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Filer:	Harinder Kaur
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2021 SB 100 Joint Agency Report Summary

Achieving 100% Clean Electricity in California

An Initial Assessment



March 2021

Senate Bill 100

Officially titled “The 100 Percent Clean Energy Act of 2018,”
Senate Bill 100 (SB 100, De León):

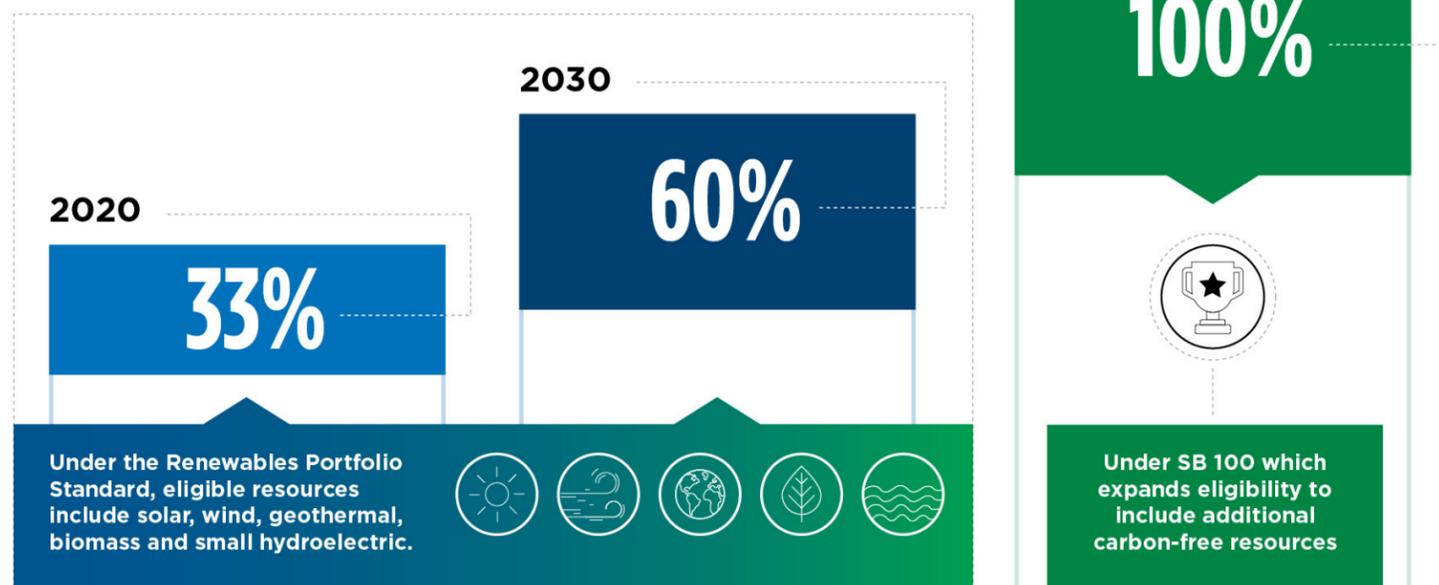
- 1 Sets a 2045 goal of powering all retail electricity sold in California and state agency electricity needs with renewable and zero-carbon resources — those such as solar and wind energy that do not emit climate-altering greenhouse gases.
- 2 Updates the state’s Renewables Portfolio Standard to ensure that by 2030 at least 60 percent of California’s electricity is renewable.
- 3 Requires the Energy Commission, Public Utilities Commission and Air Resources Board to use programs under existing laws to achieve 100 percent clean electricity and issue a joint policy report on SB 100 by 2021 and every four years thereafter.

SB 100 Builds on Existing Efforts

California has already made significant progress toward a clean energy future through many programs that promote renewable energy, energy efficiency and the storage technologies needed to retire fossil fuel resources. SB 100 builds on this progress by escalating the state’s renewables procurement requirement and makes the advancement to 100 percent clean electricity official state policy — not just an aspiration.

California’s

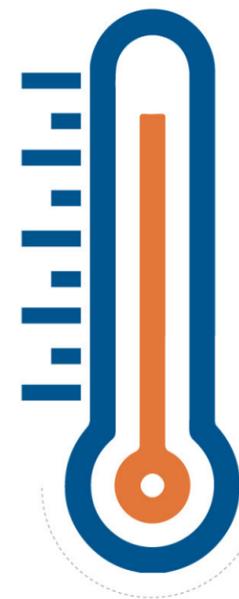
Clean Electricity Goals



The Climate Imperative



In the summer of 2020, Californians experienced the damaging effects of climate change as never before: a historic siege of wildfires and smoke, and a record-breaking heat wave. Scientists worldwide agree that without bolder mitigation measures, climate-related disasters will recur with increasing frequency and greater devastation.



BY 2100

AVERAGE ANNUAL MAXIMUM DAILY TEMPERATURE

IS PROJECTED TO INCREASE BY

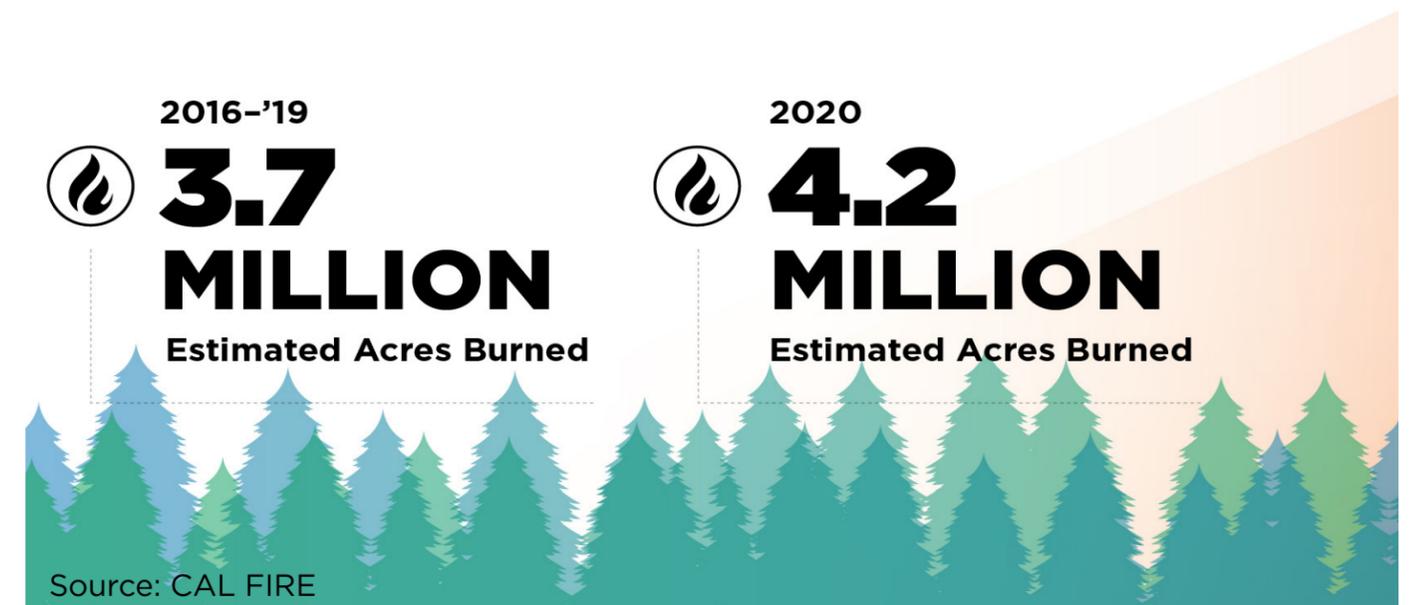
5.6–8.8°F

Depending on greenhouse gas emissions reductions. The greatest increase is seen with business-as-usual emissions levels.

Source: California’s Fourth Climate Change Assessment

More Acres Burned

From Wildfires in 2020 Than the Last Four Years Combined



Source: CAL FIRE

Continuing a Legacy of Bold Leadership

California has long led the world in combating climate change. The state's policies to vastly increase renewable energy and drastically reduce carbon emissions will not only help temper the effects of climate change globally but also improve the health of Californians and their economy. The state has now committed to becoming "carbon neutral" by 2045 — eliminating as much climate-warming pollution as it emits by that year.

In 2019,
63% of California's electricity retail sales came from non-fossil fuel sources:

RENEWABLES



HYDROELECTRIC



NUCLEAR



California has already made significant progress toward clean electricity. Carbon emissions from generating electricity have dropped 43 percent since 1990, and in 2017, for the first time ever, the state drew most of its power from carbon-free sources — primarily solar. These gains are largely attributable to:



California's energy efficiency standards for buildings and appliances



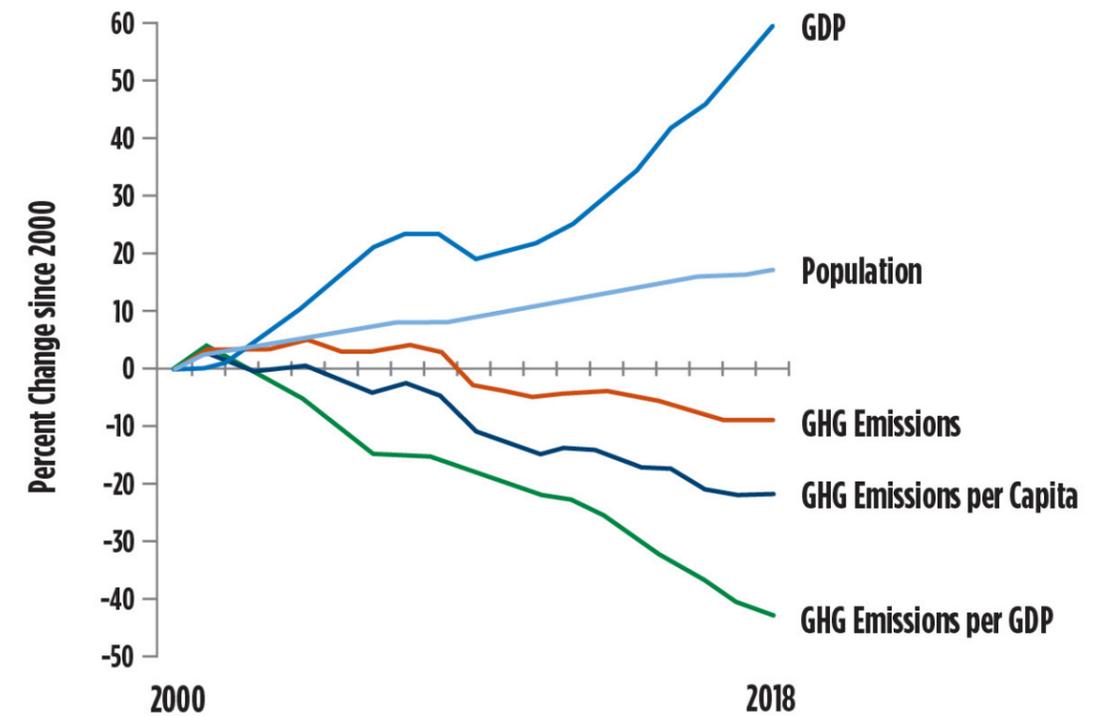
The state's Renewables Portfolio Standard



Greatly reduced use of coal-fired power plants

Statewide Trends

of Emissions and Indicators (2000–2018)



Source: California Air Resources Board



Related Clean Energy Efforts



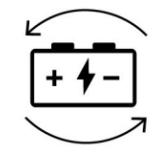
Transportation electrification – California is moving toward having 100 percent of new cars and passenger trucks sold in the state be zero-emission by 2035, but the environmental impacts of transportation are about more than tailpipe pollution. The electricity powering zero-emission vehicles must also be carbon-free.



Building decarbonization – State agencies are assessing ways to decarbonize energy use in buildings, mainly natural gas used for space and water heating. Electrifying more building energy uses is environmentally more effective if the power comes from zero-carbon sources.



Energy efficiency – The Energy Commission is continuously improving the state’s energy efficiency standards for buildings and appliances to reduce customer bills and offset the need for additional generation capacity. Improved energy efficiency will reduce the economic and environmental costs of expanding California’s clean electricity generating capacity.



Load flexibility – The state is working to increase the ability of the grid to shift the timing of electricity use to sunny and windy parts of the day when most renewable energy is produced. This load flexibility is critical to maintaining a reliable power supply at a low cost.

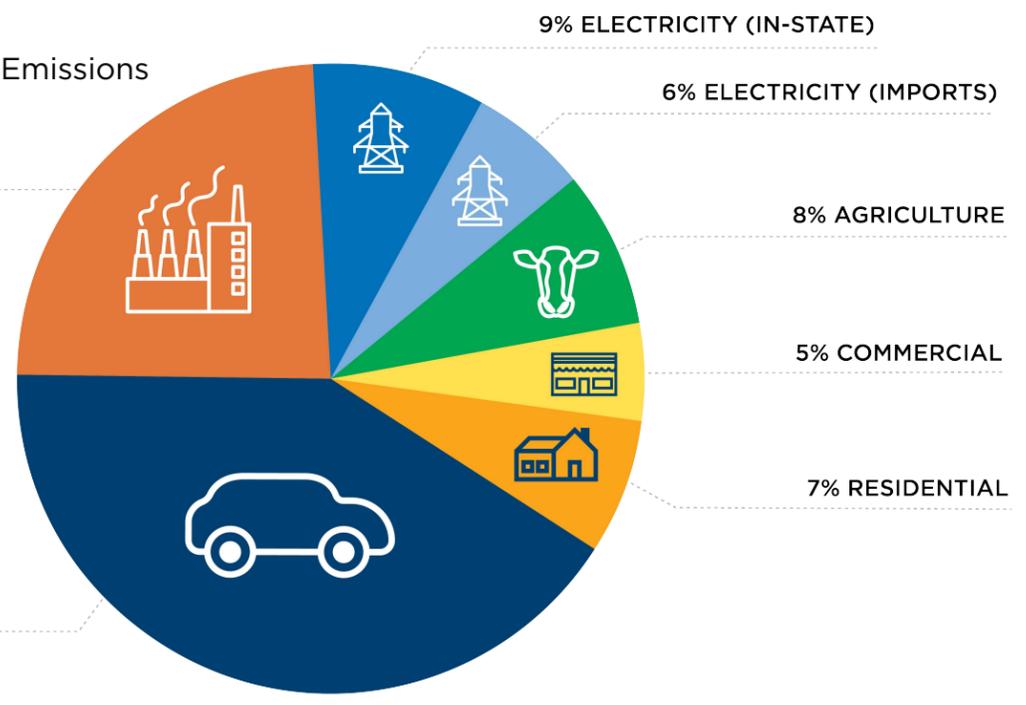
Decarbonizing the Power Grid

California’s

2018 Greenhouse Gas Emissions

24% INDUSTRIAL

41% TRANSPORTATION



Source: California Air Resources Board

A clean electricity grid is necessary to achieve economy wide carbon neutrality. Using clean electricity to power transportation, buildings and industrial operations helps decarbonize these sectors of the economy, which, along with electricity generation, account for 92 percent of the state’s carbon emissions.

SB 100 is central to improving California’s energy system. Clean electricity works in synergy with other state efforts to reduce emissions and make the state’s electricity system more resilient, affordable and environmentally sustainable.

Benefits

of 100% Clean Energy

Moving toward 100 percent clean electricity will bring social benefits, such as less air pollution and improved public health. It will also create more jobs, including those in manufacturing and installing wind turbines and solar panels, and developing new clean energy technologies.

More than 23 million Californians live in areas where smog-forming pollutants routinely exceed federal health-based standards. The phaseout of fossil fuel-generated electricity is expected to reduce smog-related deaths and illnesses.

Disadvantaged communities — low-income neighborhoods that have historically suffered poor health, dirty air and other burdens — will reap the highest health benefits from clean electricity. Half of the state’s natural gas power plants are in communities that rank among the 25 percent most disadvantaged.

SB 100-driven growth in the capacity to generate and store clean electricity can create thousands of new high-quality clean energy jobs, especially in the installation and maintenance of solar and wind systems.



The 2021 SB 100 Joint Agency Report

The 2021 report is a first step to evaluate the challenges and opportunities in implementing SB 100. It includes an initial assessment of the additional energy resources and the resource building rates needed to achieve 100 percent clean electricity, along with the associated costs. It uses a computer model to analyze these factors under various conditions and technologies.

The estimates in this report will change over time as additional factors are examined. The next study will focus mainly on grid reliability. The joint agencies will evaluate the measures needed to ensure California's power needs are met under a wide range of conditions as the state transitions to 100 percent clean electricity. Future modeling will also:

Further assess the potential of emerging technologies, such as long-duration energy storage and green hydrogen generation.

Examine the economic and land-use effects.

Evaluate consistency with the state's goals for clean energy equity.²

Public Outreach

A diverse array of interests informed this report through a year-long series of public workshops and comment opportunities. Participants included:

Community leaders

Energy experts with utilities, technology companies and trade groups

University researchers

Environmental groups

Environmental justice organizations

The joint agencies also consulted with the California balancing authorities and the Disadvantaged Communities Advisory Group, which advises the Energy Commission and Public Utilities Commission on energy equity issues.

Modeled Scenarios and Results

The energy consulting firm E3 developed the model and performed the scenario analyses. The modeling inputs and assumptions are consistent with the joint agencies' interpretation of SB 100. The analysis builds on the modeling and assumptions used for the Public Utility Commission's Integrated Resource Planning and considers California's overarching priorities on energy, climate, equity and public health.

The joint agencies interpreted "zero-carbon resources" to mean energy resources that qualify as "renewable" in the Renewables Portfolio Standard program or generate zero greenhouse gas emissions on site. The modeled zero-carbon technologies are limited to those that are consistent with state policies and priorities and are commercialized, with publicly available cost and performance data. Excluded technologies may be considered in future SB 100 analyses. Staff will update modeling as new technologies enter the market.

Renewable/Zero-Carbon Technologies Modeled:



Solar, photovoltaic and thermal (existing only)



Wind, onshore and offshore



Geothermal



Bioenergy



Fuels cells



Hydroelectric, existing large and small operations only



Nuclear, existing power plants only

Modeling Results

Clean Electricity Resources

To reach the 2045 target, California will need to roughly triple its current electricity power capacity. The projected increase is driven by the conversion to clean energy resources and growing electricity demand.

California Clean Electricity Resources

	Existing Resources	Projected New Resources	
	2019*	2030**	2045**
Solar (Utility-Scale)	12.5 GW	16.9 GW	69.4 GW
Solar (Customer)	8.0 GW	12.5 GW	28.2 GW
Storage (Battery)	0.2 GW	9.5 GW	48.8 GW
Storage (Long Duration)	3.7 GW	0.9 GW	4.0 GW
Wind (Onshore)	6.0 GW	8.2 GW	12.6 GW
Wind (Offshore)	0 GW	0 GW	10.0 GW
Geothermal	2.7 GW	0 GW	0.1 GW
Biomass	1.3 GW	0 GW	0 GW
Hydrogen Fuel Cells	0 GW	0 GW	0 GW
Hydro (Large)	12.3 GW	N/A†	N/A†
Hydro (Small)	1.8 GW	N/A†	N/A†
Nuclear	2.4 GW	N/A†	N/A†

*Includes in-state | **Includes in-state and out of state capacity | †New hydro and nuclear resources were not candidate technologies for this round of modeling and could not be selected

While no new natural gas generation is selected in the SB 100 Core scenario, much of the existing natural gas capacity is retained through 2045. Generation of renewable and zero-carbon resources must be at least equal to retail sales by 2045, however natural gas generation can serve non-retail load or system losses. Cost reductions and innovation in zero-carbon firm resources and storage resources may reduce the amount of gas generation needed.

Build Rates



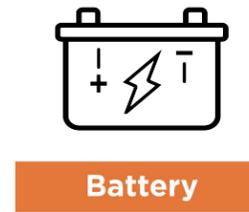
California will need to sustain its expansion of clean electricity generation capacity at a record-breaking rate for the next 25 years. On average, the state will need to build 6 GW of new solar, wind and battery storage resources annually.

To Achieve Clean Energy Development Needs To Rapidly Accelerate



3X

Solar and wind build rates need to nearly triple*



8X

Battery storage build rates need to increase by nearly eightfold**

*Based on 10-year average | **Based on 2020

Costs

Modeling results indicate that achieving 100 percent clean electricity will increase the total annual electricity system costs by nearly \$4.6 billion by 2045. This is 6 percent more than the cost under the state's Renewables Portfolio Standard requirement of having at least 60 percent clean electricity by the end of 2030. These estimates will change over time as markets change, new technologies are commercialized, and additional factors such as grid reliability are included in future analyses.

Additional Scenarios

The joint agencies modeled SB 100 implementation in a “high-flexibility” scenario in which the grid’s ability to shift high demand to times of surplus supply is improved. This scenario results in nearly \$1 billion in annual cost savings by 2045 and a reduction in the amount of energy storage (batteries) and natural gas needed to support the grid. These results suggest greater load flexibility could significantly lower implementation costs.

The agencies also explored scenarios outside their interpretation of SB 100. These “study scenarios” are intended to inform broader state planning efforts on energy, climate, and public health:



No-Combustion:

Excludes electricity generated from combustion of biomass and fossil fuels, including natural gas. Modeling indicates this scenario may result in a 12 percent increase to annual costs by 2045.



Zero-Carbon Firm Resources:

Adds generic carbon-free energy resources that are “firm” — always available. These represent emerging technologies that may become cost-competitive and commercialized over the next 25 years. Examples include 100 percent green hydrogen-fueled turbines and natural gas with systems that can capture and store 100 percent of carbon emissions. Results indicate that the inclusion of these resources could reduce annual electricity system costs in 2045 by \$2 billion, roughly 3 percent.



Accelerated Timeline:

Accelerates 100 percent target to 2030, 2035, and 2040. Preliminary results indicate these targets may be achievable but may increase overall costs.



Key Takeaways from Modeling

This initial analysis suggests SB 100 is technically achievable through multiple pathways.

Construction of clean electricity generation and storage facilities must be sustained at record-setting rates.

Diversity in energy resources and technologies lowers overall costs.

Retaining some natural gas power capacity may minimize costs while ensuring uninterrupted power supply during the transition to 100 percent clean energy.

Increased energy storage and advancements in zero-carbon technologies can reduce natural gas capacity needs.

Further analysis is needed.

Recommendations for Further Analysis

Verify that scenario results satisfy the state’s grid reliability requirements.

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

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

Hold annual workshops to support alignment among the joint agencies and continuity between SB 100 reports.



SB 100 Joint Agencies



California Energy Commission (CEC): leads the state to a 100 percent clean energy future by investing in clean energy and transportation innovation, forecasting energy demand, setting the state's appliance and building energy efficiency standards, and directing the state's response to energy emergencies.



California Public Utilities Commission (CPUC): regulates services and utilities, protects consumers, safeguards the environment, and assures Californians' access to safe and reliable utility infrastructure and services.



California Air Resources Board (CARB): leads the state's climate change programs and oversees all air pollution control efforts in the state.