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<td>Project Title</td>
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<td>Dorothy Murimi</td>
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<td>Organization</td>
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ITEM 4
SB 100 Report Resource Builds

Liz Gill, PhD
California Energy Commission
SB 100

Expands RPS

60% by Dec 31, 2030

Establishes 100% Policy

It is the policy of the state that eligible renewable energy resources and zero-carbon resources supply 100 percent of all retail sales of electricity to California end-use customers by December 31, 2045 and 100 percent of electricity procured to serve all state agencies by December 31, 2045.

PUC 399.11(a), 454.53 (a)
CEC, CPUC, and CARB to issue a Joint-Agency report every four years including the following:

A. A review of the policy (technical, safety, affordability, reliability)
B. Reliability benefits and impacts
C. Financial costs/benefits
D. Barriers/Benefits of achieving the policy
E. Alternative scenarios and costs/benefits of each
SB 100 Modeling

All modeling was conducted by consultant E3.

• RESOLVE California model:
  • Co-optimizes NPV of investment and operational costs, given reliability and policy constraints, to develop a least-cost resource portfolio

SB 100 portfolios are not precise but can inform tradeoffs around different pathways.

• A reliability assessment was not included in the scope of work for the 2021 Report.
• Portfolios do not reflect individual BA or LSE goals or decision-making.
SB 100 Scope of Analysis

Inputs

- Existing System
- Demand Forecasts/Scenarios
- Resource Costs
- Reliability Metrics
- Policy Goals
- Resource Potential
- Land Use Screens

Portfolio Development

(Capacity Expansion Modeling)

Scope of 2021 SB 100 Analysis

Reliability Testing

<table>
<thead>
<tr>
<th>Operability/Full Dispatch</th>
<th>Resource Adequacy</th>
<th>Local Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Cost Modeling</td>
<td>Probabilistic Production Cost Modeling</td>
<td>Power Flow Modeling</td>
</tr>
</tbody>
</table>

Portfolio Impacts

<table>
<thead>
<tr>
<th>Rates</th>
<th>GHG Emissions</th>
<th>Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Pollution</td>
<td>Workforce</td>
<td>Social Costs</td>
</tr>
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</table>

Inputs, impacts, and tools listed are for illustrative purposes.
### Zero-Carbon Resources Included in Modeling

<table>
<thead>
<tr>
<th>Technology</th>
<th>Eligibility Basis</th>
<th>Scenarios</th>
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</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Solar Thermal (existing only)</td>
<td>RPS</td>
<td>Core and Study</td>
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<tr>
<td>Onshore Wind</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>RPS</td>
<td>Core and Study</td>
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<tr>
<td>Geothermal</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Fuel Cells (green H2)</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Small Hydro (existing)</td>
<td>RPS</td>
<td>Core and Study</td>
</tr>
<tr>
<td>Large Hydro (existing)</td>
<td>Zero-Carbon</td>
<td>Core and Study</td>
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<tr>
<td>Nuclear (existing)</td>
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<td>Core and Study</td>
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<tr>
<td>Zero-Carbon Firm Dispatchable Resource</td>
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<td>Study Only</td>
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<tr>
<td>Zero-Carbon Firm Baseload Resource</td>
<td>Zero-Carbon</td>
<td>Study Only</td>
</tr>
</tbody>
</table>
Core Assumptions: Demand Scenarios

PATHWAYS provides RESOLVE:
- Annual loads by category (GWh/yr)
- Some load shape information for load modifiers

As of 2019, there is 80 GW of in-state capacity in California.

Customer solar shown here is a demand-side assumption. No additional customer solar was selected.
Economy-wide Decarbonization Impacts Resource Requirements
Resource Technology Pursued Impacts
Resource Requirements
Resource Technology Pursued Impacts
Resource Requirements

Selected Cumulative Capacity (MW)

- Gas Capacity Not Retained
- Shed DR
- Long Duration Storage
- Battery Storage
- Customer Solar
- Utility-Scale Solar
- Offshore Wind
- New OOS Wind
- Wind
- Biomass
- Geothermal
- Generic Zero-Carbon Baseload
- Hydrogen Fuel Cell
- Generic Zero-Carbon Dispatchable
Study scenario includes T&D and storage losses in zero-carbon target.
Going Beyond SB 100 Impacts Resource Requirements

Cumulative Selected Capacity (MW)

- Gas Capacity Not Retained
- Shed DR
- Long Duration Storage
- Battery Storage
- Customer Solar
- Utility-Scale Solar
- Offshore Wind
- New OOS Wind
- Wind
- Biomass
- Geothermal
- Geothermal
- Hydrogen Fuel Cell
- Gas
Resource Build Rates

Average Build Rate to Date

- Solar
- Wind
- Battery

- Highest 1-Year Historical

Average Build Rate to 2045

- SB 100 Core
- High Electrification Demand

Solar
- 10-Year Average Yearly Build (GW/year)
- 25-Year Average Yearly Build (GW/year)
- Highest 1-Year Historical

Wind
- 0.9

Battery
- 2.0

Yearly Build (GW/year)
Factors that May Impact Resource Build

- Electrification/electric demand
- Changes to gas fleet
- Portfolio diversity
  - Offshore wind, out-of-state wind, geothermal, etc
  - Clean firm resource development/deployment
  - DER deployment
  - Load flexibility
- Land-use constraints
Key Takeaways from Modeling

• The initial analysis suggests SB 100 is technically achievable though multiple pathways.
• Construction of clean electricity generation and storage resources must be sustained at record setting build rates.
• Diversity in energy resources lowers overall costs.
• Retaining some natural gas power capacity may minimize costs while ensuring an uninterrupted power supply during the transition to 100 percent clean energy.
  • Increased energy storage and advancements in zero-carbon firm resources and storage can reduce natural gas needs.
• Further analysis is needed.
Further Analysis Recommendations

- Verifying that scenario results satisfy the state’s grid reliability requirements across a range of conditions.

- Continuing to evaluate the potential effects of cost-saving emerging resources, such as offshore wind, long-duration storage, green hydrogen technologies, and demand flexibility.

- Assessing environmental, social, and economic costs and benefits of the additional clean electricity generation capacity and storage needed to implement SB 100.

- Holding annual workshops to support alignment among the joint agencies and continuity between SB 100 reports.
Further Analysis and Related Work

Inputs

- Existing System
- Demand Forecasts/Scenarios
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Follow-on work goals: Further quantitative assessment of reliability and portfolio impacts

Inputs, impacts, and tools listed are for illustrative purposes.
Further Analysis and Related Work

• SB 100
  • Alternative resource build options
  • Net-energy benefits
  • Reliability (long-term)

• Related Work
  • Role of DERs
  • Load Flexibility
  • Reliability (near- and mid-term)
  • Demand Scenarios

SB 100 Annual Workshop: Fall 2021/Winter 2022
Thank you!

The 2021 SB 100 Joint Agency Report and Summary Document can be found at:

https://www.energy.ca.gov/sb100