



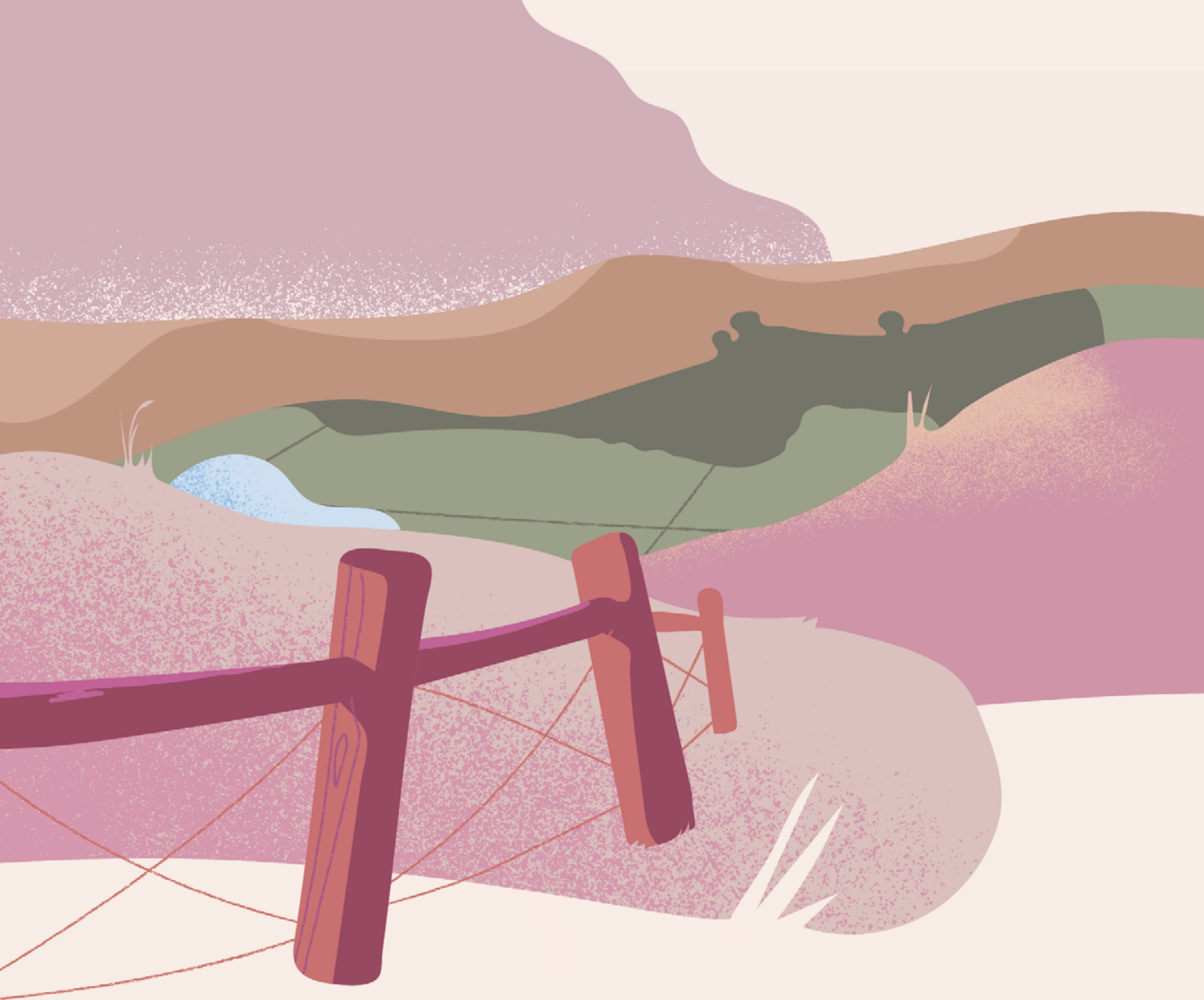
2021 — 13th Edition

California

Green Innovation

Index

Key Findings



This year marks the release of the 13th edition of Next 10's *California Green Innovation Index*. New in 2021 is a shift in format for our readers: a fully online, immersive experience for the Index that allows our readers to dig deep into the data, jump straight to the issues most important to their work, and easily find, interact with, and share the most critical climate and clean energy trends facing the state.

This overview provides a snapshot of some of this year's key takeaways. You can learn more about these trends and others at **GreenInnovationIndex.org**. We're excited for you to experience our first entirely online edition of the *California Green Innovation Index*, and we hope it can be useful to your work.



View the entire index at
[greenInnovationIndex.org](https://GreenInnovationIndex.org)

As the world looks ahead to a post-COVID-19 landscape, California's clean energy economy remains strong, but challenges persist for the state to meet its clean energy, transportation, and climate goals. Key takeaways from this year's analysis include:

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PG. 2

California is in danger of missing 2030 and 2050 climate targets.

KEY FINDING 2
PG. 3

The transportation sector is showing improvement, led by heavy duty vehicles.

KEY FINDING 3
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Wildfires are a growing emissions problem for California.

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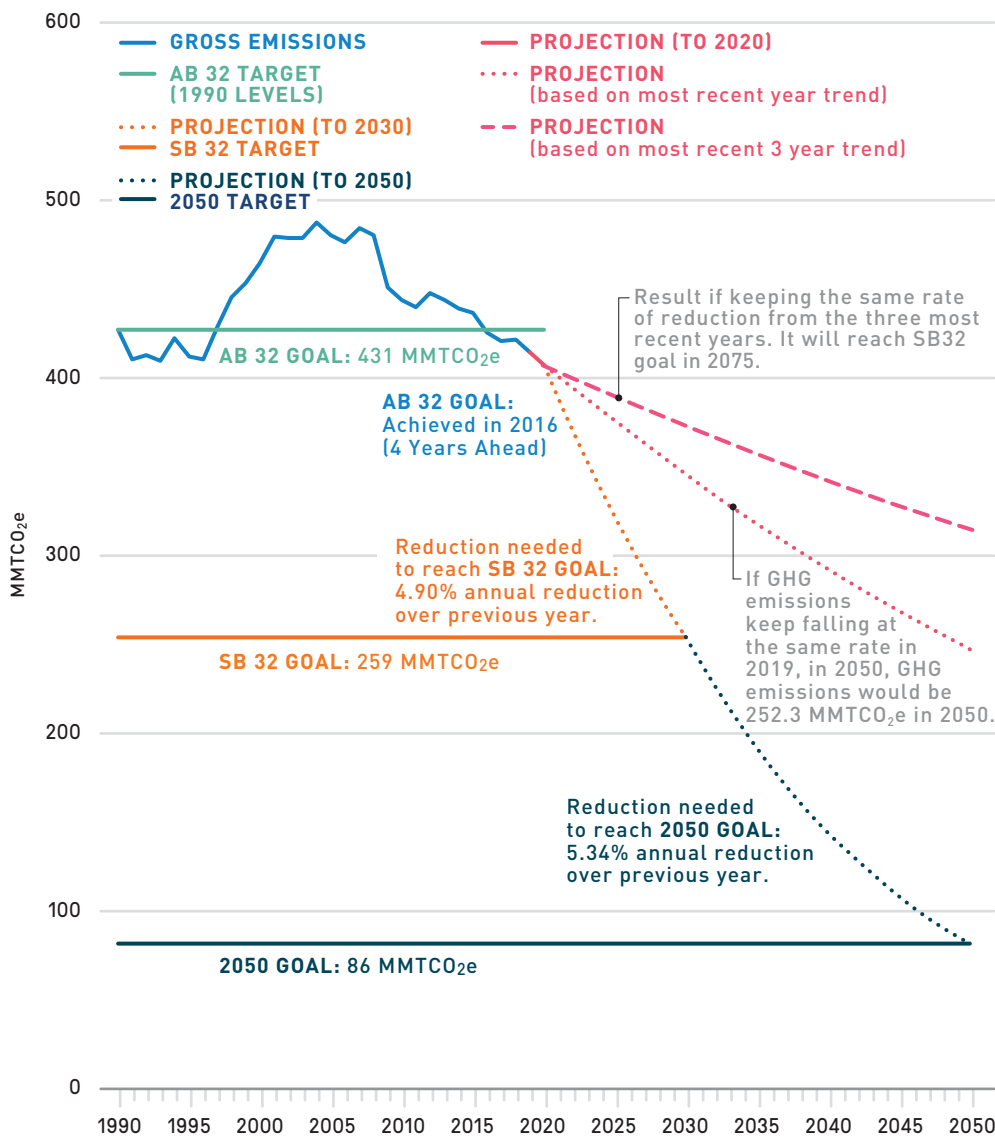
California's economy is the greenest in the nation.

California is in danger of missing 2030 and 2050 climate targets.

At the current trajectory, the state will take significantly more time to reach its SB 32 and 2050 goals than it did to reach the 2020 goal. From 2019 to 2030, the state would need to reduce greenhouse gas (GHG) emissions by 4.3 percent each year in order to meet the SB 32 goal by 2030, compared to last year's 4.1 percent reduction needed from 2018 to 2030. From 2018 to 2019 (the latest year for which emissions data are available), California reduced its GHG emissions only 1.6 percent.

Figure 1. GHG Emissions and Projected Reduction Goals

CALIFORNIA, 1990-2050



CHALLENGE:

From 2019 to 2030, the state would need to reduce GHG emissions by 4.3 percent each year in order to meet the SB 32 goal by 2030, compared to last year's 4.1 percent reduction needed from 2018 to 2030. At the current trajectory, the state will take significantly more time to reach its SB 32 and 2050 goals than it did to reach the 2020 goal. However, the COVID-19 pandemic-induced lockdowns and the shift to work from home arrangements for a large percentage of workforce could greatly reduce GHG emissions from the transportation sector in 2020.¹ National level data also suggest that GHG emissions in 2021 may be higher than those in 2020.² Whether these emission reductions remain permanent post-pandemic is not yet known.

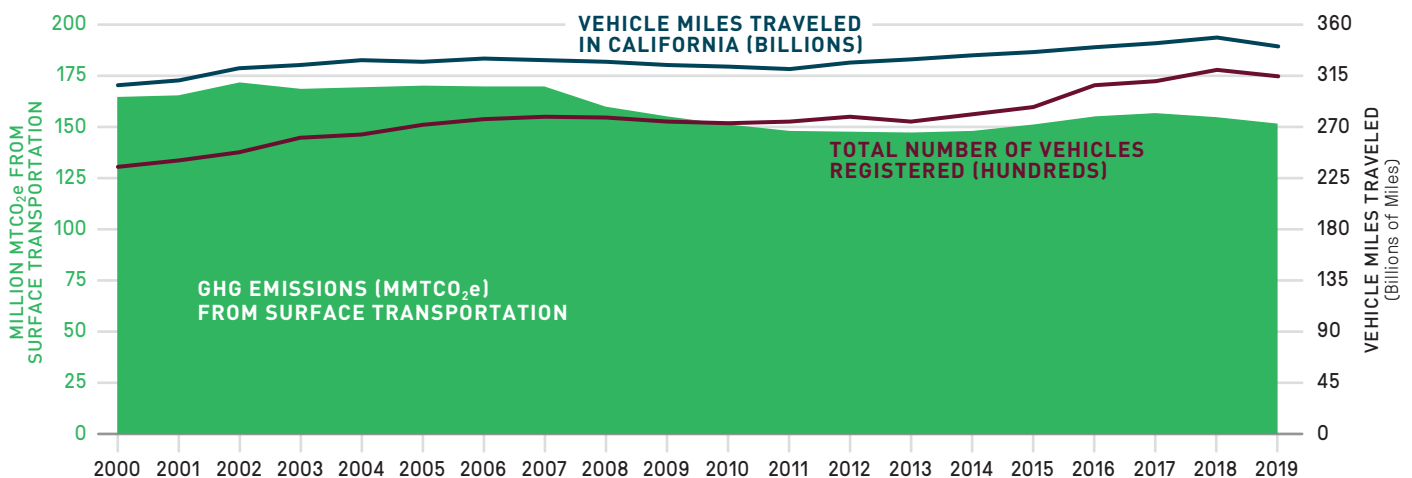
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory.
NEXT 10 / SF · CA · USA

The transportation sector is showing improvement, led by heavy-duty vehicles.

After years of increases in the total number of vehicles registered and vehicle miles traveled (VMT), both figures dropped by 1.8 percent and 2.3 percent from 2018 to 2019, respectively. The share of GHG emissions from the transportation sector was 40.7 percent in 2019—down slightly from 40.9 percent in 2018. Within the transportation sector, GHG emissions dropped 1.9 percent from on-road vehicles—thanks to larger reductions from the heavy duty subsector. New targets and commitments announced this year by both the state and federal government could help further the adoption of clean vehicles in the state.

Figure 2. Total Vehicles Registered, Vehicle Miles Traveled and Greenhouse Gas Emissions

CALIFORNIA, 2000–2019



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity; Federal Highway Administration, U.S. Department of Transportation. NEXT 10 / SF - CA - USA

HIGHLIGHT:

① After years of increases in the total number of vehicles registered and vehicle miles traveled (VMT in California), both figures dropped by 1.8 percent and 2.3 percent from 2018 to 2019, respectively. The number of vehicles registered actually dropped by another 5.9 percent—or 1.8 million—due in large part to the COVID-19 pandemic in 2020; VMT is also expected to drop significantly. GHG emissions also dropped at a similar level (–1.9%) from 2018 to 2019 and is likewise expected to drop significantly in 2020.³ ② The share of GHG emissions from the transportation sector was 40.7 percent in 2019—down slightly from 40.9 percent in 2018. The sector’s GHG emissions totaled 170.32 MMTCO₂e in 2018, down 3.63 MMTCO₂e (–2.1%) from 2017. Within the transportation sector, GHG emissions dropped 1.9 percent from on-road vehicles but increased 3.5 percent from off-road vehicles.⁴ Moving forward, the state can anticipate further emissions reductions from the heavy-duty sector thanks to the recently passed Clean Trucks Rule (July 2020) and a state budget investment of \$1.4 billion in ZEVs, which includes funding for ZEV heavy-duty trucks.

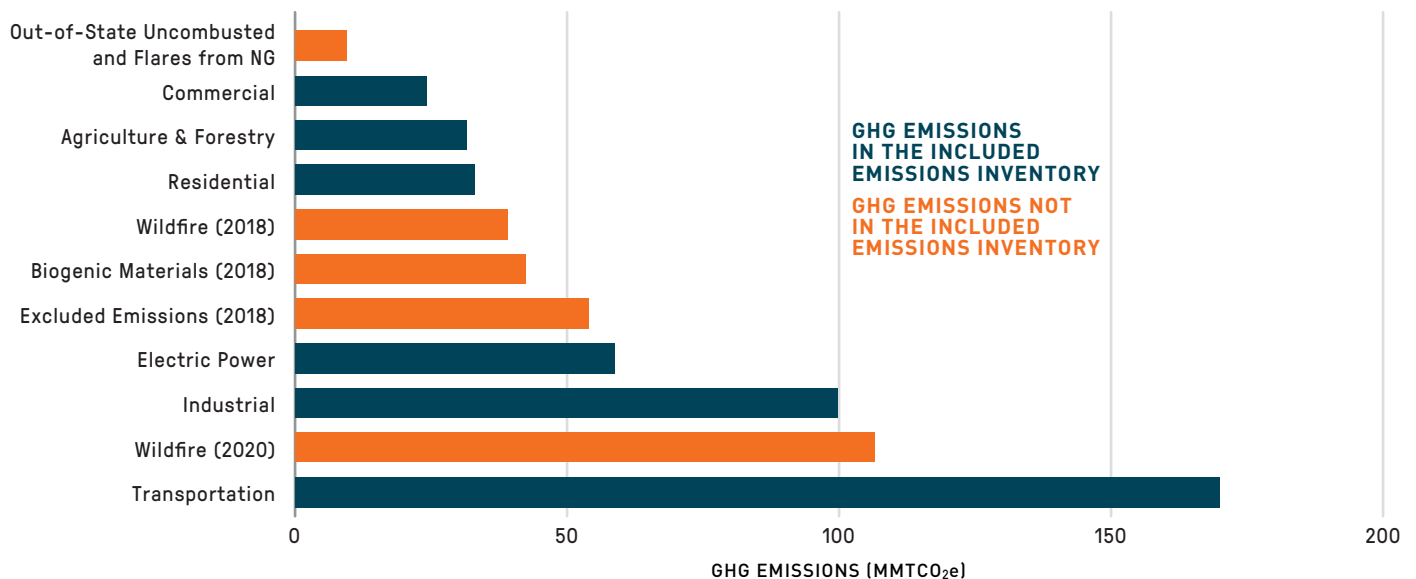
OPPORTUNITY:

The federal government is now aligned with California’s goals of electrifying the transportation sector. First, in September 2020, Governor Newsom signed Executive Order N-79-20, which sets the goal of 100 percent of in-state sales of new passenger cars and trucks to be zero-emission by 2035. In August 2021, President Biden announced a goal of 50 percent of new vehicle sales be zero-emission vehicles (ZEVs) by 2030.

Wildfires are a growing emissions problem for California.

Wildfires have been producing more GHG emissions than ever. In 2020, emissions from wildfires totaled 106.7 MMTCO₂e, more than any other economic sector except for transportation. The August Complex fire, which released an estimated 27.7 MMTCO₂e of emissions alone, is more than all the included emissions from the commercial sector (24.2 MMTCO₂e). Emissions from fires are not included in the statewide inventory as forests both serve as a source of emissions (from fires) and a sink of emissions, but increasingly wildfires present an increasing net source of emissions.

Figure 3. GHG Emissions Not in the Included Emissions Inventory Comparison



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: GHG Emission estimates for all items are expressed as MMTCO₂e under 100-year global warming potential time horizon, except for wildfire estimates. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector (for Included, Excluded, and Biogenic Materials GHG Emissions); California Air Resources Board (for 2018 Wildfire GHG Emission Estimates and GHG Out-of-state emission estimates from releases of uncombusted gas and flaring associated with natural gas consumed in California, pursuant to AB 2195); the European Centre for Medium-Range Weather Forecasts (for 2020 Wildfire GHG Emission Estimates). NEXT 10 / SF · CA · USA

CHALLENGE:

Emissions stemming from wildfires are higher than at any other point in California's recorded history. Emissions from wildfires⁹ in California totaled 106.7 MMTCO₂e in 2020, more than any other economic sector except for transportation. The August Complex fire, which released an estimated 27.7 MMTCO₂e of emissions alone, is more than all the included emissions from the commercial sector (24.2 MMTCO₂e). Unfortunately, 2021 will also be another year with high emissions from wildfires, even though California has not entered main wildfire season as of the writing of this report (early September). Emissions from fires are not included in the statewide inventory

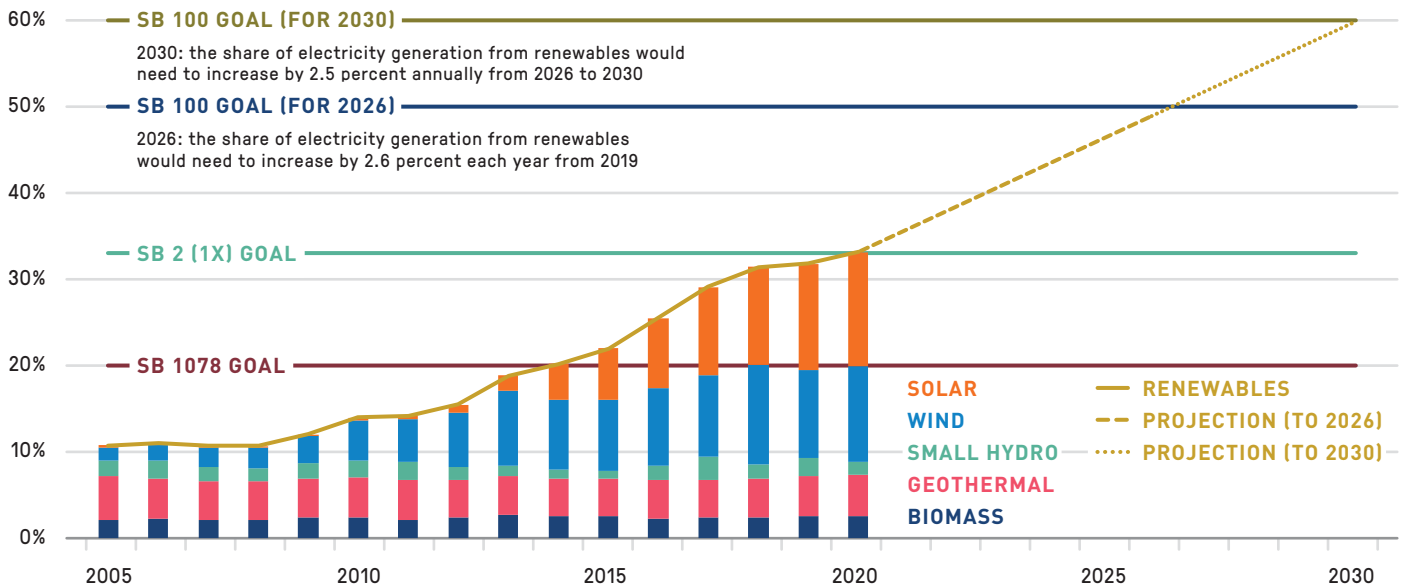
as forests both serve as a source of emissions (from fires) and a sink of emissions by removing CO₂ from the atmosphere, but increasingly wildfires present an increasing net source of emissions. Although fire is a natural and critical ecological function, California ARB has noted that "catastrophic wildfires, land conversion, and other disturbances that are largely driven by climate change and human activity, have turned [our] natural and working lands into a net source of emissions,"¹⁰ which makes achieving carbon neutrality even more challenging."

The pace of renewable generation growth is slowing.

California has set ambitious goals for increasing its share of electricity from renewable sources, including a target set in 2018 to get 100 percent of the state’s electricity from clean energy sources by 2045. The state is in a good position to meet or exceed its renewable and clean energy goals for the next few years. In recent years, however, renewable generation has slowed down. In 2020, the state barely met the interim goal of having at least 33 percent of electricity generated from Renewable Portfolio Standard (RPS)-eligible sources.

Figure 4. California’s Path to 60% RPS Goal by 2030

ASSUMING LINEAR GROWTH



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Renewables do not include large hydroelectric sources exceeding 30 megawatts. Data Source: California Energy Commission; U.S. Department of Energy, Energy Information Administration. NEXT 10 / SF · CA · USA

HIGHLIGHT:

California was successful in meeting the 2020 goal of having at least 33 percent of electricity generation from RPS-eligible renewable sources, reaching the target four years early in 2016. However, the rate of increase in renewable generation has slowed down in recent years, and the state will need to pick up the pace to meet future RPS goals. The percentage of California’s total power mix (in-state generation plus imports) from renewable sources rose 1.4 percent to 33.1 percent in 2020, barely meeting the interim goal of having 33 percent of generation from RPS-eligible sources.

CHALLENGE:

To meet the 2026 goal of 60 percent of generation from RPS-eligible renewable sources, California’s share of electricity generation from renewables would need to increase by 2.8 percent each year from 2018 to 2026, revised upward from 2.3 percent previously.

The state will need to balance renewables to avoid curtailment.

In California, curtailments have been rising every year, driven by growth in solar power to meet the state’s aggressive clean energy goals. In 2020, curtailment totaled 1,587.5 gigawatt-hours (GWh), representing a 64.5 percent increase over 2019 curtailments (965.2 GWh).

Figure 5a. Wind Curtailment¹¹ by Month

2018–2021 YTD, CALIFORNIA

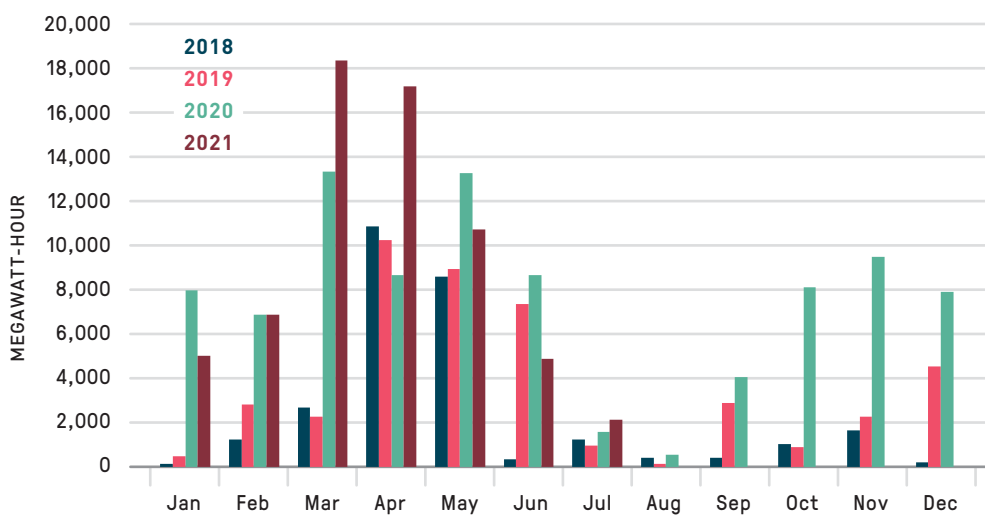
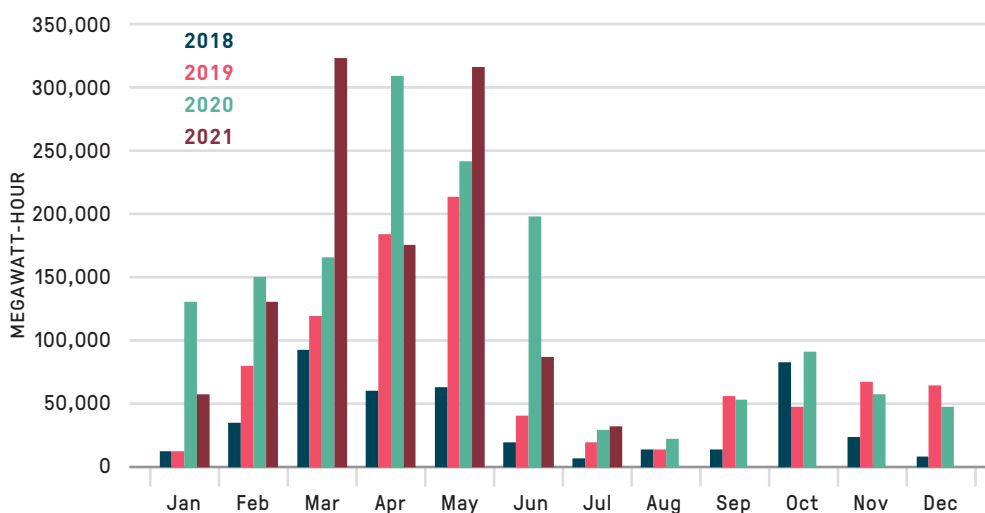


Figure 5b. Solar Curtailment¹¹ by Month

2018–2021 YTD, CALIFORNIA



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Independent System Operator. NEXT 10 / SF · CA · USA

CHALLENGE:

As more renewables come online, California faces an increasing amount of wind and solar generation curtailment, especially during the middle of the day (from 10 AM to 2 PM), when there is an oversupply of solar. In California, curtailments have been rising every year, driven by growth in solar power to meet the state’s aggressive clean energy goals. In 2020, curtailment totaled 1,587.5 gigawatt-hour electricity generated (90.3 GWh from wind and 1,497.2 GWh from solar). This curtailment represents a 64.5 percent increase over 2019 (965.2 GWh), which itself is over double (+109.4%) the curtailment amount in 2018 (461.0 GWh). Curtailment tends to be at the highest levels from March to June and lowest from July to December.

HIGHLIGHT:

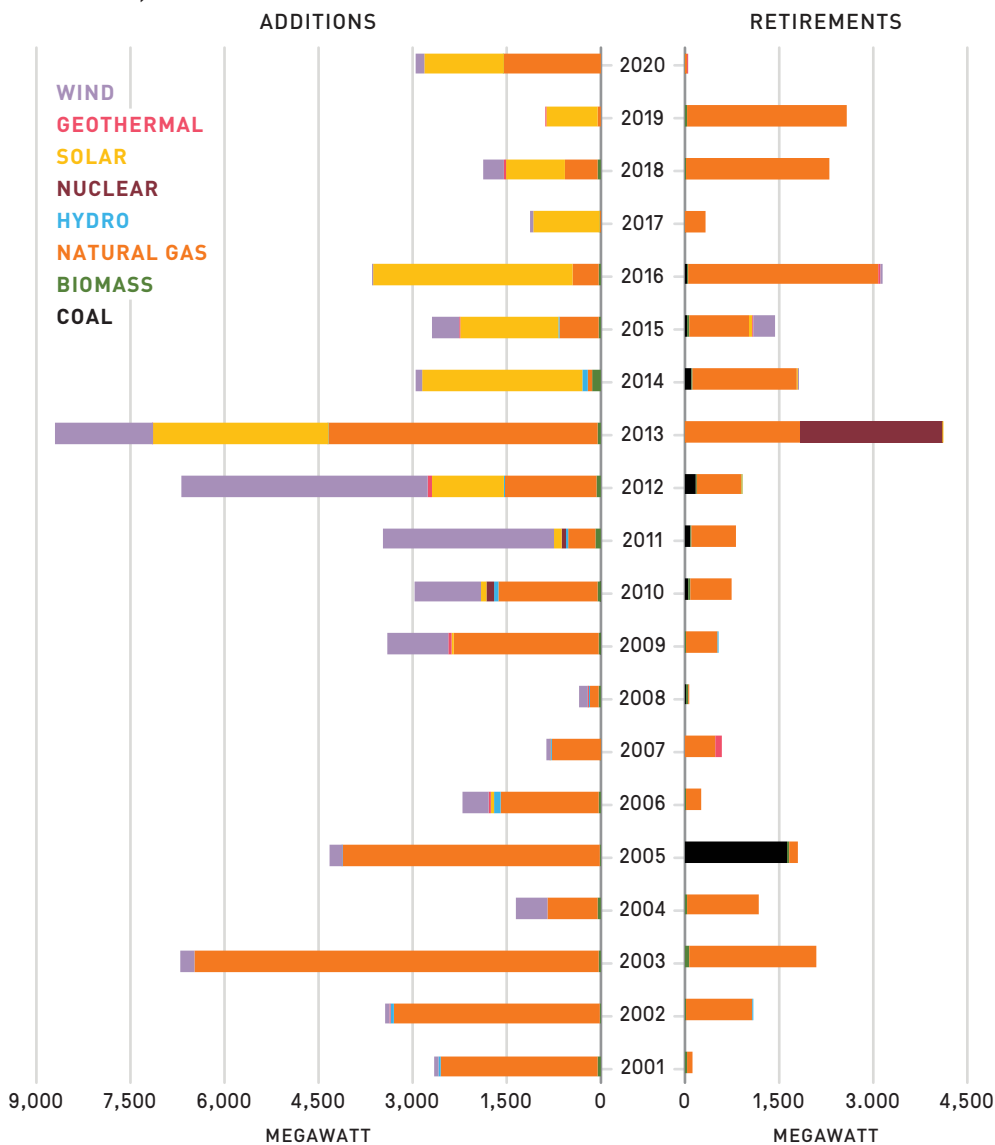
Although curtailment has been increasing, it makes up a small percentage of total in-state generation. In 2020, in-state generation from solar was 29,446 GWh; the curtailment represents 5.1 percent of in-state generation. Wind curtailment was less than one percent in 2020. Electricity generated from renewable sources tends to be higher when curtailment is also high.

Solar leads for new power plants, but natural gas persists.

Of the utility-scale power plants that came online after 2010, California added more capacity from solar than other sources. However, in 2020, California actually added more natural gas plants (1.5 gigawatts) than any other classes including solar (1.3 gigawatts).

Figure 6. Power Plant Additions and Retirements by Year and Source

CALIFORNIA, 2001-2020



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Most of the utility-scale power plants that came online after 2010 were renewables or natural gas: Solar (over 15GW from 2011 to 2020), followed by natural gas and wind (slightly under 10GW for each). Meanwhile, most of the power plants retired (about 17.5GW from 2011 to 2020) had been natural gas power plants (14GW), most of which began operations from the 1950s to the 1970s.

CHALLENGE:

The intermittent limitations of solar and wind generation and threats to grid resiliency due to natural disasters are on-going challenges to California’s grid reliability. Often, the quickest solution to meet electricity shortages is to fire up natural gas power plants. In 2020, California actually added more natural gas plants (1.5 GW) than any other classes including solar (1.3 GW)—the last time this occurred was in 2013. In August 2021, the California Energy Commission approved licenses for gas-fired power units to help the state cope with continued electricity shortages.¹² While maintaining reliability of the electricity supply is critical, these moves run at odds with California’s goal to decarbonize its grid.

California's economy is the greenest in the nation.

The state's power generation mix is the cleanest in the U.S. and California is a leader in clean energy economy jobs, as well, with more than one-third of American solar power jobs (124,817) in the state and the fifth-largest share of energy storage jobs (18,571) among all states in 2019.

Table 1. California's Green Power Generation Industry, in Comparison

POWER GENERATION	CALIFORNIA EMPLOYMENT	CALIFORNIA LQ	CALIFORNIA LQ RANK	TOP 3 STATES BY LQ
SOLAR ELECTRIC POWER GENERATION	124,817	3.04	2	Nevada, California , Hawaii
WIND ELECTRIC POWER GENERATION	6,273	0.46	35	North Dakota, South Dakota, Colorado
TRADITIONAL HYDROELECTRIC ELECTRIC POWER GENERATION	11,091	1.68	8	South Carolina, Tennessee, Michigan
FOSSIL ELECTRIC POWER GENERATION	22,890	0.93	25	Kansas, Wyoming, West Virginia

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: USEER and O*NET categories and data from QCEW(Census) and OEWS(BLS). NEXT 10 / SF · CA · USA

OPPORTUNITY:

California's ranks second in the nation in terms of specialization in solar power generation jobs—a metric measured by location quotient, which is a key economic benchmark that captures how overrepresented an economy is in an activity, compared to the national economy. The location quotient is produced when the local proportion of an activity, in this case solar jobs, is divided by the proportion that activity commands of national activity. In addition to being a top-ranking state for solar job specialization (second after only Nevada) in 2019, California also ranked fifth in terms of specialization in energy storage jobs (with a total of 18,571 jobs) among all states. While wind power has a smaller specialization in the state with only 6,273 wind power workers—there is significant opportunity to expand that specialization given recent developments at the federal and state government levels to develop offshore wind in the state.

HIGHLIGHT:

California's economy is greenest in the nation: The state's power generation mix is the cleanest in the U.S. and California is a leader in clean energy economy jobs, as well, with more than one-third of American solar power jobs (124,817) in the state in that sector in 2019—roughly three times more concentrated in these jobs than would be expected, based on its population—in 2019.

Endnotes

- ¹ "U.S. energy-related CO₂ emissions declined by 11% in 2020." U.S. Energy Information Administration April 12, 2021. Available at: <https://www.eia.gov/todayinenergy/detail.php?id=47496>
- ² The Energy Information Administration expects energy-related CO₂ emissions to increase in 2021 and 2022. Source: <https://www.eia.gov/todayinenergy/detail.php?id=46537>
- ³ U.S. energy-related CO₂ emissions from transportation declined 15 percent in 2020 nationwide. Energy-related CO₂ emissions account for most of the GHG emissions in the U.S. Source: <https://www.eia.gov/todayinenergy/detail.php?id=47496>
- ⁴ Off-road vehicles include airport ground support equipment, construction and mining equipment, industrial equipment, and oil drilling equipment.
- ⁵ The Clean Trucks Rule requires that manufacturers of heavy duty trucks meet certain targets for sales of zero-emission trucks by 2035 (zero-emission truck

sales would need to be 55% of Class 2b-3 truck sales, 75% of Class 4-8 of truck sales, and 40% of tractor sales). See: Arneja, P. (June 2020). Advanced Clean Trucks Fact Sheet. California Air Resources Board. Accessed on November 18, 2020. Retrieved from: <https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet>

- ⁶ A copy of the transportation budget can be viewed here: <http://www.ebudget.ca.gov/2021-22/pdf/Revised/BudgetSummary/Transportation.pdf>
- ⁷ Specifically, The Executive Order has the following additional goals: (1) 100 percent of medium- and heavy-duty vehicles in the State be zero-emission by 2045 for all operations where feasible and by 2035 for drayage trucks; (2) California to transition to 100 percent zero-emission off-road vehicles and equipment by 2035 where feasible. Executive Order N-79-20 can be viewed here: <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf>

About Next 10's California Green Innovation Index

Next 10's California Green Innovation Index tracks the state's progress in reducing greenhouse gas emissions, spurring technological and business innovation, and growing businesses and jobs that enable the transition to a more resource-efficient economy. The 2021 Index is the 13th edition published by Next 10.

Next 10 is an independent, nonpartisan organization that educates, engages and empowers Californians to improve the state's future. Next 10 was founded in 2003 by businessman and philanthropist F. Noel Perry. Next 10 is focused on innovation and the intersection between the economy, the environment, and quality of life issues for all Californians.

Advisors to the California Green Innovation Index

Next 10 thanks the following expert advisors for their generous time and guidance on this project over the years:

Dan Adler

Senior Advisor for Climate Finance, Governor's Office of Business and Economic Development

Morrow Cater

Founding Principal, Cater Communications

Ralph Cavanagh

Energy Co-Director, NRDC

Michael Hanemann

Professor & Julie A. Wrigley Chair in Sustainability, Department of Economics, Arizona State University

Hal Harvey

CEO, Energy Innovation: Policy and Technology LLC

Elliot Hoffman

CEO, REV

Mark Jacobson

Prof. of Civil and Environmental Engineering, Director of the Atmosphere/Energy Program, Stanford University

Dan Kammen

Class of 1935 Distinguished Professor of Energy in the Energy and Resources Group and the Goldman School of Public Policy. Director, Renewable & Appropriate Energy Laboratory, U.C. Berkeley

Joel Makower

Chairman and Executive Editor, GreenBiz Group Inc.

Jason Mark

CEO, Energy Foundation

Walter McGuire

Owner, McGuire & Co., Inc./Flex Your Power

Manuel Pastor

Professor of Sociology and American Studies & Ethnicity, Director of the USC Program for Environmental and Regional Equity, University of Southern California

Former State Senator Fran Pavley

Environmental Policy Director, USC Schwarzenegger Institute

Wendy Pulling

Director, ESG Integration, University of California, Office of the Chief Investment Officer

Dan Skopec

Vice President, Regulatory Affairs, Sempra Energy Utilities

James (Jim) Sweeney

Professor of Management Science and Engineering, Senior Fellow at Precourt Institute for Energy, Stanford University

Tim Woodward

Managing Director, Prelude Ventures LLC

Next 10 expresses its deepest condolences to the family and loved ones of advisor Carol Whiteside, who passed away earlier this year. Her experience and leadership were invaluable to the Central Valley and California policy community, and she will be missed.

⁸ The White House. "FACT SHEET: President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks." August 5, 2021. Retrieved from: <https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/>

⁹ According to California Air Resources Board, wildfire emissions contribute to climate change. It is important to note that emissions from wildfires are not part of the included emissions. In addition, fire is a natural and critical ecological function for maintaining healthy and resilient forests, and supports several ecosystem functions such as facilitating germination of seeds, replenishing soil nutrients, stimulate tree growth, and reducing fuels. This is another reason why wildfire emissions are estimated separately and are not part of the included emissions. For more information,

please visit CARB's webpage: <https://ww2.arb.ca.gov/resources/documents/frequently-asked-questions-wildfire-emissions>

¹⁰ CARB. An Inventory of Ecosystem Carbon in California's Natural & Working Lands. 2018 Edition. Downloadable from https://ww3.arb.ca.gov/cc/inventory/pubs/nwl_inventory.pdf

¹¹ Curtailment is the reduction of output of a renewable resource below what it could have otherwise produced. At times power generators may produce output that is not needed. In the absence of energy storage systems, the surplus may have to be dumped or the power plant output turned down or switched off for a while.

¹² Proctor, D. "California Will Add Gas-Fired Units to Increase Power Supply." POWERmagazine. August 20, 2021. Available at: <https://www.powermag.com/california-will-add-gas-fired-units-to-increase-power-supply/>



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