to prop up coal plants, and drive construction jobs to other states.

In either case, RTOs have a limited ability to set electricity sector policies. States play a much more prominent role, making procurement decisions, setting emissions policies, and determining retail rates. While it is not always an easy process, RTOs around the country have generally accommodated state policies on clean energy. And in the end, participation in an RTO is voluntary; utilities and states can withdraw if they are unhappy.

The research in this paper is intended to inform the debate around a regional grid by presenting arguments and evidence in a straightforward summary. This analysis explores complex legal, policy, and engineering issues, to shed light on the debate and help further inform discussions.

Adding to the difficulty for policymakers is the asymmetrical nature of the debate: technical arguments on integrating renewables and cutting carbon, on the one hand, versus governance issues on the other. Weighing this apples-to-oranges comparison will be necessary in deciding whether to move toward a regional grid.

In the meantime, the success of CAISO's Energy Imbalance Market has helped the region evolve toward more cooperative and competitive markets, and increased the comfort level of participating utilities and regulators. The rapidly declining cost of wind and solar is lowering resistance to their adoption, putting more Western states on the same page about what the future will look like.

The trends point toward regional cooperation, but the specifics will need to be worked out in partnership with other stakeholders, and not in a single California bill. The bill is the first step in allowing greater regional cooperation to proceed.

CPUC Chair Michael Picker has characterized the creation of a coordinated Western market as an evolutionary process. "The success of the EIM was that people can ease into it," he pointed out during a 2017 CAISO symposium. "The EIM is like living together before you get married, then you get married and buy a house."

II.

Introduction

POWER companies and regulators in the West have long debated, and long resisted the creation of a regional electricity market.



Regional markets have taken over most of the rest of the United States, as part of the evolution toward wholesale competition that has been the hallmark of utility policy for over thirty years.

But in the West, an organized regional market has been controversial. Price differences between regions have been one factor, as low-cost regions protect their perceived advantage over higher cost neighbors. Political differences are also important, dividing the more liberal coastal states from the more conservative interior states. And the interplay between environmental policy and economic development among western states has also been important, as California has led the world on clean energy and climate policies, while Wyoming is America's largest producer of coal.

Now technological change is driving a new appraisal of regional power markets. Rapidly maturing wind and solar power, especially, are changing the definition of a low-cost energy resource, creating economic development opportunities, and undermining the economics of traditional generation sources. Because they are variable, driven by natural forces, they are disrupting the technical and financial operations of the grid as well, creating bursts of abundant low-cost energy when the wind blows and the sun shines.

Access to low-cost wind and solar resources – or protection from them, for some power plant owners and their political allies – is an important new aspect of the debate about creating a Western market. And the successful introduction of the Energy Imbalance Market (EIM) has shown that regional markets can deliver big savings, even when limited to real-time market balancing. Many western utilities already participate in or are scheduled to join the CAISO EIM.

Given California's ambitious goals on clean energy and decarbonization, a regional grid offers some compelling technical solutions. The need to maintain reliability even as we capitalize on this large and low-cost resource means being able to balance daily surges of solar power. While there are many ways to balance variable generation like wind and solar, spreading it across the West is by all accounts the least cost way to manage it. Wind resources in California are limited compared to other states. Getting access to the bountiful plateaus and prairies of the West would help diversify our power system, adding more wind to our large and growing amount of solar, at a lower cost than relying solely on in-state resources.

But regionalization comes with some policy risks. The California grid is now run by a California entity, almost entirely for California companies and consumers. The board of the California Independent System Operator (CAISO) is appointed by the governor and confirmed by the Senate. The wholesale aspects of the California power system are subject to oversight by the Federal Energy Regulatory Commission (FERC), but retail issues are guided by the state Public Utilities Commission and California laws.

Regional markets in other parts of the country span many states, many market designs, and many market players. RTOs in those regions must balance the policy goals and needs of all states. RTOs do not set environmental, economic development, and labor policies, as states do. But they must, under FERC Order 1000, "consider transmission needs driven by public policy requirements established by state or federal laws or regulations."¹ The allocation of costs must be done according to FERC-approved principles.

1 FERC, Order No. 1000 - Transmission Planning and Cost Allocation, accessed May 2018, <https://www.ferc.gov/industries/electric/indus-act/trans-plan.asp>

The principle of free and fair competition guides those markets above all. Companies and regulators have signed away some control to regional entities that are required to be independent of all parties, including policymakers, so they can better ensure free markets. Indeed, that independence is intended to insulate decisions from political interference. States can sometimes run into conflict with wholesale market rules, depending on how they phrase their laws and how courts interpret them. But with or without a regional RTO, state policies around electricity, as with other products, are also subject to federal laws, including rules on interstate commerce.

California is free to set and pursue clean energy and climate policy goals with or without a regional RTO. But if it is to overcome the challenges that they pose for a future grid, the state could benefit from regionalization. This brief looks into what benefits a regional grid would offer, weighing the advantages and disadvantages of such an effort and addressing what the barriers and opportunities are, as well as best recommendations for how it could be done, should it prove to be an optimal solution for helping expand renewable energy and cut global warming emissions in California and the West.

III.

Grid Basics



What ISOs and RTOs do

Independent system operators (ISOs), also called regional transmission organizations (RTOs) operate markets that serve about two-thirds of the country's electricity demand. In regions without RTOs, individual utilities generate their own power or buy it from competitive generators through long-term contracts.

Grid operators are like air traffic controllers – they don't own the power plants or the transmission lines, nor do they set generation or retail prices. Instead, they run a market that facilitates bidding by power plant owners, they track and share power prices and grid conditions, and issue orders to turn

Currently, seven RTOs operate in the United States, listed in order of the size of their peak load:

- PJM Interconnection (PJM), 165 GW
- Midcontinent ISO (MISO), 126 GW
- Electric Reliability Council of Texas (ERCOT), 68 GW
- California ISO (CAISO), 50 GW
- Southwest Power Pool (SPP), 48 GW
- New York ISO (NYISO), 34 GW
- New England ISO (ISO-NE), 28 GW

While RTO regions cover much of the US, California is the only RTO in the Western Interconnection. In non-RTO regions, utilities largely supply their own power with their own power plants, but sometimes buy and sell power through bilateral transactions. There are 38 "balancing areas" in the West, or regions where supply and demand are balanced.

RTOs are regulated by the Federal Energy Regulatory Commission (FERC), under the authority of the Federal Power Act of 1935, and other laws. FERC regulates wholesale interstate electricity sales and transmission, setting rates, terms, and conditions, while state utility commissions regulate in-state activity, including retail prices.

The Federal Power Act requires rates to be "just and reasonable" with no "undue preference" given to any parties. With the growth of competitive generation, FERC ensures just and reasonable prices by making sure fair market rules produce competitive outcomes.

In all RTOs and certain retail markets, prices are set through competitive auctions. In some cases, where competition is not possible, prices are set based on the cost of service. FERC's role is to either authorize parties to sell at market-based rates or to review and authorize cost-based rates.

What CAISO does

The California Independent System Operator (CAISO) is the grid operator for much of the state and portions of Nevada, serving 80 percent of demand. Publicly-owned utilities, including cities with utilities like Los Angeles, Sacramento, and Palo Alto, plus irrigation districts and electric cooperatives, tend to operate their own systems. As a result, there are eight balancing areas in the state.

CAISO's principal task is to operate the wholesale market for electricity. Prices are set based on the bids of wholesale generators, which are typically based on the cost of generating and delivering it from particular grid locations, called nodes. There are two distinct markets: the day-ahead market runs in the days before the energy is needed, while the real-time market buys power to balance last minute demand needs. It also leads efforts on transmission planning.

CAISO was created as part of the move to introduce competition in California in 1996. It is governed by a board of five experts appointed by the governor and confirmed by the state Senate. As an RTO, its rules and tariffs are subject to FERC oversight.

More details on CAISO market operations are in the appendix.

The Western Grid

CAISO is the largest of 38 balancing areas in the West, serving 27 percent of demand in the region. Despite over 20 years of debate, the Western Interconnect has not adopted the regional market structures that dominate in the East. The PJM Interconnection, for example, serves 65 million people across 13 states in the Midwest and Mid-Atlantic. The common market of a regional transmission operator facilitates wholesale competition, coordinates on planning and building transmission, and reduces the costs and inefficiencies that come from having seams between operating areas.

In 2015 and 2016 CAISO discussed the possibility of joining with PacifiCorp, a large utility active in five Western states and a small portion of far northern California. By joining, PacifiCorp would turn control of their transmission over to the ISO and would sell their generation into the wholesale day-ahead market. But those discussions foundered on the issue of governance, and how the interests of other states would be represented in the management of the ISO. "Without acceptable regional governance, states outside California are not likely to give PacifiCorp needed approval to participate in a regional ISO," according to a PacifiCorp filing.²

Because there has been no consensus about creating an expanded Western RTO, CAISO has created what some call an "RTO-lite" – the Energy Imbalance Market (EIM). Balancing supply and demand is one of the most important functions of an RTO. By balancing at a larger scale, fewer power plants are needed to be on standby, the market chooses the least cost option, variability is lessened, and renewable energy that might have been curtailed can be used instead, reducing costs for all parties.

2 Sarah Edmonds, PacifiCorp, "PacifiCorp Comments on Second Revised Governance Principles," CEC Docket Number: 16-RGO-01, November 3, 2016,

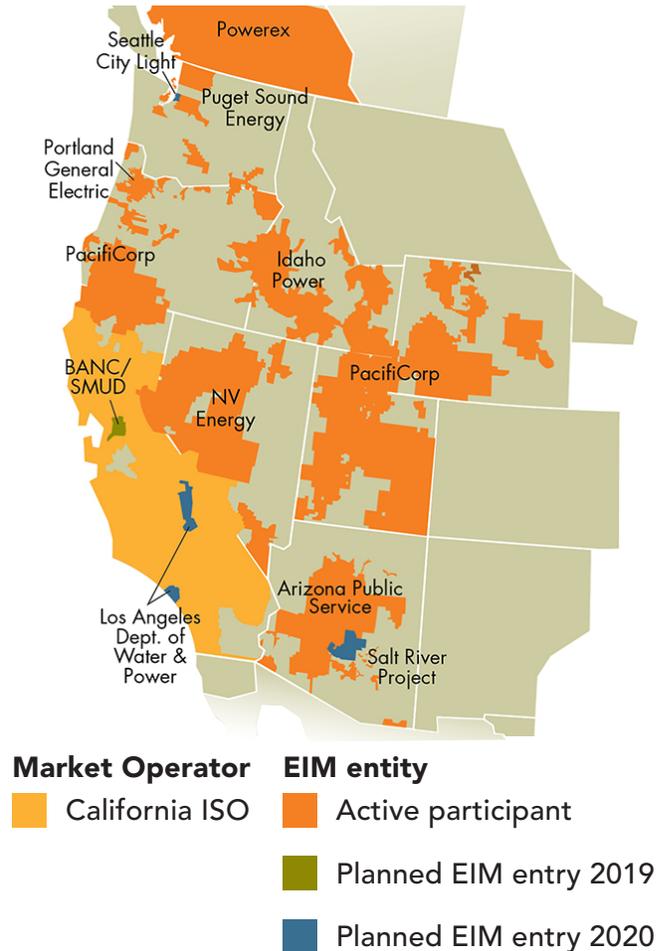
http://docketpublic.energy.ca.gov/PublicDocuments/16-RGO-01/TN214363_20161103T160104_Sarah_Edmonds_Comments_PacifiCorp_Comments_on_Second_Revised_Go.pdf

The EIM was launched in 2014 and has grown to include eight balancing authorities so far, with four more scheduled to join by 2020. CAISO estimates that the EIM has delivered \$330 million in savings since it was launched.³

But an EIM only provides short term balancing services, which account for about 5 percent of electricity sales. CAISO and others believe that greater integration of operations across the region will deliver bigger benefits, especially as California and other states across the West add greater amounts of wind and solar power. They have proposed expanding the EIM to include day-ahead markets as well.⁴

CAISO has some competition in offering those services however. Seven Western utilities are discussing terms for the Mountain West Transmission Group, which would cover Colorado, Wyoming and neighboring states. They have been negotiating to join the Southwest Power Pool, which ranges from Arkansas to Montana, but in April their largest member, Xcel Energy, pulled out of discussions.⁵ Without its largest member, the future of Mountain West is uncertain. Another option has been proposed by Peak Reliability, which provides situational awareness and real-time monitoring for the Western Interconnection. They have partnered with an affiliate of the eastern grid operator PJM Interconnection to develop a plan for a new entity to provide reliability coordination, reliability services, and energy markets in the West.⁶

FIG 1a The Western Energy Imbalance Market

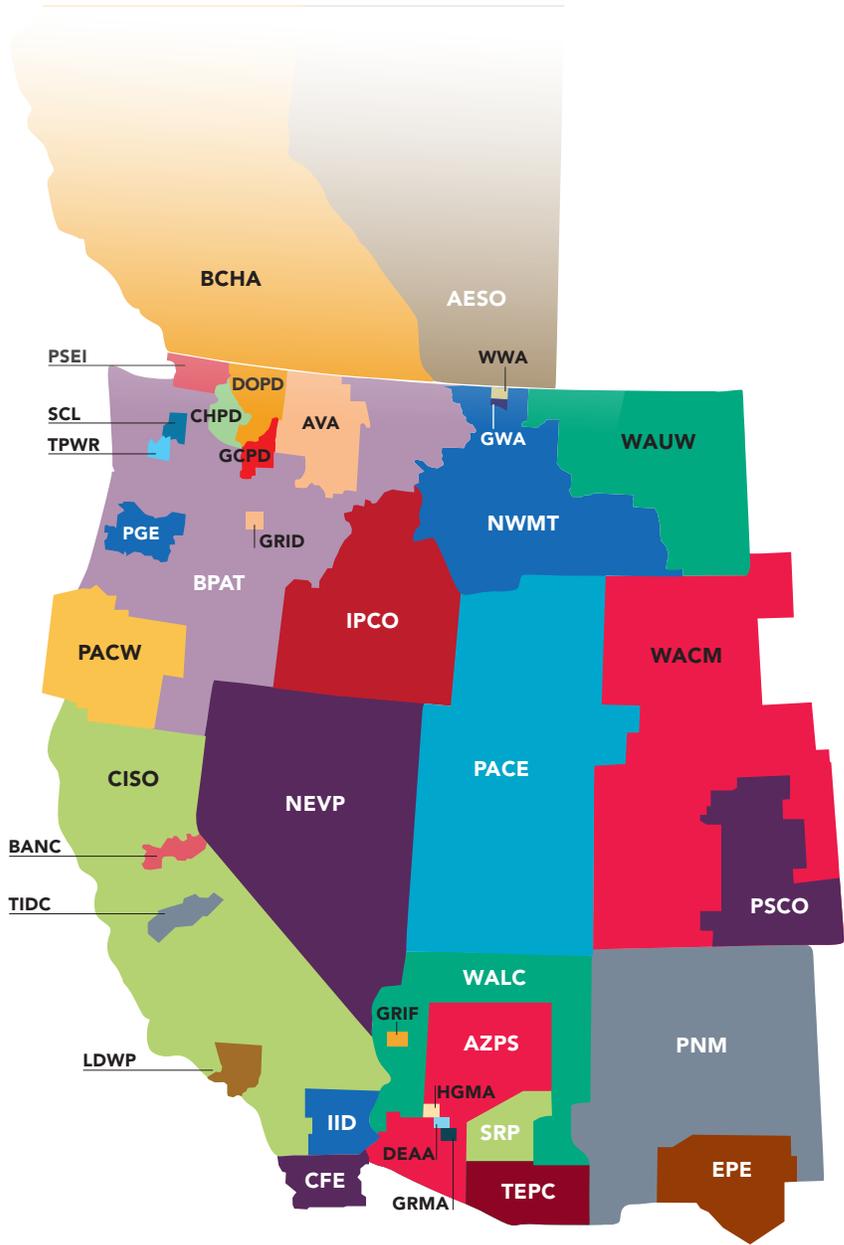


Source: California Independent System Operator (CAISO).⁷

3 Western Energy Imbalance Market, accessed April 2018, <https://www.westerneim.com/Pages/About/QuarterlyBenefits.aspx>.
 4 CAISO, "2018 Draft Policy Initiatives Roadmap," December 7, 2017, <http://www.aiso.com/Documents/2018DraftPolicyInitiativesRoadmap.pdf>
 5 Mountain West Transmission Group, accessed April 2018, <https://www.wapa.gov/About/keytopics/Pages/Mountain-West-Transmission-Group.aspx>, and Gavin Bade, "Xcel pulls out of Mountain West in blow to SPP market expansion," Utility Dive, April 23, 2018, <https://www.utilitydive.com/news/xcel-pulls-out-of-mountain-west-in-blow-to-spp-market-expansion/521988/>
 6 Peak/PJM Connex, <https://www.peakrc.com/whatwedo/PeakPJM/Pages/default.aspx>. And Kate Winston, "PJM CEO touts benefits of new market amid shifting dynamics in the West," Platts, April 27 2018, <https://www.platts.com/latest-news/electric-power/washington/pjm-ceo-touts-benefits-of-new-market-amid-shifting-10389801>.
 7 Western EIM active and pending participants. Available at <https://www.westerneim.com/Pages/About/default.aspx>.

FIG 1b Western Interconnection Balancing Authorities

AESO	Alberta Electric System Operator
AVA	Avista Corporation
AZPS	Arizona Public Service Company
BANC	Balancing Authority of Northern California
BCHA	British Columbia Hydro Authority
BPAT	Bonneville Power Administration-Transmission
CFE	Comision Federal de Electricidad
CHPD	PUD No.1 of Chelan County
CISO	California Independent System Operator
DEAA	Arlington Valley, LLC
DOPD	PUD No.2 of Grant County
GRID	Gridforce Energy Management, LLC
GRIF	Griffith Energy, LLC
GRMA	Gila River Power, LP
GWA	NaturEner Power Watch, LLC
HGMA	New Harquahala Generating Company LLC
IID	Imperial Irrigation District
IPCO	Idaho Power Company
LDWP	Los Angeles Department of Water and Power
NEVP	Nevada Power Company
NWMT	NorthWestern Energy
PACE	PacifiCorp East
PACW	PacifiCorp West
PGE	Portland General Electric Company
PNM	Public Service Company of Colorado
PSCO	Public Service Company of Colorado
PSEI	Puget Sound Energy
SCL	Seattle City Light
SRP	Salt river Project
TEPC	Tuscon Electric Power Company
TIDC	Turlock Irrigation District
TPWR	City of Tacoma, Department of Public Utilities
WACM	Western Area Power Administration, Colorado Missouri Region
WALC	Western Area Power Administration, Lower Colorado Region
WAUW	Wester Area Power Administration, Upper Great Plains West
WWA	NaturEner Wind Watch, LLC



Source: Western Electricity Coordinating Council (WECC).⁸

⁸ Used with permission by of the Western Electricity Coordinating Council. Available at https://www.wecc.biz/Administrative/Balancing_Authorities_JAN17.pdf.

IV.

The California Context

WHILE the CAISO has been considered a success, and a positive development for the California power sector, it is encountering some difficulties posed by the growth of solar and wind power, and the future growth expected due to long-term clean energy and climate goals of the state.



Solar is already providing a significant amount of California's supply. On May 26, 2018, solar and wind together provided 64.6 percent of CAISO instantaneous demand, a new record.

While California is blessed with a variety of renewable resources – sun, wind, hydropower, geothermal, biomass, and potentially ocean energy – solar is booming now. It is low in cost, quick to deploy, and lends itself to a variety of applications, from single rooftops to massive solar farms. And it has the greatest potential for future growth in California. The San Francisco consulting firm E3 predicts California could add 40 gigawatts of solar by 2030, compared to 15-20 gigawatts of other renewables, to meet the 50 percent renewables policy goal.⁹

But solar power plants all tend to operate in unison, rising in the morning with the sun, and falling in the evening with sunset. Since California is not wide, from east to west, in-state solar generators are especially synchronized. As a result, grid operators have switched to managing California's "net demand" – the total demand minus wind and solar generation, which are not controlled by grid operators. The net demand has been reshaped by solar especially, falling in the middle of the day, and rising rapidly in the evening.¹⁰ This phenomenon, called the "duck curve" by CAISO, is discussed in greater detail in the appendix.

Large amounts of solar cause two issues for grid operators. The first is over-generation, where too much electricity is available in the middle of the day. Too much generation, like too little, can disrupt reliability, so CAISO has at times been forced to curtail solar plants. The second problem is that the distance from low net demand at noon and high net demand in the evening is growing, requiring a large and steep ramp that must be met by other resources.

There are many current and emerging options for dealing with the new shape of demand in CAISO, as discussed in the appendix. These include distributed energy resources like energy storage, demand response, and targeted energy efficiency, plus more flexible generators. Converting transportation and heat energy to electricity, such as with electric vehicles and electric heat pumps, can provide more flexibility options.

Studies have shown that creating a larger regional power system by better linking California to the rest of the West may be the most cost-effective solution. The growth of low cost wind and solar, with plans for much more in the future, has been the primary driver for reviving the debate about creating a regional RTO.

9 Nancy Ryan, Energy and Environmental Economics (E3), Renewable Euphoria and the Big Long, presentation to the IEP Annual Meeting, September 20, 2016, <http://www.iepa.com/2016AnnualMeeting/Presentations/Renewable%20Euphoria%20and%20the%20Big%20Long%20-%20Nancy%20Ryan.pptx>

10 Wind power, like solar, is a variable energy source, and can cause the same market and operational impacts. But the wind can blow in California in any hour, while solar is highly concentrated in daytime hours. As a result, the impacts of wind power tend to be more spread out.

v.

The Regionalization Debate

WHILE there are many options for integrating renewable energy and cutting carbon emissions from the California power system, the option getting a lot of attention is expanding the CAISO footprint to other parts of the West to create a Western regional transmission organization (RTO).



The Clean Energy and Pollution Reduction Act of 2015 (SB 350) authorizes the transformation of CAISO into a regional organization, as long as CAISO's governance structure is amended with the approval of FERC, the legislature, and state agencies.¹¹

SB 350 required a set of studies of the impacts of regionalization, including overall benefits to California ratepayers; emissions of greenhouse gases and other air pollutants; the creation or retention of jobs and other benefits to the California economy; environmental impacts in California and elsewhere; impacts in disadvantaged communities in California; and reliability and integration of renewable energy resources.¹²

But legislation to enable regionalization encountered opposition in the 2016 and 2017 legislative sessions, and was not brought up for a vote. In 2018, Assembly Member Chris Holden carried forward AB 813, and is currently hosting discussions on it. The bill sets forth criteria that must be satisfied before California load serving entities would be permitted to join a regional RTO. These are intended to address concerns raised in the past, and to safeguard California prerogatives and policies.¹³

Regionalization has attracted significant attention and debate because the prospect of it raises important issues about the future of the California energy supply, long-term action on climate change, actions to reduce local pollution hotspots, encouragement of in-state jobs, and above all about the governance and control of a regional institution.

In this section we present the principle arguments for and against regionalization put forward by stakeholders. We offer additional insight and research when possible or useful.

The Case For Regionalization

Regionalization has a number of supporters, including Governor Brown, CAISO, the California Chamber of Commerce, and members of two coalitions, the Fix The Grid Coalition and Secure California's Energy Future.¹⁴

1. It Enables Easier Integration of Renewables

Proponents of regionalization argue that a bigger regional market would make integrating variable renewable energy like wind and solar easier and less expensive.

Big, liquid markets would provide access to a greater diversity of renewable resources, such as the massive wind energy resources of New Mexico, Wyoming, and Montana. A single market would eliminate the delivery fees charged by each balancing area, lowering the cost of delivering power over long distances. Also, wind and solar generated across a larger geographic footprint would smooth out their variability, while a larger pool of electricity demand would more readily absorb it.¹⁵

Links to other markets would also enable California solar generation to be exported during the day, instead of being curtailed when it exceeded in-state power demand, thus enabling more development of solar power in California.

11 California Energy Commission, Clean Energy & Pollution Reduction Act, SB 350 Overview, accessed May 2018, <http://www.energy.ca.gov/sb350/>

12 The SB350 studies and other materials can be found at CAISO, "Exploring a regional independent system operator (ISO)," <http://www.caiso.com/informed/Pages/RegionalEnergyMarket.aspx>

13 Assembly Bill No. 813, Introduced by Assembly Member Holden, Coauthor: Senator Wieckowski, February 15, 2017, https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB813

14 Fix the Grid consists of 18 clean energy companies, technical experts and environmental organizations, at <https://www.fixthegridcalifornia.org>. Secure California's Energy Future consists of 11 NGOs and clean tech associations and companies, plus 13 prominent energy experts, at <https://securecaenergyfuture.org>.

15 Lauren Navarro, Environmental Defense Fund, "The most important thing California can do with its clean energy could be to share it," March 9, 2018, <http://blogs.edf.org/energyexchange/2018/03/09/the-most-important-thing-california-can-do-with-its-clean-energy-could-be-to-share-it/>

According to The Brattle Group, the liquidity and transparency of a regional market will attract further investments in renewable generation beyond what is needed to meet the western states' renewable energy portfolio (RPS) requirements. Analysts at the group say that development of additional renewables would result in greater economic and environmental benefits than are modeled in the SB350 regional grid study.¹⁶

While opponents of regionalization often point to the potential for distributed generation in California as an alternative, proponents say that a bigger regional grid would also help distributed solar, which has the same integration issues as utility-scale solar, as discussed in more detail in the appendix.¹⁷

2. It Would Manage and Use Transmission Better

Because the Western grid is divided up into many balancing areas, transmission links between regions are not always used to their full potential while others are overcrowded. An ISO with control of the whole region could do better forecasting and scheduling, and have better control over the dispatch of power plants to optimize the grid and reduce congestion. It could also solve the problem of "contractual congestion." Transmission paths appear at times to be congested due to the exercise of transmission rights in bilateral contracts, even though the lines are not physically congested. In a regional market this would be reduced and eventually eliminated.

Less transmission capacity will sit idle and more pathways will be opened up to deliver power to areas when it is most needed. By using existing transmission more efficiently, new transmission could be avoided.

On the other hand, getting access to low-cost energy resources could drive new transmission construction. A number of interstate lines have been proposed over the past decade connecting wind resources in Wyoming and New Mexico to the population centers to the west. As shown in Figure 2, there are 16 new transmission projects expected to be completed by 2026 in the "common case" outlook from the Western Electricity Coordinating Council (WECC), including the 1000-mile long Gateway West project across Wyoming and Idaho.¹⁸

One consistent barrier to long transmission projects is a lack of a decision-making forum that works across state borders. A Wyoming to California line, for example, would also require approval from regulators in Utah and Nevada. Since the line may not deliver significant benefits to those transit states, regulators there may reject the application.

Another barrier that an RTO could help solve is cost allocation. A transmission upgrade in one part of the region may create benefits far from where it is built, by relieving congestion, facilitating competition, or enabling access to lower cost or cleaner resources. But lines that run across multiple areas trigger debates about who pays for the line.

FERC Orders 890 and 1000 helped address this problem by requiring all transmission owners to participate in a transmission planning region, and that each region must develop its own method of allocating costs, according to six mandatory principles. In short, these principles say that costs for transmission improvements should be allocated according to the benefit bestowed on each of the regional parties. The West has four transmission planning regions, which must also coordinate with each other.¹⁹

16 Brattle Group, E3, BEAR, and Aspen Environmental Group, Senate Bill 350 Study: The Impacts of a Regional ISO-Operated Power Market on California, prepared for CAISO, July 8, 2016, <http://www.caiso.com/Documents/ExecutiveSummary-SB350Study.pdf>

17 Carl Zichella, Ed Smeloff and Jennifer Gardner, "A Regional Grid Helps, Not Hurts Distributed Renewable Energy," Greentech Media, April 25, 2018, <https://www.greentechmedia.com/articles/read/a-regional-grid-helps-not-hurts-distributed-renewable-energy#gs.4xWafSM>

18 WECC, TEPPC Study Report: 2026 PC1 Common Case, March 8, 2017, <https://www.wecc.biz/Reliability/2026%20PC01%20-%20Common%20Case%20-%20Report.pdf>

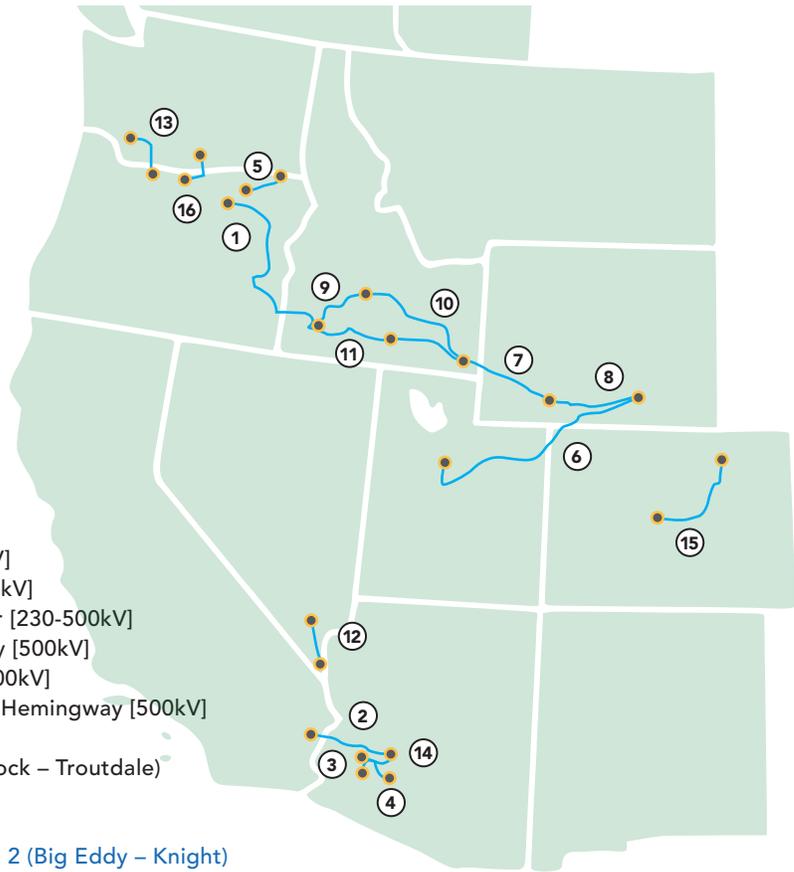
19 Robert H. Easton, Western Area Power Administration, "Regional Planning Process in the West," Tribal Webinar Series, March 30, 2016, <https://www.energy.gov/sites/prod/files/2016/04/f30/RobertEatonRegionalPlanning-Western.pdf>

FIG 2 “Common Case” Transmission Assumptions from WECC

Regional Planning Coordination Group (RPCG)

- CAISO California Independent System
- CTPG California Transmission Planning Group
- CG Columbia Grid
- CCPG Colorado Coordinated Planning Group
- NTTG Northern Tier Transmission Group
- SIERRA Sierra Subregional Planning Group
- SWAT Southwestern Area Transmission
- AESO Alberta Electric System Operator
- BCCPG BC Coordinated Planning Group

- 1** Boardman – Hemingway (B2H)[500kV]
- 2** Delaney – Colorado River (Ten West Link)
- 3** Delaney – Palo Verde [500kV]
- 4** Delaney – Sun Valley [500kV]
- 5** Energy Gateway: Wallula – McNary [230kV]
- 6** Energy Gateway South: Aeolus – Mona [500kV]
- 7** Energy Gateway West: Bridger – Populus [500kV]
- 8** Energy Gateway West: Windstar – Jim Bridger [230-500kV]
- 9** Energy Gateway West: Midpoint – Hemingway [500kV]
- 10** Energy Gateway West: Populus – Midpoint [500kV]
- 11** Energy Gateway West: Populus – Cedar Hill – Hemingway [500kV]
- 12** Harry Allen – Eldorado (Centennial II) [500kV]
- 13** I-15 Corridor Reinforcement Project (Castle Rock – Troutdale)
- 14** Morgan – Sun Valley [500kV]
- 15** Pawnee – Daniels Park
- 16** West of McNary Reinforcement Project Group 2 (Big Eddy – Knight)



Blue text – Indicated “Under Construction”

Source: WECC²¹

Regional RTOs like CAISO²⁰ typically have a transmission planning process that considers the needs of the system as a whole and apportions costs fairly. While transmission planning can take many years to result in a decision, they do allow state regulators and stakeholder to participate.

In the west, the Western Electricity Coordinating Council does planning, research and convening, and has “authority to create, monitor, and enforce reliability standards.” But it has no authority to allocate costs between customers in different states. A Western regional RTO could formally link planning with allocating the cost of transmission lines across states.

3. It Reduces Operational Costs

Operational costs can be reduced in a number of ways by a larger regional RTO. Two principal ways are in reducing the need for power plants to provide duplicative reserve capacity and in reducing the need for load-following and peaking resources.

All balancing areas, whether run by a single utility or a large RTO, must maintain a margin of extra generating capacity. Forecasts may be inaccurate, demand may be higher than expected, and “contingencies” may happen: a generator may fail or a transmission line may go down. The standard reserve margin is 15 percent, though market

20 CAISO, How Transmission Cost Recovery Through the Transmission Access Charge Works Today (Background White Paper), April 12, 2017, <http://www.caiso.com/Documents/BackgroundWhitePaper-ReviewTransmissionAccessChargeStructure.pdf>

21 TEPPC Study Report: 2026 PC1 Common Case. Available at <https://www.wecc.biz/Reliability/2026%20PC01%20-%20Common%20Case%20-%20Report.pdf>

conditions and the size and type of individual generators may result in higher or lower levels. Power plant owners get paid for having their plants in the reserve pool.

Very large generators increase the need for reserves. If Diablo Canyon has a mechanical problem and goes offline, for example, supply would suddenly drop by 2,200 MW of capacity, which would have to be made up by plants in the reserve, or by cutting demand. If Diablo Canyon operated in a small pool, such as just PG&E’s operating territory, it would require a large number of plants in the reserve, relative to the total size of the pool. But since it operates in the larger CAISO system of about 50,000 MW of peak demand, the reserve costs are proportionally smaller.

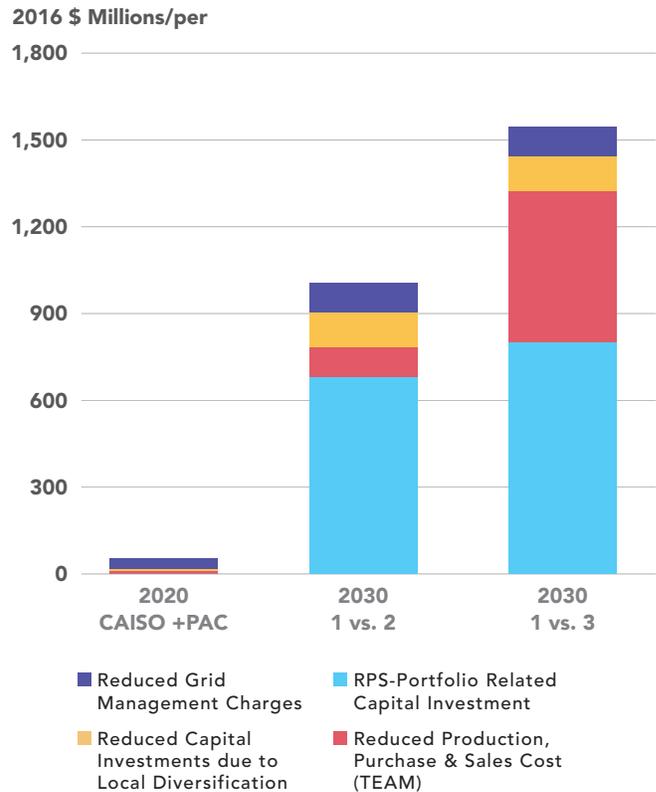
In other words, a larger pool shares the cost of keeping plants in reserve. CAISO’s Energy Imbalance Market (EIM) has helped reduce the demand for duplicative reserves, a significant ingredient in the \$330 million of savings that the EIM has delivered to date.

Consolidating many small balancing areas in the West into a regional RTO would increase the savings by reducing the demand for power plants in reserve. It could deal with contingencies in other ways, such as transfers between regions and a larger pool of demand response options.

The size of a regional market itself can reduce the need for peaking and load-following resources (power plants that change output to match demand that is rising or falling) which are often gas or coal-fired. By creating a larger operating pool, the variability of demand is smoothed out, resulting in ramps that rise and fall more gradually. Peaks would also become “less peaky,” since the large geographic area of the West, different weather patterns, and two time zones spread out periods of peak demand.

Altogether, the Brattle Group found that a regional market would reduce load-following and regulation requirements by around 20 to 25 percent, which contributes to more efficient use of resources and lower costs (since less resources are needed to be set aside for operating reserves).²²

FIG 3 Estimated Annual Ratepayer Net Benefits from Regionalization



Source: CAISO²³

A system with load movements that are less abrupt and more predictable provides a significant opportunity for increasing renewable generation in the West as wind and solar power add an increased element of unpredictability.

4. It Improves Competition and Choice, Producing Savings

One of the original drivers for creation of RTOs was to allow customers unfettered access to the lowest cost generation, as a way to spur competition and drive down costs. A Western RTO could offer the same benefit, especially in accessing low cost renewable resources.

²² Brattle Group, Senate Bill 350 Study, Volume V: Production Cost Analysis, July 8, 2016, <http://www.caiso.com/Documents/SB350Study-Volume5ProductionCostAnalysis.pdf>

²³ Senate Bill 350 Study, prepared for CAISO. Available at <http://www.caiso.com/Documents/SB350Study-Volume7RatepayerImpactAnalysis.pdf>

The SB350 regionalization study identified lower cost renewables as the largest way to get cost savings from regionalization, rising to over \$700 million per year for California consumers by 2030. The savings come from reduced curtailment of in-state renewable generators and the ability to tap lower cost resources in other regions, such as very low-cost wind power in places like Wyoming, New Mexico, and Montana.²⁴

As shown in Figure 3, the study also saw significant savings from increased wholesale transactions, due to lower-cost imports and higher export sales revenues when California generators would otherwise have to curtail renewable generation or export power at a zero market price. Total savings were estimated to rise to \$1.5 billion per year by 2030, continuing thereafter. By comparison, electricity sales in California totaled \$41 billion in 2017, according to the Energy Information Administration.

Lower regional costs would help drive down prices for consumers, even if only some have a choice of a retailer provider. However, California policymakers have announced that we are entering a new era of customer choice, even without a conscious plan to do so. Community choice aggregation (CCA) allows local elected officials to set up a “buying club” for residents and businesses of a community, choosing a new power supplier. There are 18 CCAs in operation and more coming, including large cities like San Francisco (launched 2015) and San Jose (launching September 2018). Between CCAs, competitive power marketers, and customer-owned distributed energy resources, the CPUC predicts that investor-owned utilities could lose over 85 percent of their sales by the mid-2020s, and become primarily grid management companies.²⁵

CCAs can benefit from the greater choice created by a regional RTO, buying lower cost or cleaner power from anywhere in the RTO footprint. All CCAs are subject to the state RPS, but many intend to go beyond those levels, acquiring more renewables sooner than required.

Likewise, competitive electric service providers, who primarily serve commercial and industrial customers, would be able to choose from a larger pool of generation providers. Electricity prices for commercial customers in California are the fourth highest in the US, while industrial customers pay the sixth highest prices.²⁶ Lower cost power would help make California industry more competitive.

5. It Puts Pressure on the Least Competitive Power Plants

A related benefit is that a regional market can increase the economic pressure on the least competitive power plants in the region to retire, often the largest polluters.

As described above, a competitive wholesale market reveals and gives access to lower cost resources for generation, capacity, load following, and other services. Generators are required to place bids that reveal their operating costs and allow market participants to choose the least cost options. Higher cost plants, typically less efficient plants using more expensive fuels, are selected less often, make less money, and are eventually retired.

Without a competitive market, utilities have a strong incentive to choose their own plants, regardless of cost. Regulators are supposed to be watchdogs for cost-cutting opportunities, such as retiring old and inefficient plants, but they are often dissuaded by the utility, by elected officials and local communities, and by interest groups. A market is not as sentimental, and can be much faster acting than a drawn-out regulatory process.

A Western RTO would be similar to the Midcontinent ISO (MISO) and the Southwest Power Pool (SPP), which serve states that are mostly regulated. (PJM, New York, and New England states generally have fully competitive markets.)

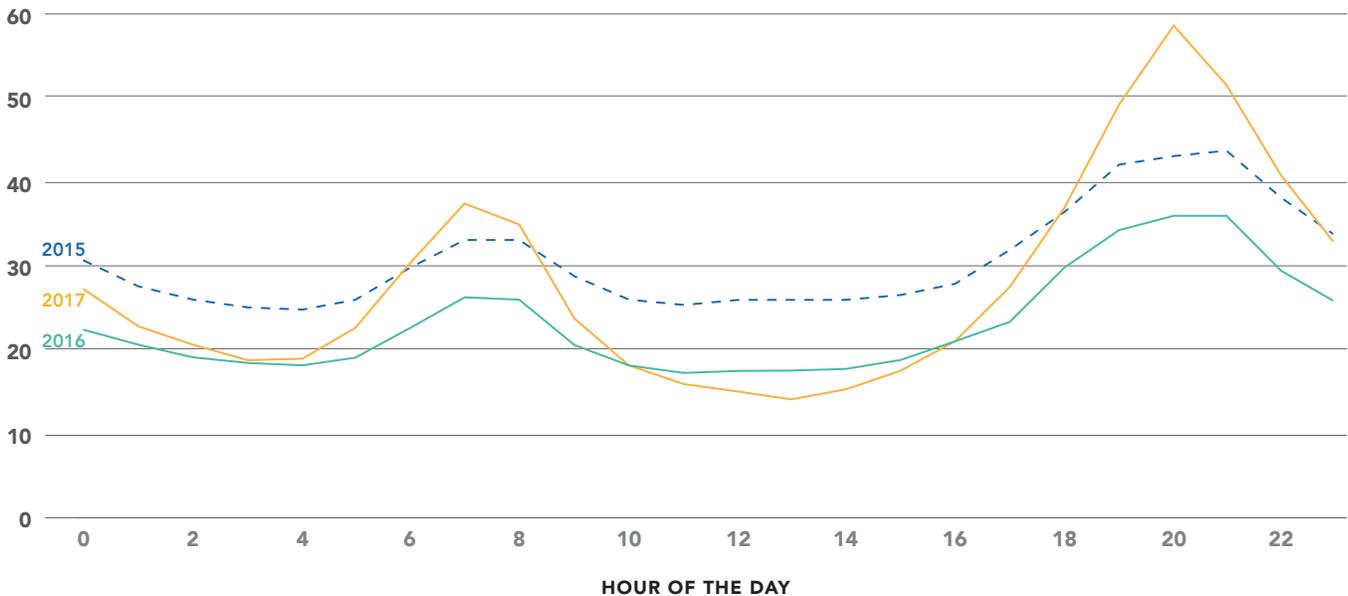
24 SB350 study, executive summary. See footnote 12.

25 CPUC’s Staff White Paper: Consumer and Retail Choice, the Role of the Utility, and an Evolving Regulatory Framework, May 2017, http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/News_Room/News_and_Updates/Retail_Choice_White_Paper_5_8_17.pdf

26 US Energy Information Administration (EIA), Average Retail Price of Electricity, Electricity Data Browser, <https://www.eia.gov/electricity/data/browser>.

FIG 4 CAISO Average Hourly Day-Ahead Energy Market Prices

Dollars per Megawatt hour

Source: CAISO²³

MISO and SPP have a mix of utility-owned power plants and merchant power plants, who sell their power through long-term contracts or on the daily spot market. Regulated utilities buy and sell power on the daily and real-time power markets, with their plants being dispatched according to market results. Later, when regulators do a rate case to true up the finances of a utility, they make adjustments to reflect their market sales and purchases. A power plant that is not competitive and not being dispatched by the market is not “used and useful,” a key test for whether utility investments should be repaid by captive ratepayers. An unused plant should be taken out of “rate base” by regulators and retired.

There are still avenues for market participants and their allies to seek special treatment in an RTO market. The most common way is to have a plant designated as a “reliability must run” (RMR) facility, needed to maintain reliability in a congested area. With RMR, the plant’s revenues are cost-based, rather market based. But RMR is intended to be a temporary designation, to give time for better solutions, not a permanent

shelter against competitive forces. Also, any decision to suspend competition is subject to market rules, a transparent process, opportunities for appeal, and judicial oversight.

Wind and solar power have no fuel cost and very low operation and maintenance costs compared with fossil-fueled competitors. In a competitive market, renewable generation will be used before costlier and more polluting fossil generation, especially those that are least efficient and flexible.

Solar is already having an impact on wholesale market prices in CAISO. Figure 4 shows that over the past few years prices have fallen in the middle of the day as large amounts of solar are generated, but are rising in the morning and evening as gas power plants and imports are used to meet peak demand periods.²⁷

California has the largest portion of its power from solar of any US region (except Hawaii) so is seeing the effects on wholesale markets first. But as solar grows, the same effects can be expected to emerge in other regions, including in a Western RTO. Arizona, Nevada,

²⁷ Energy Information Administration, “California wholesale electricity prices are higher at the beginning and end of the day,” July 24, 2017, <https://www.eia.gov/todayinenergy/detail.php?id=32172>

and Utah already have large amounts of solar installed, ranking third, fourth, and sixth nationally. Recent bids in Colorado show that solar is one of the least cost sources of new generation. As of 2016, Western states made up five of the top six solar states per capita, according to the Solar Energy Industries Association.²⁸

A regional RTO will be better able to move this electricity around to reach consumers, including consumers in California, thus lowering the cost of achieving the high renewable energy goals that have been set or contemplated. Moreover, using low-cost renewables from other states will help displace fossil-fuel plants within California, reducing pollution in state. Exporting surplus renewables from California will also help cut emissions elsewhere.

Lastly, a regional grid will also enable easier export of mid-day California solar power to other states that is now curtailed during many hours because there is not enough demand to absorb it. These exports would create the same market price impact in other states that they are creating in California, if there were a broader western market.

The Case Against Regionalization

Opponents of regionalization include labor groups, the Sierra Club, The Utility Reform Network (TURN), some municipal utilities, and the Clean Coalition.

Opponents are skeptical of the forecasted benefits and argue that regionalization would make California's hard-won climate goals vulnerable to other states' dirtier power mixes. They also worry a regional system will make California vulnerable to the authority of the Trump-appointed Federal Energy Regulatory Commission (FERC), and encourage construction jobs to move out of state.

1. It Raises Governance Risks

Governance is a primary concern about California being part of a regional RTO.

According to TURN and other opponents, under the expansion proposal, California's elected leadership would no longer have any direct role in selecting or approving RTO board members and the resulting board would, in their view, have no obligations or accountability to California government.²⁹

Currently, CAISO is overseen by a board that is appointed by the California governor, with the consent of the state Senate. The Board is responsible for reviewing and approving grid planning and market design changes, as well as the annual ISO budget and other ISO policies. If tariff changes are made, the Board submits those changes to FERC after stakeholders have had a chance to review and comment on the changes.³⁰

CAISO has no formal membership or voting opportunities for stakeholders. All meetings are open to the public and all materials are posted online, giving equal access to any participant, whether a utility or an activist. Because there is no formal voting process on issues,

28 Solar Energy Industries Association, "Top 10 Solar States," accessed May 2018, <https://www.seia.org/research-resources/top-10-solar-states>

29 TURN, Sierra Club, State Building and Construction Trades Council of California, California State Pipe Trades Council, Western States SMART, and California State Association of Electrical Workers, "Letter to the Honorable Christopher Holden, Re: AB 813 (CAISO regional expansion) – OPPOSE," June 4, 2018.

30 E4theFuture and Synapse Energy Economics, Regional Energy Markets: Do Inconsistent Governance Structures Impede U.S. Market Success?, July, 2016, <http://e4thefuture.org/the-future-of-net-metering-utilities-and-solar-companies-align>

the board decides on all CAISO matters, although FERC must approve CAISO's filings and any stakeholder can challenge a decision at FERC and federal courts.

The structure of the CAISO board has been contentious. Originally, the Energy Oversight Board, created by AB1890, was composed exclusively of California residents and representatives of eleven "stakeholder" classes. The legislature reformed CAISO in 2001 in the wake of the California power crisis, giving the governor the authority to appoint all five members. FERC challenged that arrangement on that grounds that "having CAISO run by a state appointed board conflicted with the principles... that ISOs should be independent of market participants." Because the state Department of Water Resources had become a major market participant during the power crisis, FERC saw a state-appointed board as conflicting with the prohibition on market participants. FERC took the step of recruiting new members and ordered CAISO to install them in place of its current board. California appealed and the DC Court of Appeals overturned that order, citing FERC's lack of authority.³¹

The court's ruling said that "If California stubbornly refuses to make CAISO conform to FERC's requirements for ISOs, then FERC can declare that CAISO is not an ISO, or threaten to do so. FERC has the authority not to accept something which it does not deem an ISO. It does not have the authority to reform and regulate the governing body of a public utility." FERC did not decertify CAISO, nor did it appeal the ruling.

In other RTOs, the board is independent from elected officials – and indeed from all stakeholders, according to their charters – with board members appointed by the board itself and approved by a vote of RTO members.³² While many allow the public to participate in RTO business activities, typically only paying members can vote. Stakeholders and members are organized into working groups that discuss and vote on recommendations to the board. Members are often sorted

into categories, such as generation owner, transmission owner, or customer, with voting rights weighted for each. All multi-state RTOs have a special committee for state regulators, such as SPP's Regional State Committee or the Organization of MISO States.

Nearly all RTOs, including CAISO, follow a process in which proposed changes are identified by the RTO or by stakeholders, the issue is reviewed and discussed in working groups comprised of interested parties, potential solutions to the problem are developed, and, if there is consensus around the solution, it is brought before the RTO governance body.

Critics complain that RTO rules that give authority to market participants like generation owners can stifle progressive change, and that California's many clean energy policies could be blocked by a regional RTO. However, FERC rules and orders require that decision-making authority is vested in an independent board, not in market participants. And FERC has ordered RTOs to take state policies into account for transmission planning, including clean energy and climate policy goals.

Some argue that the structure of decision-making in RTOs favors market incumbent and makes change difficult. A successful vote on a proposal can require coalitions and compromises to achieve even a simple majority vote in support. "This makes it easier to prevent change than to achieve change – an intentional feature for an industry that proceeds slowly and cautiously in everything that it does," according a report from E4theFuture, an energy advocacy nonprofit, and Synapse Energy Economics.

Others point out that the status quo often favors the interests of market incumbents who dominate the RTO stakeholder process. "Incumbent interests often run counter to reforms... especially those calling for expanded competition from advanced technologies," says a report from R Street, a Washington, DC think tank. "This produces gridlock at the expense of proactive market design and transmission-planning protocol reforms."³³

31 US Court of Appeals, *California Independent System Operator Corporation v. Federal Energy Regulatory Commission*, Decided June 22, 2004 (No. 02-1287), [https://www.cadc.uscourts.gov/internet/opinions.nsf/FD419E21FBEC2E4985256F82006D2F53/\\$file/02-1287a.pdf](https://www.cadc.uscourts.gov/internet/opinions.nsf/FD419E21FBEC2E4985256F82006D2F53/$file/02-1287a.pdf)

32 E4theFuture and Synapse Energy Economics, *ibid.*

33 Devin Hartman, R Street, *Wholesale Electricity Markets in the Technological Age*, August 2016, <https://www.rstreet.org/wp-content/uploads/2016/08/67.pdf>

However, a number of FERC orders have had the effect of countering the power of incumbents, such as 2011's Order 1000. The Order, among other things, ended the "right of first refusal" that let incumbent transmission utilities have priority over competing companies in developing a line proposed by a regional transmission plan.³⁴

E4theFuture stresses that all stakeholder activities are only advisory to their respective RTO board. "The 'independence' that FERC requires to approve an RTO includes independence from market participants (stakeholders)," they write. Importantly, that includes influence from state regulators and political entities as well. Indeed, RTOs have been the battleground for industry and political struggles to support or undermine certain resources, including current attempts by the Trump Administration to prop up uncompetitive coal and nuclear plants in the PJM region. The independence of the PJM board and staff provides at least some insulation from the pressure being applied.³⁵

Ultimately, it is FERC that approves or rejects tariffs and operating rules proposed by RTOs. Their decisions can be good or bad, depending on one's perspective. FERC has strongly supported the equal treatment of demand response and storage, for example, over the strong objection of some market participants, especially power plant owners who didn't welcome their competition.

On the other hand, FERC decisions around the California power crisis of 2000-2001 have left hard feelings among California stakeholders. FERC's weak response to the market manipulation by Enron and others led to provisions in the Energy Policy Act of 2005 which gave

FERC broad authority to ban fraudulent schemes. FERC created the Office of Enforcement, which has become an aggressive enforcer of market rules.³⁶ RTOs also have independent market monitors that serve as official watchdogs, auditing market functions in detail.

In past debates, governance has been a major barrier to the creation of a Western RTO, from policymakers both in and outside of California. When PacifiCorp proposed joining CAISO in 2016, there was strong opposition from regulators in other states to having representation on the board tied to a state's electricity load, since it would give California a virtual veto over any action.³⁷

Since CAISO is already under FERC jurisdiction, some argue that nothing would change. But others think that a Trump-appointed FERC would move to block progressive California policies, as the administration has done with California's clean vehicle standards. However, FERC is an independent agency, and unanimously rejected recent proposals by the Department of Energy to give extra payments to struggling coal and nuclear plants that store fuel on site, in the name of "resiliency." However, even independent agencies are not immune to political pressure, and future decisions may not be so independent or clear-cut.³⁸

FERC also has limited powers under the Federal Power Act of 1935. The Act initially created a "bright line" of jurisdiction – FERC oversaw wholesale and interstate markets, states regulated retail markets – but technology and regulatory changes since then have blurred the distinction, creating new jurisdictional issues and tensions. Distributed energy technologies, for example, function at the retail level but can directly affect wholesale markets. FERC rulings on demand response have

34 Scott Hempling, Attorney at Law LLC, *Order 1000 Narrows the "Right of First Refusal": Will Regional Planning be Cost-Effective and Nondiscriminatory?*, April 2012, http://www.scotthemplinglaw.com/files/pdf/ppr_memo_rofr_hempling05032.pdf

35 Gavin Bade, "Trump administration preparing 2-year coal, nuke bailout," *Utility Dive*, June 1, 2018, <https://www.utilitydive.com/news/trump-administration-preparing-2-year-coal-nuke-bailout/524788/>

36 Shaun Ledgerwood and Gary Taylor, "Enron's California schemes haunt regulators 15 years later," *Risk.net*, January 14, 2016, <https://www.risk.net/commodities/energy/2441392/enrons-california-schemes-haunt-regulators-15-years-later>

37 See Footnote 2 from Sarah Edmonds, above.

38 David Roberts, "Trump's crude bailout of dirty power plants failed, but a subtler bailout is underway: A look at some ominous goings-on in FERC," March 23, 2018, <https://www.vox.com/energy-and-environment/2018/3/23/17146028/ferc-coal-natural-gas-bailout-mopr>

already by adjudicated by the US Supreme Court.³⁹

There are a number of checks and balances built into the RTO-FERC regulatory process. Any stakeholder can make an alternative filing in any case if they don't like what their RTO files. If they don't like FERC's ruling, any stakeholder may appeal to the courts. And they certainly do – as of March 30, 2018, there were 134 appeals pending.⁴⁰

The last resort from a state that disagrees with an RTO decision is to prohibit their retail distribution utilities from being members of the RTO. However, all utilities who have FERC jurisdictional transmission, whether a member of an RTO or not, are subject to FERC rulings.

CAISO is testing regional governance structures with their Energy Imbalance Market (EIM). The EIM has its own governance with independent board members nominated by a committee of stakeholders and approved by the current board, though it is supervised by the CAISO board. To date no significant conflicts between the two boards have arisen.

AB813

Legislation now pending in the legislature, AB 813, seeks to address governance issues by setting the rules that would authorize California utilities' participation in a multistate regional transmission system organization.⁴¹ It was prompted by SB350 and builds on a governance proposal that CAISO presented in October 2016.

While the bill is still evolving, as of mid-June the bill laid out a set of 17 principles that must be met before state regulators will let California power companies join. To participate in the market, California companies would have to meet a series of requirements from FERC and from California, including carbon emissions accounting and distributed energy policies. It would require participants to follow "resource adequacy" rules, signing

contracts for all expected load plus a reserve margin, but would prohibit a centralized capacity market.

In addition to a new independent board, it would establish a "Western States Committee," with three representatives from each state that has a transmission operator participating in the RTO, to "provide input" to the board. Participation in RTO meetings would be open to the public without membership fees, with the same participation and transparency practices that CAISO currently follows.

Importantly, the bill seeks to "Protect and preserve a state's authority over matters regulated by the state, including procurement policy, resource planning, and resource or transmission siting within the state."

Some details are left to CAISO "to develop and refine this proposal, subject to its public process." Whatever is decided by that public process must then be approved by California state agencies before utilities may join.

For example, AB813 does not say whether voting rights for the Western States Committee would be apportioned one per state or based on their market share. Since California accounts for 27 percent of sales in the Western Interconnect, it may have to pay a larger share of operating expenses and therefore might want a bigger say in decisions.

Proposals during the consideration of the CAISO-PacifiCorp integration to have a weighted voting system were put on hold due to opposition from other states. "Weighted voting for the Western States Committee seems to be a deal requirement for California, yet could very likely be a deal breaker for other Western states," noted Jennifer Gardner of Western Resource Advocates.⁴² Gardner suggested having different voting rules based on the type of decision being considered.

Other parties recommended not having regional representation at all. San Diego Gas & Electric points out that the primary mission of an RTO is to ensure fair and

39 Jeffery S. Dennis, Suedeem G. Kelly, Robert R. Nordhaus, and Douglas W. Smith, Federal/State Jurisdictional Split: Implications for Emerging Electricity Technologies, Lawrence Berkeley National Laboratory, LBNL-1006675, December 2016, <https://www.energy.gov/sites/prod/files/2017/01/f34/Federal%20State%20Jurisdictional%20Split--Implications%20for%20Emerging%20Electricity%20Technologies.pdf>

40 FERC, "Pending Cases," as of March 30, 2018, <https://www.ferc.gov/legal/court-cases/pend-case.asp>

41 Assembly Member Holden, *AB-813 Multistate regional transmission system organization: membership*, introduced February 15, 2017 with amendments, accessed May 4, 2018, https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB813

42 Jennifer Gardner, Western Resource Advocates, *Western States Committee Voting Considerations*, CEC Docket number 16-RGO-01, September 19, 2016, http://docketpublic.energy.ca.gov/PublicDocuments/16-RGO-01/TN214078_20161017T160051_Western_States_Committee_Voting_Considerations.pdf

functioning markets and non-discriminatory transmission planning. “This mission has little to do with geography and everything to do with independence, vision and expertise.”⁴³ The charters of other RTOs have similar requirements; the boards of PJM and MISO, for example, consist mostly of retired energy executives, financial experts, and people who live outside their respective regions. But as mentioned previously, RTOs do have advisory bodies that give state regulators a prominent voice.

2. It Could Limit the Influence of State Stakeholders and Policies

Critics of the regional plan argue that if the CAISO becomes an independent regional entity, there would be greater risk that other states could undermine California policies.⁴⁴

A regional RTO would have to take into account the policy needs of all Western states, based on principles established in its charter. It would have less ability to coordinate solely with California entities to develop and meet state policy goals. An example of how RTO actions can incorporate state policies is presented in the sidebar, “RTO-State Collaboration: A Case Study.”

The principal California agencies concerned with energy regularly collaborate and coordinate on policy and planning. As required under 1996’s AB 1890, electric infrastructure planning in California is split among the Energy Commission (CEC), the Public Utilities Commission (CPUC), and CAISO.⁴⁵ Their tasks include long-term forecasting in the CEC’s biennial Integrated Energy

Policy Report (IEPR), the CPUC’s biennial Long Term Procurement Plan (LTPP), and the CAISO’s annual Transmission Planning Process (TPP). The three agencies set up a Joint Agency Steering Committee (JASC) to ensure regular communication on planning coordination.

Critics point to a number of cases in other states that have demonstrated tension between independent RTOs and state policy objectives.

- **North Dakota v. Heydinger** – In this case, Minnesota’s Next Generation Energy Act was seen as trying to regulate the carbon emissions of coal plants in both Minnesota and neighboring states that serve Minnesota customers. It was successfully challenged in the 8th Circuit Court on the grounds that it violated the interstate commerce clause.⁴⁶
- **Energy & Environmental Legal Institute (EELI) vs. Epel** – In this case, the Colorado renewable portfolio standard was challenged as a violation of the interstate commerce clause. In upholding the law, the 10th Circuit Court said that “non-price standards for products sold in-state” were intended to create benefits for Colorado citizens that outweighed the burden put on interstate commerce, and that the law affected in-state and out-of-state producers equally. The opinion was written by Judge Neil Gorsuch, now on the US Supreme Court.⁴⁷

43 California Energy Commission, *Summary of Stakeholder Comments to Second Revised Proposal Principles for Governance of a Regional ISO, 10/07/16*, Docket 16-RGO-01, December 1, 2016, http://docketpublic.energy.ca.gov/PublicDocuments/16-RGO-01/TN214600_20161201T100347_Summary_of_Stakeholder_Comments_to_Second_Revised_Proposal_Date.pdf

44 Wenonah Hauter, “Opinion: California must retain control of its electric grid,” *San Francisco Chronicle*, June 6, 2018, <https://www.sfchronicle.com/opinion/openforum/article/California-must-retain-control-of-its-electric-12973810.php>

45 CPUC, CEC and CAISO Staff, *Alignment of Key Infrastructure Planning Processes*, December 23, 2014, http://www.caiso.com/Documents/TPP-LTPP-IEPR_AlignmentExplanatoryText.pdf

46 *North Dakota v. Heydinger*, No. 14-2156 (8th Cir. 2016), <https://law.justia.com/cases/federal/appellate-courts/ca8/14-2156/14-2156-2016-06-15.html>. The Natural Resources Defense Council (NRDC) argues that the court was “concerned about the control that the Minnesota statute would exert on ‘non-Minnesota entities and transactions.’” California laws on power plant emissions and renewables (SB1368 and the California RPS) “only regulate transactions entered into in order to serve California customers,” they point out, and do not make “distinctions between in-state and out-of-state generators.” Allison Clements and Miles Farmer, NRDC, “California Clean Energy Laws Do Not Violate Commerce Clause,” June 29, 2016, <https://www.nrdc.org/experts/allison-clements/california-clean-energy-laws-do-not-violate-commerce-clause>

47 *Energy & Environmental Legal Institute (EELI) vs. Epel*, No. 14-1216 (10th Circuit, 2015), <http://www.lawandenvironment.com/wp-content/uploads/sites/5/2015/07/14-1216.pdf>

- **Hughes vs. Talen**⁴⁸ - A developer proposing a new gas-fired plant in Maryland was unsuccessful in their bids to get paid in the PJM capacity market, so Maryland regulators went “out of market” to give the developer a subsidy that allowed it to succeed in the PJM market, so they could build the in-state plant. This tactic was challenged by competitors, struck down by a district court, and confirmed by a unanimous decision of the US Supreme court, in *Hughes vs. Talen*. The Maryland action, the Court wrote, “sets an interstate wholesale rate, contravening the [Federal Power Act’s] division of authority between state and federal regulators.” The court went on to clarify that “Neither Maryland nor other States are foreclosed from encouraging production of new or clean generation through measures that do not condition payment of funds on capacity clearing the auction.”

A FERC ruling from 2011 shows how states can encourage certain generators without running afoul of wholesale market rules. A California law on combined heat and power (CHP) plants (AB 1613) directed the CPUC to create a fixed price for their output, which the commission set higher for more efficient CHP plants. California utilities challenged the rule, but FERC upheld it, agreeing that “the concept of a multi-tiered avoided cost rate structure is consistent” with federal law. They said the decision “simply reflects the reality that states have the authority to dictate the generation resources from which utilities may procure electric energy.”⁴⁹

Yale researchers point out that interstate commerce challenges would remain whether California is in a regional RTO or not, since “wholesale sales and transmission of electricity in the CAISO footprint are already treated as forms of interstate commerce.”⁵⁰ Colorado, for example, is not part of an organized RTO. The Yale study concluded that there would be no additional legal risks to California policy under a Western RTO.

This tension between state policies and wholesale markets shows no sign of abating. Illinois and New York have both created new subsidies for existing nuclear plants in the form of zero emission credits (ZECs). Their move was spurred partly to avoid losing large zero-emission generators, which would undermine their carbon reduction goals, and partly to avoid the local economic impacts that plant closures would cause. These actions are being challenged by other generators as violating the principles of competitive regional markets.⁵¹

Currently, coal and nuclear plant owners in the PJM region are seeking help from the US Department of Energy (DOE) to support their plants that are losing out to lower-cost natural gas power, wind power, and demand response, as energy efficiency gains keep demand flat. DOE proposed that FERC create new reliability standards that would reward power plant owners for keeping a 90-day supply of fuel on site, but FERC unanimously rejected the idea. Plant owners are lobbying PJM heavily to create new revenue opportunities for conventional generators.⁵² As of this writing, DOE is considering invoking the Defense Production Act, a Korean War-era law that allows the agency to support certain power plants for “national security” reasons.⁵³

48 Supreme Court of the United States, *Hughes, Chairman, Maryland Public Service Commission [sic], et al. v. Talen Energy Marketing, LLC, FKA PPL EnergyPlus, LLC, et al.*, No. 14–614, Decided April 19, 2016, https://www.supremecourt.gov/opinions/15pdf/14-614_k5fm.pdf

49 Federal Energy Regulatory Commission, Order Denying Rehearing, 134 FERC ¶ 61,044, Dockets No. EL10-64-002 and EL10-66-002, Issued January 20, 2011, <https://www.ferc.gov/whats-new/comm-meet/2011/012011/E-13.pdf>

50 Juliana Brint, Josh Constanti, Franz Hochstrasser, and Lucy Kessler, *Enhanced Western Grid Integration: A Legal and Policy Analysis of the Effects on California’s Clean Energy Laws*, May 2017, https://law.yale.edu/system/files/area/clinic/document/yaleeepc_enhanced_western_grid_integration_may_2017.pdf

51 Jared Anderson, “Oral arguments heard in New York ZEC case, state subsidies in spotlight,” *Platts*, March 12, 2018, <https://www.platts.com/latest-news/electric-power/newyork/oral-arguments-heard-in-new-york-zec-case-state-21543045>

52 Gavin Bade, “PJM files competing capacity market reforms at FERC,” *Utility Dive*, April 10, 2018, <https://www.utilitydive.com/news/pjm-files-competing-capacity-market-reforms-at-ferc/520982/>

53 Gavin Bade, “Trump administration preparing 2-year coal, nuke bailout,” *Utility Dive*, June 1, 2018, <https://www.utilitydive.com/news/trump-administration-preparing-2-year-coal-nuke-bailout/524788/>

This approach, if carried out, would affect all US power plants, not just those in organized RTO markets. Since California gets about 10 percent of its power from coal plants across the West currently, California consumers could also be affected, even without a regional RTO.

In March, the Utah legislature approved \$1.65 million to fund a lawsuit challenging California's climate laws, specifically SB1368 and AB32. The move was inspired in part by their impacts on the Intermountain Power Plant, which is partly owned by the Los Angeles Department of Water and Power (LADWP). LADWP has announced plans to convert the plant from coal to gas by 2025, resulting in a loss of operating jobs at the plant and nearby coal mine. It was also inspired by the success of *North Dakota v. Heydinger*, mentioned earlier, in overturning a Minnesota law on carbon emissions.⁵⁴

Traditionally FERC has put a very strong emphasis on promoting competition, and has viewed environmental and other state policies through that lens. "It is national policy to support competitive wholesale power markets," they write.⁵⁵ When FERC does interfere in state policy decisions it is on the grounds of preserving competition, not because the policies are aimed at environmental performance. Presumably, clean energy policies that are compatible with competition will be less likely to run afoul of FERC oversight.

3. It Could Increase Sales by Regional Coal Plants

Sierra Club and others have raised concerns that a regional RTO could facilitate sales for Western coal plants, thus increasing their use and associated greenhouse gas emissions.

Under standard market theory and uniform RTO practice over the history of these institutions, low-cost generators are dispatched more than higher cost generators. A regional RTO would expose uncompetitive plants to greater competition, they would see dwindling revenues, and would be shut down. Large old coal plants, some built right next to coal mines, can have very low operating costs – especially if they can avoid the need to upgrade to modern pollution controls. But if wind, solar, and gas plants have lower marginal costs, they would be called on more than old coal plants.

Sierra Club has raised concerns from other regions that utility-owned coal plants may run more even if an RTO delivers lower market prices. For example, in a recent study they concluded that several utilities in the Southwest Power Pool (SPP) are distorting the market by running their own coal plants instead of taking advantage of lower cost resources. Up to 40 percent of power in SPP comes from coal plants that are "self-committed" by their utility owners. When a plant is self-committed, the owner takes whatever the market price allows, rather than bidding based on the marginal economic costs of those units. Unlike unregulated merchant power plants, who bear the direct impacts of market prices, utility-owned plants have captive customers, and their finances are subject to oversight by state regulators or by the boards of publicly-owned utilities. Sierra Club is concerned that regulators may be slow to respond to market forces and shut down uneconomic plants.⁵⁷

54 Memo from Denise Dragoo, Snell and Wilmer Law Offices, to Utah Rep. Michael Noel, Re: Legislative Appropriation for Lawsuit Challenging California's Carbon Surcharge and Ban on Coal-Fired Electric Generation (Privileged and Confidential), February 9 2018, <https://le.utah.gov/interim/2018/pdf/00001589.pdf>; Brian Maffly, Salt Lake Tribune, "Lawmakers considering spending millions to sue California and fight the 'war on Utah coal'," February 18, 2018, <https://www.sltrib.com/news/environment/2018/02/16/lawmakers-considering-spending-millions-to-sue-california-and-fight-the-war-on-utah-coal/>; Salt Lake Tribune, "Editorial: Utah's Legislature passes a win, and a loss, for the environment," March 10, <https://www.sltrib.com/opinion/editorial/2018/03/10/tribune-editorial-utahs-legislature-passes-a-win-and-a-loss-for-the-environment/>

55 FERC, "Addressing the 2000-2001 Western Energy Crisis," accessed May 2018, <https://www.ferc.gov/industries/electric/indus-act/wec.asp>

56 Total System Electric Generation. Data at http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html

57 Joe Daniel, *Backdoor Subsidies for Coal in the Southwest Power Pool*, Sierra Club, December 5, 2017, <https://www.sierraclub.org/sites/www.sierraclub.org/files/Backdoor-Coal-Subsidies.pdf>

A CASE STUDY

RTO-STATE COLLABORATION

Since many of state policy conflicts raised by opponents of a Western RTO are speculative, it may help to offer a case study on how state policies can interact with a regional RTO. One clear example is from the transmission planning process of the Midcontinent ISO (MISO).⁶⁰ Starting in 2008, MISO undertook a regional transmission expansion plan to incorporate state policies, anticipate the growth of wind power, and respond to other regional planning discussions between states.

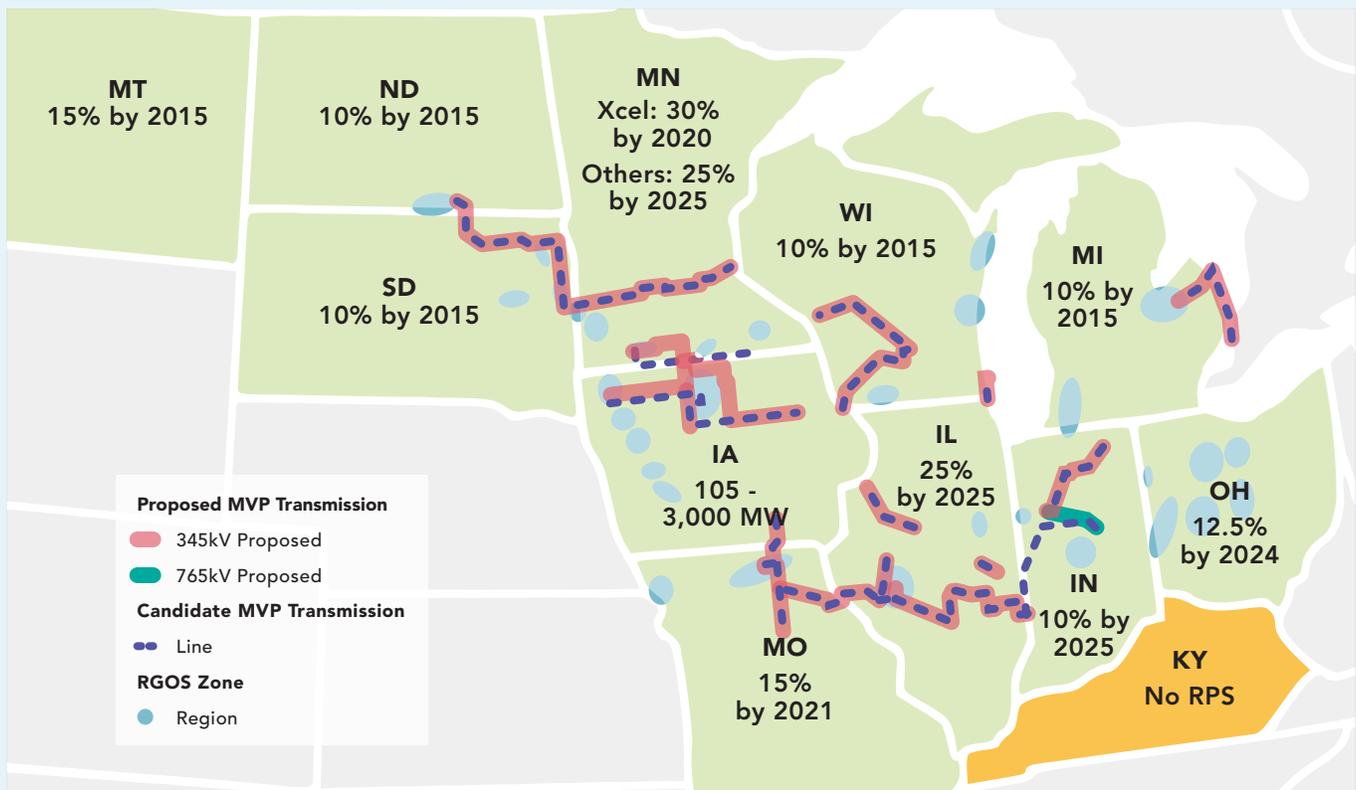
To estimate how much and where the wind power might be developed, MISO relied on state renewable portfolio standards (RPS) and resource assessments of

windy land in relation to load. As shown in Figure 7, almost every state had RPS goals, adding up to 23.5 gigawatts of wind power demand. (Planning assumed only wind power, which was the lowest cost renewable resource in the region.)

The next step was to plan for where the wind might be developed, in anticipation of future interconnection requests. Figure 5 shows wind resource areas in blue, and proposes new transmission needed to serve them.

Based on this analysis, MISO approved a set of 17 “multi-value projects” with a total capital cost of \$5.2 billion, and a benefit to cost ratio ranging from 1.8 to 3.0. MISO then allocated costs to all MISO customers to pay for the development.

FIG 5 State RPS Laws Used in MISO Transmission Planning & MISO Wind Resource Areas and Transmission Plans



Source: MISO^{58 59}

58 MISO Wind Resource Areas and Transmission Plans.

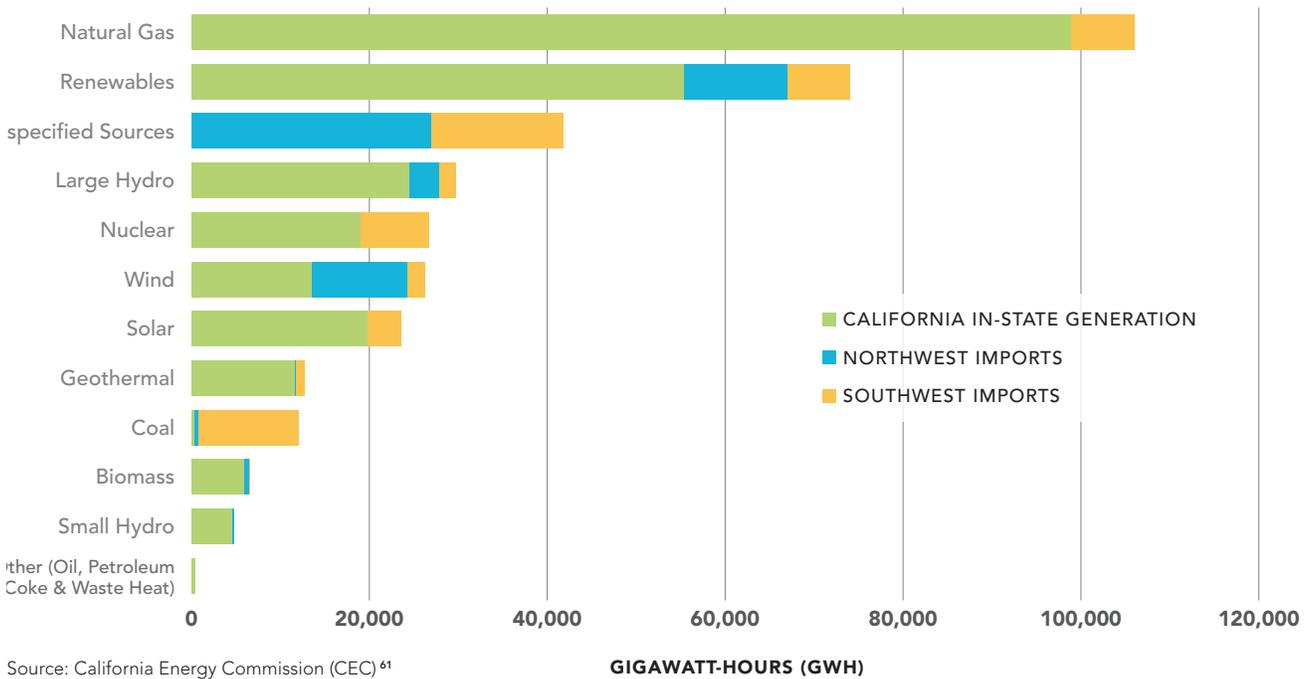
Available at <https://cdn.misoenergy.org/2011%20MVP%20Portfolio%20Analysis%20Full%20Report117059.pdf>.

59 Multi Value Project Portfolio. Available at <https://cdn.misoenergy.org/2011%20MVP%20Portfolio%20Analysis%20Full%20Report117059.pdf>

60 MISO, Multi Value Project Portfolio Results and Analyses, January 10, 2012,

<https://cdn.misoenergy.org/2011%20MVP%20Portfolio%20Analysis%20Full%20Report117059.pdf>

FIG 6 Generation Sources from California, Northwest and Southwest, 2016



Source: California Energy Commission (CEC)⁶¹

In 2016, California was a net importer of about one-third of its power from generators in the Southwest and Northwest, as shown in Figure 7. A significant portion of imports are from “unspecified sources,” made when there is surplus generation on the spot market that is less expensive than California plants. While these sources are not tracked, the CEC says that much of the Pacific Northwest unspecified power comes from surplus hydro and newer gas-fired power plants. The Southwest spot market purchases are typically comprised of new combined cycle natural gas and some coal. Coal accounted for less than nine percent of total state demand in 2016. Coal power demand by California retailers is scheduled to decline as the Los Angeles Department of Water and Power (LADWP) gets out of coal by 2025.

Coal power has declined in the West since 2001, falling from 230 million to 168 million MWh, even as total generation has risen. Overall, coal fell from 37 percent of total generation to 23 percent.⁶²

California tracks and regulates carbon emissions from the power sector, under AB32 and SB32. As shown in Figure 8, power sector emissions have been falling steadily since 2008, driven by higher energy efficiency standards, the Renewable Portfolio Standard (RPS), and carbon pricing in the cap-and-trade program. The greenhouse gas (GHG) intensity of imported electricity has been declining steadily over time, while the GHG intensity of in-state electricity has been relatively constant.⁶³

Current RPS requirements are set at 50 percent by 2030, while proposed legislation (SB100) would increase the target to 60 percent by 2030 and 100 percent “clean energy” by 2050. As a result, there may be limited space for increased coal in the portfolios of California utilities, retailers, and community choice aggregators.

However, Sierra Club points out that utilities in other states may get around California climate policies by exporting their clean energy to California and consuming coal-fired power within the state – “resource shuffling”

61 Total System Electric Generation. Data at http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html

62 Energy Information Administration (EIA), Electricity Data Browser, <https://www.eia.gov/electricity/data/browser>.

63 California Air Resources Board, California GHG Emission Inventory: 2000 – 2015 (2017 Edition), June 6, 2017, https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2015/ghg_inventory_trends_00-15.pdf

– resulting in no change to their generation mix and no reduction in pollution. PacifiCorp, for example, has substantial amounts of both wind and coal, and could easily shuffle the power around to their retail utilities in five states as needed.⁶⁴ Of course, since these utilities sell power into the CAISO market today, they may already be doing this.

The SB350 regionalization study predicted a small decrease in carbon emissions in California and across the West due to regionalization, compared to reductions already expected due to state and federal policies, coal plant retirements, and the growth of renewables. State emissions would fall an additional 8 percent, while Western grid emissions would fall about 3 percent.⁶⁵ However, critics of the study noted that much of the assumed decrease in emissions was the result of an additional 5,000 MW of wind that were assumed to be developed as a result of regionalization. That wind was an input to the model, not an output.

4. It Could Shift Jobs to Other States

TURN and labor groups have claimed that one unique feature of California’s renewable portfolio standard (RPS) would be threatened by a regional RTO. The RPS uses a system of three “buckets” to prioritize electricity and renewable energy credits (RECs) delivered directly into CAISO over out-of-state generation that is not directly delivered. The “bucket one” requirement for direct delivery of power and RECs has risen to 75 percent of the total RPS requirement.⁶⁷ If CAISO became a regional RTO, TURN argues, renewable generation anywhere in the RTO would count as bucket one, reducing the incentive to develop projects in or near California. This would shift renewable energy project construction jobs to other states.⁶⁸

FIG 7a GHG Emissions from the Electric Power Sector

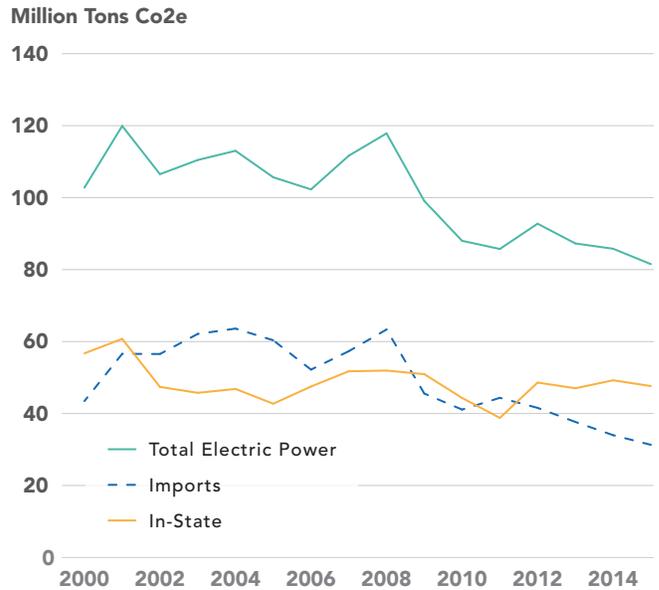
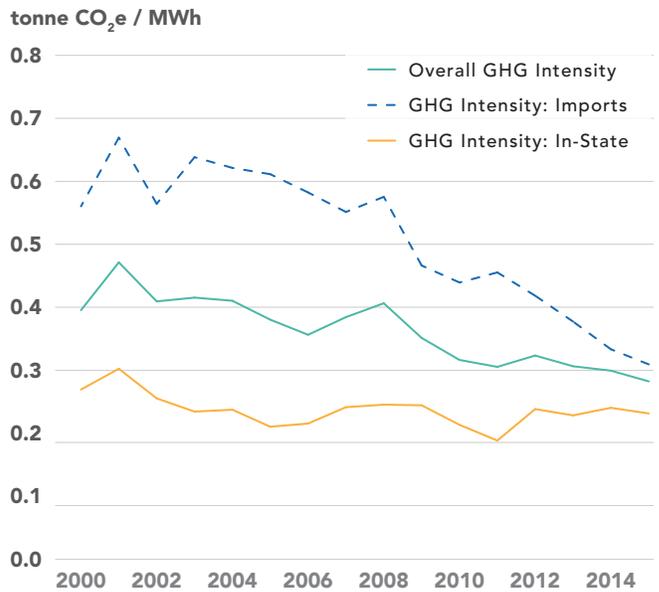


FIG 7b GHG Intensity of Electricity Generation



Source: CARB⁶⁶

64 Sierra Club, *CAISO & PacifiCorp Market Integration Plan May Bring Coal To California*, undated, https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org/creative-archive/files/pdfs/1077-CAISO-FactSheet_06_low.pdf

65 See footnote 10.

66 CARB GHG Inventory. Available at <https://www.arb.ca.gov/cc/inventory/data/data.htm>.

67 CPUC, 33% RPS Procurement Rules, accessed June 2018, http://www.cpuc.ca.gov/RPS_Procurement_Rules_33/.

68 TURN, Sierra Club, et al., *ibid*

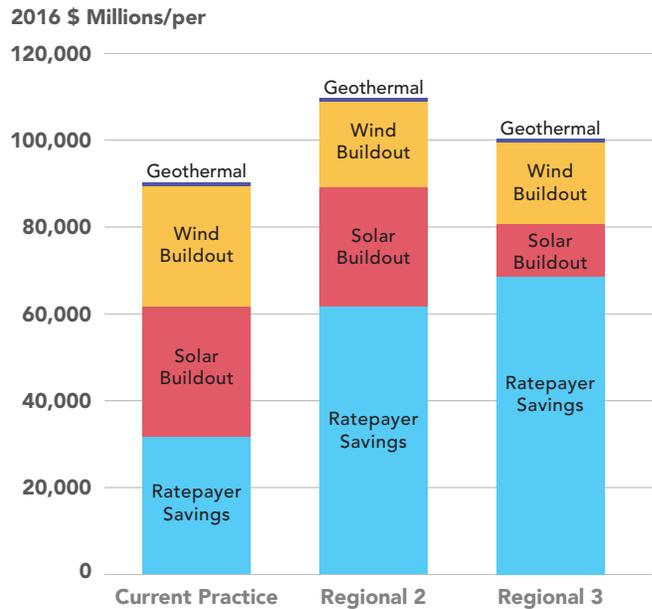
The SB350 regionalization studies looked at job creation, finding that in-state job creation was affected by overall costs to ratepayers, by procurement practices that focused on in-state development, and whether grid operations were state-focused or regional.⁶⁹

In the “Current Practice” base case shown in Figure 8 – that is, under current procurement practices and grid operations and no regional RTO – the growth of renewable energy was expected to create about 90,000 jobs in California. About 35,000 of the new jobs would come from lower electricity prices, since they would reduce business expenses and induce job creation across the whole state economy. This scenario sees about 11 GW of in-state renewables development, compared to 5.5 GW out of state.

The most total jobs were created under a regional RTO scenario with current procurement practices but regional operations (“Regional 2”), largely due to 60,000 jobs induced by lower prices. Renewable energy deployment and jobs were about the same as in Current Practice. The “Regional 3” scenario, with regional procurement and regional operations, resulted in half as much in-state renewables development and fewer in-state construction jobs, but the highest number of induced jobs through ratepayer savings.

TURN and others saw that a sensitivity scenario (Scenario 1b), with no regional RTO but more exports, was better for in-state construction jobs.⁷⁰ That case is the same as Current Practice but assumes four times as much export capacity, so results in 20,000 more in-state construction jobs by 2030, and 9,200 more jobs than the Regional 3 case. However, the report authors considered this scenario “an extreme bookend” and “extremely unlikely given the operational and market barriers that exist in the West.”⁷¹

FIG 8 Statewide Jobs Created from Regionalization



Source: CAISO⁷¹

5. There are Other Ways to Integrate Renewables

As detailed in the appendix, California has many options for integrating higher levels of renewables into a reliable power supply. These range from supply side options like using more diverse renewable generation technologies to demand side options like energy efficiency and rate design.

Some argue that relying more on distributed energy resources (DERs) than on regionalization could improve reliability, create more jobs in California, and capitalize on the state’s competitive advantage in advanced technology. On the other hand, that approach could cost substantially more than regional solutions, increasing prices for consumers. Under an expanded RTO, California could still incorporate greater utilization of DERs to optimize the grid.

69 David Roland-Holst, et al., Berkeley Economic Advising and Research, Senate Bill 350 Study, Volume VIII: Economic Impact Analysis, July 8, 2016, <https://www.caiso.com/Documents/SB350Study-Volume8EconomicImpacts.pdf>

70 TURN, Sierra Club, et al., *ibid.* The position paper cites “110,000 jobs” that would be lost to other states, but that is derived by taking the 9,200 jobs in 2030 from Scenario 1b and multiplying by 12 years (from 2018 to 2030). That is more accurately referred to as “job-years,” not “jobs.”

71 Senate Bill 350 Study, Economic Impact Analysis. Available at <https://www.caiso.com/Documents/SB350Study-Volume8EconomicImpacts.pdf>.

The CLEAN Coalition, based in Menlo Park, argues for intensification of the grid rather than expansion. They call for a network of dedicated distribution system operators (DSOs) to manage collections of DERs at the distribution level. "Rather than looking to an ever-larger central grid to provide control," they write, "a DSO-based energy system can manage load and generation locally to integrate complementary renewable technologies and optimize use of the resources already in place."⁷²

Increasing imports from distant generators, they argue, would require new transmission lines that are vulnerable to outages from weather, fires, and other insults, reducing reliability. Distributed energy, on the other hand, can be configured to operate even if there are grid outages.

DERs can also enable more in-state generation by taking over integration tasks. Energy storage, especially, would enable greater deployment of in-state solar energy, shifting its power from afternoons to early evenings, and reducing the need for imported electricity. Battery storage prices have been steadily falling, largely due to growing demand from the electric vehicle sector. Bloomberg New Energy Finance reports that lithium-ion battery prices fell 73 percent between 2010 and 2016, and could fall by another two-thirds by 2030.⁷³

Two California laws mandate the deployment of over 1,800 MW of storage deployment, making the state a national leader. The CPUC's Self Generation Incentive Program (SGIP) will provide over \$400 million in funding for storage systems over the next three years. And additional bills are pending in the legislature to create further deployment.

California is investing a great deal of effort in policy development, financial incentives, and deployment of distributed energy resources (DERs), making it a world leader. California has more distributed solar, more stationary batteries, and more electric vehicles than

any other state. Distributed energy technologies are a major export product for California firms, with significant potential for growth.⁷⁴

Despite their potential, one major caveat to a DER-intensive approach is the likely higher cost compared to regionalization. Proponents argue that costs are falling rapidly and that distributed energy provides higher value to consumers. Opponents point to the higher cost of distributed generation compared to centralized wind and solar projects. Distributed resources can create savings and efficiencies that could counteract their higher individual costs, such as by reducing the need for new transmission lines. At present, however, DERs make up only a small portion of the state's overall energy supply. Large-scale integration of DERs as an alternative to a western RTO could not only be more expensive, it could take time to get there.

More precise planning to further integrate DERs could include developing comprehensive scenarios of deployment with varying levels of centralized and distributed technologies, in order to compare the costs and performance of each. This "production cost modeling" approach, used by consultants, labs, and academic researchers, matches the engineering capabilities of the technologies with electricity demand, requiring all load to be met at all times.

The studies commissioned by SB350 did not include a distributed scenario as an alternative to regionalization. And despite the significant body of research on future energy systems in California, there seems to be little such analysis of a highly-distributed power system. More research in this area could certainly help further understanding of cost-effectiveness for greater DER integration.

One study by UC researchers and others looked at scenarios for achieving an 85 percent carbon reduction in the WECC region.⁷⁵ It found that a combination

72 Doug Karpa, CLEAN Coalition, "Local Balancing Is the Key to California's Clean Energy Future. Regionalization Isn't," Greentech Media, February 21, 2018, <https://www.greentechmedia.com/articles/read/local-balancing-california-not-regional-integration#gs.B89uNsM>

73 Claire Curry, Bloomberg New Energy Finance, Lithium-Ion Battery Costs and Market, July 5, 2017, <https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf>

74 For more information on distributed energy, see the forthcoming companion Next10 report.

75 Ana Mileva, Josiah Johnston, James H. Nelson, and Daniel M. Kammen, "Power system balancing for deep decarbonization of the electricity sector," Volume 162, 15 January 2016, Pages 1001-1009, <https://www.sciencedirect.com/science/article/pii/S0306261915014300>

of low-cost solar PV and low-cost batteries delivered the cheapest option, beating out scenarios with more wind, nuclear, transmission, and other variables. This scenario was attractive because sunshine is widely distributed across the West, including near load, thus reducing the cost of transmission; sunshine is not as seasonably variable as wind power, reducing the need for seasonal or long-term balancing options; and solar output is mostly correlated to daily load patterns, making the short-term capability of batteries useful for meeting night-time loads.

This suggests that if solar and storage become cheap enough, they can be the backbone of our power supply, with less need for regional markets. However, the study did not focus on California specifically, did not drill down to assess costs and benefits at the distribution grid level, and did not differentiate between rooftop and utility-scale PV.

Another study by the Rocky Mountain Institute (RMI) looked at how Texas could balance very large amounts of wind and solar power without using natural gas power plants.⁷⁶

RMI modeled tens of millions of demand-side “flexibility assets,” including 4.2 million residential and commercial water heaters, 3.9 million home and business ceramic brick heat storage systems, 3.7 million ice energy air conditioner systems, 15 million household plug loads, and 11.5 million grid-responsive electric vehicles.

This increased renewables revenue by 36 percent, cut renewable curtailment by 40 percent, lowered peak demand by 24 percent, and reduced the “duck curve” evening ramps by 56 percent. Altogether it avoided \$1.5 billion in annual capital costs, along with \$400 million in avoided fuel costs and 6 million tons per year of carbon emissions, about 20 percent of state emissions.

A similar analysis for California would be useful.

There are also some more conventional alternatives that could provide short term gains. First, natural gas turbine manufacturers like GE and Siemens have developed new, more flexible turbines, capable of quicker startup and response. These turbines are being deployed now, but more could be deployed to replace existing, less efficient plants, providing greater flexibility within the California generation fleet. Also, California still hosts eight balancing areas, run by publicly-owned utilities like the Sacramento Municipal Utility District (SMUD), LADWP, and Imperial Irrigation District. Some of these balancing areas are already planning to join the EIM. If they consolidate with CAISO, it would boost state power coverage from 80 percent to 100 percent – while still staying inside state borders and avoiding governance issues.

Of course, DERs and transmission are not an either-or choice. A bigger regional market could facilitate the growth of DERs by helping integrate more rooftop solar, by paying DERs for wholesale grid services, and creating a bigger market for deployment. The current bi-level system of transmission and distribution will probably continue indefinitely, since both offer value to customers.

One last alternative to regionalization is to extend aspects of the Day-Ahead Market to the current EIM, which CAISO has recently proposed.⁷⁷ It would allow participating utilities to bid into the imbalance market a day in advance, and create new imbalance reserve product.

While this seems like a compromise that would be beneficial to California, there is a tipping point – the more integrated out-of-state utilities become in CAISO operations, the more their regulators will require representation in CAISO governance. While an EIM board may include non-California members, decision-making authority is still held by the CAISO board, which is appointed by the California governor.

76 Jeff St. John, “How ‘Demand Flexibility’ Could Boost Renewables and Save Texas Billions,” Greentech Media, February 14, 2018, <https://www.greentechmedia.com/articles/read/demand-flexibility-could-save-texas-billions-boost-renewables#gs.ozIS3Dc>

77 CAISO, *Day Ahead Market Enhancements, Revised Straw Proposal*, April 11, 2018, <http://www.caiso.com/Documents/RevisedStrawProposal-DayAheadMarketEnhancements.pdf>

VI.

Conclusion

OUR goal for this paper has been to inform the debate about whether the California ISO should become part of a wider regional grid.

While this debate has been going on for decades, the success of CAISO's Energy Imbalance Market has increased the comfort level of regional utilities and regulators. Greater collaboration is yielding increasing amounts of savings for consumers, cutting emissions, and improving reliability.

The cost-effectiveness of wind and solar power, along with increasingly ambitious plans for their growth, has called the question on regionalization. A regional market, predicated on unfettered competition above all, could be the best way to integrate renewables. Or, as some fear, it could undermine the close coordination between state agencies and CAISO that is creating such

forward progress currently. The rapid evolution of distributed energy technologies is a wild card that argues both for and against committing to a regional vision.

The asymmetrical nature of the debate – technical and economic benefits versus governance issues – makes it difficult to compare arguments as equals. However, if California is to achieve its ambitious clean energy policies, rapid expansion of access to affordable, renewable energy will be critical. While avoiding entering into an expanded RTO may ensure the greatest amount of California's political independence, the very same market may provide the surest way for the Golden State to meet its clean energy goals affordably and reliably.

As state leaders weigh policy options to help California reach its clean energy goals, we hope that this summary may provide some insight into the tradeoffs and benefits that a regional western RTO may provide.



VI.

APPENDIX: How the Grid Works

Though the power system is often described as linear – from the generator through the power line to the customer – it is really better understood as a network. Every generator is connected to every electric appliance through a vast network of wires. By interconnecting everything, the grid taps into the awesome power of statistics to smooth out operations, thus reducing costs and improving reliability.

The map of the grid is not the same as a political map. Utility service territories, regional transmission organizations, and transmission lines can all cross state lines. Electricity flows where it is pulled along wires, and does not respect state boundaries.

The power industry started becoming regional in the 1920s, when the PJM Interconnection formed on the East coast, creating the world's first "power pool." A power pool was a way for utilities to share their power plants to reduce the costs of maintaining a reserve. Instead of building more power plants, utilities could buy from their neighbors in times of need, and cut their costs significantly. To facilitate sharing, utilities built major interconnecting transmission lines large enough to deliver power in case of a major generator outage.⁷⁸

The Public Utility Regulatory Policy Act (PURPA) of 1978 opened up generation to non-utility companies. In the late 1980s FERC introduced competitive auctions to power pools, while laws and FERC actions in the 1990s opened up access to transmission lines to all generators.

Competitive regional markets and open-access transmission turned informal pools into formal regional transmission organizations (RTOs). Each RTO (or ISO) developed a full-scale energy and ancillary services market in which buyers and sellers could bid for or offer generation, with winning bidders selling power to wholesale customers.

RTOs have operational control of the transmission system, are independent of their members, transparently manage transmission congestion, coordinate the maintenance of the generation and transmission system, oversee a transmission planning process to identify needed upgrades in both the near- and long-term, and set transmission access prices.

RTOs do not own transmission or generation assets, perform the actual maintenance on generation or transmission equipment, or directly serve end use customers.

HOW CAISO WORKS

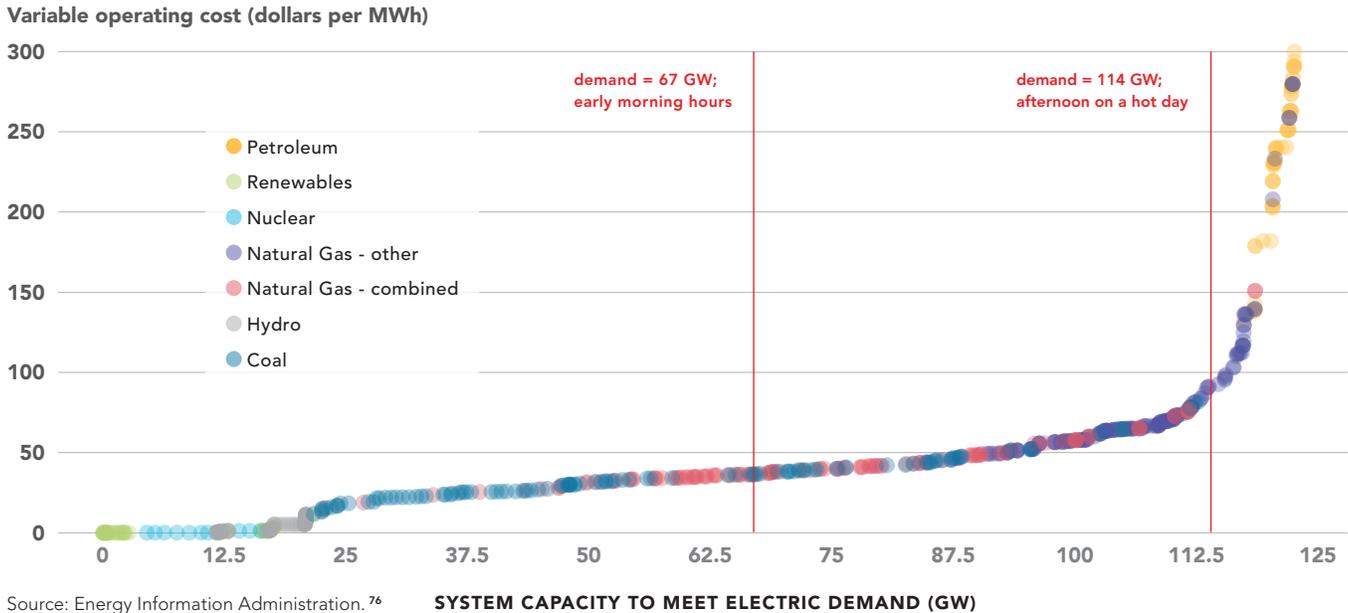
To run their California electricity market, first the CAISO estimates demand for upcoming days. Generation owners work through a broker (called a scheduling coordinator) to place bids in the day-ahead market for amounts and prices of generation. Coordinators can place bids up to seven days in advance, and the market closes the day before the power is to be delivered.

CAISO selects the generation bids based on price, from low to high, stopping when they have enough to meet the next day's demand, and taking into account grid congestion and reliability constraints. The last bid selected sets the price for all of the accepted bids.

In the hypothetical example shown in Figure A1, the prices bid by various generators are lined up in a "dispatch" curve, from low to high price. Renewables, nuclear, and hydropower tend to have very low variable operating costs, so their owners bid a low price. Coal and gas prices tend to reflect fuel costs and plant efficiency, which can vary widely, as well as compliance costs in states like California that regulate carbon emissions. On the day shown in the figure, demand ranges between 67 and 114 gigawatts, causing the price to shift from under \$50 per MWh to about \$100.⁷⁹

⁷⁸ For further reading, see FERC's 2015 Energy Primer, <https://www.ferc.gov/market-oversight/guide/energy-primer.pdf>

⁷⁹ Energy Information Administration, "Electric generator dispatch depends on system demand and the relative cost of operation," August 17, 2012, <https://www.eia.gov/todayinenergy/detail.php?id=7590>

FIG A1 How a Market Selects a Price

During the day of delivery, CAISO runs a real-time spot market, where utilities or retailers can buy power to meet the last few increments of demand not covered in their day ahead schedules. In CAISO, 95 percent of all energy transactions are scheduled in the day-ahead market, and the rest scheduled in real-time.

The day-ahead market also pays for reserves, which are power plants that are standing by for use if needed, and for energy needed to regulate the stability of the grid (called ancillary services).

Often a generator has a contract with a utility, power retailer, or large customer, rather than selling their power on the CAISO markets. But to preserve the functioning of the wholesale market, all power must be transacted through CAISO, even if the price and amounts are determined outside the CAISO market. These generators place a quantity bid with CAISO, but not a price bid, meaning they take whatever the clearing price is for that hour. (The generators and their customers make up the difference in cost later.)

Prices also vary by location, through a system called “locational marginal prices” or LMPs. CAISO tracks LMPs at about 5000 locations across the West.⁸¹ LMPs are often higher near cities, where demand for electric power is concentrated. Significant differences in LMPs across a region are usually caused by congestion, where a lack of transmission capacity prevents power from moving from lower-priced to high-priced areas.

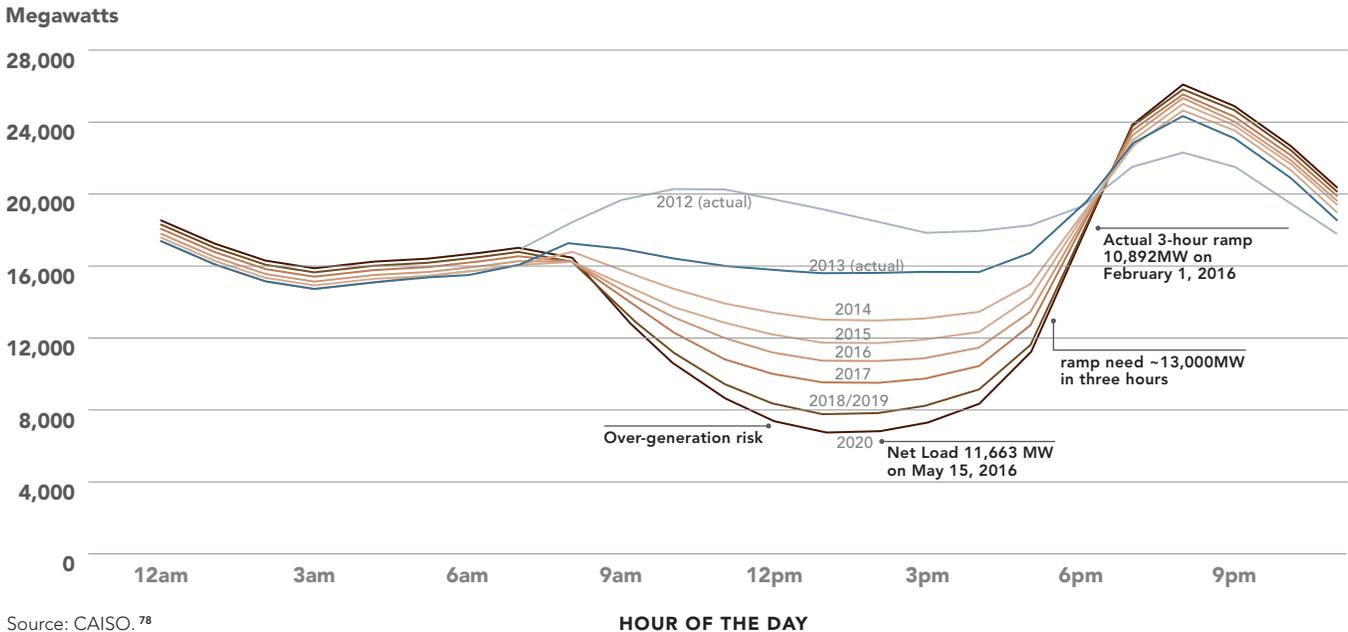
Prices can be very low, and sometimes even negative. Negative prices are not strictly a problem—they are just signals to market participants to generate less power or consume more—but if California’s clean energy and climate goals are to be met, they can create long-term complications. The solution to negative prices is to reduce generation, increase demand, or export the power to another region.

As wind and especially solar grow, there are already hours of the year when there is too much supply for existing demand. On spring afternoons, for example, when the snowmelt is coming off the Sierras, hydroelectric generation can be high. If it is sunny, solar output may be high, while spring winds may result in a lot

⁸⁰ Electric generator dispatch depends on system demand and the relative cost of operation. Available at <https://www.eia.gov/todayinenergy/detail.php?id=7590>.

⁸¹ CAISO market price maps, <http://www.caiso.com/PriceMap/Pages/default.aspx>.

FIG A2 The Duck Curve



Source: CAISO.⁷⁸

of wind power. At the same time, electricity demand is low, since Central Valley temperatures are mild and air conditioners are not running.

Too much generation poses a reliability threat to the grid, so the CAISO market sends price signals to generators to back down, in the form of low and negative prices, and can ask for “decremental bids” from generators, who get paid to turn down. Some natural gas generators may be needed in specific locations to supply support to the grid, and nuclear power plants tend not to reduce production unless there is an emergency or shut down.⁸³ So a growing amount of solar is being curtailed, or being paid to shut off, on those spring afternoons. This too is not a technical or financial problem, but it does waste zero-emission electricity that is needed to meet our clean energy and climate goals, and that could be exported more easily in a regional market.

NET DEMAND AND “THE DUCK”

As discussed earlier in the report, the growth of solar is causing significant operational changes in CAISO. There is so much solar now that grid operators have switched to managing California’s “net demand” – the total demand minus wind and solar generation, which are not controlled by grid operators. The net demand has been reshaped by solar especially, falling in the middle of the day, and rising rapidly in the evening.⁸⁴ This phenomenon, called the “duck curve” by CAISO, is shown in Figure A2.

The duck curve illustrates two issues for grid operators. The first is over-generation – the belly of the duck – where too much electricity is available in the middle of the day. Too much generation, like too little, can disrupt reliability. Some conventional power plants are needed to operate to maintain grid support, especially in certain locations. Other plants have contracts that allow them to run without regard to other generators or prices.

82 California ISO Fast Facts. Available at https://www.caiso.com/documents/flexibleresourceshelprenewables_fastfacts.pdf

83 There is an ongoing debate about whether nuclear power plants are technically capable of ramping up and down to meet changes in demand. Because they have very low operating costs compared to coal and gas plants, they have traditionally run at or near full capacity as “baseload” plants. Some advocates would like to see nuclear ramp up and down to help integrate wind and solar power, instead of carbon-emitting natural gas power plants. See for example: Argonne National Labs, “Balancing nuclear and renewable energy,” April 25, 2018, <http://www.anl.gov/articles/balancing-nuclear-and-renewable-energy>.

84 Wind power, like solar, is a variable energy source, and can cause the same market and operational impacts. But the wind can blow in California in any hour, while solar is highly concentrated in daytime hours. As a result, the impacts of wind power tend to be more spread out.

CAISO has two solutions to periods of over-generation. The first is that power prices bid in the real-time auction will fall, encouraging some generators to drop off. They can even fall into the negative range, which require generators who stay on to pay to operate, rather than get paid. These price signals are almost always able to solve the issue, but if not CAISO can issue orders to curtail power plants, most often solar generators. Curtailment is quick and effective, but results in missing out on low-cost, emission-free power.

The second challenge is the evening ramp, or the neck of the duck. CAISO load tends to peak in the early evening, about the same time that solar is fading. The distance from the minimum net demand to the maximum – from the belly to the head of the duck – is growing bigger and steeper, requiring other sources to meet the evening ramp.

The conventional solution is to have other generators (mostly gas-fired in California) standing by to ramp up output, or to increase imports from generators in other states. The problem is that as wind and solar grow, other plants will operate less often, resulting in lower overall revenues to those plant owners. Those plants will need to make their living in the few hours in the evening when they are needed. If prices are not high enough in those hours, they will not get enough income and will go out of business.

Large amounts of solar will also cause some self-inflicted financial problems. Because solar is produced when it is available, rather than in response to market prices, it injects supply onto the market regardless of conditions. As shown previously, small amounts of solar power have little effect on the market clearing price; they shift the supply curve to the right, but only slightly. As solar grows, it can have larger financial effects, lowering the clearing price substantially during hours of peak demand.⁸⁵

But when solar becomes a major player in the market, it can actually crash the market price altogether. If solar and other low variable cost resources meet all demand, the clearing price may be very low or even zero. If solar generators are paid through revenues on the market, their own revenues may fall. (Currently most solar plants are developed under long-term contracts that eliminate this effect.) So the more solar grows, the less it is worth, an effect known as “value deflation.”⁸⁶

Solar also has value by providing capacity during peak periods. But with plentiful amounts of solar, each new solar panel is worth less in terms of capacity value.

SOLUTIONS

Fortunately, our electricity system has many options for dealing with the impact of large amounts of solar power, on both the supply side and the demand side.

Ten of these options were cataloged by the Regulatory Assistance Project in their paper, “Teaching the Duck to Fly.”⁸⁷

- **Target energy efficiency to the hours when load ramps up sharply:** Some energy efficiency programs aim to produce the maximum amount of savings, regardless of when they occur. Others are aimed at reducing peak demand, which has traditionally been gross demand instead of the increasingly more important net demand. But efficiency programs could be aimed at reducing net peak, thus shrinking the size of the ramp.
- **Acquire and deploy peak-oriented renewable resources:** this can include a more varied choice of renewables, including dispatchable sources like biomass and geothermal. It can also mean providing incentives for solar generation that tracks the sun or is oriented to the west to produce more later in the day.

85 See University of Texas Energy Institute, “Energy 101: Merit Order Calculator,” 2014, <http://www.energy101.com/calculators/>

86 Andrew Mills and Ryan Wiser, Lawrence Berkeley National Lab, *Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot Case Study of California*, June 2012, <https://emp.lbl.gov/sites/all/files/lbnl-5445e.pdf>. Also Bentham Paulos, “Do We Really Need Solar That’s Too Cheap to Meter?” Greentech Media, May 3, 2016, <https://www.greentechmedia.com/articles/read/making-solar-too-cheap-to-meter#gs.E9Mlsm0>

87 Jim Lazar, *Teaching the “Duck” to Fly, Second Edition*, Regulatory Assistance Project, 2016, <http://www.raonline.org/document/download/id/7956>

- **Manage water and wastewater pumping loads:** California’s water systems use a massive amount of electricity, as much as 20 percent of state demand by some estimates.⁸⁸ Thanks to reservoirs, there is some flexibility about when pumping can occur, making it possible to run pumps in a way that help integrate solar. Pumps could run when the sun shines, for example, while reservoirs could discharge to generate power during evening peaks. The reservoirs can act as a form of energy storage.
 - **Control electric water heaters to reduce peak demand and increase load at strategic hours:** Water heaters also store energy in the form of heat. If more California buildings had electric water heaters they could be used a grid resource, by heating water during the day and shutting off in the evening.
 - **Convert commercial air conditioning to ice storage or chilled-water storage:** Air conditioning makes up a significant share of the California summer peak, which drives the evening ramp. Some companies, like Santa Barbara’s Ice Energy, make air conditioners that freeze water during off peak hours, then blow air over the ice during peak times to provide cool air for buildings.⁸⁹
 - **Deploy electrical energy storage in targeted locations:** Batteries are often touted as the only solution to variable wind and solar, but they are just one of many. They deliver the most value when they perform multiple services, such as reducing congestion and improving reliability in specific locations on the grid.
 - **Implement aggressive demand-response programs:** Demand response is the ability of customers to change their demand (up or down) in response to price signals. Demand response can be automated with software controls or can be done manually, by changing behavior.
 - **Retire inflexible generating plants with high off-peak must-run requirements:** The most inflexible generators tend to be coal and nuclear plants, sometimes called “base load” plants since they run at full capacity all the time to meet base demand. As solar pushes down the belly of the duck, these inflexible plants get in the way of more solar generation. Fortunately, California has few of these plants, and the retirement of nuclear and coal plants in the West is reducing their impact.
 - **Rate design:** focus utility prices on the “ramping hours” to enable price-induced changes in load: To provide a price incentive for most of these technologies and strategies, electricity rates should encourage consumers to reduce demand during peak times and increase it during periods of bountiful solar power. California investor-owned utilities are moving residential customers to default time-of-use (TOU) rates by 2020, as required in a July 2015 CPUC decision.
 - **Use inter-regional power exchanges to take advantage of diversity in loads and resources:** Making CAISO regional can also help with integration of solar. This is discussed further earlier in the brief.
- While this seems like an exhaustive list, there are even more options, including the integration of electric vehicles (EVs). If California is to meet Governor Brown’s goal of 5 million electric vehicles on the road by 2030, the state will add over 150 gigawatt-hours of batteries on wheels -- a massive tool for integrating wind and solar through vehicle-grid integration, as California’s peak demand is only about 50 gigawatts.⁹⁰ While EV batteries will only be available to the grid when the cars are not in use, CPUC research found that a typical California car sits parked 96 percent of the time.⁹¹ For more information on grid impacts of EVs, see the forthcoming report from Next10, at next10.org.

88 PPIC Water Policy Center, Public Policy Institute of California, “Energy and Water,” October 2016, http://www.ppic.org/content/pubs/report/R_1016AER.pdf

89 For more information see <https://www.ice-energy.com/>

90 Office of the Governor, “Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments,” January 26, 2018, <https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/>. Total battery capacity is estimated based on an average of 30 kWh of capacity in each car.

91 Adam Langton and Noel Crisostomo, California Public Utilities Commission, Vehicle - Grid Integration A Vision for Zero-Emission Transportation Interconnected throughout California’s Electricity System, March 2014, <http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7744>

And there are longer term options that may help. UC Irvine and Southern California Gas are conducting research on creating hydrogen with solar electricity, and injecting it into the campus natural gas system.⁹² Most hydrogen (H₂) is created by splitting natural gas (CH₄), but it can also be created by using electricity to split water (H₂O). This “renewable natural gas” can then be used for heat, electricity production, and in fuel cell vehicles.

The Electric Power Research Institute in Palo Alto is leading research on converting end uses to electricity, including heat pumps for space and water heating, electric technologies in industry and heavy transportation, and others.⁹³ Greater electrification, they say, would drive down total energy consumption and carbon emissions, even as it drove up electricity demand, due to the greater efficiency of electric motors and appliances. It would also provide new opportunities for more flexibility, demand response, and storage.

92 UCI News, “Greening the grid: UCI tests integration of renewable hydrogen into existing natural gas systems,” January 3, 2017. <https://news.uci.edu/2017/01/03/greening-the-grid/>

93 Electric Power Research Institute, U.S. National Electrification Assessment, April 2, 2018, <https://www.epri.com/#/pages/product/000000003002013582/>