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## 2021 Senate Bill 100 (SB 100) Joint-Agency Report Modeling Framework and Scenarios Overview

August 31, 2020

### Contents

1. 2021 SB 100 Joint-Agency Report Timeline
2. Candidate Zero-Carbon Resources for Modeling
3. Loads Subject to SB 100
4. Modeling Scenarios
5. Response to Stakeholder Comments on Modeling

### 1. 2021 SB 100 Joint-Agency Report Timeline

The 2021 SB 100 Joint-Agency Report (SB 100 Report) is progressing largely on schedule, with some delays as joint-agency staff has adjusted to teleworking and work capacity effects of the COVID-19 crisis. The agencies are working to meet the January 1, 2021, statutory deadline.

The joint-agency team (California Energy Commission, California Public Utilities Commission, and California Air Resources Board) has completed the SB 100 modeling scope for the SB 100 Report with the project consultant, Energy and Environmental Economics (E3). At the SB 100 Draft Results Workshop, which will be held remotely September 2, 2020, staff will present the draft modeling results. The modeling results will also be posted publicly along with this document before the workshop.

Joint-agency staff plans to release a draft of the SB 100 Report for public review in fall 2020. The draft report will be accompanied by a draft report workshop, which will be held remotely. The date, materials, and attendance details will be posted on the SB 100 website and distributed on the SB 100 list serve.

**Table 1: SB 100 Report Development Process**

Activity	Estimated Date
Kickoff Workshop (Sacramento)	September 2019
Scoping Workshop 1: Central Valley (Fresno)	September 2019
Scoping Workshop 2: Northern California (Redding)	October 2019
Scoping Workshop 3: Southern California (Diamond Bar)	October 2019
Technical Workshop (San Francisco)	November 2019
Modeling Inputs & Assumptions Workshop (Sacramento)	February 2020
<b>Draft Modeling Results Workshop (Remote Only)</b>	<b>September 2020</b>
Draft Report Workshop (Remote Only)	November 2020
Report due to Legislature	January 1, 2021

## 2. Candidate Zero-Carbon Resources for 2020 Modeling

Senate Bill 100 (De León, Chapter 312, Statutes of 2018) revises state policy in “that eligible renewable energy resources and zero-carbon resources supply 100% of retail sales of electricity to California end-use customers and 100% of electricity procured to serve all state agencies by December 31, 2045. The bill would require that the achievement of this policy for California not increase carbon emissions elsewhere in the western grid and that the achievement not allow resource shuffling.” (454.53 [a]).<sup>1</sup>

The joint agencies’ interpretation of “zero-carbon resources,” as stated in the statute, includes generation resources that meet one or both of the following criteria. (This set of criteria has been referred to as “RPS+” in previous SB 100 workshops and documents.)

1. Meets the requirements for RPS-eligibility set forth in the most recent RPS Eligibility Guidebook.<sup>2</sup>
2. Has zero onsite greenhouse gas emissions.<sup>3</sup>

For modeling for the SB 100 Report, staff included candidate generation resources that meet the above criteria *and* are viable resources in terms of technology readiness, alignment with other state policies and public and

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<sup>1</sup> Senate Bill 100 (De León, Chapter 312, Statutes of 2018), [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=201720180SB100](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100).

<sup>2</sup> [RPS Eligibility Guidebook, Ninth Edition Revised](https://efiling.energy.ca.gov/getdocument.aspx?tn=217317), <https://efiling.energy.ca.gov/getdocument.aspx?tn=217317>.

<sup>3</sup> For modeling, this list does not acknowledge de minimis emissions associated with included technologies. Further discussion on this point will be included in the report. For example, natural gas with CCS may not result in absolute zero emissions.

environmental health priorities, and resource availability. Only commercialized technologies with vetted and publicly available cost and performance datasets were included for core scenarios. (Scenarios are broken into two categories, “core scenarios” and “study scenarios,” as described in Section 4.)

The study scenarios, which serve as exploratory analyses (described in Section 4), also include generic firm dispatchable and baseload resources to illustrate the impact emerging resources, such as gas generation with carbon capture or out-of-state advanced nuclear generation, might have on a 2045 portfolio. These generic resources were not included in the core scenarios because of uncertainty in cost and development timelines.

Table 2 lists renewable and zero-carbon generation resources included in modeling for the SB 100 Report. These technologies are not intended to be a prescriptive list of technologies that will be eligible under a 100 percent clean electricity program. Rather, the list approximates technologies that could meet the SB 100 criteria for renewable and zero-carbon resources, as interpreted by the three agencies, for study purposes to evaluate impacts and benefits and inform state planning.

**Table 2: Generation Technologies Included in Modeling**

Technology	Eligibility Basis	Scenarios
Solar PV	RPS	Core and Study
Solar Thermal	RPS	Core and Study
Onshore Wind	RPS	Core and Study
Offshore Wind	RPS	Core and Study
Geothermal	RPS	Core and Study
Bioenergy	RPS	Core and Study
Fuel Cells (green H2)	RPS	Core and Study
Large Hydro (existing)	Zero-Carbon	Core and Study
Nuclear (existing)	Zero-Carbon	Core and Study
Generic Firm Dispatchable Resource <sup>4</sup>	Zero-Carbon	Study Only
Generic Firm Baseload Resource <sup>5</sup>	Zero-Carbon	Study Only

4 This resource could represent several technologies, such as gas with carbon capture and sequestration or generation using drop-in renewable fuels, that can serve as a zero-carbon dispatchable resource at the prices indicated in the SB 100 Draft Modeling Results Presentation.

5 This resource could represent several technologies, such as imports of emerging nuclear generation technologies, that can serve as a zero-carbon baseload resource at the prices indicated in the SB 100 Draft Modeling Results Presentation.

Technologies that could meet the zero-emissions criteria but have other barriers to development were excluded from modeling for the reasons indicated in Table 3. If the noted reasons for exclusion change, the technologies listed in Table 3 may be included in future SB 100 modeling. (Additional information on the reasons for these exclusions will be included in the SB 100 Report.) Moreover, staff will update future SB 100 modeling to reflect the commercialization of emerging technologies.

**Table 3: Considered Technologies Excluded From 2020 Modeling<sup>2</sup>**

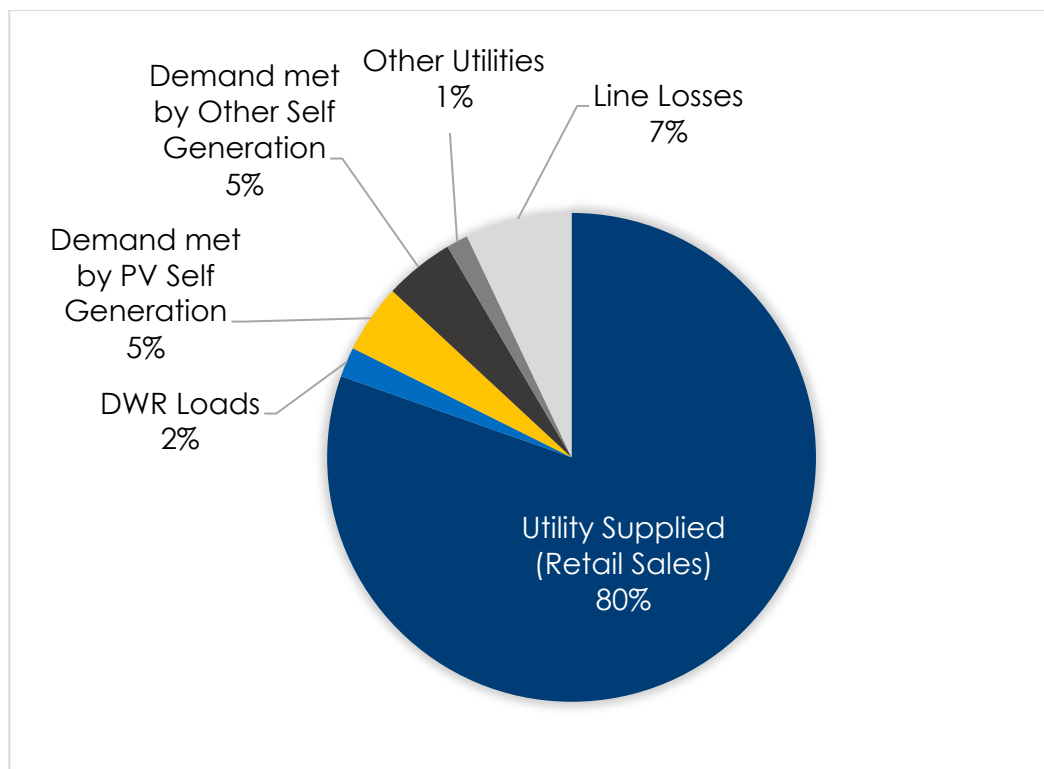
Technology	Reason for Exclusion
New in-state nuclear	Effective moratorium on new in-state nuclear power plants as described in the Warren Alquist Act. <sup>6</sup>
Drop-in renewable fuels (hydrogen and biomethane)	Technology not yet commercially available in California; inadequate cost and supply data for modeling.
Coal-fired generation with carbon capture and sequestration	Coal-fired generation is incompatible with the state's environmental and public health priorities.
Small hydro	Inadequate data on new capacity cost and resource availability for modeling purposes.
New large hydro generation	Limited development feasibility at this time and concerns around environmental impacts.

### 3. Loads Subject to SB 100

SB 100 modeling reflects a statutory interpretation by the agencies that the bill requires procurement of energy from eligible resources to equal the specified percentages of retail sales and other state agency loads only and excludes wholesale, or nonretail, sales, storage losses, and transmission and distribution line losses. The loads subject to SB 100 are the total of the utility supplied (retail sales) and Department of Water Resources (DWR) loads. As shown in blue in Figure 1, they accounted for roughly 82 percent of total state consumption in 2018. The remaining loads have been determined to be outside the scope of the SB 100 2045 goal. Solar self-generation accounted for an additional 5 percent of total state consumption in 2018, indicated in gold in Figure 1.

<sup>6</sup> [Warren-Alquist Act](https://ww2.energy.ca.gov/2020publications/CEC-140-2020-001/CEC-140-2020-001.pdf), <https://ww2.energy.ca.gov/2020publications/CEC-140-2020-001/CEC-140-2020-001.pdf>.

**Figure 1: 2018 California Electricity Loads**



The modeled scenarios also reflect assumptions made about electricity demand. The joint agencies analyzed a reference demand case using an extrapolation from the *2019 Integrated Energy Policy Report California Energy Demand Forecast*,<sup>7</sup> as well as high electrification, high biofuels, and high hydrogen scenarios, building off the analysis in the *2018 Deep Decarbonization in a High Renewables Future*<sup>8</sup> report.

#### 4. 2020 Modeling Scenarios

SB 100 states that the SB 100 Report shall include “*alternative scenarios in which the policy ... can be achieved and the estimated costs and benefits of each scenario.*” Furthermore, the statute requires the joint-agency report to include “a

7 California Energy Commission. 2019. [2019 Integrated Energy Policy Report](https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2019-integrated-energy-policy-report), <https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2019-integrated-energy-policy-report>.

8 Energy and Environmental Economics, Inc. June 2018. [Deep Decarbonization in a High Renewables Future](https://www2.energy.ca.gov/2018publications/CEC-500-2018-012/CEC-500-2018-012.pdf). California Energy Commission, <https://www2.energy.ca.gov/2018publications/CEC-500-2018-012/CEC-500-2018-012.pdf>.

review of the policy ... focused on technologies, forecasts, then-existing transmission, and maintaining safety, environmental and public safety protection, affordability, and system and local reliability.” (454.53 [b])<sup>9</sup>

The modeling scope outlined here evaluates costs and benefits of various potential technological pathways to meet the 2045 goal while acknowledging that costs, performance, and availability of commercialized technologies will change over the next 25 years. Future modeling will be updated to reflect such changes in available technologies. Scenarios are broken into two categories, “core scenarios” and “study scenarios,” as described below.

### Core Scenarios

The core scenarios modeled for the SB 100 Report are consistent with the joint agencies’ interpretation of the statute. Therefore, they include the proposed loads subject to SB 100 (retail sales + state agency loads) and zero-carbon resources as described in Section 2. The SB 100 inputs and assumptions document has modeling inputs and assumptions for all modeled technologies.

### Study Scenarios

The study scenarios are exploratory analyses that examine outcomes outside the core modeling assumptions or outside the scope of the joint agencies’ interpretation of the SB 100 goal. They are intended to provide additional information for consideration and support broader state agency energy planning.

**Table 3: Modeling Scenarios for the SB 100 Report**

	Grouping	Scenario	Description
Ref.	Counterfactual	Counterfactual- High Elect	60% RPS; High Elect. Demand
		Counterfactual- Ref	60% RPS; Ref. Demand
Core	SB 100 Core	Core Scenario	100% Retail; High Elect. Demand
	Core Demand Sensitivities	Core- Reference	100% Retail; Ref. Demand
		Core- High Biofuels	100% Retail; High Biofuels Demand
		Core- High Hydrogen	100% Retail; High Hydrogen Demand
		Flexible Load	100% Retail; High Elect; Load shape changes
Core Resource Sensitivities	No OOS Wind (Core)	100% Retail; High Elect. Demand; No OOS Tx	

<sup>9</sup> [Senate Bill 100, 2018](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100), [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=201720180SB100](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100).

		No OSW (Core)	100% Retail; High Elect. Demand; No OSW
		No OOS Wind or OSW (Core)	100% Retail; High Elect. Demand; No OOS Tx or OSW
<b>Study</b>	SB 100 Study	SB 100 Study Scenario	100% Retail +Losses; High Elect. Demand
	SB 100 Study: Demand Sensitivity	Study- Reference Demand	100% Retail +Losses; Ref. Demand
	SB 100 Study: Resource Sensitivities	No OOS Wind (Study)	100% Retail +Losses; High Elect. Demand; No OOS Tx
		No OSW (Study)	100% Retail +Losses; High Elect. Demand; No OSW
		No OOS Wind or OSW (Study)	100% Retail +Losses; High Elect. Demand; No OOS Tx or OSW
	Study: Accelerated Timelines	100% in 2030	Accelerate 100% Retail target to 2030
		100% in 2035	Accelerate 100% Retail target to 2035
		100% in 2040	Accelerate 100% Retail target to 2040
	Study: No Combustion	No Combustion	Retire all combustion, no combustion candidates (0 MMT GHG)
	Study: Zero Carbon Firm	Zero Carbon Firm Dispatchable (High Cost)	Add zero carbon firm dispatchable resource as a candidate resource
		Zero Carbon Firm Baseload	Add zero carbon firm baseload resource as a candidate resource
Zero Carbon Firm Dispatchable + Baseload		Add zero carbon firm dispatchable and baseload resources as candidate resources	

### 5. Stakeholder Comments on Modeling

The joint agencies received a large number of comments pertaining to SB 100 modeling from a diverse group of stakeholders. The team appreciates the strong public and stakeholder engagement to date. Some comments have been addressed for analysis in the SB 100 Report, while others will help inform future SB 100 modeling.



A significant number of comments received relate to three overarching themes, which are discussed below. These are 1) resource eligibility and assumptions, 2) loads subject to SB 100, and 3) public and environmental health.

### Resource Eligibility and Assumptions

Many stakeholders commented in support of the proposed “RPS+” criteria for candidate resources. Moreover, many stakeholders urged the joint agencies to keep eligibility broadly defined to allow innovation and maximize resource diversity. In response, the joint agencies retained the attribute-based criteria for zero-carbon resources, as described in Section 2 of this document, rather than develop a prescriptive list of candidate technologies. Attribute-based criteria are focused on RPS eligibility, lack of any onsite carbon emissions, compatibility with the state’s policies, technology readiness, and impacts on the environment and public health. Technologies that lack adequate cost and performance data or that are incompatible with state policies and environmental and public health priorities are excluded from “core” modeling scenarios.

The joint agencies received a high number of comments in favor of including or excluding specific technologies or technology types. The agencies carefully considered these comments and made changes where appropriate. For a full list of technologies, inputs, and assumptions used for 2020 modeling, refer to the SB 100 inputs & assumptions document.

### Loads Subject to SB 100

Several stakeholders commented on the scope of loads covered by the 100 percent renewable and zero-carbon resource requirement. As noted above, the policy states “that eligible renewable energy resources and zero-carbon resources supply 100% of retail sales of electricity to California end-use customers and 100% of electricity procured to serve all state agencies by December 31, 2045.”

Comments received favoring the inclusion of system losses, including transmission, distribution, and storage losses, cited the use of the term “supply” in the statutory language, interpreting the term to include upstream generation requirements required to deliver an amount of electricity equal to retail sales.

After careful consideration, the joint agencies have interpreted the statutory language to include only retail sales and state loads under the scope of SB 100 to be consistent with existing precedent under the RPS.

## Equity and Health

A third major category of comments relates to equity, public health, and environmental health considerations for the analysis. Stakeholder groups submitted comments recommending the joint agencies consider an equity scenario that excludes combustion resources and includes social costs and non-energy benefits (NEBs).

Stakeholders recommended the joint agencies integrate at least the following NEBs and social costs:

- Land-Use impacts
- Public health and air quality
- Water supply and quality
- Economic impacts
- Resiliency

The joint agencies included a study scenario, which excludes all new and existing combustion resources, in the modeling scope. Refinement to localized air pollution impacts and the other NEBs listed above were not feasible in this round of modeling, given the modeling tools available, remaining unknowns about where generation resources will be located, and lack of high-resolution data on when and how specific resources will be used. The joint agencies plan to continue engaging with the environmental justice and other stakeholders to explore opportunities to better integrate these topics into future analyses. The SB 100 report will include a state-level discussion on topics including affordability, public health, reliability, land use, and workforce development.