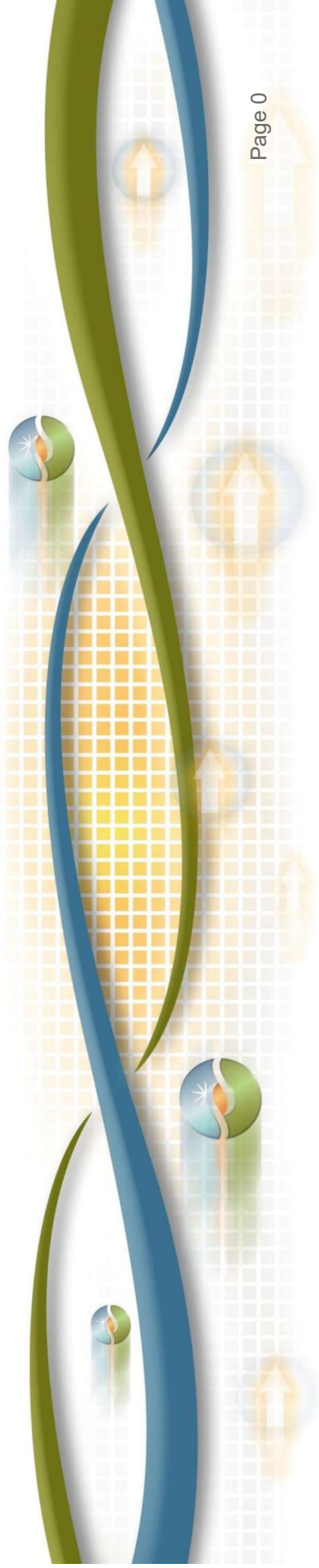




Clean Energy and Pollution Reduction Act Senate Bill 350 Study: *Preliminary Results*

May 24, 2016



SB 350 Regional Market Study

Analysis and Preliminary Results

PRESENTED TO

Stakeholders to the SB 350 Study

PREPARED BY

Judy Chang
Johannes Pfeifenberger

Mariko Geronimo Aydin
Onur Aydin
Kai Van Horn
David Luke Oates
Lauren Regan
Peter Cahill
Colin McIntyre

May 24–25, 2016

THE **Brattle** GROUP

Content

1. Introduction
 2. Summary of Findings
 3. Refinements to Study Approach Based on Stakeholder Input
 4. Overall Analytical Framework
 5. Production Cost Simulations and Results
 6. Load Diversity Analysis
 7. California Ratepayer Impact Analysis
 8. Impacts on GHG Emissions
 9. Reliability Impacts and Renewable Integration
 10. Next Steps for SB 350 Study
- Appendices A–F

Scope of the SB 350 Study

Legislative Requirement:

- 359.5. (a) It is the intent of the Legislature to provide for the transformation of the Independent System Operator into a regional organization..., and that the transformation should only occur where it is in the best interests of California and its ratepayers.
- The ISO will conduct studies of the impacts of a regional market, including:
 1. Overall benefits to California ratepayers
 2. Emissions of greenhouse gases and other air pollutants
 3. Creation or retention of jobs and other benefits to the California economy
 4. Environmental impacts in California and elsewhere
 5. Impacts in disadvantaged communities
 6. Reliability and integration of renewable energy resources
- The modeling, including all assumptions underlying the modeling, shall be made available for public review.

Impacts Evaluated

The Study teams have been estimating these impacts, in accordance with SB 350 requirements:

Benefits Considered	Where	Impact to be Analyzed	Metrics
1. Overall benefits to ratepayers			
Operating cost savings	CA, WECC	Production costs and wholesale market prices	Production & Net Purchase Costs (CA); Production Costs (WECC-wide)
Capital (investment) cost savings	CA, WECC	Renewable integration, resource adequacy, resource procurement	Net fixed and capital costs
2. GHG and other air pollutants	CA, WECC	Air quality and carbon intensity	Changes in emissions, including in nonattainment areas
3. Jobs and economic impact to CA	CA	Infrastructure investment, responses to changes in retail and operating costs	Employment, Gross State Product, incomes, tax revenues
4. Environmental impacts in CA and elsewhere	CA, WECC	Land use/visual resources, biological/ecology, water supply	Impacts on environmental resources and sensitive areas
5. Impacts in disadvantaged communities	CA	Environmental and economic	Impacts in specific communities
6. Reliability and integration of renewable energy resources	CA, WECC	Ability to integrate diverse renewable resources; regional operations and control	Description of improved system monitoring and ability to integrate diverse resources



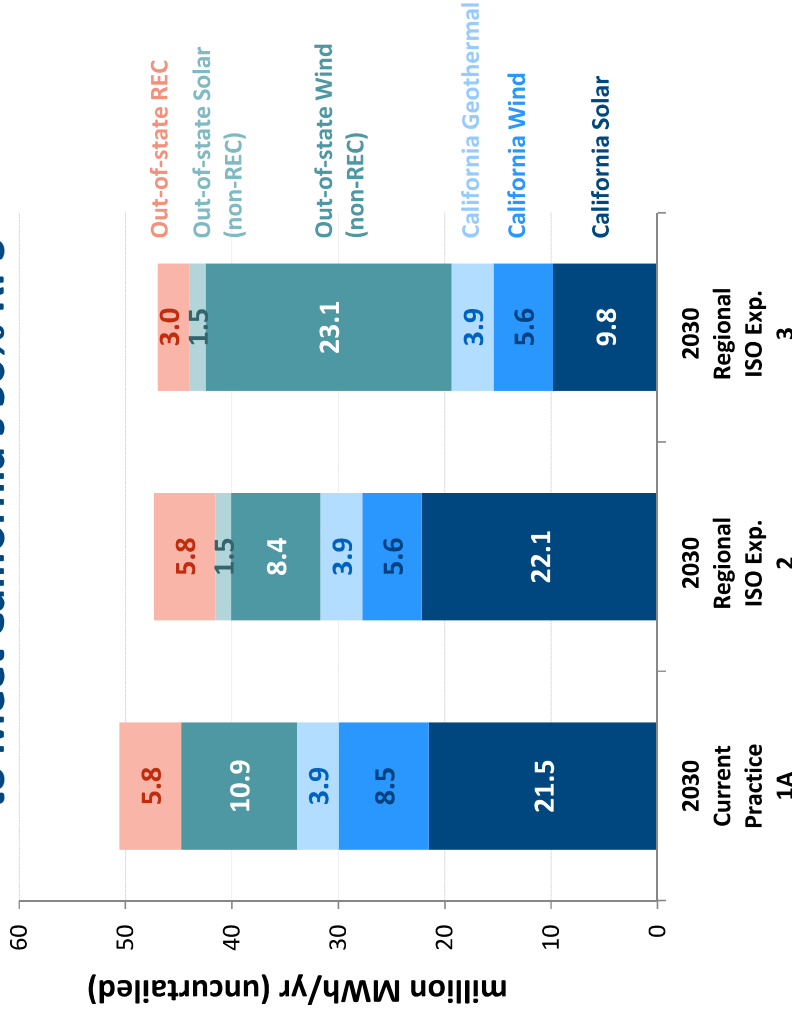
Content

1. Introduction
 - 2. Summary of Findings**
 3. Refinements to Study Approach Based on Stakeholder Input
 4. Overall Analytical Framework
 5. Production Cost Simulations and Results
 6. Load Diversity Analysis
 7. California Ratepayer Impact Analysis
 8. Impacts on GHG Emissions
 9. Reliability Impacts and Renewable Integration
 10. Next Steps for the SB 350 Study
- Appendices A–F

Summary of Findings

Studied Three 2030 Scenarios for 50% RPS in CA

Renewables Added Between 2020–2030 to Meet California’s 50% RPS*



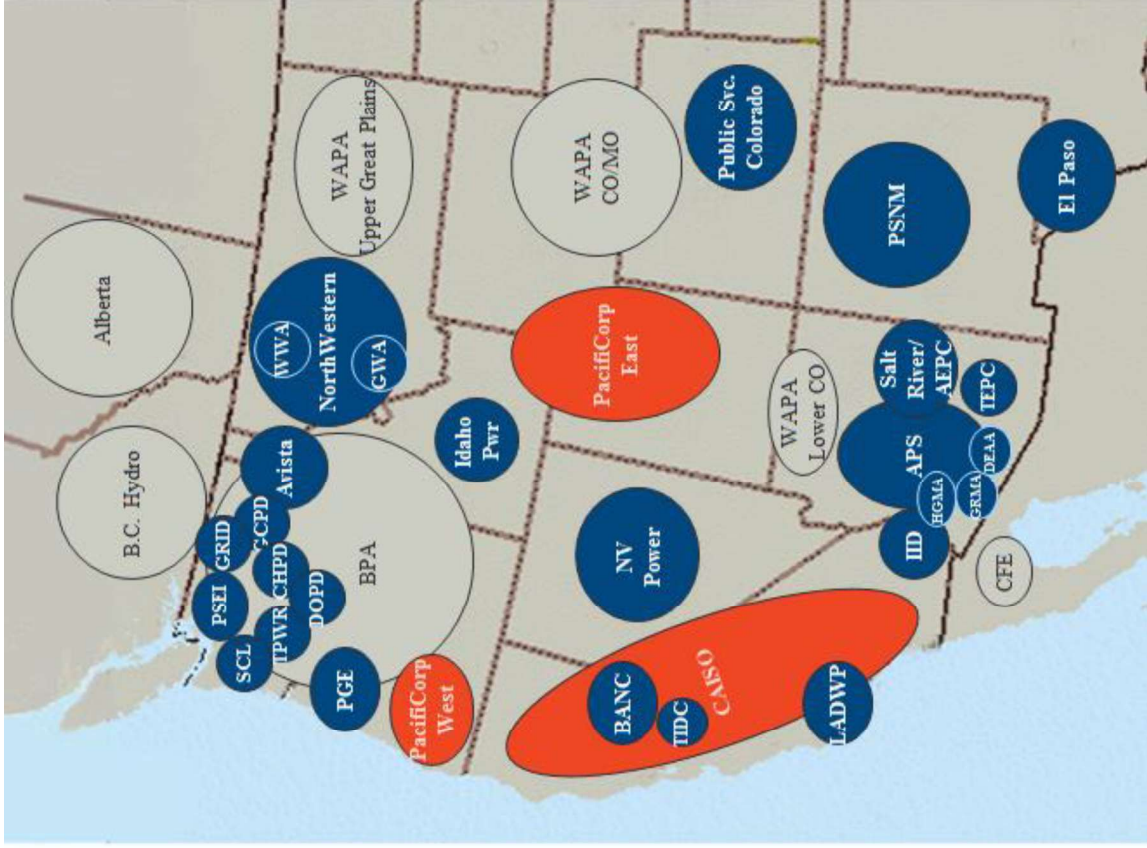
* Includes renewables added in non-CAISO entities (BANC, IID, LADWP, TIDC)

* Regional market cases were developed through consultation with stakeholders for the sole purpose of assessing the benefits of a regional market over a range of plausible renewable procurement scenarios. This study is not promoting or advocating for a particular procurement scenario.

E3 developed three main portfolios for meeting California’s RPS in 2030

- Portfolio 1A assumes no regionalization (Current Practice)
- Portfolios 2 and 3 assume regional market
 - Portfolio 2: current practice renewable generation procurement (more in-state)
 - Portfolio 3: more regional resource procurement
- Analysis updated in response to stakeholder feedback
- Further details and sensitivities will be discussed by E3

Summary of Findings 2020 and 2030 Hypothetical Regional Footprints



WECC currently consists of 38 individual Balancing Authorities

● **2020 Footprint:** Regional ISO to consist of only CAISO and PacifiCorp: denoted as “**CAISO+PAC**”

● + ● **2030 Footprint and 2020**

Sensitivity: Expanded regional ISO to consolidate all balancing areas in the U.S. WECC except the Federal Power Marketing Agencies: denoted as “**Regional**” (U.S. WECC w/o PMAs)

PMAs shown in the graphic as BPA, WAPA Upper Great Plains, WAPA CO/MO, WAPA Lower CO

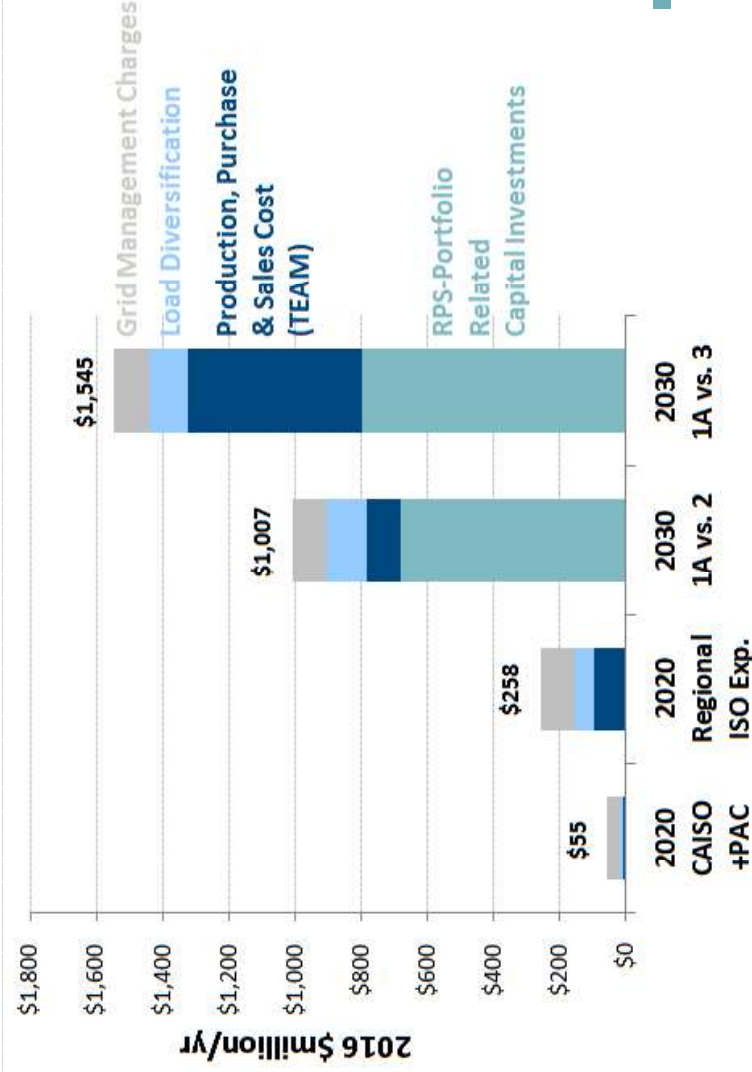
Summary of Findings

1. Overall Benefits to California Ratepayers

- California ratepayer impact analysis of an expanded regional market shows estimated savings of:

- **\$55 million/year in 2020** (0.1% of retail rates) based on limited scope of CAISO-PAC region.
 - Would be \$258 million/year for expanded regional footprint (WECC without PMAs)
- **\$1 billion to \$1.5 billion/year in 2030** (2–3% of retail rates) depending on renewable procurement to meet 50% RPS
- 2030 sensitivities show range from \$767 million to \$1.75 billion/year

Annual California Ratepayer Benefits in 2020 & 2030



Overall benefits likely larger, consistent with findings in other regional market studies (see Appendix D)

- Estimates based on conservative assumptions
- Value of additional regional market benefits was not quantified

Summary of Findings

1. Additional Ratepayer Benefits not Quantified

- **Increased system reliability** due to expanding ISO operations to a larger regional footprint that improves pricing, congestion management, generation commitment, real-time operations, and system visibility/monitoring
- **Improved use of the physical capabilities of the existing grid** both on constrained WECC transmission paths and within the existing WECC balancing areas
- **Improved regional and inter-regional system planning** to increase efficiency in transmission buildout across the West
- **Improved risk mitigation** from a more diverse resource mix and larger integrated market that can better manage the economic impacts of transmission and major generation outages and better diversify weather, hydro, and renewable generation uncertainties
- **Long-term benefits** from stronger generation efficiency incentives and better long-term investment signals across a larger regional footprint
- Consistent with findings of other regional market studies (see Appendix D)

Summary of Findings

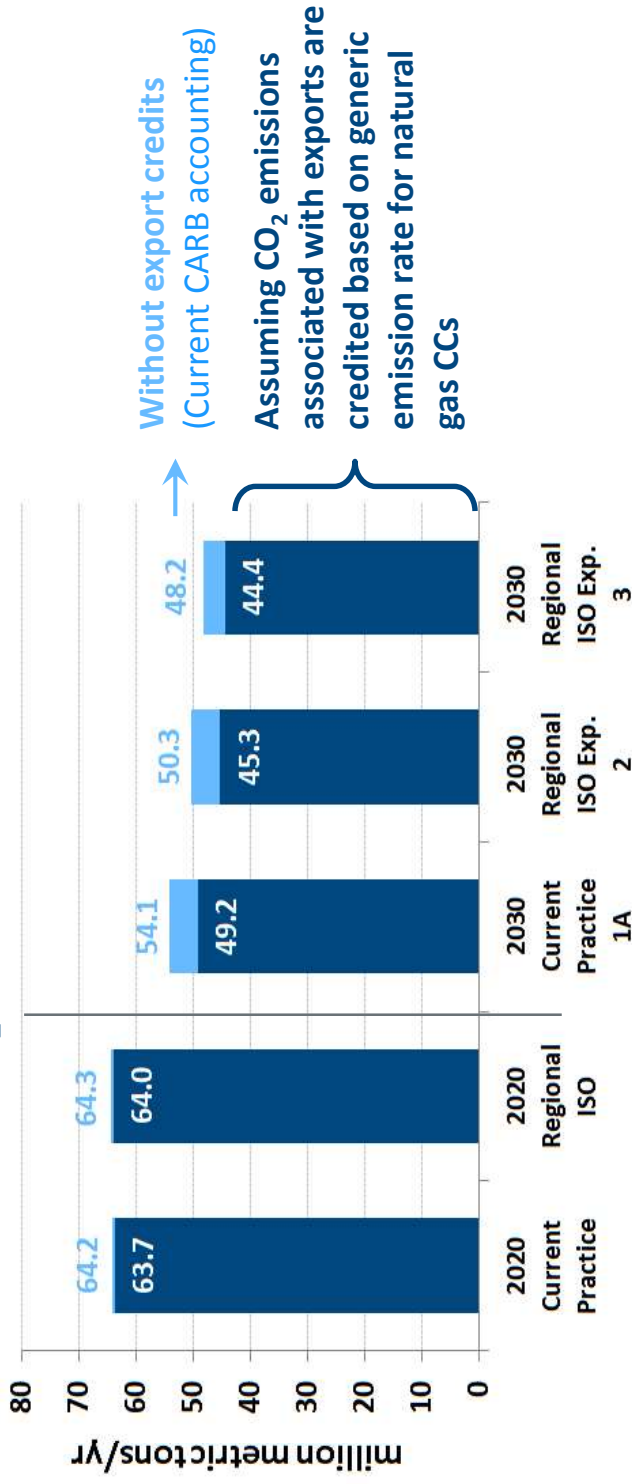
2. Emissions of GHGs and Other Air Pollutants

- Expanded regionalization (by 2030) decreases electric sector CO₂, NO_x, SO₂, and PM_{2.5} emissions WECC-wide and within California
- Magnitude of impact of regional market **on emissions *per se* is modest**; it depends primarily on:
 - Coal plant retirements
 - Relative economics of different fuels and technologies
 - Environmental regulations in CA and rest of WECC
 - Renewable energy resource development beyond RPS (as facilitated by market)
- Limited regionalization with only PAC has a very small impact and depends on the carbon pricing and CA import hurdles faced by PacifiCorp's coal fleet
- California meets EPA's Clean Power Plan (CPP) limits in all scenarios analyzed
- With a modest WECC-wide CO₂ price (\$15/tonne), WECC meets CPP, after accounting for additional coal plant retirements (announced or assumed by utilities' resource plans) and WECC RPS requirements
- Results similar to CEERT/NREL Low Carbon Grid Study
- The following slides focus on CO₂ (Aspen will provide results for NO_x, SO₂, and PM_{2.5})

Summary of Findings

2. California CO₂ Emissions

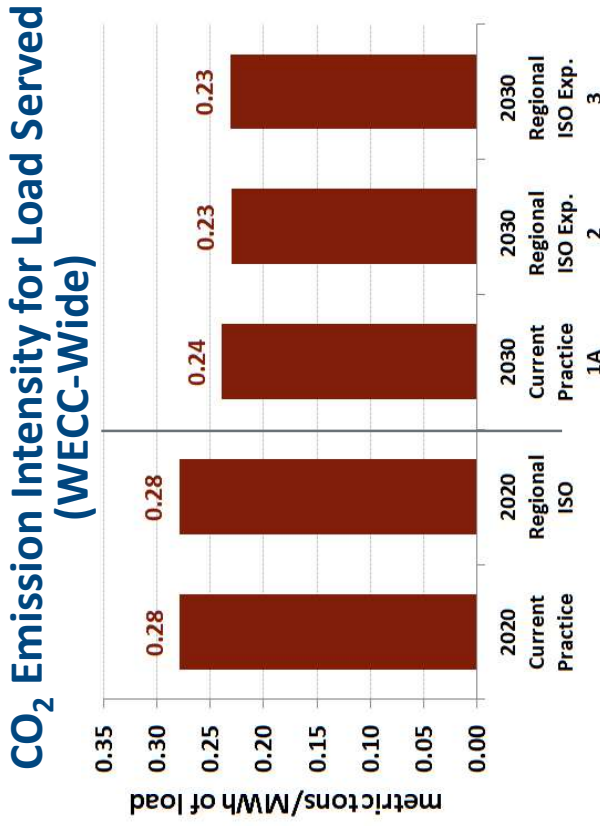
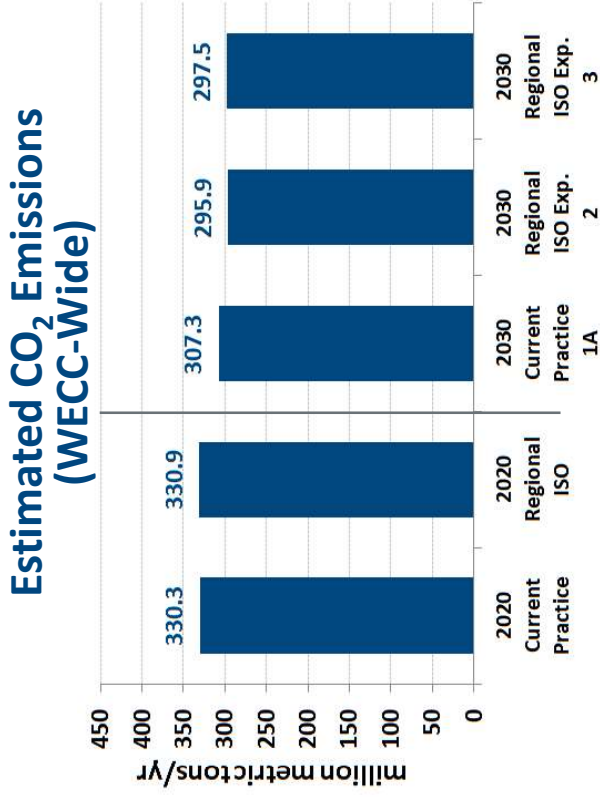
Estimated CO₂ Emissions in California



- Significant electricity sector emissions reductions between 2020 and 2030, with **2030 emissions 55–60% below 1990 levels and below EPA’s CPP requirements for California**
- Regional market reduces CO₂ emissions associated with serving California load
 - Little/no change in 2020
 - **Decrease of 4–5 million tonnes (8–10% of total) of CO₂ emissions level in 2030**
- By 2030, CA exports of surplus renewable energy displaces 4-5 million tonnes of CO₂ in rest of WECC; export credits not currently considered in CARB accounting

Summary of Findings

2. WECC-Wide CO₂ Emissions



- 2020 simulations of regional market (CAISO+PAC) show almost no change in CO₂ emissions relative to Current Practice
- In 2030 (and despite load growth in rest of WECC), the expanded regional market (U.S. WECC without PMAs) is estimated to **decrease CO₂ emissions levels by about 10–11 million tonnes (3.2–3.7% of total)** depending on the Scenario
 - For load served across WECC, regional market in 2030 is expected to **reduce CO₂ emission intensity by 0.01 tonne/MWh**
- Achieving CPP compliance would require additional measures

Executive Summary

3. Jobs and Other Benefits to the California Economy

Regionalization creates numerous and diverse jobs and delivers benefits to California households and enterprises

- Regionalization (Scenarios 2 and 3) can create 9,900–19,400 more jobs than Current Practice (Scenario 1A) in California, primarily by making electricity more affordable
 - Higher statewide household real disposable income due to more affordable energy
 - \$300–\$550 more disposable income per household in 2030 due to regional market
 - Higher statewide Gross State Product, real output, state revenue, and employment
- Regional market with California-focused procurement (Scenario 2) can help California balance ratepayer savings with job creation from renewable resource buildout
 - Highest impact on statewide output and employment
 - But higher environmental impacts (see next slide)
- The detailed results will be discussed by BEAR (on Day 2)

Summary of Findings

4. Environmental Impacts in California and Elsewhere

With a more efficient buildout for RPS, regional market reduces impacts on land use, biological resources, and groundwater use for construction

- Reduces acreage for new wind and solar developments by at least 42,000 acres in California
- Reduces acreage for new wind and solar outside of California for RPS by approximately 32,000 acres (Regional 2)
- Regional 3 increases land use for new out-of-state transmission
- With more renewable resource development outside of California (Regional 3), impacts on biological resources in California are reduced (and eliminated in some CREZs)
 - Tradeoff is a greater biological impact out-of-state, particularly for wind in Wyoming and New Mexico
- Both regional market scenarios decrease in-state groundwater consumption for plant operations, due to a slight decrease in generation output from California combined cycle plants
 - Similarly, consumption decreases in the rest of U.S. WECC, due to decreased output from gas and coal
- These results will be discussed in detail by Aspen (on Day 2)

Summary of Findings

5. Impacts in Disadvantaged Communities

A regional market offers benefits to disadvantaged communities:

Economic Benefits

- Increases real income and jobs in several disadvantaged communities, particularly in Inland Valley, Greater Los Angeles, and Central Valley
 - 1,300–4,600 more jobs over 2020–2030 period
 - Real income increased by \$180–330 per household per year
 - These results will be discussed in detail by BEAR (on Day 2)

Environmental Benefits

- Decreases community-scale construction-related environmental impacts from decreasing renewable resource development in California, particularly in Westlands where a significant amount of new solar would be built in the Current Practice Scenario
- Lower output from natural gas-fired generators in California decreases the amount of water used during power production and decreases power plant emissions in the San Joaquin Valley and South Coast air basins
- These results will be discussed in detail by Aspen (on Day 2)

Summary of Findings

6. Reliability and Integration of Renewable Energy

A regional market reduces the cost of maintaining system reliability

- Reduced operating reserves needed to meet reliability requirements
- Better real-time visibility of system conditions in larger regional footprint
- Improved management of unscheduled power flows

A regional market improves integration of renewables to meet California's 50% RPS

- Reduces curtailments associated with bilateral trading frictions
- Regional pooling of resources to meet flexibility reserves allows smaller areas with disproportionately high renewable generation to use region's resources to balance the intermittent output
- Improved utilization of the existing grid and better regional transmission planning will lower the transmission-related integration cost

Regional markets facilitate low-cost renewable generation developments beyond those needed for RPS

Simulation Assumptions: Power Systems Optimizer (PSO) Model

Production cost analysis utilized PSO model to simulate least-cost security-constrained unit commitment and economic dispatch in WECC footprint

- Started with inputs from CAISO's 2020 Gridview model used in 2015/16 Transmission Planning Process (TPP)
- Included same WECC areas in CAISO Gridview model
- Updated key modeling assumptions based on more recent data available and stakeholder feedback

See slides 5, 16-18, 22-23, and 29-31 of main presentation for summary of study assumptions

