Western Regional Market Developments:
Impact on Renewable Generation Investments and Balancing Costs

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The West is Endowed with Low-Cost Wind & Solar

- Focusing on lowest-cost areas of the WECC can substantially reduce the investment cost of meeting RPS and carbon emissions goals.
- Balancing high concentrations of mostly one type of resource (e.g., solar in southern CA or wind in WY) is a significant challenge for the 39 balancing areas in the WECC.

Diversifying Low-Cost Renewable Generation

Resource diversification in the West offers significant benefits that can be realized

- Regional diversification of resources (and load) reduces the investment and balancing cost in a future with high levels of intermittent resources
- Diversity of resources (and load) also increases the value of transmission that interconnects them
Regional Market Efforts in WECC

Motivated in large part by renewable balancing needs and cost savings, several regional market initiatives have materialized:

- **Energy Imbalance Market (EIM):**
  - CAISO, PAC, NV Energy, and APS (participating); PGE, Puget, Idacorp (committed); LADWP, Baha Mexico (announced)
  - CAISO+PAC+NVE: $20-25 million savings per quarter (approx. 25% NVE, 33% CAISO)

- **CAISO-PAC Regional Market Initiative:** setting up and studying a full (Day-2) RTO market that could include much of WECC
  - SB350 Study to support CA decision

- **Mountain West Transmission Group (MWTG):**
  - PSCo, WAPA (CRSP, LAP), Tristate, Black Hills, Basin Platte River, CO Springs studying Day-2 market in CO and WY
Operational Scope: EIM vs. Full Day-2 Market

Day-Ahead Unit Commitment
- De-pancaked transmission & scheduling charges
- Full grid utilization
- Reduced operating reserves
- Regionally optimized unit commitment
- Reduced additional commitment hurdle

Day-Ahead Market Dispatch
- De-pancaked transmission & scheduling charges
- Full grid utilization
- Reduced operating reserves
- Regionally optimized unit dispatch
- Avoided bilateral transaction cost

Intra-Day Adjustments
- De-pancaked transmission & scheduling charges
- Full grid utilization
- Reduced operating reserves
- Adjusted unit commitment and real-time bids
- Avoided bilateral transaction cost

Real-Time Market Dispatch
- De-pancaked transmission & scheduling charges
- Full grid utilization
- Reduced operating reserves
- Regionally optimized unit dispatch
- Reduced A/S needs
- Resolved uncertainties

Scope of SB350 Regional Day-2 Market Simulations
(without forecast errors, renewable uncertainty, real-time outages, etc.)
SB350 Regional Market Study

The SB350 Study developed plausibly-optimal resource additions to meet California’s **50% RPS** by 2030 for CAISO-only and Regional-Market cases

- A significant amount of solar generation will be built in or close to California, unless the rules allow for more out-of-state resources to qualify

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**2020 WECC Resource Mix**
(33% CA, already Contracted)

- **California**: 36 GW
- **Northwest**: 17 GW
- **Southwest**: 12 GW
- **Rocky Mt**: 5 GW
- **WECC non-US**: 2 GW

**2020–2030 Additions**
Current Practice 1
(CAISO Standalone)

- **California**: 16 GW
- **Northwest**: 9 GW
- **Southwest**: 5 GW
- **Rocky Mt**: 4 GW
- **WECC non-US**: 2 GW

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**Legend**
- Wind
- Solar DG
- Solar
- Hydro/PS
- Geothermal
- Biomass/Biogas
- Oil Peaker
- Gas Peaker
- Gas CC
- CHP/QF
- Coal
- Nuclear
## 2020-2030 Additional Procurement for CA RPS

In a regional market, procurement needs and costs to meet California RPS would be reduced by (1) avoided in-state curtailments; and (2) access to lower-cost resources in the larger region.

- Large solar competes with roof-top solar and low-cost wind in WY and NM.
- 2020-30 Solar cost: $1.40/W in base case and $1.00/W in low-cost sensitivity case.
- A regional market that provides access to lowest-cost locations will also attract additional investments beyond RPS needs (e.g., 18,000 MW wind additions beyond-RPS in western ERCOT, SPP, and MISO in just the last five years).

### Regional Market Impact

<table>
<thead>
<tr>
<th></th>
<th>&quot;Current Practice 1&quot; (CA Standalone)</th>
<th>&quot;Regional 2&quot; (Continued CA-focused Procurement)</th>
<th>&quot;Regional 3&quot; (More Regional Procurement)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA Utility-Scale Solar</td>
<td>7,600</td>
<td>200</td>
<td>(4,200)</td>
</tr>
<tr>
<td>SW Utility-Scale Solar</td>
<td>1,000</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Total California Resources</td>
<td>11,100</td>
<td>(900)</td>
<td>(5,300)</td>
</tr>
<tr>
<td>Total Out-of-State Resources</td>
<td>5,600</td>
<td>(400)</td>
<td>2,100</td>
</tr>
<tr>
<td>Total Renewable Resources</td>
<td>16,700</td>
<td>(1,300)</td>
<td>(3,100)</td>
</tr>
</tbody>
</table>

### Regional Market Impact (Low-Solar-Cost Sensitivity)

- "Current Practice 1" (CA Standalone)
- "Regional 2" (Continued CA-focused Procurement)
- "Regional 3" (More Regional Procurement)

### Source:
E3 RESOLVE simulations in SB350 Study
CAISO’s Extreme “Duck Curve” in 2030

- The substantial solar additions create an extreme “duck curve” with total renewable generation exceeding total California load by up to 10,000 MW at times (negative net load), creating:
  - Net imports of 5,000 MW during the night
  - Net exports of 8,000 MW plus ~13,000 MW of curtailments during the day
With substantial solar development in the state, California will shift from being a net importer in all hours (even in 2020) to approx. 1,500 hours of net exports reaching 8,000 MW by 2030.

Higher imports due to greater reliance on low-cost out-of-state renewables in Regional 3.

Higher export capability in Regional 2 mitigates surplus generation conditions and renewable curtailments in California.
California 2030 Wholesale Energy Prices

Regional market operations would significantly (1) reduce the number of curtailment hours and (2) increase prices obtained by CA LSEs during surplus generation hours.

Low or negative prices could impose significant costs on ratepayers (due to surplus-generation conditions in California). These costs can be mitigated by participating in a Regional Market.

Zero or negative prices during curtailment hours.
California’s Annual Savings from a Regional Market

Savings increase with (1) higher RPS goals (e.g., 33% → 50% → 60%) and (2) greater reliance on lower-cost out of state procurement

The 55% and 60% RPS sensitivity cases conservatively assume that the California production, purchase, and sales cost savings would remain at the same level estimated under the baseline scenarios (50% RPS).
The SB350 Study of the impacts of a California joining a regional market found:

1. Overall benefits to **California ratepayers**
2. Lower emissions of **greenhouse gases** and **other air pollutants**
3. Creation or retention of **jobs** and other **benefits to the California economy**
4. Reduced **Environmental** impacts in California and elsewhere
5. Reduced impacts in disadvantaged communities
6. Improved Reliability and integration of renewable resources

Analyses were undertaken with substantial stakeholder review and input. Modeling results, including all assumptions and inputs underlying the modeling, have been made available for public review.

Johannes (Hannes) Pfeifenberger is an economist with a background in power engineering and over 20 years of experience in the areas of public utility economics and finance. He has published widely, assisted clients and stakeholder groups in the formulation of business and regulatory strategy, and submitted expert testimony to the U.S. Congress, courts, state and federal regulatory agencies, and in arbitration proceedings.

Hannes has extensive experience in the economic analyses of wholesale power markets and transmission systems. His recent experience includes the benefit of regional markets in the West, capacity markets and resource adequacy designs, testimony in contract disputes, and the analysis of transmission benefits, cost allocation, and rate design. He is advising a wide range of clients, including investor-owned utilities, independent system operators, transmission companies, regulatory agencies, public power companies, and generators across North America.

Hannes received an M.A. in Economics and Finance from Brandeis University and an M.S. in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.
Ms. Judy Chang is an energy economist and policy expert with a background in electrical engineering and 20 years of experience in advising energy companies and project developers with regulatory and financial issues. Ms. Chang has submitted expert testimonies to the U.S. Federal Energy Regulatory Commission, U.S. state and Canadian provincial regulatory authorities on topics related to transmission access, power market designs and associated contract issues. She also has authored numerous reports and articles detailing the economic issues associated with system planning, including comparing the costs and benefits of transmission. In addition, she assists clients in comprehensive organizational strategic planning, asset valuation, finance, and regulatory policies.

Ms. Chang has presented at a variety of industry conferences and has advised international and multilateral agencies on the valuation of renewable energy investments. She holds a BSc. in Electrical Engineering from University of California, Davis, and Masters in Public Policy from Harvard Kennedy School, is a member of the Board of Directors of The Brattle Group, and the founding Director of New England Women in Energy and the Environment.

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