
Senate Bill 350 Study

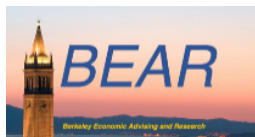
Volume III: Description of Scenarios and Sensitivities

PREPARED FOR



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THE **Brattle** GROUP



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Senate Bill 350 Study

The Impacts of a Regional ISO-Operated Power Market on California

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Volume III. Description of Scenarios and Sensitivities

A. INTRODUCTION

California’s Senate Bill No. 350—the Clean Energy and Pollution Reduction Act of 2015—(“SB 350”) requires the California Independent System Operator (“CAISO,” “Existing ISO,” or “ISO”) to conduct one or more studies of the impacts of a regional market enabled by governance modifications that would transform the ISO into a multistate or regional entity (“Regional ISO”).

At the foundation of the study it was necessary to define an analytical framework that would allow the study team to estimate the impact of having a regional market in the west. Such an analytical framework would include simulations of the west without a Regional ISO and comparison simulations with some level of regionalization. The comparison of the simulated results would then reflect the estimated impact of regionalization. With this approach, we solicited stakeholder input early in the process to ensure that the design of the scenarios incorporated stakeholder feedback and comments.¹

With stakeholder input, the study team developed five baseline scenarios to evaluate. The first two scenarios reflect near-term market conditions: one with and one without a limited definition of a Regional ISO. The limited Regional ISO includes the current CAISO and PacifiCorp (“2020 CAISO+PAC”) and is compared to “2020 Current Practice.”

The three other scenarios reflect longer-term market conditions—in 2030—when California is expected to procure enough new renewables to meet its 50% Renewables Portfolio Standard (“50% RPS”). One of the 2030 cases (“2030 Current Practice 1”) assumes no regional market and incorporates the existing practice of having to conduct bilateral trading with entities in the West outside of the existing CAISO. This scenario, in effect, assumes that excess intermittent renewable generation from California in 2030 will face barriers when selling to the rest of the west in large quantities (i.e., when a significant amount of wind and solar capacity is on the California system and when solar output from California is at its maximum).

¹ Further detail of the stakeholder process is included in Volume II of this report.

The remaining two 2030 baseline cases assume an expanded Regional ISO that includes all of the U.S. WECC without the federal Power Marketing Agencies (“PMAs”) Bonneville Power Administration (“BPA”) and the Western Area Power Administration (“WAPA”).² These two Regional ISO cases reflect the efficiencies of broader regionalization, and they reflect two alternative renewable portfolio procurement possibilities: one to meet California’s 50% RPS with an in-state procurement focus (“2030 Expanded Regional ISO 2”) and one with a more out-of-state procurement focus (“2030 Expanded Regional ISO 3”).

In response to stakeholder feedback, we also conducted a number of sensitivities to our analyses, with a focus on assumptions that could change our estimates of emissions impacts and ratepayer impacts.

Sections B and C of this Volume of our report describe in more detail the study’s key assumptions, the scope of regionalization, and the definition of the five baseline scenarios. Section D provides a summary of the sensitivities analyzed.

B. SCOPE OF A REGIONAL MARKET

The language of the SB 350 legislation does not define a specific scope for regionalization, neither in terms of the footprint of electric service areas that would be part of a Regional ISO, nor in terms of when load-serving entities might choose to join a Regional ISO. However, the question is informed by a request from PacifiCorp to explore the impact of consolidating the CAISO and PacifiCorp balancing areas into a single balancing area, and of expanding the CAISO markets to the larger balancing area that would benefit both entities’ ratepayers.

We defined two possible footprints of a Regional ISO which cover a range, from a very limited footprint with only CAISO plus PacifiCorp, to an expanded Regional ISO that covers almost the entire U.S. WECC region. We defined two future snapshots of possible market conditions that

² Specifically, the PMAs excluded for the purpose of this analysis are Bonneville Power Administration (“BPA”) and Western Area Power Administration (“WAPA”)—Colorado-Missouri Region, Lower Colorado Region and Upper Great Plains West. WAPA’s Sierra Nevada Region is included in the Balancing Area of North California and, because it is not a separate balancing area, was included in the analysis. The PMAs were excluded solely for providing a smaller geographic footprint. This choice does not reflect any suggestion that the PMAs would not be interested in participating in a regional market. In fact, in the eastern interconnection, WAPA’s Upper Great Plains Region has already joined the Southwest Power Pool.

would set the stage for expanded regionalization: a near-term year, 2020, with a regulatory framework and market conditions similar to today's, and a more distant year, 2030, when California and other western states are expected to have made major changes to how electricity is supplied, with significantly more renewables and less fossil fuel use. The combination of these assumptions on regional footprint and market conditions forms the basis for our baseline scenarios.

1. Regional Market Footprint

Figure 1 illustrates the two regional market footprints we analyze. The first assumes only CAISO and PacifiCorp form a regional entity. The second assumes that all of U.S. WECC, with the exception of the PMAs, forms an expanded Regional ISO. These footprints are hypothetical and are designed to capture a plausible range of impacts. We understand that the individual utilities and states will have to conduct their own evaluations of the benefits and tradeoffs of joining a regional entity, and to decide whether or not to join one.

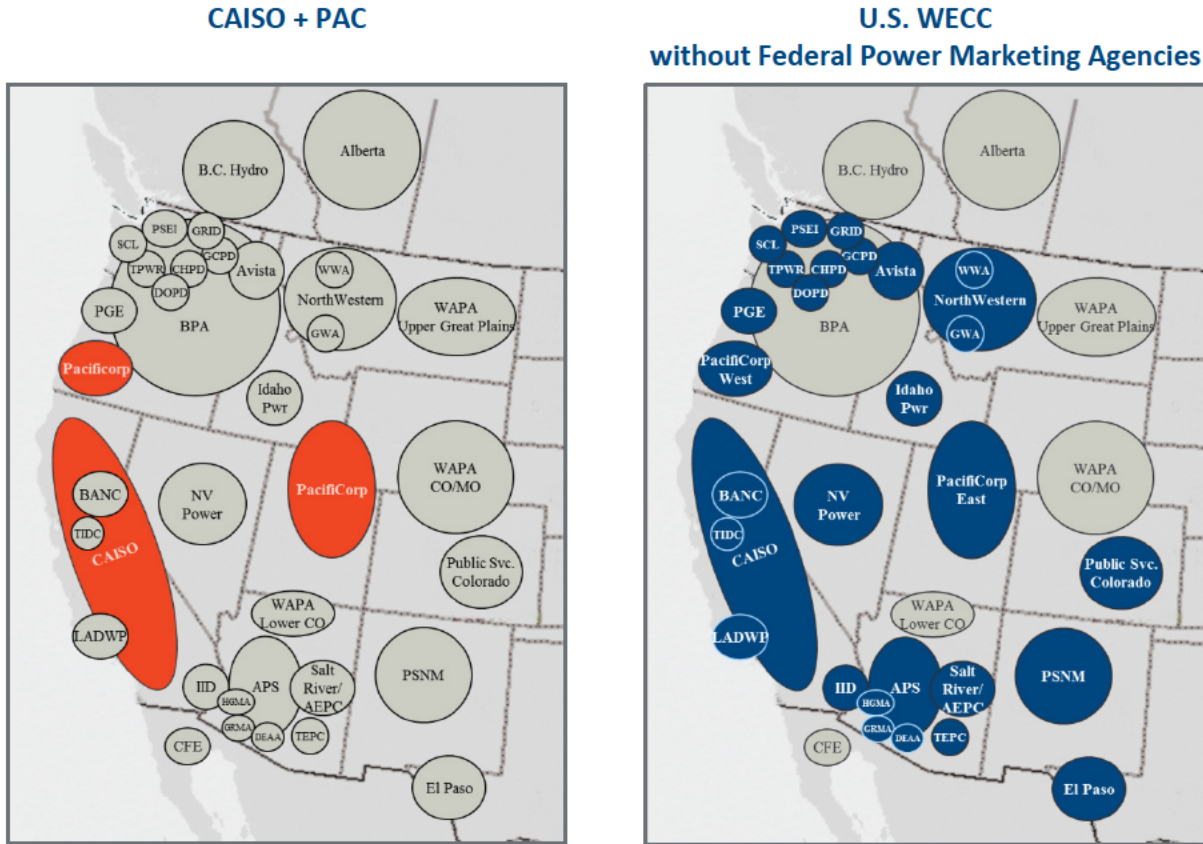
Both of these assumed footprints were developed based on feedback from the stakeholders of the SB 350 study. Several stakeholders expressed the desire to reflect conservative regional footprints, including a case that assumes only CAISO and PacifiCorp form a regional entity. This case was viewed by several stakeholders as a tangible near-term representation of a Regional ISO due to PacifiCorp's expressed interest (in 2015) in becoming a full ISO member. If PacifiCorp were to become a Participating Transmission Owner, it would remain to be seen whether other utilities and states would also choose to join the Regional ISO and broaden the regional footprint.³

Based on the experience with the Energy Imbalance Market, and with regional markets in other areas of the country, the study team finds it unlikely that the regional market would be confined to the ISO and PacifiCorp by 2030 or beyond. Since the 2020 case presents a bookend analysis of a very limited regional market in the near-term, the study team believed it appropriate to model a more realistic larger regional market for the longer-term. This is particularly important since entities are likely to continue to join even beyond 2030. While the study team is confident that additional entities would join the regional market, it is impossible at this time to know which

³ A Participating Transmission Owner turns over operational control of their transmission system and their balancing area is' subsumed within the CAISO balancing area.

and how many entities would join by 2030, which would join after 2030, and which would not join until later (or not at all).

Figure 1: Regional Market Footprints Analyzed



Several stakeholders expressed that an expanded Regional ISO that included all of the U.S. WECC service areas would not be realistic. They wanted a more conservative view of broad regionalization. In response, we developed a baseline case that assumes that all of U.S. WECC, with the exception of the PMAs, participates in a Regional ISO (“U.S. WECC without PMAs”). BPA and WAPA did not request to be excluded from our hypothetical regional footprints. In response to stakeholders, we restricted the definition of broad regionalization, and BPA and WAPA were chosen for exclusion simply by virtue of their unique operational and regulatory situation. The study team believed it unlikely that the Canadian and Mexican entities would join the regional market by 2030, even though Manitoba Hydro is a member of the Midcontinent ISO.

Beyond the considerations described above, the study team did not wish to speculate whether any particular group of entities in the West (EIM participants, investor-owned utilities, publicly-owned utilities, California utilities, etc.) would be more or less likely to join the regional market.

2. Representative Years

The study evaluates regional market impacts for two representative years:

- **2020:** As introduced above, 2020 is selected to represent near-term market conditions similar to today's, both in terms of policies and other market fundamentals. PacifiCorp is currently targeting implementation of the Regional ISO, if approved by various regulatory authorities, in 2019. In 2020 we expect that California will meet its 33% RPS (resources are already mostly contracted as of 2016), retirements and replacements to meet the state's Once-Through Cooling requirements will not yet be completed, Diablo Canyon will not yet be retired, the state's energy storage requirements will not yet be due, and the EPA's Clean Power Plan will not yet be implemented. We also expect that the demand for electricity will look similar to today's, and so will various investment costs and operating costs (particularly natural gas and coal prices), in California and in the rest of WECC. By analyzing 2020 we are asking, "How could regionalization impact a world with which we're familiar?" We recognize that even if PacifiCorp becomes a Participating Transmission Owner by 2020, it is only at the early stage of that expanded market, thus, 2020 can be viewed as a year that represents the "beginning" of an expanded market structure; one that will evolve gradually over time.
- **2030:** This year is selected to represent simulated longer-term market conditions with higher demand for electricity and a very different supply stack for electricity across the West. For instance, by 2030, we anticipate a significant amount of natural gas-fired capacity will be retired in California to meet Once-Through Cooling requirements, and California is expected to develop sufficient amount of new renewable energy resources to meet its 50% RPS. In the rest of U.S. portion of WECC, we expect that load will have grown relative to the near-term rate (e.g. 1.2% per year from 2020), a significant amount of coal-fired capacity will have been retired, and other states in the West will have developed significant amount of additional renewables to meet those states' respective RPS (already set today, but growing in proportion through 2030). By analyzing 2030 we are asking, "How could regionalization impact a world with relatively high renewables resources deployed and less fossil fuel use?"

C. BASELINE SCENARIOS (5)

Figure 2 below provides a summary of the 5 baseline scenarios, which combine the near-term market outlook (2020) with a minimal Regional ISO footprint (CAISO + PAC), and the longer-term market outlook (2030) with an expanded Regional ISO footprint (U.S. WECC without PMAs).

- 2020 Current Practice: reflects near-term market conditions. California has developed enough renewables to meet its 33% RPS. CAISO operates as-is with no regionalization.
- 2020 CAISO+PAC: reflects near-term market conditions. California has developed enough renewables to meet its 33% RPS. CAISO and PacifiCorp form a Regional ISO. Up to 776 MW in energy transfers between CAISO and PacifiCorp are free of economic and operational hurdles. CAISO and PacifiCorp resources are committed and dispatched in a coordinated fashion to meet combined energy and operating reserves requirements for the expanded balancing area. PacifiCorp's coal fleet faces the same generic natural gas-based greenhouse gas emissions hurdle to serve California load as in the Current Practice case.⁴ This scenario is compared to the 2020 Current Practice scenario to evaluate the impacts of extremely limited regionalization.
- 2030 Current Practice 1: reflects longer-term market conditions. California has developed enough renewables to meet its 50% RPS, with a business-as-usual in-state procurement focus. CAISO operates as-is with no regionalization. Bilateral markets and trading frictions limit the sales of excess generation from the portfolios of CAISO entities to 2,000 MW. This means it is assumed in this Current Practice 1 scenario that bilateral markets would accommodate the re-export of all prevailing existing imports (ranging from 3,000-4,000 MW per hour) plus export an additional 2,000 MW of (mostly intermittent) renewable resources.
- 2030 Expanded Regional ISO 2 (or "Regional 2"): reflects longer-term market conditions. California has developed enough renewables to meet its 50% RPS, with an in-state procurement focus. All of U.S. WECC without PMAs has formed a Regional ISO. All energy transfers among the Regional ISO members are free of economic and operational hurdles. Regional ISO resources are committed and dispatched in a coordinated fashion to meet combined energy and operating reserves requirements. Oversupply from

⁴ This assumption is based on today's administrative rules under California's AB 32. In reality, with regionalization this administrative carbon hurdle would likely be revisited by the California Air Resources Board to ensure greenhouse gas emissions from PacifiCorp's coal fleet are properly treated under California's greenhouse gas cap-and-trade system.

California's renewables portfolio is more readily absorbed by the regional marketplace (reflected in a more relaxed 8,000 MW physical CAISO export limit). This scenario is compared to the 2030 Current Practice 1 scenario to evaluate the impacts of broader (but still limited) regionalization.

- 2030 Expanded Regional ISO 3 (or "Regional 3"): reflects longer-term market conditions. California has developed enough renewables to meet its 50% RPS, with more of an out-of-state procurement focus compared to Regional 2. All of U.S. WECC without PMAs has formed a Regional ISO. All energy transfers among the Regional ISO members are free of economic and operational hurdles. Regional ISO resources are committed and dispatched in a coordinated fashion to meet combined energy and operating reserves requirements. Oversupply from California's renewables portfolio is more readily absorbed by the regional marketplace (reflected in a more relaxed 8,000 MW physical CAISO export limit). This scenario is compared to the 2030 Current Practice 1 scenario to evaluate the impacts of broader (but still limited) regionalization.

Overall study results for these five scenarios are discussed in Volume I of the SB 350 study.

Figure 2: Key Assumptions to SB 350 Study Baseline Scenarios

Scenario	Regional ISO Footprint	California’s Renewable Portfolio	Market Conditions	CAISO’s Ability to Sell Power to Rest of West	Focus of Analysis
2020 Current Practice	None; CAISO as-is	Already contracted for 33%	Near-term	Net exports from CAISO limited to 0 MW ⁵ (but CAISO is a net importer)	Baseline
2020 CAISO + PAC	Limited to only CAISO plus PacifiCorp	Already contracted for 33%	Near-term	Transfers between CAISO and PAC limited to 776 MW	Impact of limited near-term regional market with CAISO+PAC only
2030 Current Practice 1	None; CAISO as-is	RESOLVE portfolio for Current Practice 1 to meet 50%	Longer-term	2,000 MW limit on net bilateral sales	Baseline
2030 Expanded Regional ISO 2 (Regional 2)	All of U.S. WECC without PMAs (BPA and WAPA)	RESOLVE portfolio for Regional 2 to meet 50%	Longer-term	8,000 MW limit on physical exports (no other limit on net bilateral sales)	Impact of regional market under current renewable procurement practices
2030 Expanded Regional ISO 3 (Regional 3)	All of U.S. WECC without PMAs (BPA and WAPA)	RESOLVE portfolio for Regional 3 to meet 50%	Longer-term	8,000 MW limit on physical exports (no other limit on net bilateral sales)	Impact of greater regional renewable procurement

D. SENSITIVITY ANALYSES

To ensure that the analyses are robust, and to address various stakeholders’ requests, the study team used sensitivity analyses to test how numerous alternative assumptions would affect the results of the SB 350 study. Figure 3 summarizes all the sensitivity analyses conducted, including key differences to baseline scenarios as well as the analytical scope (and analytical tools) that were applied to these sensitivities.

⁵ California has been a net import since the 1960s, thus a net export of 0 would be considered current practice.

Figure 3: Key Assumptions for SB 350 Study Sensitivities

Sensitivity	Focus of Analysis Impact of...	Key Inputs	Analytical Scope (Tool)		
			Renewable Investment Costs (RESOLVE)	Production Costs and Emissions (PSO)	CA Production, Purchase, & Sales Cost (TEAM)
2030 Current Practice 1B*	High coordination under bilateral markets, even without regionalization	Increase limit on net bilateral sales to 8,000 MW	✓*	✓*	✓*
High Energy Efficiency	Significantly more energy efficiency savings by 2030 in California	Double California’s projected “Additional Achievable Energy Efficiency”	✓		
High Flexible Loads	More resources to respond to California’s oversupply	Add 3,000 MW of flexible loads in all 2030 cases	✓		
Low Portfolio Diversity	Fewer technology options to meet California’s 50% RPS	Remove assumed new pumped hydro and geothermal resources	✓		
High Rooftop PV	More solar, rather than wind, development to meet California’s 50% RPS	Increase CAISO rooftop PV from 16 GW to 21 GW by 2030	✓		
High Out-of-State Resource Availability	More REC-only procurement from out-of-state, rather than solar and wind development for California’s 50% RPS	Increase available SW Solar and NW Wind RECs to half of the 50% RPS goal (IOUs only)	✓		
Low Cost Solar	Continued steep reductions in solar development costs for many years	Reduce solar cost to \$1/W by 2025	✓		
55% RPS	RPS that may better support a goal of 40% GHG reduction by 2030 and/or PG&E’s goals to replace Diablo Canyon	Increase California RPS to 55% in all 2030 scenarios	✓		
2020 Expanded Regional ISO	An expanded regional footprint under near-term market conditions	Expand 2020 regional footprint to all of U.S. WECC without PMAs		✓	✓
2030 Regional ISO 1	Holding the renewable portfolio constant, isolate the impacts of de-hurdling and reserve sharing	<u>Current Practice 1</u> renewable portfolio, with expanded Regional ISO that reflects de-hurdling and reserve-sharing in U.S. WECC minus PMAs		✓	
2030 Regional ISO 3 w/o Renewables Beyond RPS	Barriers to the regional marketplace attracting renewables development beyond RPS	Remove 5,000 MW of additional renewables beyond states’ RPS		✓	✓
2030 with WECC-Wide CO₂ Price	Federal carbon constraints	\$15/ton CO ₂ price in the rest of U.S. WECC (in Current Practice 1 and Regional 3)		✓	
Low Willingness to Buy in Bilateral Market	California having to pay others to take power during oversupply conditions	Decrease transaction floor price from \$0 to -\$40/MWh			✓

*Sensitivity 2030 Current Practice 1B was also evaluated in the economic and environmental studies.

Note: The economic impact analysis also looked at a hypothetical reference case that holds California’s 33% RPS by 2020 constant through 2030. That case is not included in this table, and it is discussed in Volume VIII of the SB 350 study.

As shown in the table above, the “2030 Current Practice 1B” sensitivity was analyzed throughout the SB 350 study, and the results for this sensitivity are discussed in Volume I. Sensitivities evaluated for the purpose renewables investment cost analysis are discussed in more detail in Volume IV. Sensitivities evaluated in our production cost and emissions analyses are discussed in Volume V and Volume IX. Sensitivity analyses surrounding changes in assumptions in the calculations of California production, purchase, and sales cost (utilizing the CAISO’s “TEAM” framework) are discussed in Volume V. A ratepayer impact analysis was undertaken for each sensitivity for which the TEAM framework was applied. The results of these ratepayer impact sensitivities are discussed in Volume VII.

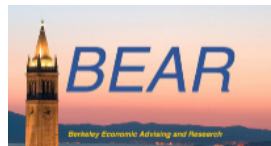
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