



NEXT 10


2019

California Green Innovation Index

11th edition

GDP

Gross Domestic Product (inflation-adjusted to 2017 dollars)

$2.7 Trillion
2017

2.3% Average annual growth
1990–2017

$69,477 Per capita GDP
2017

Population

39.5 Million
2017

1.0%
Average annual growth rate
1990–2017

California's Carbon Economy

1.54
2017

2.92
1990

Million metric tons of CO_2 equivalent / inflation-adjusted GDP

Next 10's *California Green Innovation Index* tracks the state's progress in reducing greenhouse gas (GHG) emissions, spurring technological and business innovation, and growing businesses and jobs that enable the transition to a more resource-efficient economy. The 2019 Index is the 11th 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.

For more information about the *California Green Innovation Index,* please visit www.next10.org.

California Emissions

Total GHG Emissions

424.1[1]
2017

429
2016

Million metric tons of CO_2 equivalent

-0.06% Average annual growth
1990–2017

-1.15% One year growth
2016–2017

Targets: Total GHG Emissions

259
by 2030

431
2020 target met in 2016

86
by 2050

Million metric tons of CO_2 equivalent

Per Capita GHG Emissions

10.73
2017

Metric tons of CO_2 equivalent

Population Data Source: California Department of Finance.
Gross Domestic Product Data Source: Bureau of Economic Analysis.
Greenhouse Gas Data Source: California Air Resources Board, "2019 California Greenhouse Gas Inventory – by Sector and Activity." California Department of Finance.
Carbon Economy: California Air Resources Board, "2019 California Greenhouse Gas Inventory – by Sector and Activity." Bureau of Economic Analysis.

www.next10.org

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Dear Californians,

In 2018, global greenhouse gas emissions went up and the world's foremost authority on climate science reported that we had about 12 years to make significant emissions cuts and develop a plan to reach "net zero" emissions by 2050 in order to stave off the worst impacts of global warming.

Meanwhile, in California, the state announced that it had met its first climate goal four years early, passed a new law to transition the state to 100 percent clean energy by 2050, announced an executive order calling for a carbon-neutral economy by 2045, and saw increases in both renewable energy generation and clean tech investment—all while continuing to grow the economy.

California has seen consistent progress over the last eleven years that we have tracked environmental and economic indicators as part of the *California Green Innovation Index,* but the state has some hard truths to face as it looks to deliver much steeper annual emissions reductions in the years ahead. If California continues to reduce emissions at the same rate we have most recently (-1.15% in 2017), we would meet our 2030 target 30 years late and our 2050 target more than 100 years late.

To succeed, we will need policy and technology breakthroughs to transition the harder-to-reach, consumer-oriented sectors of transportation and buildings to cleaner electricity—while ensuring an equitable future for all Californians. Each choice we make about how to use our land, power our buildings, and travel around the state adds up.

The transportation sector alone represents 41 percent of California's statewide emissions—a percentage that has been increasing the last few years. Vehicle ownership has hit an all-time high and even in climate-conscious California, consumer preferences for SUVs and larger vehicles are adding to the challenges. And unfortunately, the state's clean car standards—the most effective tool for limiting vehicle emissions to date—continue to face attacks from the federal administration. Despite this, California has successfully led coalitions of other states, manufacturers, and international governments who are prioritizing the advancement of vehicle, appliance, and building standards.

The state is fighting to transition to cleaner vehicles—and to cleaner buildings. This year, Berkeley became the first city in the nation to ban natural gas development in new residential buildings—and other California cities are following suit. San Jose just became the nation's largest city to approve restrictions on gas development, and more than fifty California local governments considering similar measures.

While we work to decarbonize our higher-emitting sectors, we must also fight to reduce wildfire risk. Last year, emissions released from wildfires were greater than emissions released from the Commercial, Residential, or Agriculture sectors in 2017. As the wildfire seasons grow longer and our lands grow dryer, managing this threat will be critical to our climate success.

California has achieved much, but we have much to do. It is critical that we take every step we can to reduce emissions, ensure equitable economic growth, and create new opportunity for a clean energy future for all Californians. With the future of the state's climate and economy in mind, we are proud to share the latest data and insights from the *California Green Innovation Index.* We hope that you will find our new format and analysis useful in your work as we all strive for a strong, clean energy economy.

Sincerely,

F. Noel Perry

F. Noel Perry, Founder

NEXT 10

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Table of Contents

California's Greenhouse Gas Emissions

- Total greenhouse gas (GHG) emissions **fell by 1.15 percent, or 4.94 million metric tons of carbon dioxide equivalent** ($MMTCO_2e$) between 2016 and 2017—to a total of 424.1 $MMTCO_2e$ in 2017.
- Among the key sectors of the California economy, only the **electricity generation sector has seen continuous and significant improvements** in terms of reducing GHG emissions. The Industrial (-4.4%), Residential (-4.2%) and Transportation (-4.9%) sectors have seen only marginal decreases compared to 2000, while emissions from Commercial increased 64.7 percent from 2000—driven largely by an increase in GHGs from high global warming potential gases. Looking deeper, on-road passenger vehicles accounted for 28 percent of the state's total GHG emissions, up 0.5 percent from 2016, while the Transportation sector as a whole represented 41.1 percent of the state's total emissions.
- If the current trajectory continues, the state will take **significantly more time to reach its 2030 and 2050 goals** than it did to reach the 2020 goal. Assuming the same rate of reduction from 2016 to 2017, California will reach its 2030 and 2050 goals in 2061 and 2157, respectively—representing a 31-year and a 107-year delay. Even using the average rate of decline from the three most recent years (-1.57%), the respective goals would be met in 2050 and 2121.
- California's fossil fuel energy-related carbon dioxide emissions per capita were 9.2 $MMTCO_2e$ per person in 2016—the second-lowest among the 50 states, behind New York—and have remained relatively constant since 2011. The U.S. average in 2016 was 16 $MMTCO_2e$ per person.

Carbon

After meeting the 2020 climate goal set by Assembly Bill 32 **four years early in 2016,** California's greenhouse gas emissions continued to decline below the 1990 levels while its economy continued to grow. California's carbon intensity—emissions relative to GDP—**has fallen 27.6 percent** from 1990 to 2017, and declined at a faster rate between 2016 and 2017 than in the ten years prior.

While emissions continue to move in the right direction, significant challenges remain that the state will need to overcome in order to meet its 2030 climate targets.

California's Carbon Economy

- From 2016 to 2017, California's inflation-adjusted GDP per capita **grew 3.1 percent** while economy-wide per capita GHG emissions **decreased 1.8 percent**. Compared to 1990, California's per capita GDP grew 41.3 percent while reducing per capita GHG emissions by 25.4 percent.
- California's carbon intensity continues to improve. From 2012 to 2017, its carbon intensity relative to economic output declined at a rate of **4.53 percent per year**—faster than the 10-year average of 3.18 percent from 2007 to 2017.
- In 2016, California's carbon intensity relative to GDP was **54.3 percent lower** than that of the rest of the U.S. Compared to the other populous states, California's carbon intensity was 44.2 percent lower than Florida's, 46.1 percent lower than Illinois', 54.1 percent lower than Pennsylvania's, 58.2 percent lower than Ohio's, and 66.2 percent lower than Texas' in 2016.
- California's carbon intensity relative to energy supply **declined only 1.6 percent** from 2000 to 2016, the smallest decrease among the most populous states. By comparison, energy supply carbon intensity declined 10.4 percent in the rest of U.S. over the same period.

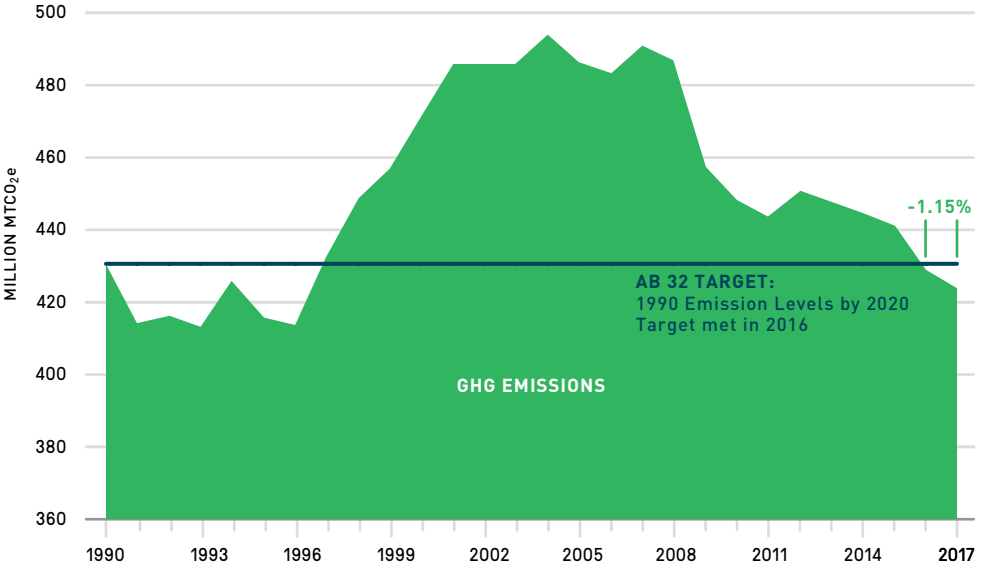
Economy

Greenhouse Gas Emissions by Sector: Challenges & Opportunities

- The transportation sector remains by far the largest emitting sector in California, reaching a record high of **41.1 percent of total emissions in 2017**—up from 40.4 percent in 2016—yet the annual increase in transportation emissions has slowed down slightly compared to the previous three years. Transportation has long been California's largest emitting economic sector, but it only recently overtook electricity generation sector as the largest-emitting sector in the U.S. overall in 2017.
- GHG Emissions from aviation-related activities have **increased in recent years** due to an improving economy. GHG emissions from international flights (up 41% relative to 2000) have far outpaced GHG emissions from intrastate flights (up 20.8% compared to 2000) and interstate flights (up 10.4% relative to 2000).
- Californians are also disposing of an increasing amount of waste in landfills since 2012 and the Great Recession—and **emissions from landfills have gone up every single year** since 2004. GHG emissions from the Landfill sub-sector within the Industrial sector totaled 8.54 $MMTCO_2e$ in 2017, up 15.2 percent from 2004.

Figure 1. Total California Greenhouse Gas Emissions

GROSS ANNUAL EMISSIONS, 1990–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Gross greenhouse gas emissions (GHG) includes fossil fuel CO_2, with electric imports and international fuels (carbon dioxide equivalents) and noncarbon GHG emissions (in CO_2 equivalents). Noncarbon GHG emissions are made up of Agriculture (CH_4 and N_2O), Soils, ODS substitutes, Semi-conductor manufacture (PFCs), Electric Utilities (SF_6). Cement, Other Industrial Processes, Solid Waste Management, Landfill Gas, and Wastewater, Methane from oil and gas systems, Methane and N_2O from Fossil Fuel Combustion.
Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity. NEXT 10 / SF · CA · USA

HIGHLIGHT:

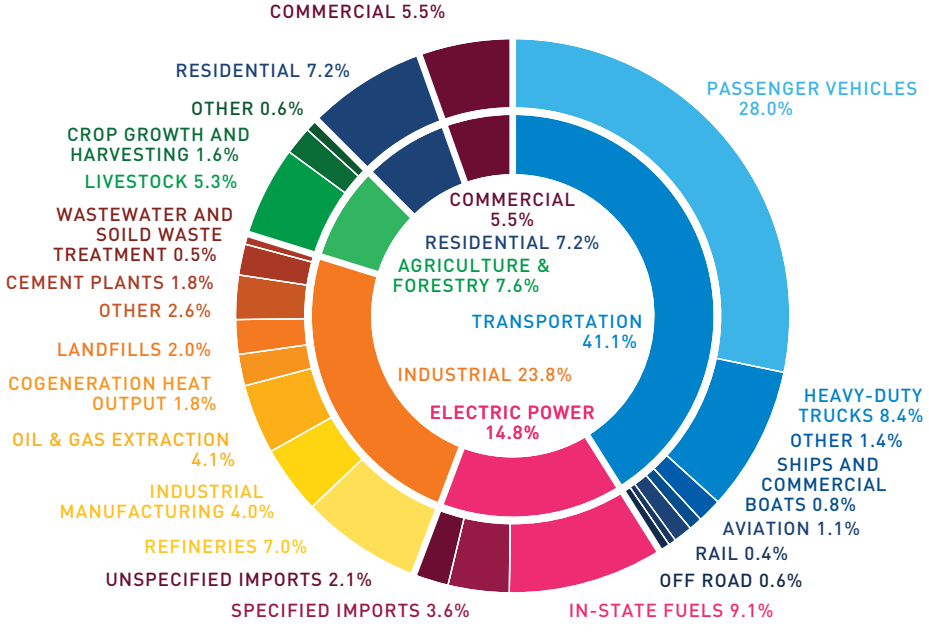
After meeting the AB 32 goal in 2016, total included greenhouse gas emissions[2] fell 4.94 $MMTCO_2e$ to 424.1 $MMTCO_2e$ (-1.15%) in 2017, remaining below the 1990 level of 431 $MMTCO_2e$.

CHALLENGE:

Once again, electricity generation (both in-state and imports) provided the lion's share of emissions decreases between 2016 and 2017, with each falling 8.9 percent. Because other sectors are not seeing significant declines and—in some cases—are contributing increased emissions, California would not be on track to meet its Senate Bill 32 (SB 32) goal of reducing total emissions to 259 $MMTCO_2e$ in 2030 if these trends continue.

Figure 2. Greenhouse Gas Emissions by Source

CALIFORNIA, 2017



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

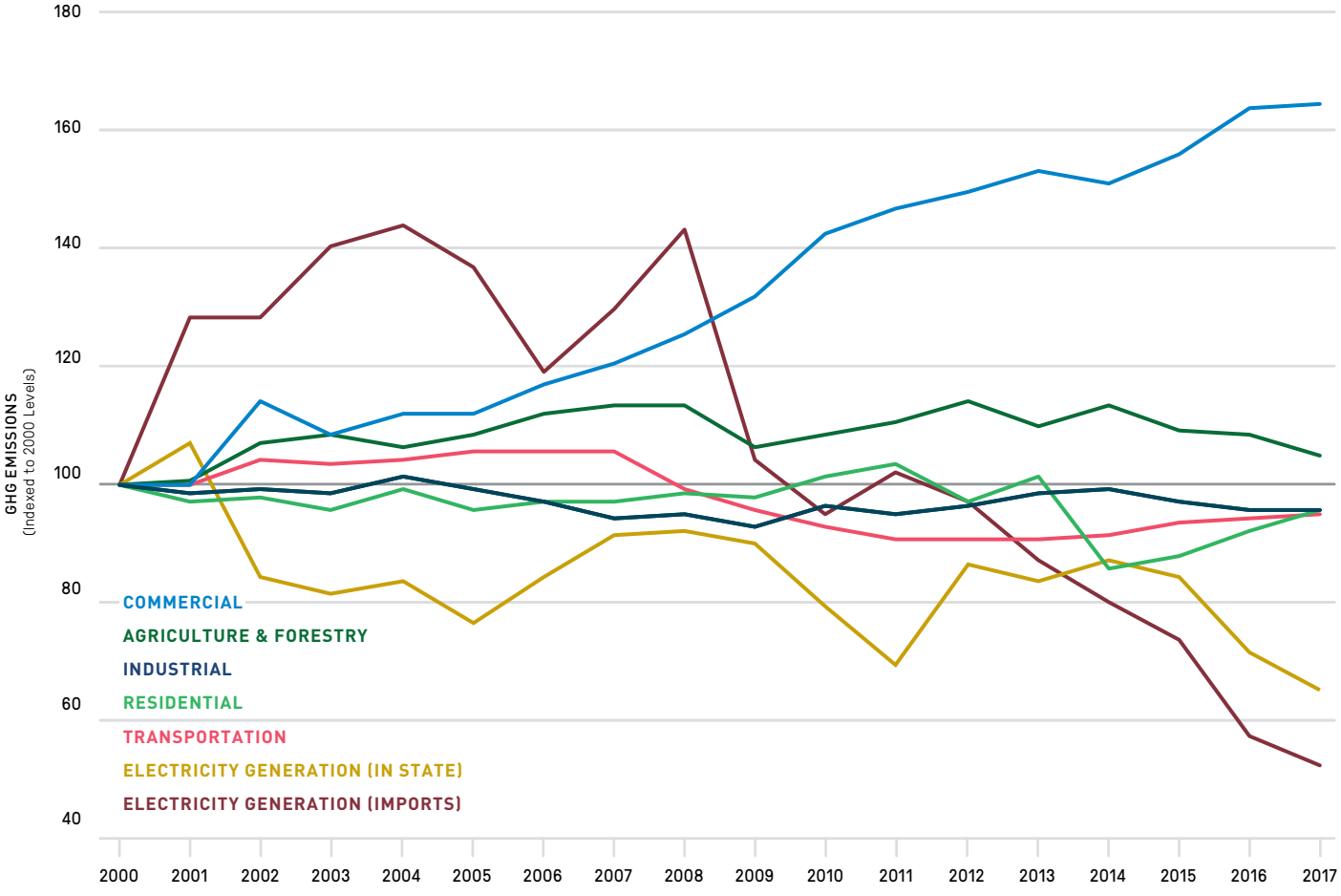
HIGHLIGHTS:

❶ The transportation sector remains the largest-emitting sector in California by far at 41.1 percent of the total in 2017, up from 40.4 percent in 2016. On-road passenger vehicles alone accounted for 28 percent of the state's total emissions, up 0.5 percent from 2016. Comparatively, emissions from the entire power sector make up less than 15 percent of the state's total emissions.

❷ The electric power sector's share fell from 16 percent in 2016 to 14.8 percent, about equal the combined shares of Agriculture & Forestry (7.6%) and Residential (7.2%). As the state continues to decarbonize its grid, the electric power sector's share of total emissions is on track to become even smaller.

Figure 3. GHG Emissions (Indexed to 2000 levels)

BY SECTOR, CALIFORNIA



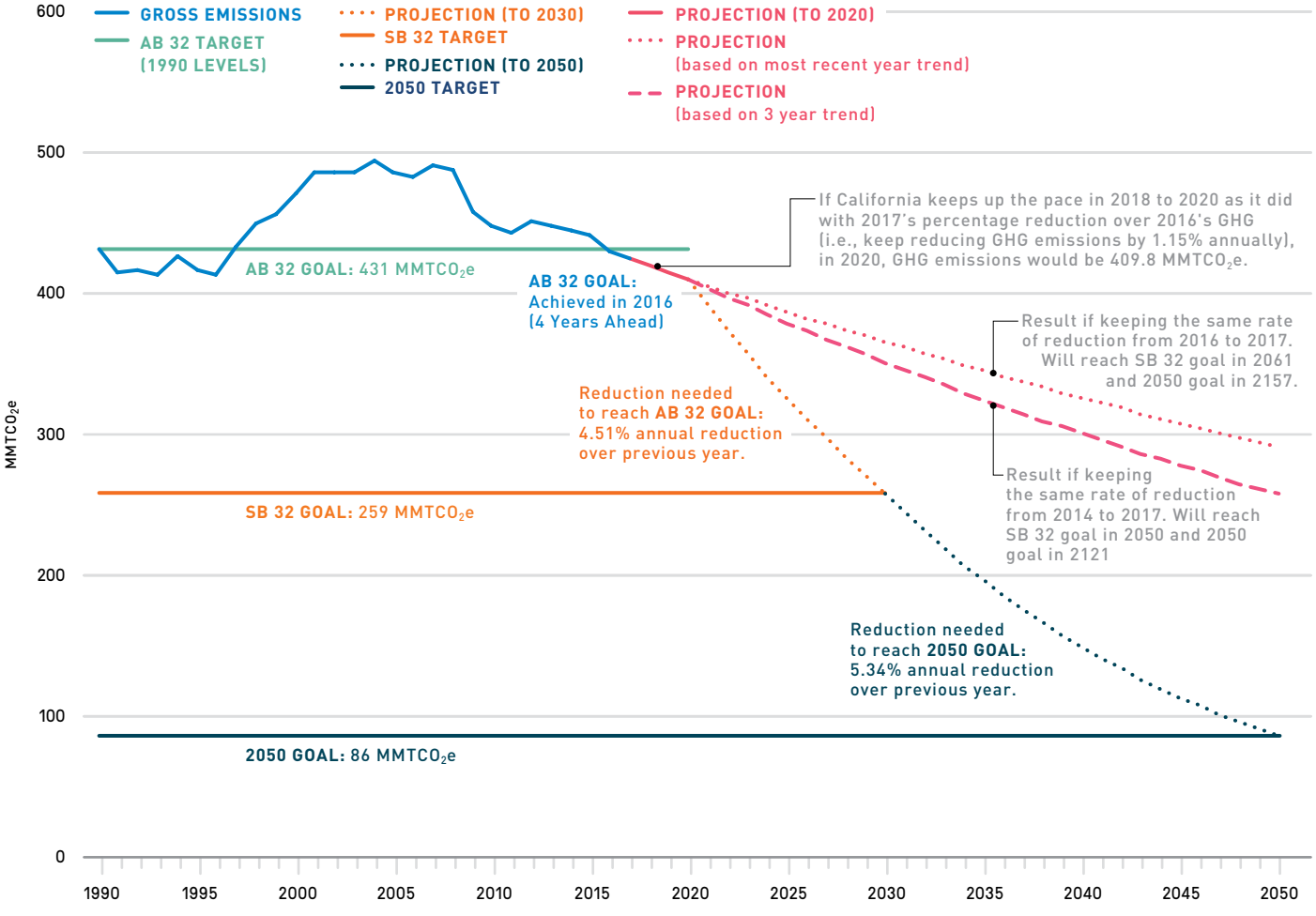
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas inventory - by Sector and Activity. NEXT 10 / SF · CA · USA

CHALLENGES:

❶ By top-level economic sector, only the electricity generation sectors have seen continuous and significant improvements in terms of reducing GHG emissions. GHG emissions from electricity imports and from in-state generation are down 47.9 percent and 35.0 percent, respectively, relative to 2000. ❷ Industrial (-4.4%), Residential (-4.2%) and Transportation (-4.9%) have seen only marginal decreases compared to 2000; in fact, the Transportation sector has been trending in the wrong direction since 2013. Unfortunately, GHG emissions in the Commercial sector keep increasing (+64.7% relative to 2000), due primarily to an increase in high global warming potential gases stemming from the use of substitutes for ozone depleting substances (ODS substitutes). These substitutes are primarily used for refrigerants and air conditioning. ❸ Clean electricity will be foundational to a decarbonized economy. However, relying solely on the electric power sector to score overall GHG emission reductions is not sustainable in the long-term. So far, the electric power sectors have seen dramatic reductions because the state has a great degree of control over its power mix, while GHG emissions from all other sectors are fundamentally functions of end-users' consumption behaviors. Addressing emissions from some of these harder-to-reach sectors will be critical to meeting the state's future climate goals.

Figure 4. GHG Emissions and Projected Reduction Goals

CALIFORNIA, 1990–2050



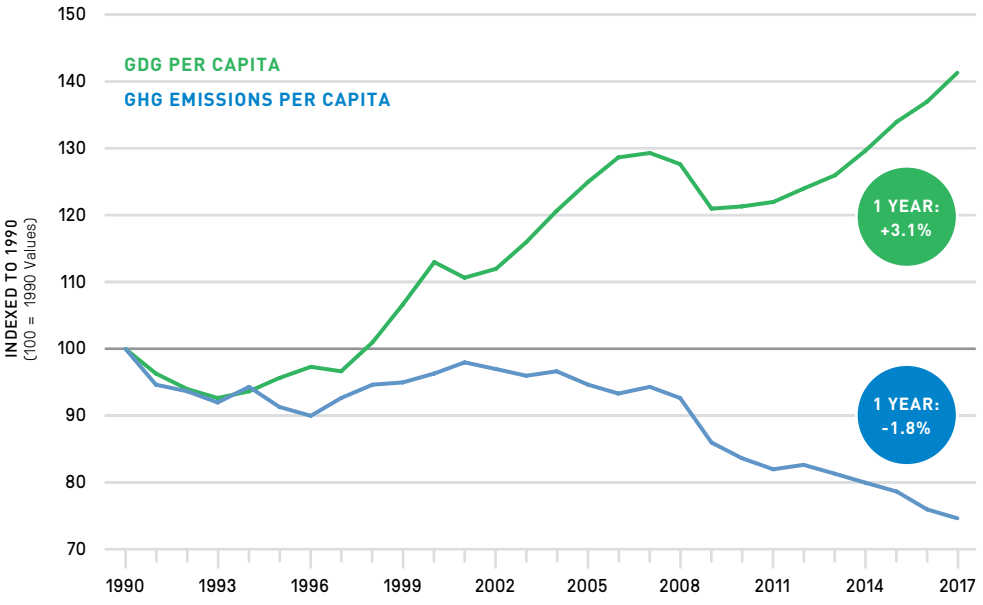
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory. NEXT 10 / SF · CA · USA

CHALLENGES:

❶ Based on the current pace of year-over-year percentage reductions, the state will need to work increasingly harder in order to meet the SB 32 goal by 2030. Previously, the state needed to reduce its GHG emissions by an average of 3.92 percent annually between 2016 to 2030 in order to attain the goal. However, since the state only achieved a 1.15 percent reduction between 2016 and 2017, the state will now need to reduce its GHG emissions by an average of 4.51 percent annually from 2017 to 2030 in order to attain the goal—a three-fold increase. ❷ 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. Assuming the same rate of reduction from 2016 to 2017, California would reach its SB 32 and 2050 goals in 2061 and 2157, respectively—representing a 31-year and a 107-year delay. Using the average rate of decline from the three most recent years (-1.57%), the respective goals would be met in 2050 and 2121 instead.

Figure 5. Greenhouse Gas Emissions and Gross Domestic Product, California Relative Trends Since 1990

GREENHOUSE GAS EMISSIONS ($MTCO_2e$) AND GDP DOLLARS PER CAPITA



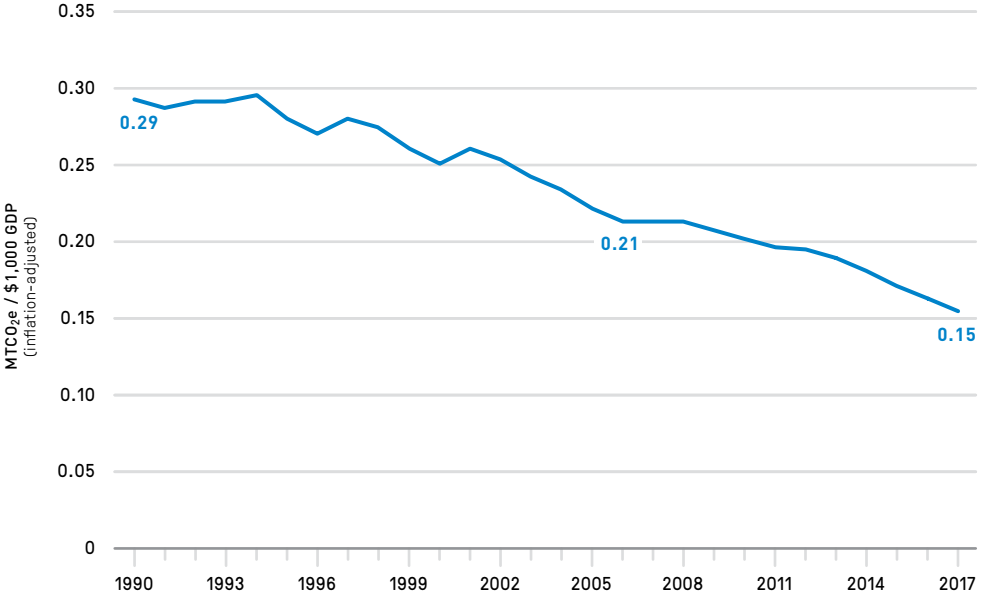
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity; Bureau of Economic Analysis, U.S. Department of Commerce; U.S. Census Bureau. NEXT 10 / SF · CA · USA

HIGHLIGHT:

California continues to demonstrate that economic growth need not to be compromised in order to reduce GHG emissions. From 2016 to 2017, the state's inflation-adjusted GDP per capita grew 3.1 percent while per capita GHG emissions decreased 1.8 percent. Compared to 1990, California's per capita GDP grew 41.3 percent while per capita GHG emissions decreased by 25.4 percent.

Figure 6. Gross Emissions Relative to Gross Domestic Product

CALIFORNIA, 1990–2017



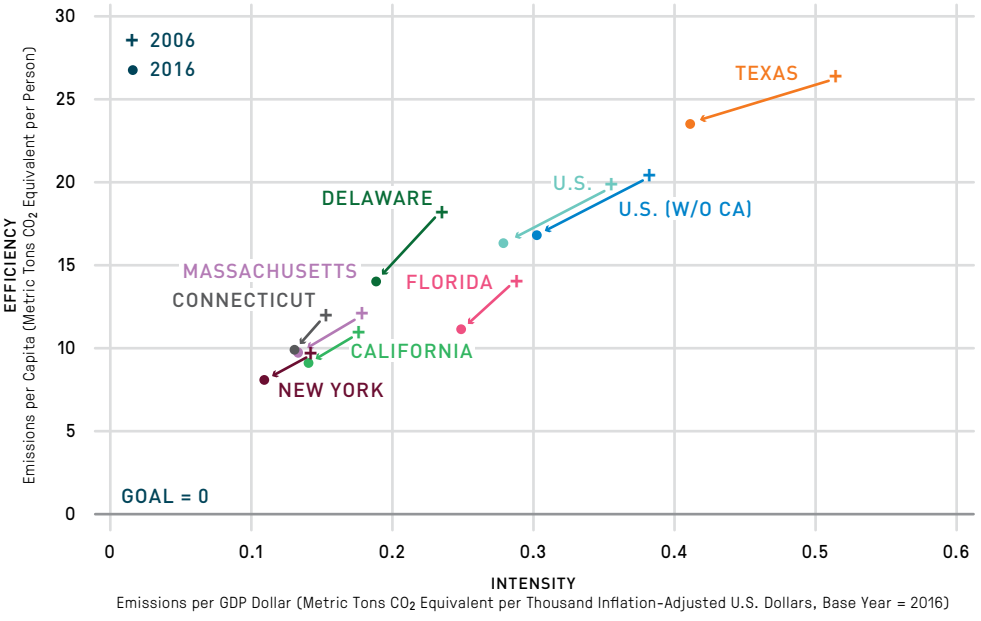
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

HIGHLIGHTS:

❶ The carbon intensity of the California economy continues to decline, with emissions of 0.154 $MTCO_2e$ per $1,000 of GDP (inflation-adjusted to 2017 dollars) generated in 2017, a 4.7 percent improvement compared to 2016 and a 27.6 percent improvement compared to ten years prior. California's carbon intensity has declined consistently since 2007—the most recent year when carbon intensity was higher than during the previous year. ❷ From 1990 to 2017, California's carbon intensity declined at a rate of 2.34 percent per year. From 2007 to 2017, its carbon intensity declined at a rate of 3.18 percent per year, and from 2012 to 2017, its carbon intensity declined at a rate of 4.53 percent per year. This means that the rate of decline is increasing and has gotten faster within the last five years.

Figure 7. Carbon Intensity and Efficiency

SELECTED U.S. STATES, 2006 v. 2016



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: GDP in Real 2016 U.S. Dollars. Greenhouse gas emissions are from consumption of energy. Data Source: U.S. Energy Information Administration; U.S. Bureau of Economic Analysis, USDA Economic Research Service; U.S. Census Bureau.
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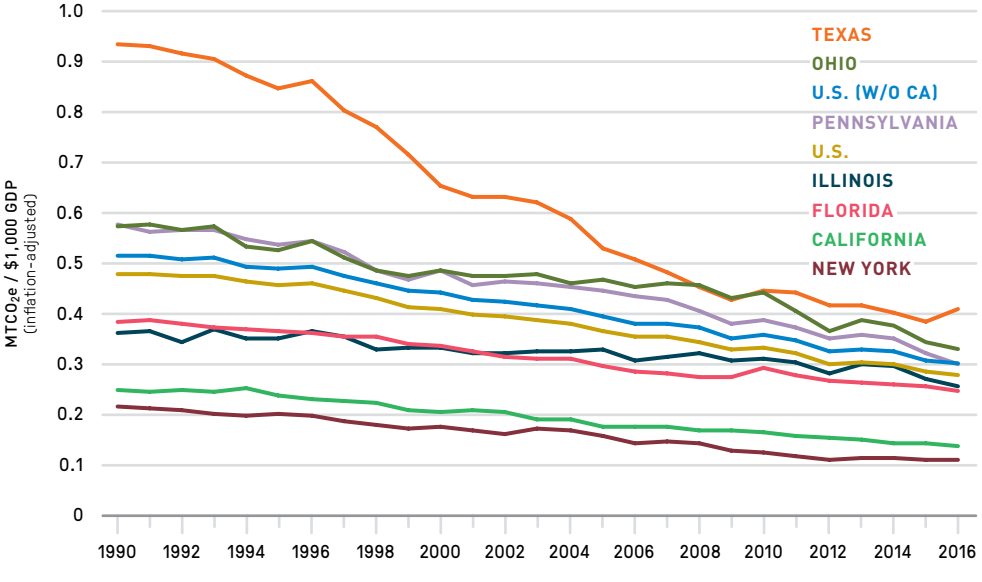
HIGHLIGHT:

In 2016 (the latest year for which nationally comparable data are available), $1,000 of economic activity[3] in California resulted in 0.139 $MTCO_2e$ produced. In comparison, the same $1,000 of economic activity in the U.S. (excluding California) resulted in 0.304 $MTCO_2e$ produced in 2016—more than double that of California. In addition to performing well in terms of carbon intensity, California also has one of the lowest energy-related GHG emissions per capita levels at 9.2 $MTCO_2e$ per person in 2016. The Golden State maintained its position in 2016 as the state with the second-lowest energy-related carbon dioxide emissions per capita, behind only New York.

Figure 8. The Carbon Economy in California and Other States

ENERGY-RELATED CARBON EMISSIONS (METRIC TONS) PER 1,000 DOLLARS GDP (2016 DOLLARS)



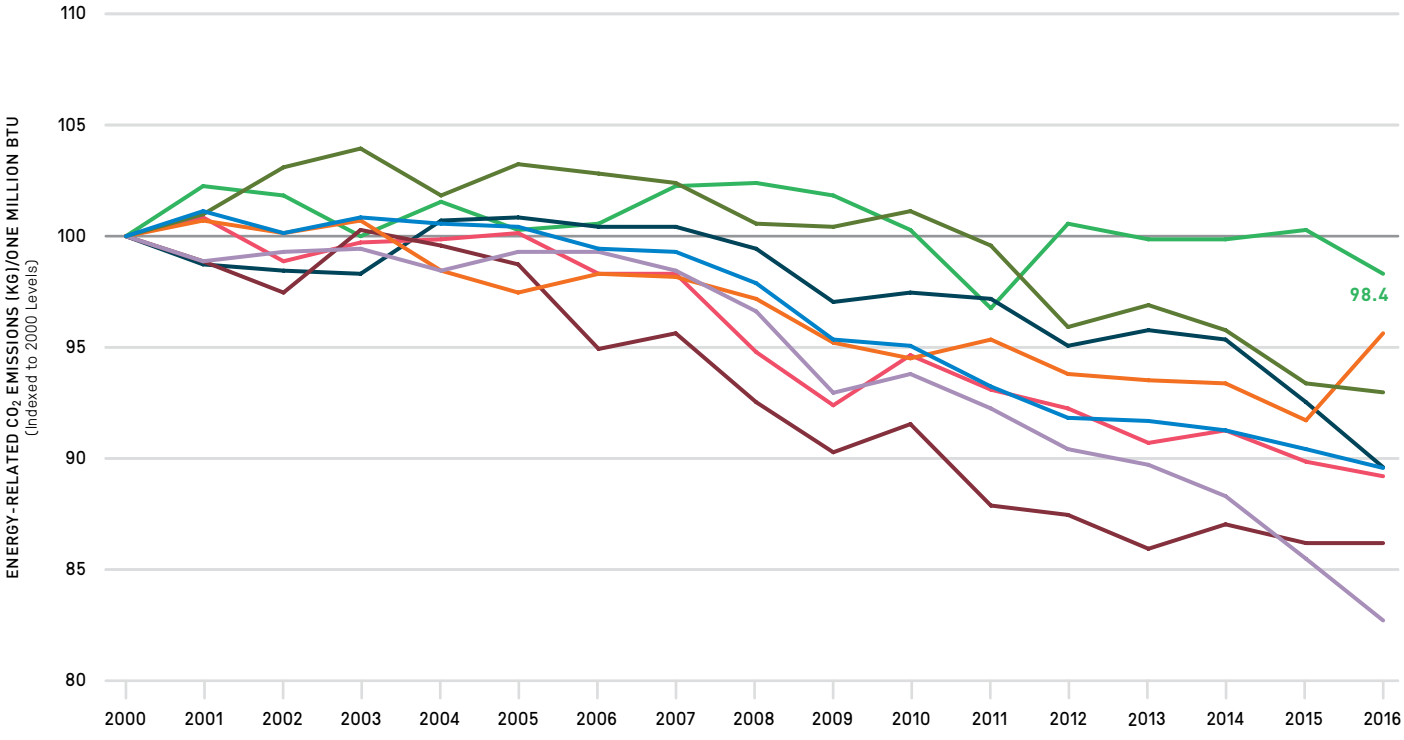
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: GHG emissions data that allows for state-level comparison is from the Energy Information Administration and is limited to carbon emissions (fossil fuel combustion). Therefore, data represented here differs from analyses represented in other charts of total GHG emissions for California. Data Source: Energy Information Administration, U.S. Department of Energy; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

HIGHLIGHTS:

❶ In 2016, California's carbon intensity was 54.3 percent lower than that of the rest of the U.S. Compared to years past, the difference between California's carbon intensity and that of the rest of the U.S. has gradually widened. Relative to the rest of the U.S., California's carbon intensity was 51.7 percent lower in 1990, 53.2 percent lower in 1996, 53.9 percent lower in 2006, and 54.0 percent lower in 2015. ❷ California maintained its high rank as the fourth-most carbon-efficient compared to other U.S. states in 2016. Compared to 2015, the state's carbon intensity decreased 2.8 percent, surpassing the nationwide average decline of 2.3 percent. However, New York (-2.9%), Connecticut (-5.8%), and Massachusetts (-3.4%)—the three states with lower carbon intensities than California—all recorded greater year-over-year decreases in carbon intensity between 2015 to 2016.

Figure 9. Carbon Intensity of the Energy Supply in California and Other States

INDEXED TO 2000 LEVELS



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: The carbon intensity of energy supply (CO_2/BTU) reflects the energy fuel mix within a state. Data Source: Energy Information Administration, U.S. Department of Energy. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Relative to GDP, California's economy-wide carbon intensity has seen consistent declines over the years. However, this is not true relative to energy supply, specifically. Relative to 2000, California's carbon intensity in energy supply ($MTCO_2e$ relative to British thermal unit) declined only 1.6 percent in 2016—the smallest among the most populous states. By comparison, carbon intensity of energy supply declined 10.4 percent in the rest of U.S. Even New York, which always has had lower energy supply carbon intensity than California, managed to see a 13.8 percent decline over the same period.

CHALLENGE:

Generally, the states with lower energy intensity also tend to be more densely populated. However, California is an exception to this rule. Over time, as California has moved away from natural gas and toward more renewables, the state's remaining fossil fuel consumption mix (which includes coal and natural gas predominantly in power plants, and petroleum predominantly in the transportation sector) shifted slightly toward more petroleum and less natural gas. Indeed, compared to 2009, when petroleum accounted for 65.0 percent of emissions, in 2016 petroleum use (which was primarily from vehicles) accounted for 66.2 percent of the emissions. Meanwhile, the share of emissions from natural gas declined from 33.7 percent to 33.0 percent over the same time period. Outside of California, the consumption mix of other states has also become cleaner, with either a shift from coal to petroleum and natural gas (e.g., Illinois and the U.S.), or from coal and petroleum to natural gas (e.g., New York). As a result of these shifting energy source trends, while energy supply carbon intensity is decreasing in the rest of the U.S., it has remained at a relatively stagnant level in California since 2000.

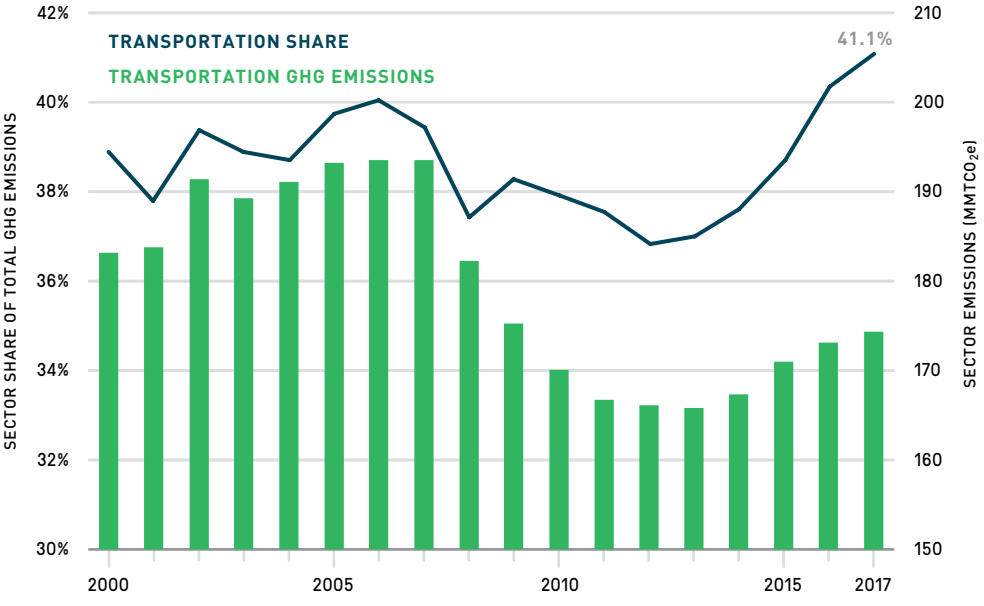
OPPORTUNITY:

That petroleum is the main source of emissions from fuel underscores California's need to reduce emissions from transportation. As zero-emission vehicles become more commonplace and the transportation sector becomes increasingly electrified, the state should move away from fossil fuels as a significant source of emissions.

CHALLENGES

Figure 10. GHG Emissions from Transportation Sector and as Share of Total GHG Emissions

CALIFORNIA, 2000–2017



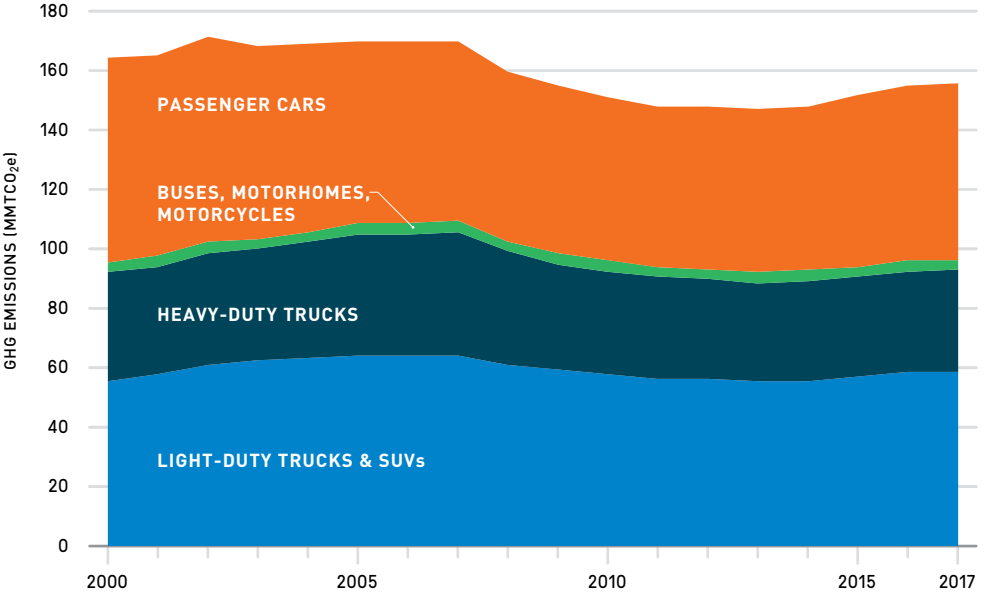
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector. NEXT 10 / SF · CA · USA

CHALLENGE:

Transportation's share of GHG emissions reached 41.1 percent in 2017—a record high. The sector's GHG emissions totaled 174.31 $MMTCO_2e$, up 1 $MMTCO_2e$ from 2016. Nevertheless, while transportation emissions have been increasing in recent years, the rate of increase has slowed down slightly compared to the previous three years. Transportation has long been California's largest-emitting economic sector by far, whereas it recently overtook electricity generation sector to becoming the largest-emitting sector in the U.S. overall in 2017.

Figure 11. On-Road Transportation Sub-sector GHG Emissions

CALIFORNIA, 2000–2017



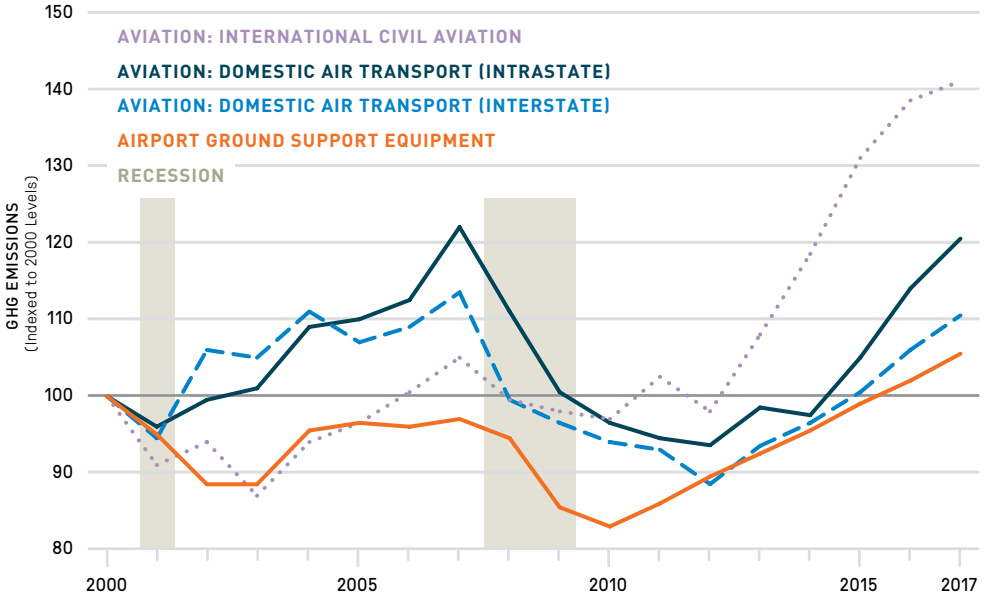
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity. NEXT 10 / SF · CA · USA

CHALLENGE:

On-road private transportation (passenger vehicles and light-duty trucks & SUVs) accounted for the lion's share of the transportation sector's emissions at 118.20 $MMTCO_2e$ altogether—or 68 percent of the sector's total emissions. California has a long way to go in curbing emissions from private transportation—and unfortunately, the barriers to success are significant. It is imperative that the state maintains its strong greenhouse gas emissions standards for vehicles in the face of a federal rollback of national standards and a proposed revocation of California's authority under the Clean Air Act to set stricter standards.

Figure 12. Transportation: Aviation Sub-sector Related GHG Emissions

CALIFORNIA, INDEXED TO 2000 LEVELS



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Excluded emissions in dashed lines. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity. NEXT 10 / SF · CA · USA

CHALLENGE:

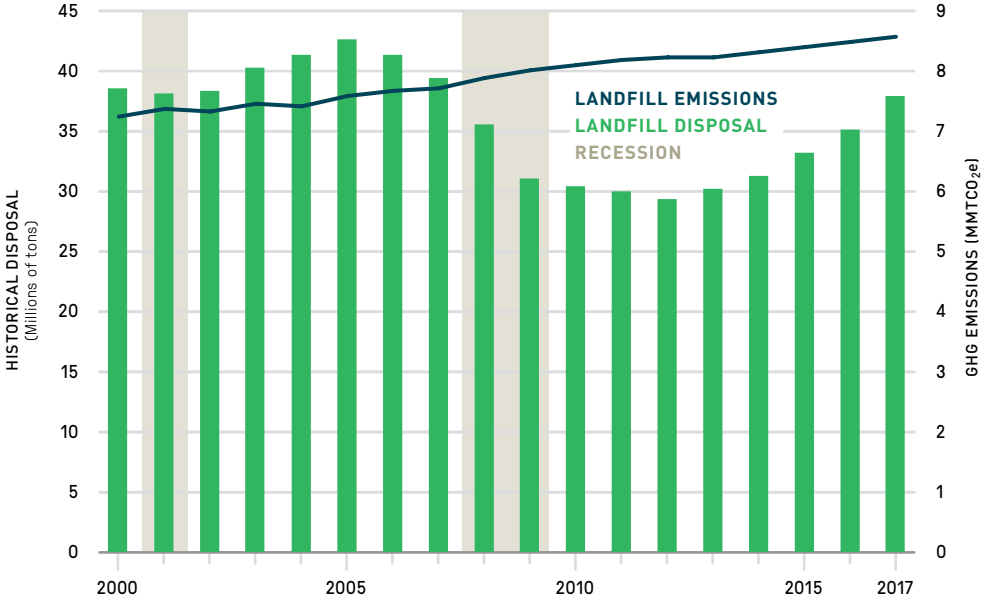
GHG emissions from aviation-related activities have increased in recent years due to an improving economy. The only periods when aviation emissions declined were during the 2001 and 2007–08 recessions. Emissions from international flights (up 41% relative to 2000)—which are not part of the included emissions inventory[4]—have far outpaced emissions from intrastate (included emissions; up 20.8% compared to 2000) and interstate (excluded emissions; up 10.4% relative to 2000).

OPPORTUNITY:

Reducing emissions from aviation will be important to driving down transportation sector-wide emissions in the state. While the future of high-speed rail in the state may be uncertain, moving to alternatives to intrastate travel could provide an opportunity for reducing intrastate air travel and associated emissions.

Figure 13. Landfill Emissions and Waste Disposed in Landfill

CALIFORNIA, 2000–2017



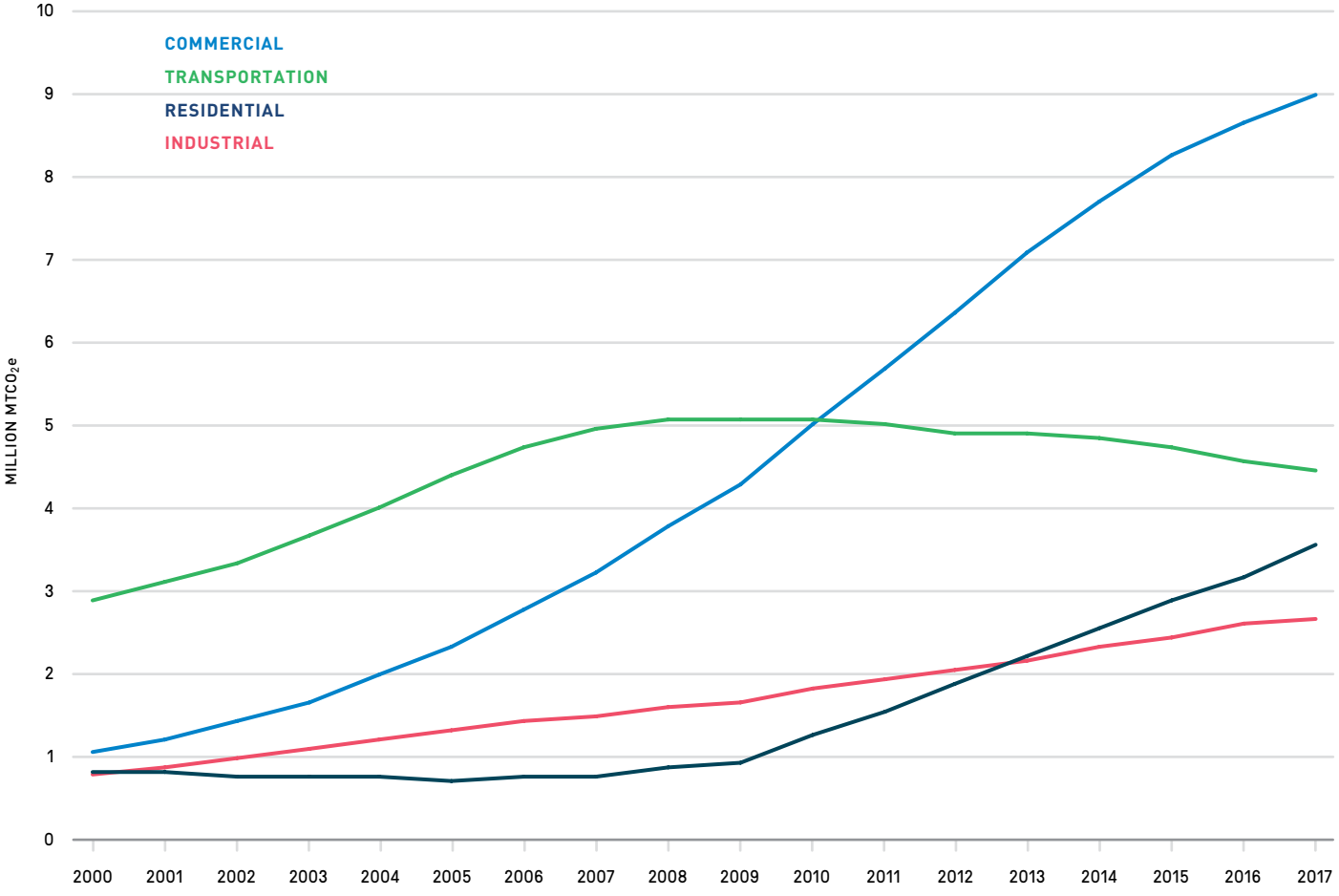
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Disposal includes total landfilled in state and total exported tons reported at the time but does not include transformation. Data Source: CalRecycle and CARB. NEXT 10 / SF · CA · USA

CHALLENGE:

❶ In 2017, Californians exported or sent to landfills 37.8 million tons of waste, up 7.4 percent compared to 2016. As the economy continues to grow, people consume more and solid waste generation generally continues to increase. In 2017, the recycling rate was 42 percent, down from 44 percent in 2016.[5] At the current pace, the state is not on track to meeting its goal of 75 percent recycling rate by 2020. ❷ As landfills are burdened with an increasing amount of waste, landfill emissions have gone up every single year since 2004. Emissions from the industrial landfills sub-sector totaled 8.54 $MMTCO_2e$ in 2017, up 15.2 percent from 2004.

Figure 14. Emissions from Substitutes for Ozone-Depleting Substances by Sector

FOR AEROSOLS, FOAMS, SOLVENTS, FIRE PROTECTION, REFRIGERATION AND AIR CONDITIONING: CALIFORNIA, 2000–2017



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

CHALLENGE:

Emissions from the use of substitutes for ozone-depleting substances (ODS substitutes),[6] which emit high global warming potential (GWP) gases, have continued to increase rapidly especially in the Commercial sector as they replace ODS banned under the 1987 Montreal Protocol.[7] For the Commercial and Industrial sectors, the increase in emissions from ODS substitutes is associated with hydrofluorocarbons (HFCs) found in foams and used in refrigeration and air conditioning activities. For the Residential sector, refrigeration and air conditioning activities account entirely for the increase in emissions. From 2007 to 2017, emissions stemming from foams activities increased 2,582.8 percent in the Commercial and 2,923.5 percent in the Industrial sectors. Emissions stemming from refrigeration and air conditioning increased 191.9 percent, 58.4 percent, and 1,362.5 percent in the Commercial, Industrial and Residential sectors, respectively, during the same ten-year period. High GWP emissions from other activities have either remained stable (Solvents and Fire Protection) or declined (Aerosols).

OPPORTUNITY:

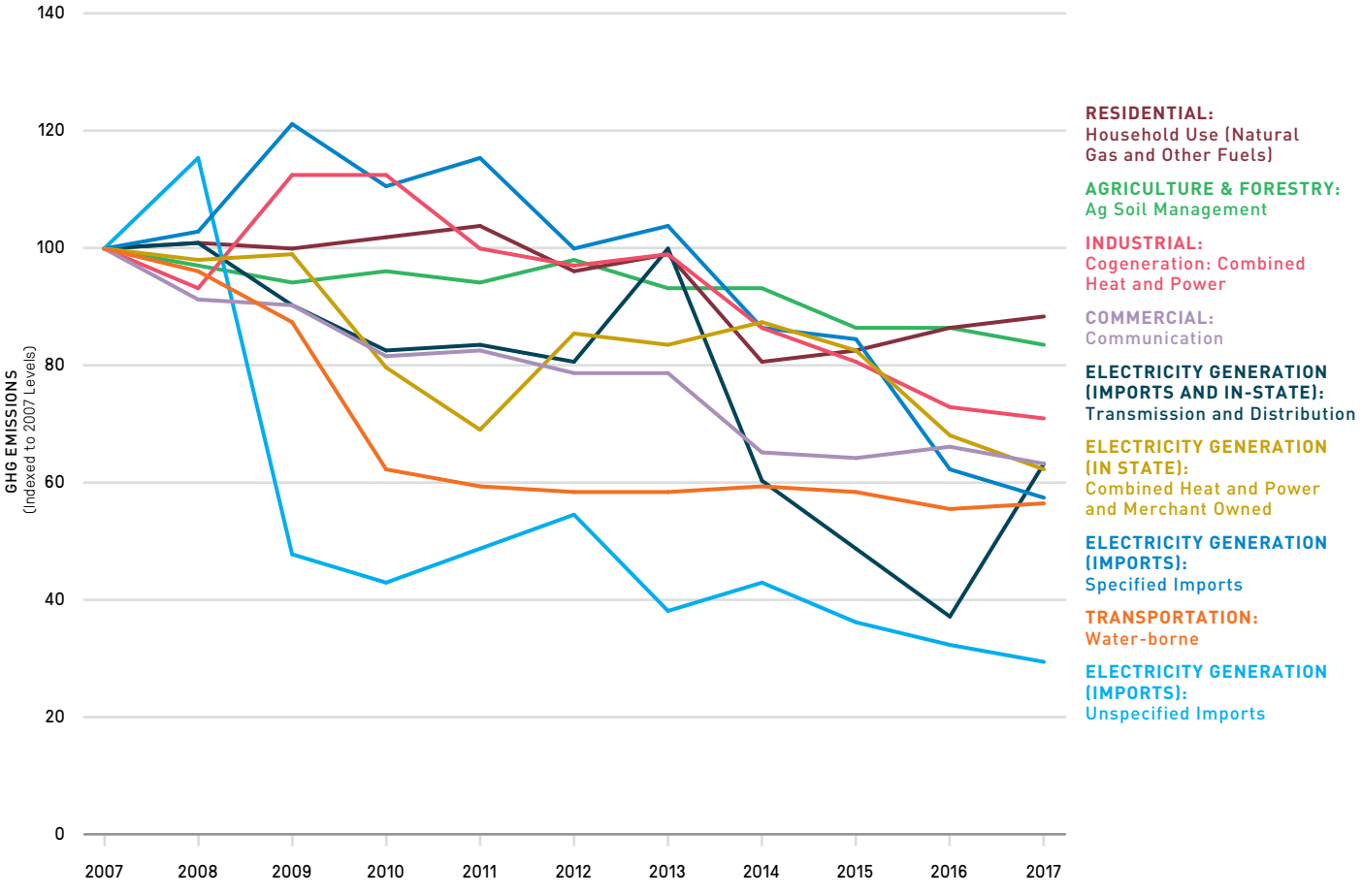
The trend in increased GHGs as a result of ODS substitutes could likely come down as a result of the state's Short-Lived Climate Pollutant (SLCP) Plan, which started implementation in 2018. The SCLP plan requires a 40 percent reduction in HFCs, among other high GWP gases to be limited, by 2030.[8]

OPPORTUNITIES

Despite a number of areas that urgently need improvement, overall, the state has achieved GHG reduction milestones across each economic sector.

Figure 15. Sub-sectors with Decreasing GHG Emissions Over Time

CALIFORNIA, INDEXED TO 2007 LEVELS, INCLUDED EMISSIONS ONLY



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

HIGHLIGHTS:

❶ The electric power sector has seen significant reductions within the past ten years. In particular, GHG emissions from electricity generation from imports (-59.9% overall) declined across all sub-sectors from 2007 to 2017: Specified Imports (-44.2%), Unspecified Imports (-73.0%) and Transmission and Distribution (-43.1%). GHG emissions from the sub-sectors in the figure above decreased 38.17 percent from 2007 to 2017, while statewide included emissions overall only decreased by 10 percent. From 2007 to 2017, GHG emissions from In-State Generation (-29.0%) decreased significantly across most sub-sectors: Combined Heat and Power: Industrial[9] (-21.0%), Merchant-Owned (-49.1%) and Transmission and Distribution (-34.8%). However, emissions from In-State Generation in the Utility-Owned sub-sector increased 12.9 percent during the same ten-year period. ❷ Aside from electric power, all of the other sectors have had varying degrees of success in reducing GHG emissions in select sub-sectors. GHG emissions from Water-Borne Transportation, for example, have continued to gradually decrease after a rapid deceleration from 2007 to 2010, and in 2017, the sub-sector's GHG emissions were 44.8 percent lower than in 2007.

FEATURE: Wildfire

California experienced some of the most devastating fires in the state's history in recent years. In 2018, more than 1.8 million acres of California land burned in wildfires[10]—a fivefold increase since 1972 and the largest burned acreage recorded in a statewide fire season[11]—with the Camp Fire in November representing California's deadliest and most destructive wildfire.[12]

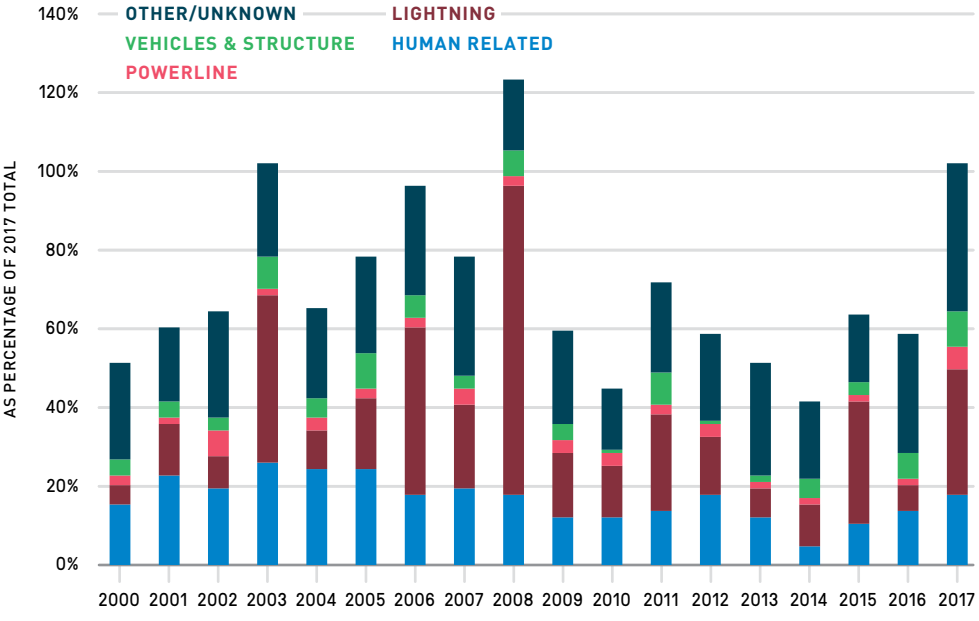
Wildfires are an essential part of nature's process, but past fire suppression and forest management strategies have led to forest overgrowth and an increased risk of large fires. It is estimated that as many as 15 million acres of California forests need some form of restoration, and 129 million trees have died across the state since 2010 due to drought and bark beetles.[13] These millions of dead trees and accumulated fuel lead to larger, more damaging wildfires—having long-term impacts on our air, water, and climate.

As the climate continues to change, the size and severity of wildfires has increased. The fire season has increased by an estimated 75 days across the Sierra Nevada, seeming to correspond with an increase in the extent of forest fires across the state.[14]

If greenhouse gas emissions continue to rise, a recent California Energy Commission report found that the average area burned statewide may increase by 77 percent by 2100.[15] The growing risk has many Californians worried: a recent survey from the Public Policy Institute of California found that 71 percent of respondents were very concerned with wildfires becoming more severe as a result of global warming.[16] These concerns are compounded by the fact that increasing wildfires could also result in higher electricity costs as utilities that are found liable (but not at fault) for a fire could end up passing on a portion of those costs onto customers. Powering sectors like buildings and transportation with clean electricity is a key component of California's strategy to reduce greenhouse gas emissions, and any increases to the cost of electricity could negatively impact the state's progress. Changing the way that we manage both wildfire prevention and the costs of wildfire damage will be important to building a safe and affordable California.

Figure 16. Significant Wildfire Count by Cause

CALIFORNIA, 2000–2017



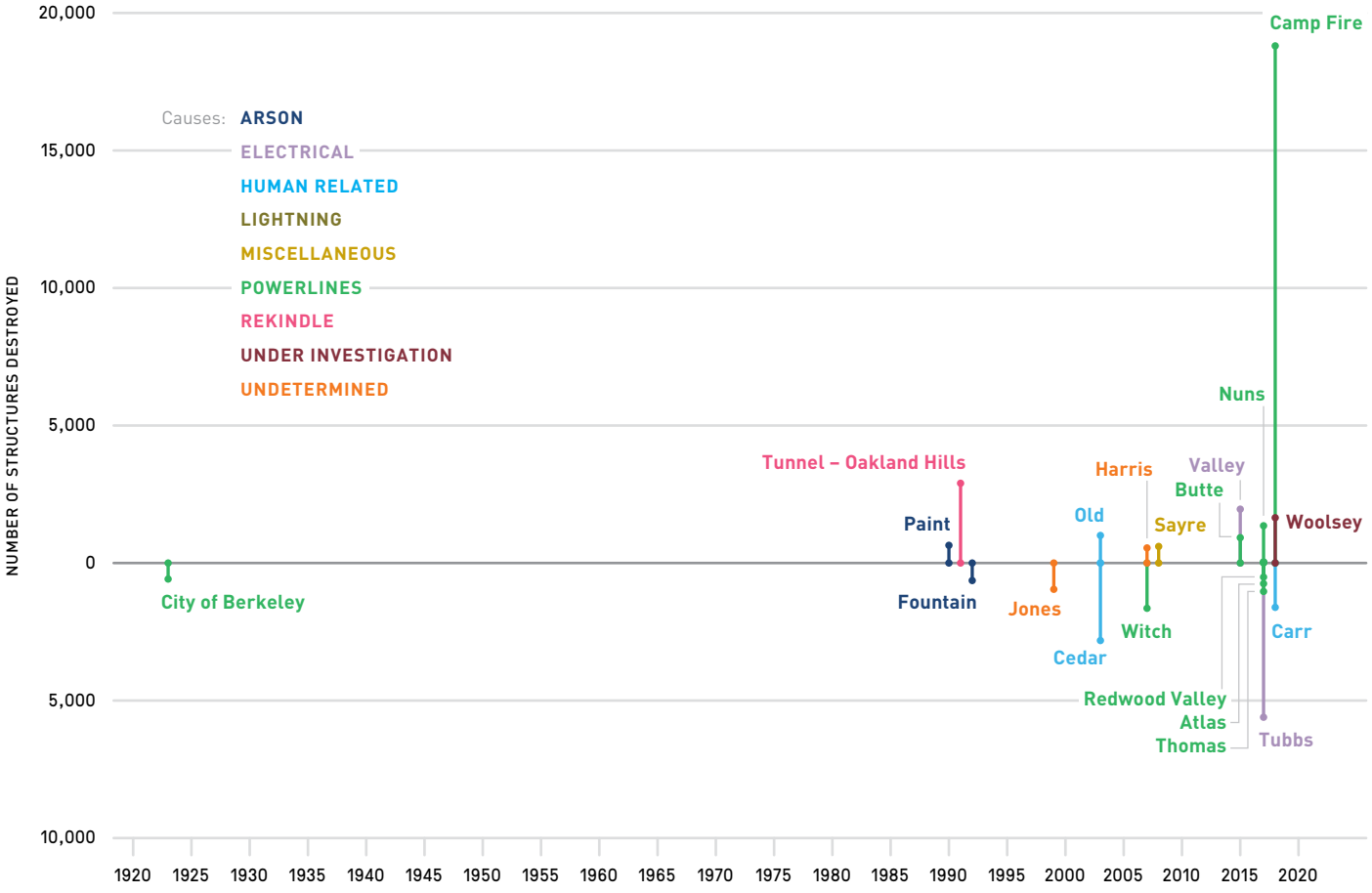
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Human Related: Arson, Campfire, Illegal Alien Campfire, Equipment Use, Playing with Fire, Smoking, Firefighter Training, and Nonfirefighter Training. Vehicles and Structure: Aircraft, Railroad, Structure, and Vehicle. Other/Unknown: Debris, Escaped Prescribed Burn, Miscellaneous, and Unknown/Unidentified. Data Source: Cal Fire. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Between 2000 and 2017, the number one cause of wildfires was those categorized as "other"—which includes debris, escaped prescribed burn, miscellaneous causes, and unknown/unidentified—(34.2%), followed by lightning (31.1%), human-caused (23.7%), vehicles/structure (7%), and powerlines (4%).

Figure 17. Top 20 Most Destructive California Wildfires

BY STRUCTURES DESTROYED



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Length from timeline to node represents structures destroyed. The longer the line between the timeline and the node, the more structures destroyed. Data Source: Cal Fire. NEXT 10 / SF · CA · USA

HIGHLIGHT:

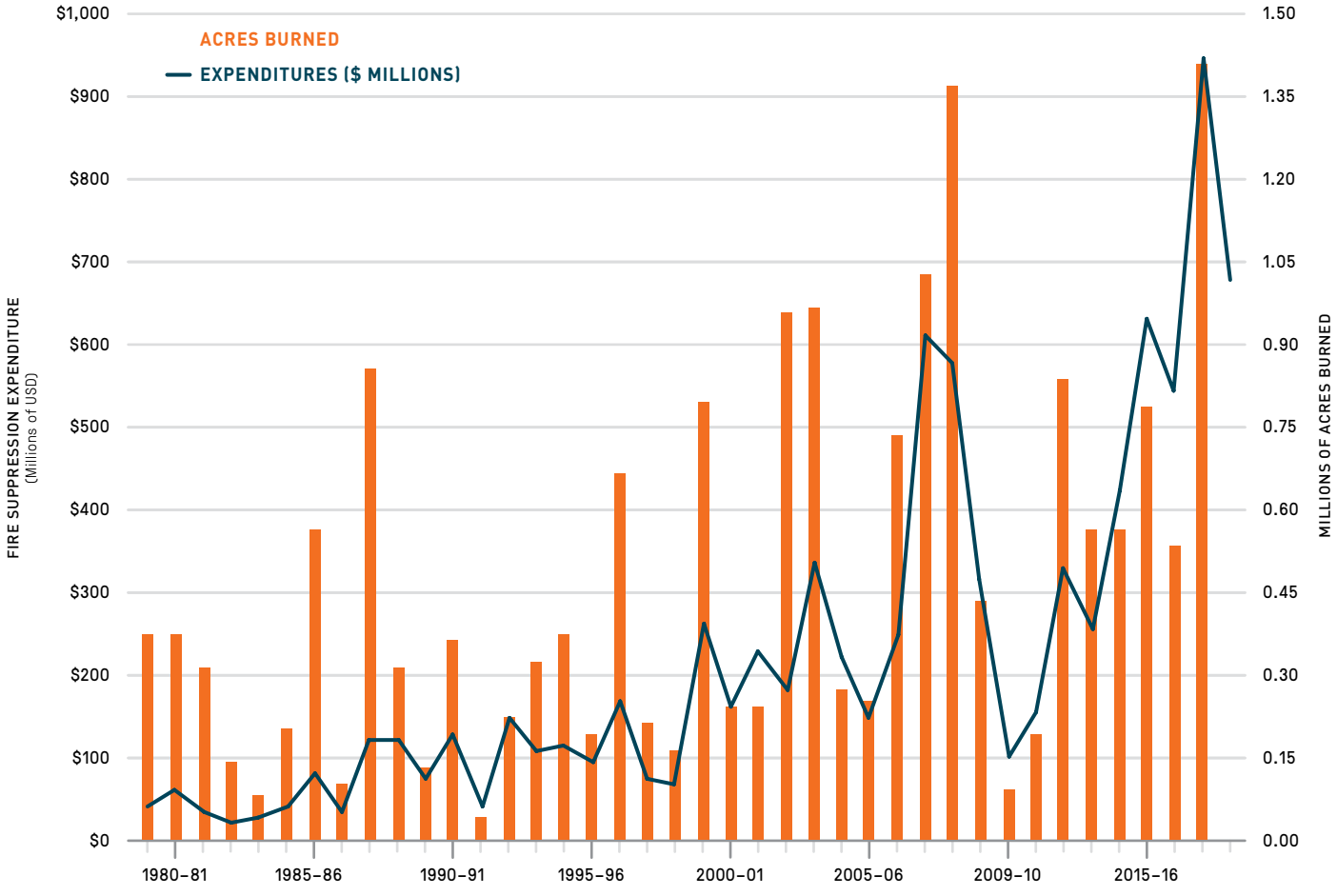
While powerlines may not cause the most fires, they tend to cause the most destructive fires in terms of the number of structures destroyed, as powerlines are located in more populated areas of the state. California's most destructive fire to date—the Camp Fire in Butte County in November 2018—was caused by powerlines and destroyed 18,804 structures. The top 20 most destructive wildfires in the state's history destroyed 46,660 structures in total, with 40 percent of those structures destroyed in the Camp Fire alone. Eight of California's most destructive fires were caused by powerlines, accounting for 55 percent of all structures destroyed by the top 20 most devastating fires. The second most destructive cause was electrical system (16.3%), followed by human-related (11.7%).[17]

CHALLENGE:

Not only are wildfires becoming more severe, the frequency of historically-destructive fires has also been increasing over the last decade. Ten of the state's most destructive fires occurred since 2010, and 19 of them have occurred within the last 30 years.[18] Temperature increases of 1.4°C since the early 1970s are very likely linked to the increase in acres burned in summer and fall fires by drying fuels,[19] while drought conditions—like those experienced in California from 2013 to 2016—have compounded the problem by further drying out the landscape.

Figure 18. Emergency Fund Fire Suppression Expenditures and Acres Burned by Year

CALIFORNIA, 1980–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Cal Fire. NEXT 10 / SF · CA · USA

HIGHLIGHT:

The proximity of a fire to a populated area also has a large impact on the suppression costs associated with that fire. For example, roughly the same number of acres burned from 2008–09 and 2017–18, but the suppression costs were nearly half as much in 2008–09. Expenditures in 2017–18 were $947 million, compared to $577 million in 2008–09 (adjusted for inflation).[20]

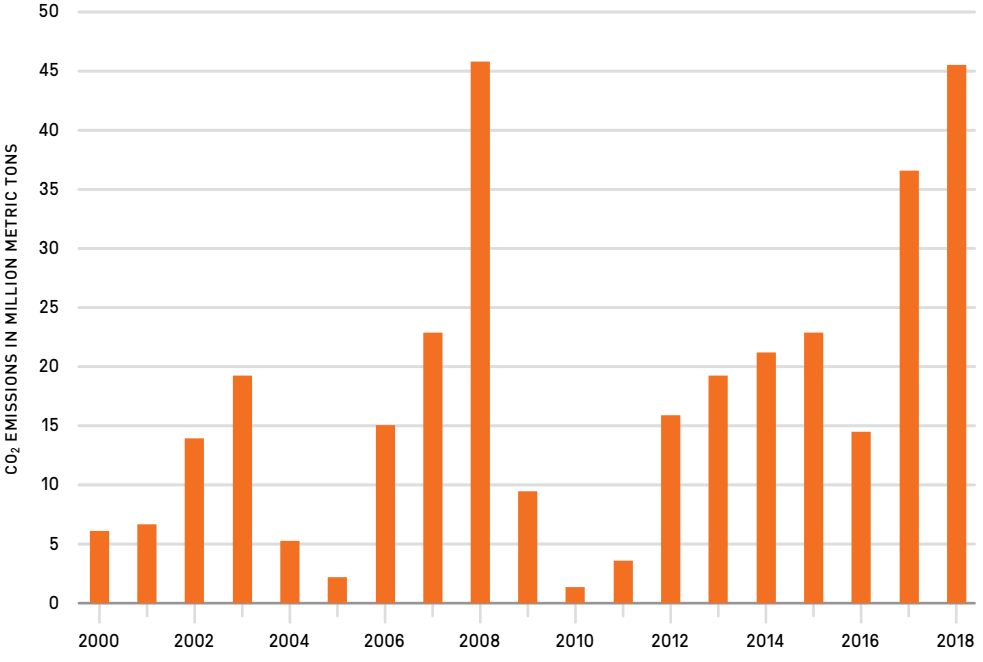
CHALLENGE:

The 2017–18 wildfire season included the Tubbs fire, which was the second-most destructive in the state's history and took place in the more populated counties of Napa and Sonoma.[21] While the 2008–09 wildfire season saw a comparable level of acres burned, the largest fire that season (Klamath Theater Complex) occurred in rural Siskiyou County, a significantly less-populated and less-developed area.[22]

In terms of property damage, the 2017–18 wildfire season was the most destructive season on record in California due to the large fires in wildland-urban interface, an ecological zone of transition between wildland and developed land. As California looks to solve its housing crisis and develop new housing across the state, further development in high fire risk areas could result in increased damages, costs, and loss of life from destructive wildfires. This summer, the state legislature passed a bill (Senate Bill 99) that could help with this issue by requiring cities and counties to better account for residential safety risks in their general plans.[23]

Figure 19. Preliminary Estimates of Wildfire CO_2 Emissions

CALIFORNIA, 2000–2018

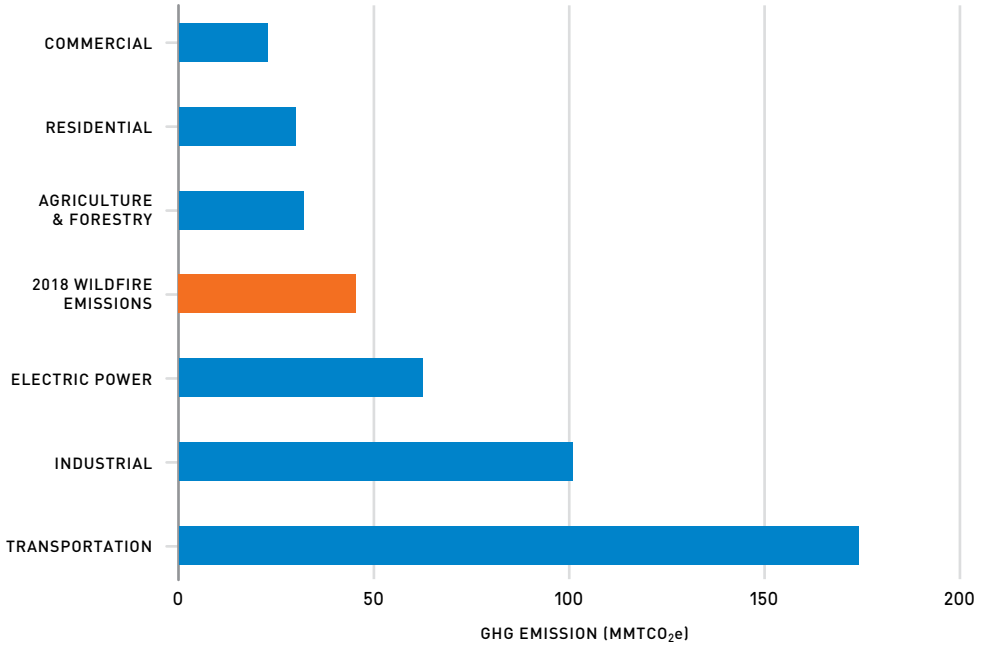


NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board. Updated 6/7/2019. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Preliminary findings from the ARB show that these increasing fires have troubling consequences for the climate and the fight to reduce emissions. California wildfires in 2018 emitted an estimated 45.5 $MMTCO_2$—a 24 percent increase from 2017, when California wildfires released an estimated total of 36.7 $MMTCO_2$.[24] While year over year increases in emissions from fires are not particularly instructive, as historical fluctuations vary considerably, the data are useful in understanding annual trends. Key to understanding the impact of GHG emissions from wildfires is also understanding the service the state's forests provide in capturing and storing GHG emissions each year, as well.

Figure 20. California 2017 Emissions by Sector and 2018 Estimated Wildfire Emissions



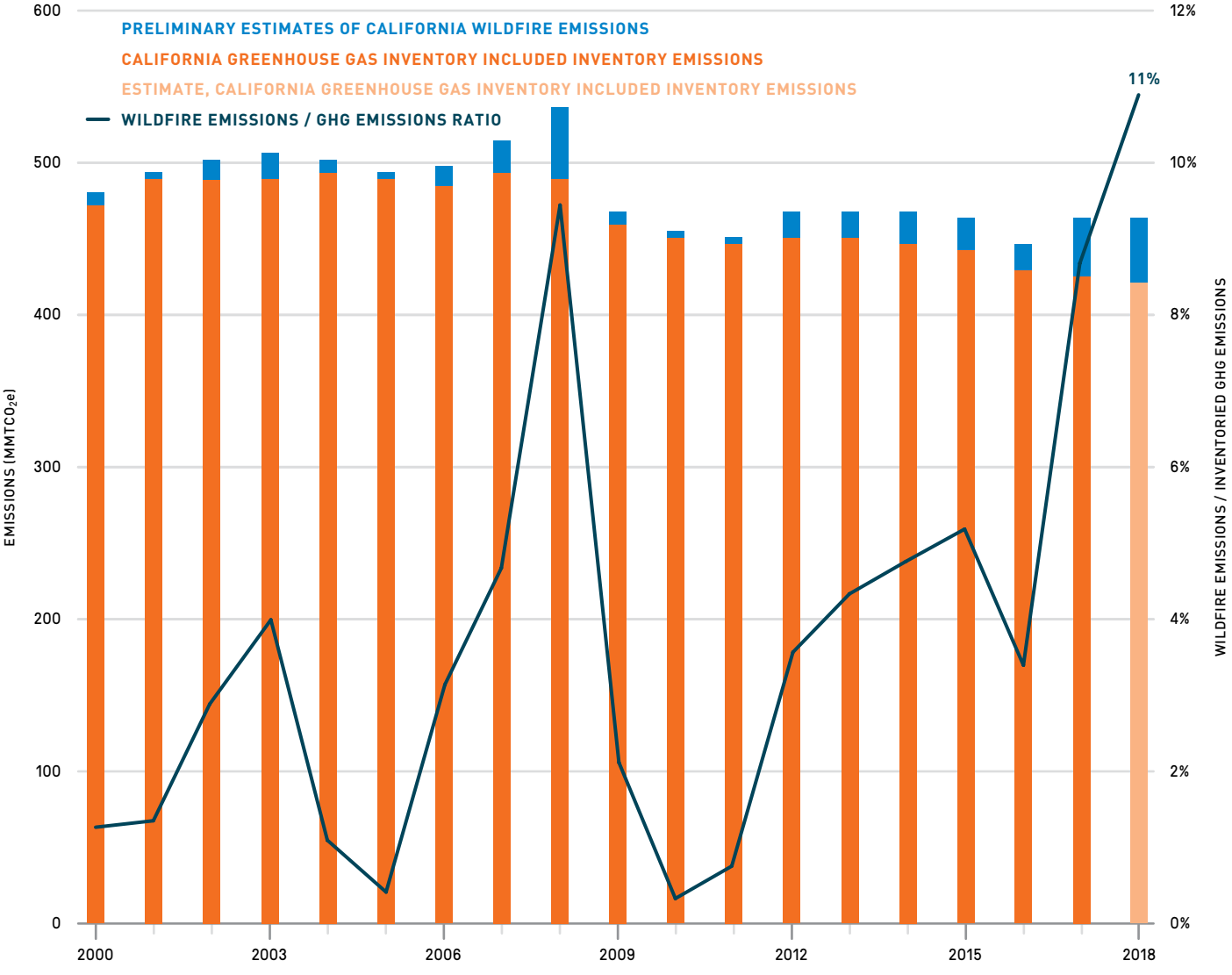
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board. NEXT 10 / SF · CA · USA

HIGHLIGHT:

California has achieved consistent emissions reductions annually for the past several years, reducing emissions by 1.15 percent economy-wide in 2017. But these achievements were eclipsed several times over by the 2018 wildfires, which produced more than nine times more emissions than were reduced in 2017. If wildfires were listed as an emissions source, along with the other sectors that the state tracks, emissions from the 2018 wildfires would be larger than the 2017 emissions from Commercial (23.26 $MMTCO_2e$), Residential (30.40 $MMTCO_2e$), or Agriculture (32.42 $MMTCO_2e$) sectors, but less than the Transportation (174.31 $MMTCO_2e$), Industrial (101.14 $MMTCO_2e$), and Electric Power (62.57 $MMTCO_2e$) sectors.

Figure 21. Estimated Wildfire Emissions and Inventoried GHG Emissions

CALIFORNIA, 2000–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: 2018 GHG Included Inventory Emissions is an estimate based on trends within the five most recent years. Data Source: California Air Resources Board Wildfire Emissions Preliminary Estimates, California Greenhouse Gas Inventory. NEXT 10 / SF · CA · USA

HIGHLIGHT:

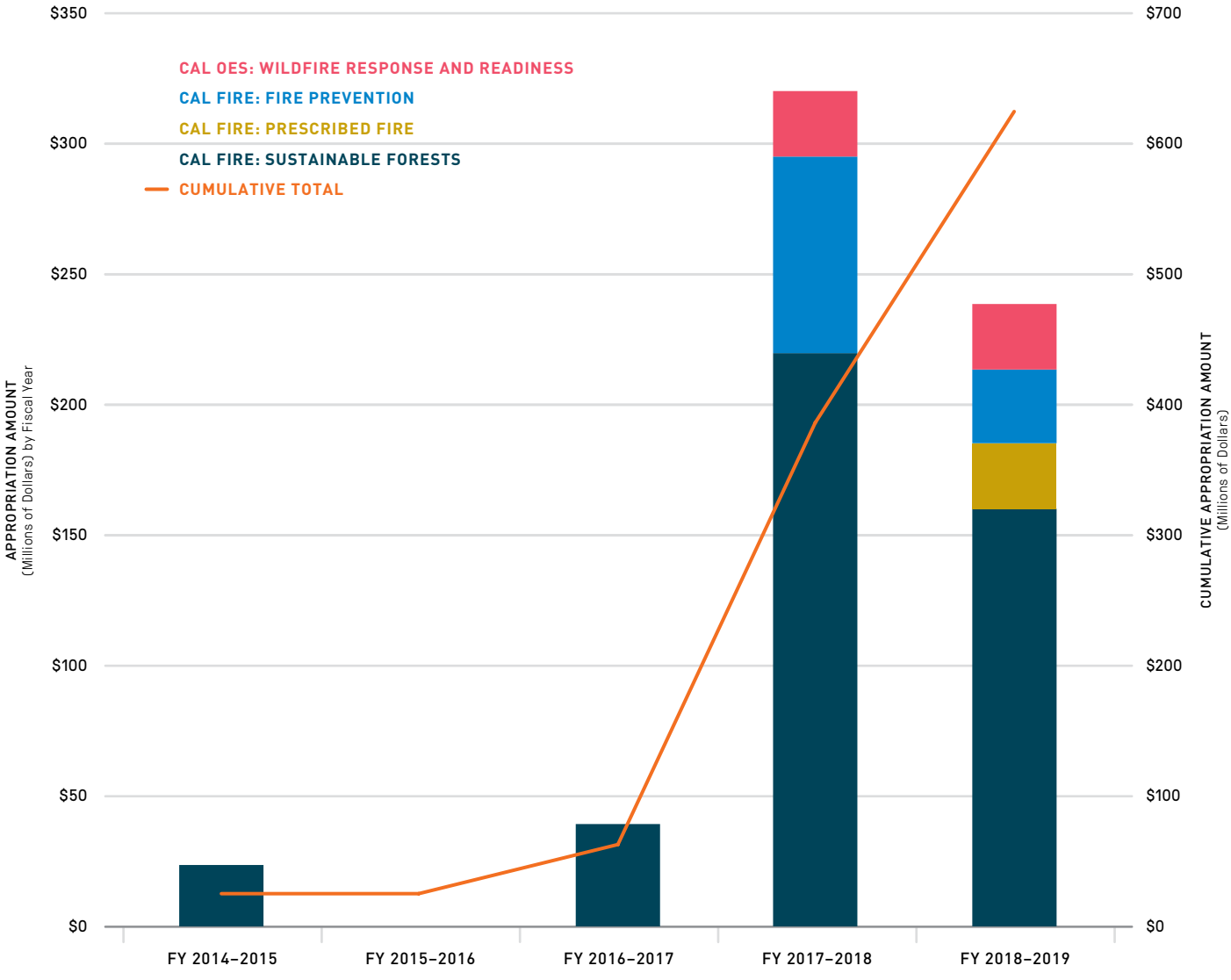
While wildfire emissions have been significant in the last few years, they represent only a fraction of the state's overall emissions—about 11 percent in 2018, based on estimated emissions, though it should be noted that wildfires have emitted significantly less in past years. When a wildfire occurs, emissions are released from the state's forests as trees burn down, but throughout each year, California forests also capture (or sequester) carbon dioxide emissions from the atmosphere and store that carbon in the ground and vegetation. The wildfire emissions estimate data do not account for GHGs that the state's forests sequester and, as such, should not necessarily be seen as a net increase in emissions. In 2017, the state's forests remained a net carbon sink, sequestering 27.9 $MMTCO_2e$ per year—though this accounts for some, but not all, wildfire emissions.[25]

CHALLENGE:

When accounting for all estimated wildfire CO_2 emissions for 2017, the state's forests may have acted as a net source for carbon emissions—releasing 8.8 $MMTCO_2e$ that year. While the nature of wildfire emissions relative to inventoried greenhouse gas emissions is cyclical, this ratio of emissions is increasing. Moving forward, it will be critical to ensure that the state's forests can continue to sequester increasing amounts of carbon while minimizing the risk of wildfires and associated emissions, though long-term climate effects may make this more difficult.[26]

Figure 22. Fire and Wildfire Programs Appropriations from GGRF

BY FISCAL YEAR, CUMULATIVE TOTAL: CALIFORNIA, 2014–2019



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Climate Investments, Annual Report, 2015 to 2019 versions.

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HIGHLIGHT:

Recognizing that climate change has played a significant role in the increased frequency and severity of wildfires across the state, the Legislature has increased allocations of the state's Greenhouse Gas Reduction Fund (GGRF) toward fire prevention programs in the last two years. Over $400 million was appropriated in fiscal year (FY) 2018–19 to Sustainable Forests projects, to restore forest health and improve long-term urban forest management with projects such as urban tree site improvement, and urban wood and biomass use. An additional $25 million was allocated for prescribed fire burning.[27]

Current Actions to Address the Challenge

KEY POLICY & PLANNING DEVELOPMENTS

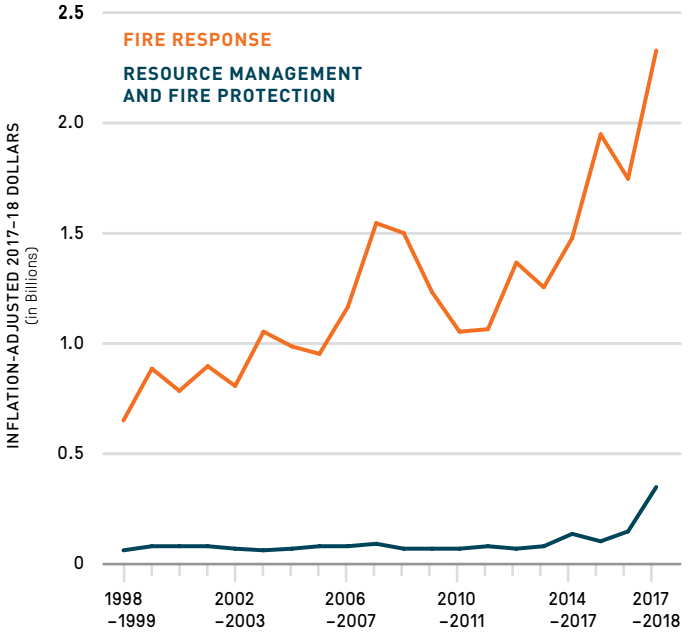
Some recently passed, notable policies and other developments targeted at the state's wildfire challenge include:

- **Senate Bill 901 (SB 901):** Passed in 2018, provides $1 billion in funding from the GGRF over five years for forest health, fire prevention, and fuel reduction projects. The 2019-20 state budget includes the first $200 million expenditure, including funding for 35 high priority fuel reduction projects identified by CAL FIRE that will help reduce the public safety risk to over 200 communities in high-risk areas.[28]
- **Assembly Bill 1054 (AB 1054):** Passed this year, authorized the creation of a $21 billion Wildfire Fund to address future damages from catastrophic fires resulting from electric utility equipment, which will be jointly funded by both the investor-owned utility (IOU) shareholders and ratepayers. Establishes new wildfire safety standards and oversight of IOU grid operations and allocates $5 billion to wildfire mitigation.[29]
- **Increased workforce:** In February 2019, Governor Newsom redirected 110 National Guard troops to support CAL FIRE in its fire prevention and fire suppression efforts to prepare for the upcoming fire season. Senate Bill 462, currently in the legislature as of July 2019, would create an Urban and Rural Forest and Woodlands Restoration and Fire Resiliency Workforce Program at California community colleges no later than July 2021.[30]
- **Assembly Bill 2518 (AB 2518):** Passed in 2018, requires CAL FIRE to identify barriers to in-state production of mass timber and other innovative forest products, which include dead trees removed from fire hazard areas, by January 2020 that can be used in construction and for other purposes. They must also develop solutions that are consistent with the state's climate objectives on forest land.[31]
- **Improving safety and emergency response:** Senate Bill 99, which passed this summer, is aimed at incorporating fire risk into the general plan process to ensure that new residential developments in high-hazard areas have at least two planned evacuation routes.[32] Another pending bill (SB 560)[33] would improve the notification requirements for residents when it becomes necessary to deenergize electrical lines to prevent fire, while Senate Bill 167 would set requirements for utilities to ensure that customers who require consistent access to energy for medical reasons would be able to access backup energy when lines are deenergized.[34]

SPENDING

Figure 23. CAL FIRE Spending on Response and Proactive Management

1998–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Cal Fire = California Department of Forestry and Fire Protection. Analysis: Legislative Analyst's Office. NEXT 10 / SF · CA · USA

HIGHLIGHT:

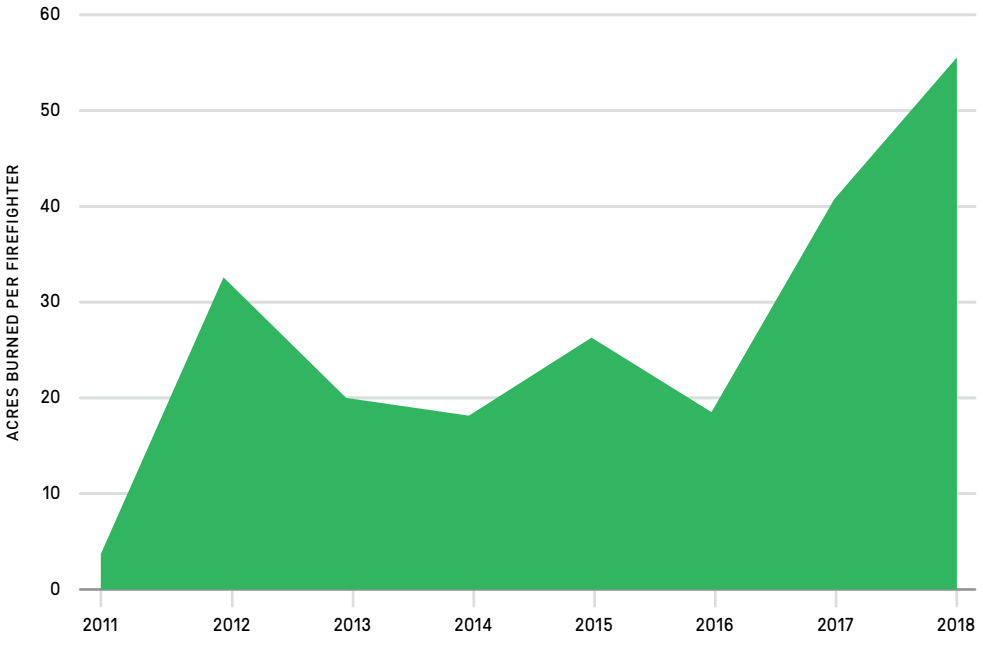
While fire response spending has always been higher than that for prevention, the divergence has increased markedly in the last 10 years. Fire response spending, which grew from $650 million in FY 1998–99 (adjusted for inflation) to more than $2.3 billion in 2017–18, makes up over 90 percent of CAL FIRE's annual spending.[35] Meanwhile, spending on preventative activities, such as resource management and fire prevention, has remained relatively flat, averaging $77 million and seven percent of the department's total expenditures through 2013–14.[36] Beginning in 2014–15, CAL FIRE began receiving GGRF funds for forest health activities which has increased resource management spending notably, compared to historical levels. In 2017–18, resource management spending was $350 million, nearly five times as much as the average prior to 2014–15.

OPPORTUNITY:

For the current 2019–20 budget year, CAL FIRE will see a $600 million increase in its budget to nearly $2.9 billion. It includes greater investments in forest management and firefighting capacity, including $225 million from various funds to complete fuel reduction projects, implement the first year of SB 901 funding, and other wildfire risk reduction efforts in the wildland-urban interface.

Figure 24. Acres Burned per Firefighter

CALIFORNIA, 2011–2018



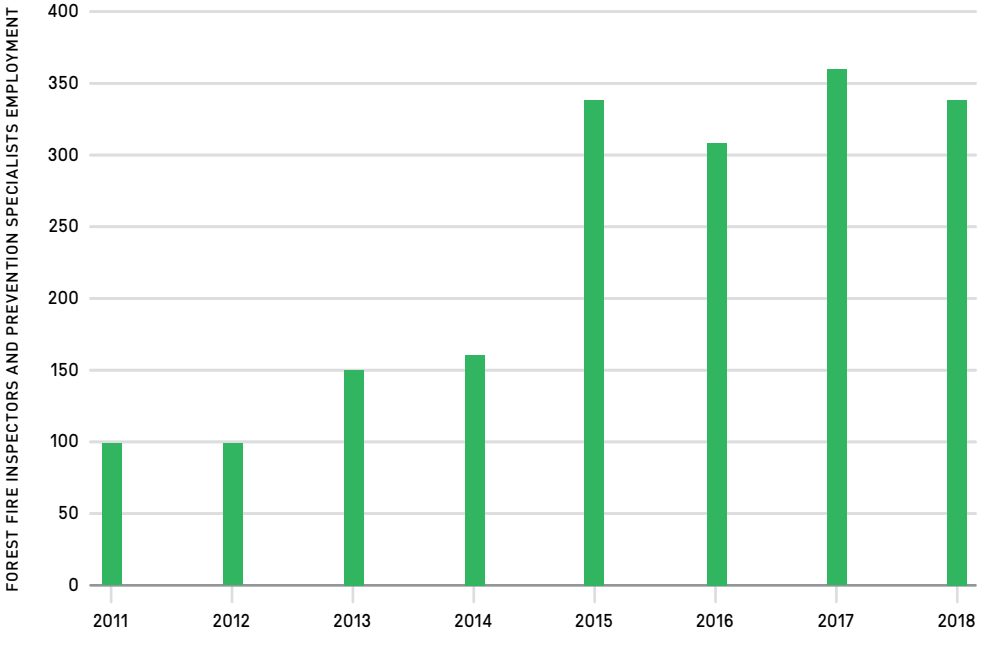
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Bureau of Labor Statistics Occupational and Employment Statistics, National Interagency Fire Center. NEXT 10 / SF · CA · USA

OPPORTUNITY:

In 2018, California paid $207 million in overtime to firefighters to help battle the season's wildfires.[37] Fire response spending has gone up in recent years, but it hasn't necessarily resulted in a proportional increase in the state's firefighter workforce—based on the severity of wildfires seen in the state. The number of firefighters in California has remained largely stable, with 33,200 employed in 2011 compared to 32,910 employed in 2018—with the CAL FIRE workforce hovering around 6,500 firefighters.[38] Increasingly severe fires have caused a spike in acres burned per firefighter, jumping from four to over 55 between 2011 and 2018.[39, 40] This figure and resulting damage caused by wildfires could be brought down by increasing the firefighter workforce. In July, the Governor signed Executive Order N-16-19 authorizing an increase of 393 seasonal firefighters to help support staffing.[41]

Figure 25. Forest Fire Inspectors and Prevention Specialists

CALIFORNIA, 2011–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Bureau of Labor Statistics Occupational Employment Statistics.
NEXT 10 / SF · CA · USA

HIGHLIGHT:

Fire prevention funding has increased since the beginning of fiscal year 2015, as has the number of forest fire inspectors and prevention specialists employed by the state. These individuals enforce fire regulations, inspect forest for fire hazards, and recommend forest fire prevention or control measures. While these forest fire prevention workers have grown in number, the number of fire inspectors and investigators (who are responsible more for structural fire-related investigations and inspections roles, including building inspections) has declined sharply, falling from 1,820 in 2011 to 700 in 2018.[42]

California Policy Timeline

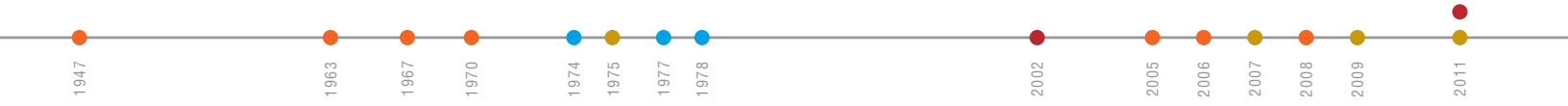
For decades, California has been a national and global leader in the development of innovative energy and environmental policies. The state has led the way as an early adopter of a clean energy future, implementing standards and policies to reduce pollution, improve energy efficiency, and incentivize clean energy and technology development that have been replicated in both other states as well as nations. From the creation of the Los Angeles Air Pollution Control District in 1947 to the passing of the state's landmark climate change legislation (AB 32) in 2006 and countless innovative policies passed since then—California has demonstrated a decades-long commitment to reducing pollution, addressing climate change, and creating new opportunities for a clean energy economy.

The current federal administration continues to backtrack on the nation's clean energy and climate progress, but California—along with many leading states—is committed to advancing climate policy innovation. Last year, the state met its AB 32-mandated 2020 climate change goal four years early and passed a policy to transition the state to 100 percent zero-carbon sources by 2045. Now, in order to achieve future climate and clean energy goals, the state will need to build policies that help tackle harder-to-reach emissions reductions, including those from the transportation sector. The policies in the subsequent timeline reflect decades of collaboration and innovation to address climate and pollution concerns while simultaneously developing one of the world's largest economies. Highlights of some of the state's most significant environmental and clean energy policies from the past are shown below, while notable policy developments from the last year are shown to the right.

- Air & Environment
- Energy Efficiency
- Clean Transportation
- Renewable Energy

★ 1st in U.S.

U.S.: United States Policy



1947

★ Los Angeles Air Pollution Control District created

1963

- **U.S.:** Clean Air Act

1967

★ California Air Resources Board established

1970

- **U.S.:** Environmental Protection Agency created by Presidential Executive Order

1974

- California Energy Commission created

1975

- **U.S.:** Congress enacts the Corporate Average Fuel Economy (CAFE) regulations to improve average fuel economy of cars and light trucks in the U.S.

1977

- Efficiency standards for appliances (Title 20)

1978

- Efficiency standards for new buildings (Title 24)

2002

- California passes the state's first Renewable Portfolio Standard (RPS), requiring 20% of total electricity procured from renewables by 2017 (SB 1078)

2005

- Governor Schwarzenegger executive order set greenhouse gas emission reduction targets (S-3-05)

2006

★ California Global Warming Solutions Act of 2006 (AB 32)

2007

- Governor Schwarzenegger establishes Low Carbon Fuel Standard regulations to reduce carbon intensity of transportation fuel 10% by 2020 (S-01-07)

2008

★ California passes the Sustainable Communities and Climate Protection Act (SB 375), targeting greenhouse gas emissions reductions from passenger vehicles through planning and land use strategy

2009

- **U.S.:** U.S. Environmental Protection Agency adopts more stringent tailpipe rules modeled after those of California

2011

- California increases the state's RPS to require at least 33% of electricity procured from renewable resources by 2020, the most ambitious standard in the country at the time (SB X1-2)
- **U.S.:** The Obama administration and 13 major automakers agree to raise CAFE standards up from 27 to an average of 54.5 miles per gallon by 2025

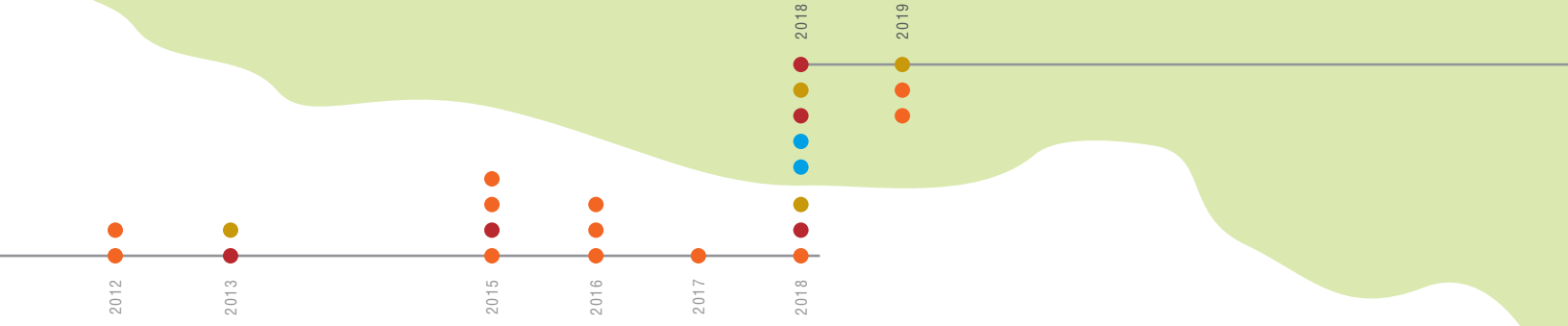
Notable Policy Developments

SEPTEMBER 2018

- California passes the 100 Percent Clean Energy Act of 2017, increasing the RPS requirement from 50 percent by 2030 to 60 percent and setting a target to meet all of the state's retail electricity supply with a mix of RPS-eligible and zero-carbon resources by 2045 (SB 100)
- ★ The California Clean Miles Standard and Incentive Program is created to increase the use of zero-emission vehicles by ride-hailing companies, requiring GHG reduction targets to be set for such companies by ARB (SB 1014)
- Bill passed that aims to develop hydrogen as a strategy for seasonal energy storage and to flatten spikes in renewable energy production and late afternoon demand (SB 1369)
- The Self-Generation Incentive Program is extended to 2026 and more than $800 million is allocated in additional incentive funds to promote expansion of energy storage, with new requirements to reserve 25 percent of funds for low-income residents, government agencies, educational institutions, nonprofits and other customers located in areas impacted by environmental concerns (SB 700)
- Requires the CEC to regularly prepare and update a statewide assessment of the electric vehicle charging infrastructure needed to support the levels of electric vehicle adoption required for the state to meet its goals of putting at least 5 million zero-emission vehicles on California roads by 2030 and of reducing emissions of greenhouse gases to 40% below 1990 levels by 2030 (AB 2127)
- California Energy Commission will—by January 1, 2021—assess the potential for the state to reduce greenhouse gas emissions from California's residential and commercial building stock by at least 40 percent below 1990 levels by January 1, 2030 (AB 3232)
- $50 million to be deployed annually to help advance the state's market for low-emission space and water heating equipment for new and existing residential buildings and to provide incentives for the deployment of near-zero-emission building technologies (SB 1477)

JULY 2019

- ★ Berkeley, CA became the first in the nation to phase out natural gas in new residential developments beginning January 1, 2020
- California and a consortium of automanufacturers agree to a voluntary framework to ensure improved vehicle emissions standards through 2026 for light-duty cars and trucks—in line with goals set under the Obama administration, despite efforts from the Trump administration to freeze emission standards at 2020 levels through 2026
- The Wildfire Fund—to be jointly funded at $21 billion by electrical corporations and ratepayers—is authorized to address future damages from the increasing amount of wildfires in the state (AB 1054)



2012

- California established the Greenhouse Gas Reduction Fund as a special fund to collect cap-and-trade auction revenues (SB 1018)
- California Air Resources Board conducts its first quarterly auction for emissions allowances in the cap-and-trade program as authorized by AB 32

2013

- Governor Brown releases the Zero Emission Vehicle Action Plan that identifies specific strategies and actions that state agencies will take to meet milestones of the executive order for 1.5 million zero-emission vehicles in California by 2025
- ★ California PUC mandates that the state's three investor owned utilities add a combined 1.3 gigawatts of energy storage by 2020

2015

- Governor Brown signs an Executive Order for an interim target of reducing GHG emissions 40% below 1990 levels by 2030 (B-30-15)
- California spearheaded and signed the Under 2 MOU along with other sub-national governments that commits signatories to limit emissions to a level that would limit global warming to less than 2ºC
- California passes a law to increase the RPS for renewable energy to 50% and double energy efficiency in buildings (SB 350)
- **U.S.:** At the Conference of Parties (COP 21) in Paris, parties to the U.N. Framework Convention on Climate Change reached a landmark agreement to limit global warming to less than 2ºC and implement programs to support that goal

2016

- **U.S.:** The U.S. Supreme Court halted the Environmental Protection Agency's implementation of the Clean Power Plan, a federal program to reduce GHG emissions, while the program is being fought in a lower court
- California extends emission limits from AB32 to mandate statewide emissions reduction equivalent to 40% below 1990 levels by 2030 and requires state board to submit annual reports on GHG mitigation progress (SB 32)
- ★ California becomes the first in the world to develop a policy aimed at reducing harmful emissions of short-lived climate pollutants—which have the highest global warming potential of all GHGs—by establishing targets to achieve a reduction in methane emissions by 40%, hydrofluorocarbon gases by 40%, and anthropogenic black carbon by 50% below 2013 levels by 2030 (SB 1383)

2017

- **U.S.:** The Trump administration announces its intention to withdraw from the Paris Climate Agreement

2018

- California updates its ZEV Action Plan goal from 1.5 million EVs on the road by 2025 to 5 million on the road by 2030
- ★ California approves mandate to require rooftop solar on all new homes under three stories as part of its 2019 update to Title 24 Building Energy Efficiency Standards
- CARB announces that the state has surpassed the 2020 emissions goal of 431 $MMTCO_2e$ four years ahead of schedule

Transportation has long been the **largest energy-consuming and greenhouse-gas-emitting sector** in California. Despite California's efforts to reduce GHG emissions from transportation through several programs targeting light-, medium-, and heavy-duty vehicles,[43] emissions from on-road passenger vehicles have ticked up continuously since 2013, although still below pre-recession levels.

Though California has experience a sustained growth of electric vehicle (EV) adoption, the state faces many challenges in reducing emissions from the transportation sector—from increasing car ownership rates, declining public transit usage, to shifting consumer preferences from more fuel-efficient sedans and compact cars to pickup trucks and SUVs.

Alternative Fuel Vehicles

- California's alternative fuel vehicle registrations[44] as a share of total vehicles registered reached **five percent** in 2018–the highest it has ever been and up from 4.6 percent in 2017. Of that five percent, 3.4 percent are hybrids and 1.5 percent are electric vehicles.
- However, hybrid vehicle sales in the state are slowing, so in the near future, as some hybrids begin to retire from the roads, **hybrid vehicles' share of total vehicle registrations is expected to start decreasing**. Meanwhile, the share of electric vehicles is expected to continue increasing.

Zero-Emission Vehicles (ZEVs)

- There were just under a **half of a million ZEVs** on road in 2018, an increase of 37.6 percent from 2017. Over the last five years, the state has seen an average annual increase in ZEVs of more than 50 percent.
- At the current growth rate, the number of ZEVs on the road will **need to increase by 17.7 percent annually** in order to reach the 2025 goal of 1.5 million ZEVs, and by 27.2 percent annually from 2026 to 2030 to reach the 2030 goal of five million.
- The number of plug-in hybrid electric vehicle rebates and battery electric vehicle rebates distributed increased **39 percent and 67 percent,** respectively, from 2017 to 2018.

Transportation Emissions and Vehicle Ownership

- Greenhouse gas emissions from surface transportation in California totaled 155.8 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in 2017, a **0.7 percent increase** from 2016.
- Vehicle miles traveled (VMT) and GHG emissions from surface transportation per capita increased **0.5 percent and 0.1 percent,** respectively, from 2016 to 2017.
- Total vehicles registered and vehicle miles traveled reached record highs. The number of vehicles registered increased 1.2 percent from 2016 to **31 million** in 2017, and VMT increased 1.1 percent to 343.9 billion miles over the same period. VMT per capita increased 0.5 percent, while VMT per vehicle decreased slightly (-0.08%) from 2016 to 2017.
- The vehicle ownership rate is increasing faster than ever, reaching **80.6 vehicles per 100 persons** in 2018. ZEVs and hybrids accounted for about 4.0 vehicles per 100 persons.

Transportation

Public Transit Ridership

- Public transit ridership **continues to decline** throughout California. Of California's 26 Metropolitan Statistical Areas (MSAs), only five recorded significantly higher total unlinked passenger trips (UPTs, or trips on one transit vehicle, not including connections) in 2018 than in 2017. Among those MSAs (Bakersfield, Fresno, Hanford–Corcoran, Merced, Stockton–Lodi), three of them also had higher total UPTs in the years prior (Bakersfield, Hanford–Corcoran, and Merced) from 2016 to 2017.
- Public transit ridership per capita **declined substantially** throughout most of California between 2008 and 2018, from a decrease of 8.9 percent in San Francisco to 34.3 percent in Fresno. On the other hand, ridership declined only 4 percent in the New York metro area and remained flat in the Seattle metro area.

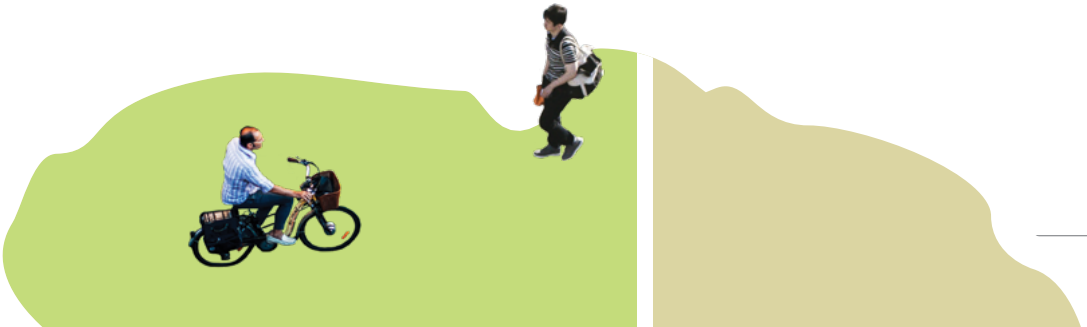
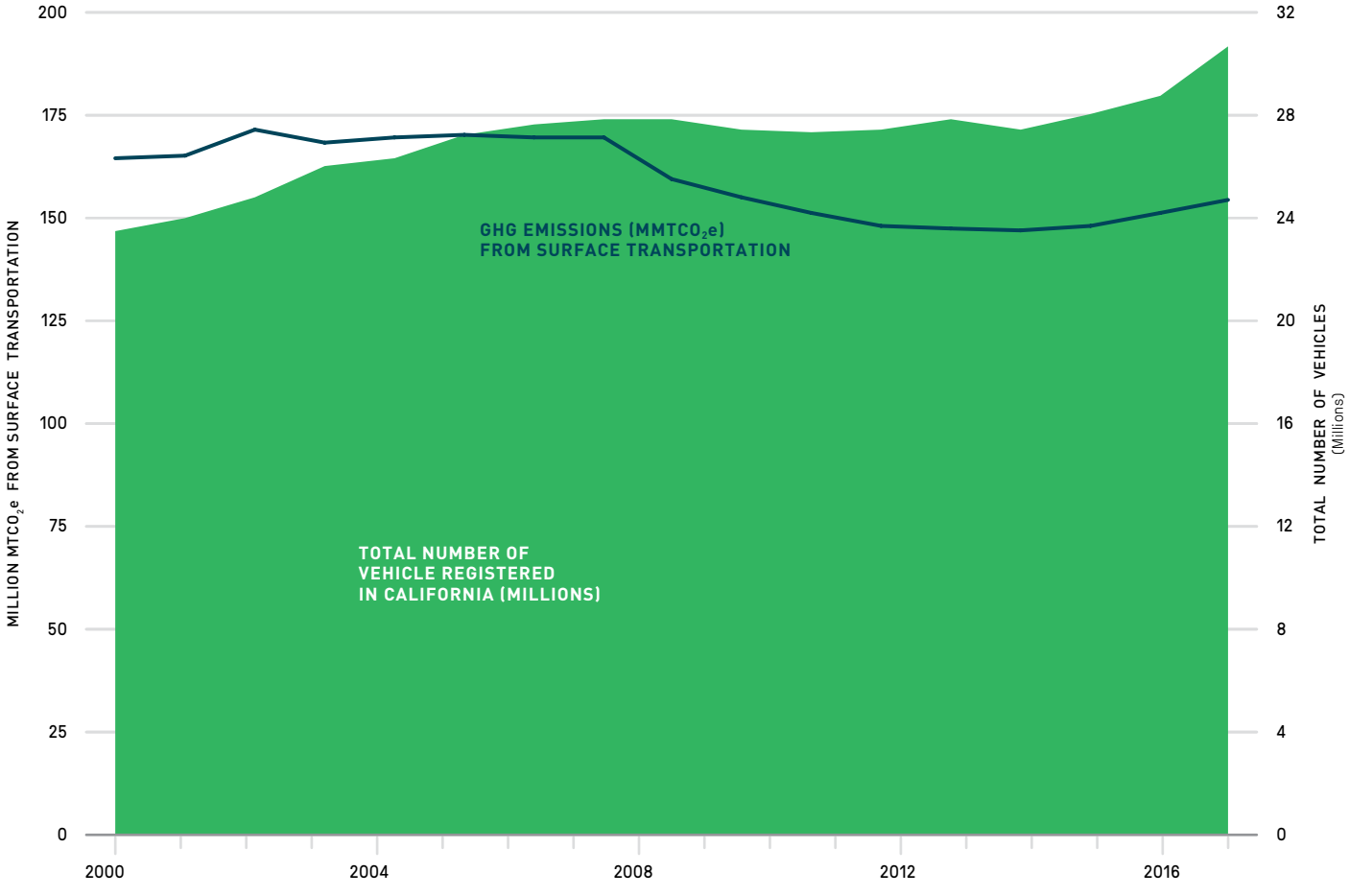


Figure 26. Total Vehicles and Greenhouse Gas Emissions

CALIFORNIA, 2000–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory - by Sector and Activity; California Energy Commission.

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HIGHLIGHT:

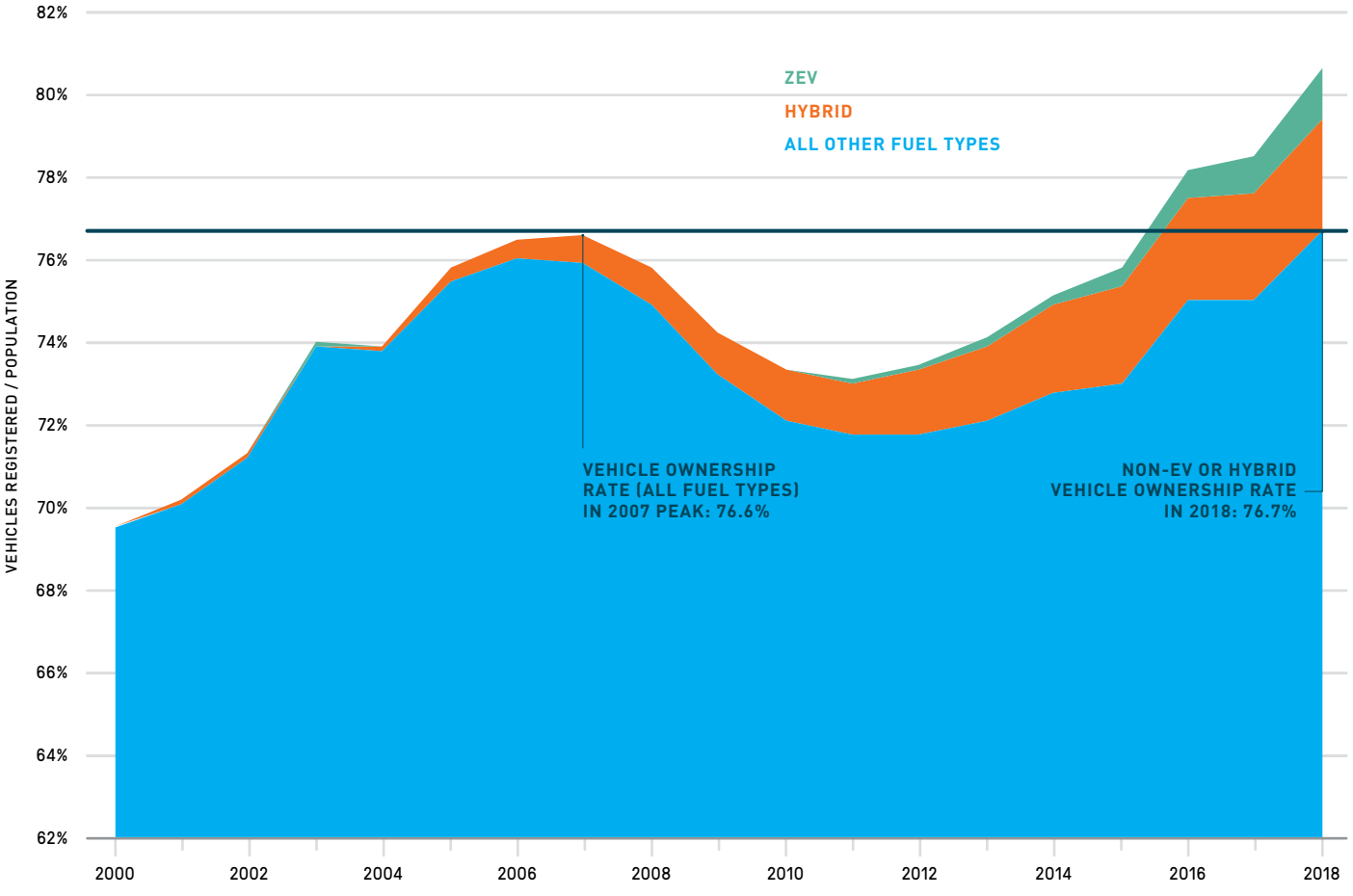
Between 2016 and 2017, the total number of vehicles registered increased 1.2 percent to 31 million vehicles, a more moderate increase compared to the 6.7 percent increase from 2015 to 2016. Growth in the registered vehicles has far outpaced population growth—from 2012 to 2017, the state added 1.5 million residents (+4.0%) and registered 3.1 million vehicles (+11.3%).

CHALLENGE:

The increase in vehicle ownership has resulted in a steady increase of related emissions. Emissions from surface transportation in California hit 155.8 $MMTCO_2e$ in 2017, a 0.7 percent increase from 2016. While the increase is modest compared to the increase in vehicles registered, emissions from surface transportation have increased each year since 2013.

Figure 27. Vehicle Ownership Rate by Fuel Type

CALIFORNIA, 2000–2018



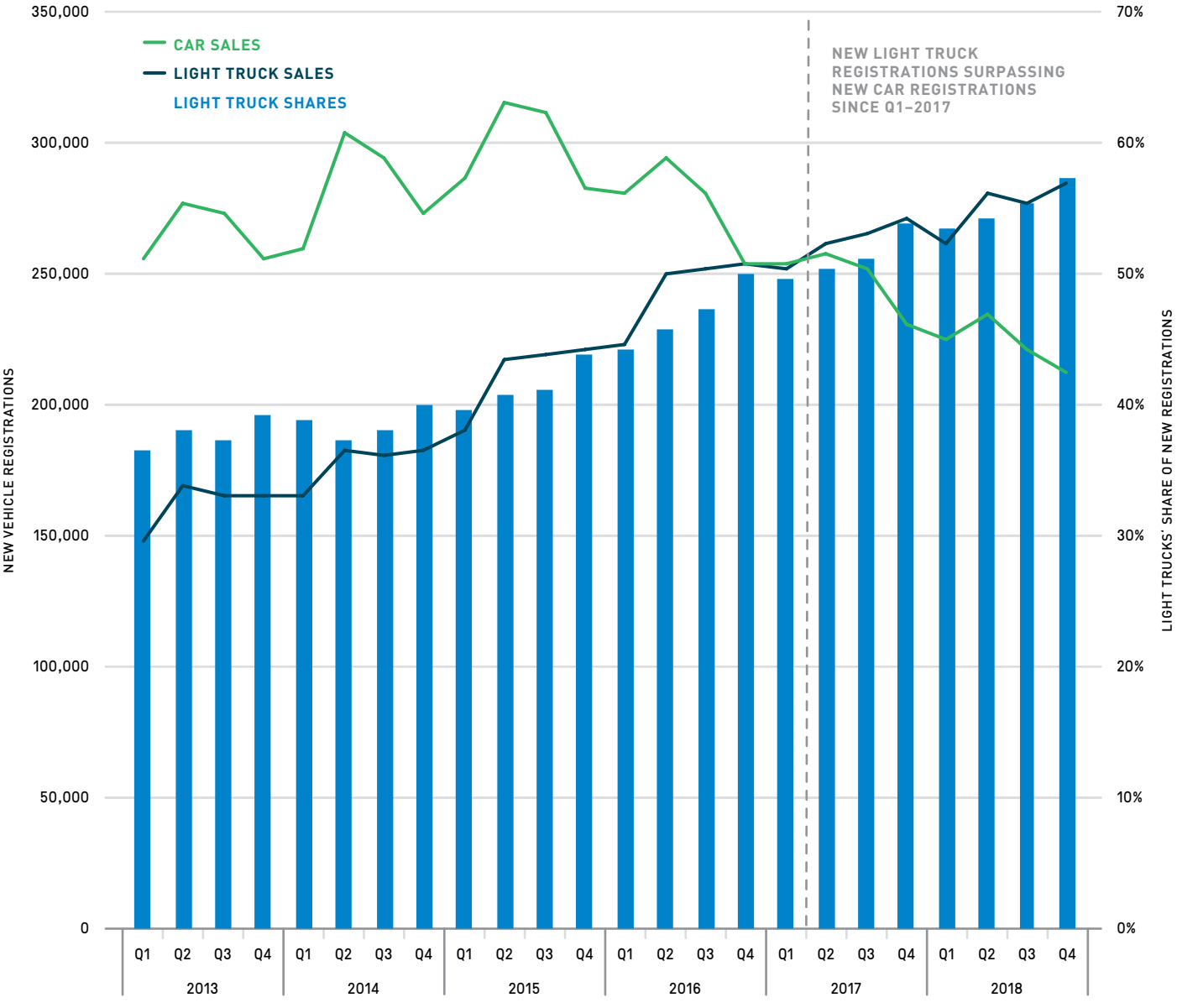
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Energy Commission; California Department of Finance. NEXT 10 / SF · CA · USA

HIGHLIGHT:

The vehicle ownership rate is increasing faster than ever, reaching 80.6 vehicles per 100 persons in 2018. ZEVs and hybrids (HEVs) accounted for about 4.0 vehicles per 100 persons. The non-zero emission vehicle ownership rate reached a new peak of 76.7 vehicles per 100 persons, a new high since 2006 when total vehicle ownership rate (of both ZEVs and non-ZEVs) was 76.1 vehicles per 100 persons (black dotted line, which represents 2018's vehicles registered per capita of non-ZEV or HEV vehicles in 2018). In California, new vehicle registrations plateaued in 2016 with 2.09 million new vehicles registered, which was double the number of new vehicles registered (1.04 million) at the height of the Great Recession in 2009. New vehicle registration has since declined slightly in 2017 (2.05 million) and 2018 (2.00 million). New vehicle registrations are on track to fall below two million units in 2019, but without more cars retiring from the roads, overall vehicle ownership continues to increase.

Figure 28. New Light Truck Registrations as a Percentage of Total New Light Vehicle Registrations

CALIFORNIA, 2013–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: New light vehicles only and does not include used vehicles and vehicles coming off lease. Cars include subcompact, compact, mid-size, large sedans and sports cars. Light trucks include pickup trucks, mini vans, large vans, and SUVs. Data Source: IHS Automotive, California New Car Dealers Association. NEXT 10 / SF · CA · USA

HIGHLIGHT:

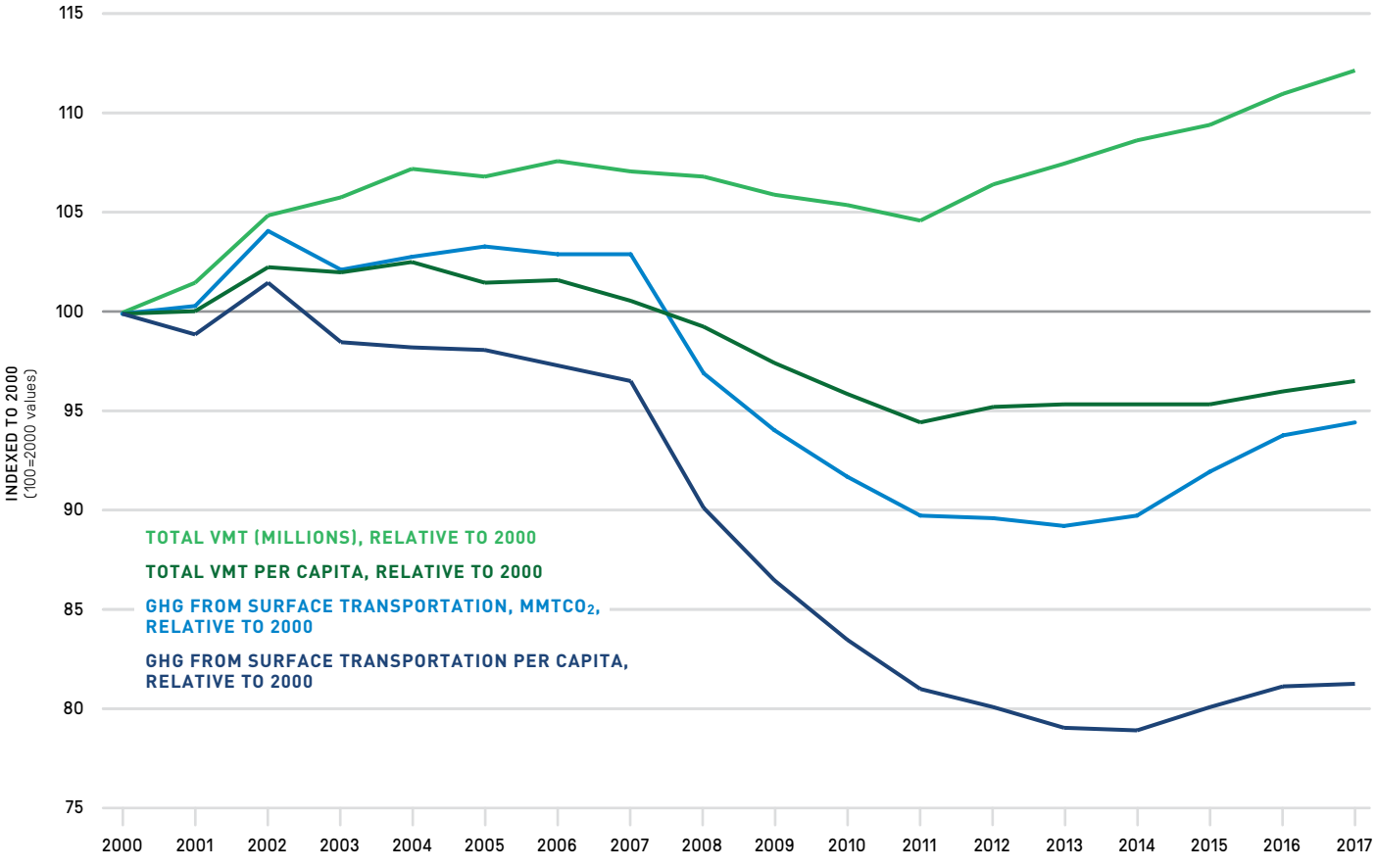
Not only is vehicle ownership up, but consumer preferences have shifted toward less efficient pickup trucks, mini-vans, and SUVs, and away from sedans with better fuel economy. By the fourth quarter of 2018, light-duty pickup trucks, mini-vans, and SUVs made up 57.3 percent of new vehicle registration, up from 54 percent from one year ago and 39.3 percent from five years ago.

CHALLENGE:

Until zero-emission vehicles become more mainstream and replace internal combustion engine vehicles (ICEVs) as a household's primary vehicle, most GHG reductions from the transportation sector will need to come from the Low Carbon Fuel Standard (LCFS) and reducing vehicle miles traveled. Currently, a portion of LCFS credits are generated from EVs, with a majority coming from lower-carbon fuel use vehicles.

Figure 29. Vehicle Miles Traveled and Greenhouse Gas Emissions from Surface Transportation

TOTAL VMT AND EMISSIONS AND PER CAPITA, CALIFORNIA, 2000–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity; California Department of Transportation; California Department of Finance. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Vehicle miles traveled (VMT) rose 1.1 percent between 2016 and 2017 to 343.9 billion miles, an increase of 11.2 percent over the 2000 level. VMT per capita increased by half a percent between 2016 and 2017 to 8,697.3 miles per person. Between 2008 and 2017, total VMT increased 5 percent in California, but declined in Pennsylvania (-6%) and New York (-8%). Texas saw the greatest increase over the period (+16%).

CHALLENGE:

VMT and GHG emissions from surface transportation per capita increased 0.5 percent and 0.1 percent, respectively, from 2016 to 2017. The fact that VMT has increased faster than emissions from surface transportation indicates that the state's GHG tailpipe standards and policies are working to reduce emissions. However, given that transportation is by far the largest-emitting sector—and with most of the emissions coming from on-road light-duty passenger vehicles—the current upward trajectory of VMT and surface transportation GHG emissions cannot continue if the state is to meet its climate goals.

Vehicle Miles Traveled

CALIFORNIA, 2017

VMT (MILLIONS)	VMT PER CAPITA	2016–2017 PER CAPITA CHANGE	VMT PER REGISTERED VEHICLE	2016–2017 PER VEHICLE CHANGE
343,862.11	8,697	0.488%	11,087	-0.08%

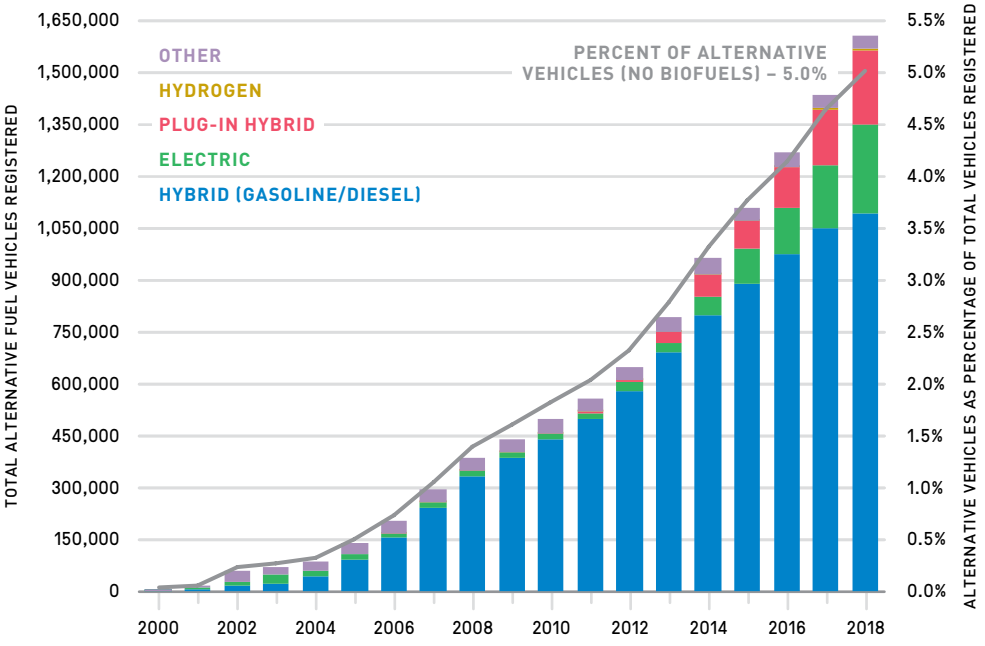
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Department of Transportation.

On the other hand, VMT per registered vehicle declined modestly between 2016 and 2017. In fact, VMT per registered vehicle has been on a sustained declining trend since 2000, due to vehicles registered far outpacing both population growth and VMT. From 2000 to 2017, the number of vehicles registered increased by 32.2 percent, while population increased by only 16.3 percent and VMT increased by 12.2 percent.

Alternative Fuel Vehicles

Figure 30. Trends in Alternative Fuel Vehicle Registrations

CALIFORNIA, 2000–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Other includes Natural Gas and Propane. Data Source: California Energy Commission.
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HIGHLIGHT:

In 2018, battery electric, plug-in hybrid, and hydrogen vehicles accounted for 1.5 percent of all registered on-road vehicles in California, up from 1.1 percent in 2017. At current pace, the share will reach 2 percent by end of 2019.

CHALLENGE:

On the other hand, hybrid vehicles' share of total vehicles registered has been increasing at a decreasing rate. In 2018, hybrid vehicles' share was 3.4 percent, barely inching up from the 3.38 percent share in 2017. While sales of new hybrid vehicles remain higher than the number of hybrid vehicles being retired, sales of new hybrid vehicles have declined continuously since 2013.[45]

Zero-Emission Vehicles (ZEVs)

Table 1. Alternative Fuel and Zero-Emission Vehicle Registrations

CALIFORNIA, 2017–2018

	% CHANGE 18–17	2018	2017
ELECTRIC	42.0%	257,018	181,001
PLUG-IN HYBRID	32.1%	216,974	164,286
NATURAL GAS	-3.2%	33,457	34,576
HYBRID	3.9%	1,091,200	1,049,853
HYDROGEN	68.2%	5,552	3,301
TOTAL ALTERNATIVE FUEL VEHICLES	11.9%	1,604,201	1,433,017
TOTAL ZEV	37.6%	479,544	348,588
TOTAL VEHICLES	3.3%	32,035,366	31,016,029

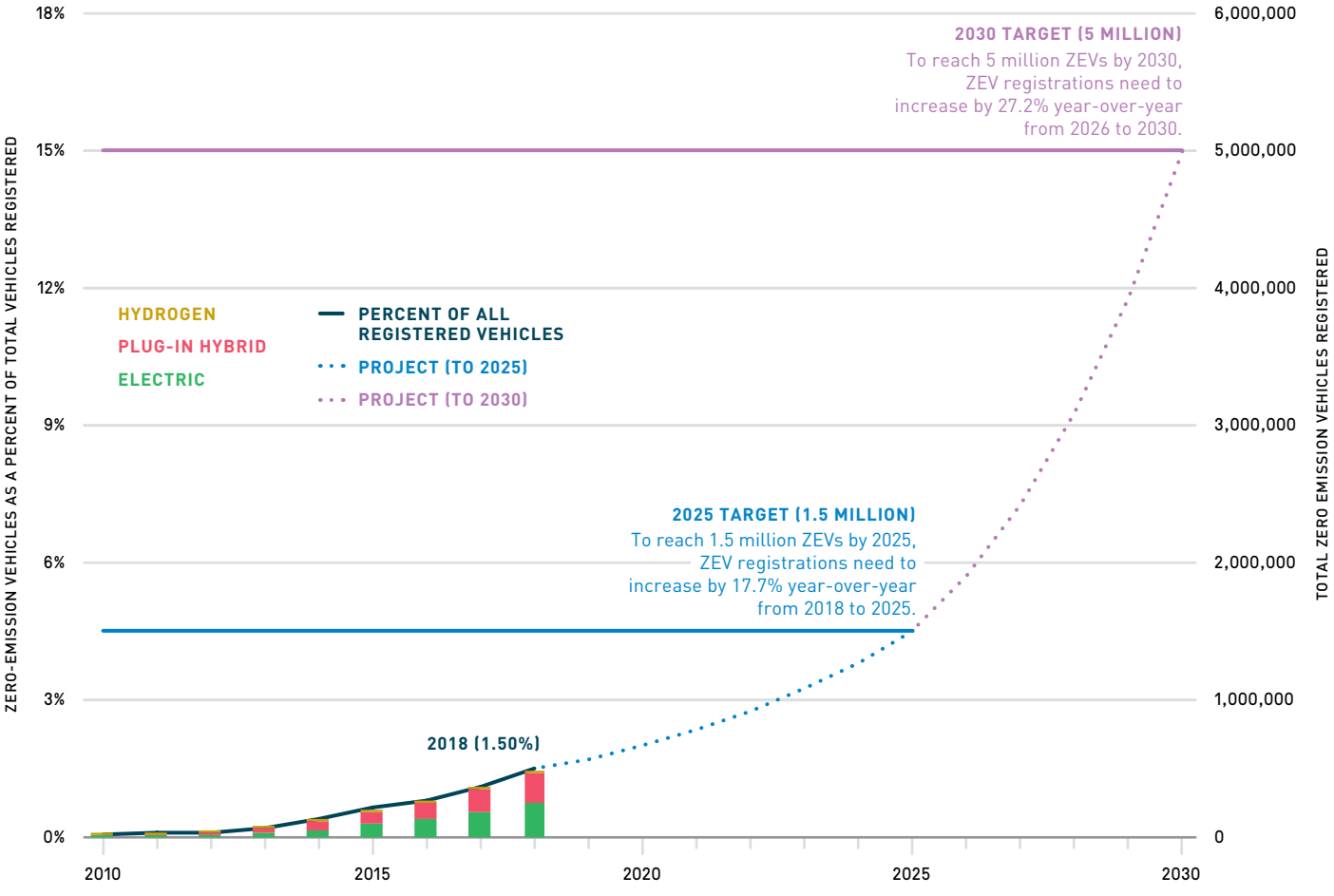
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Zero Emission Vehicles include electric, plug-in hybrid, and hydrogen fuel-cell vehicles. Excludes biofuels. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT:

The number of ZEVs on road, which is just slightly under half a million as of the end of 2018, increased 37.6 percent in 2018 compared to 2017. The percentage increases of ZEVs have held steady for the last three years.

Figure 31. Trends in Total Zero-Emission Vehicle Registrations and Projected Needs to Meet 2025 and 2030 Goals

CALIFORNIA, 2010–2018



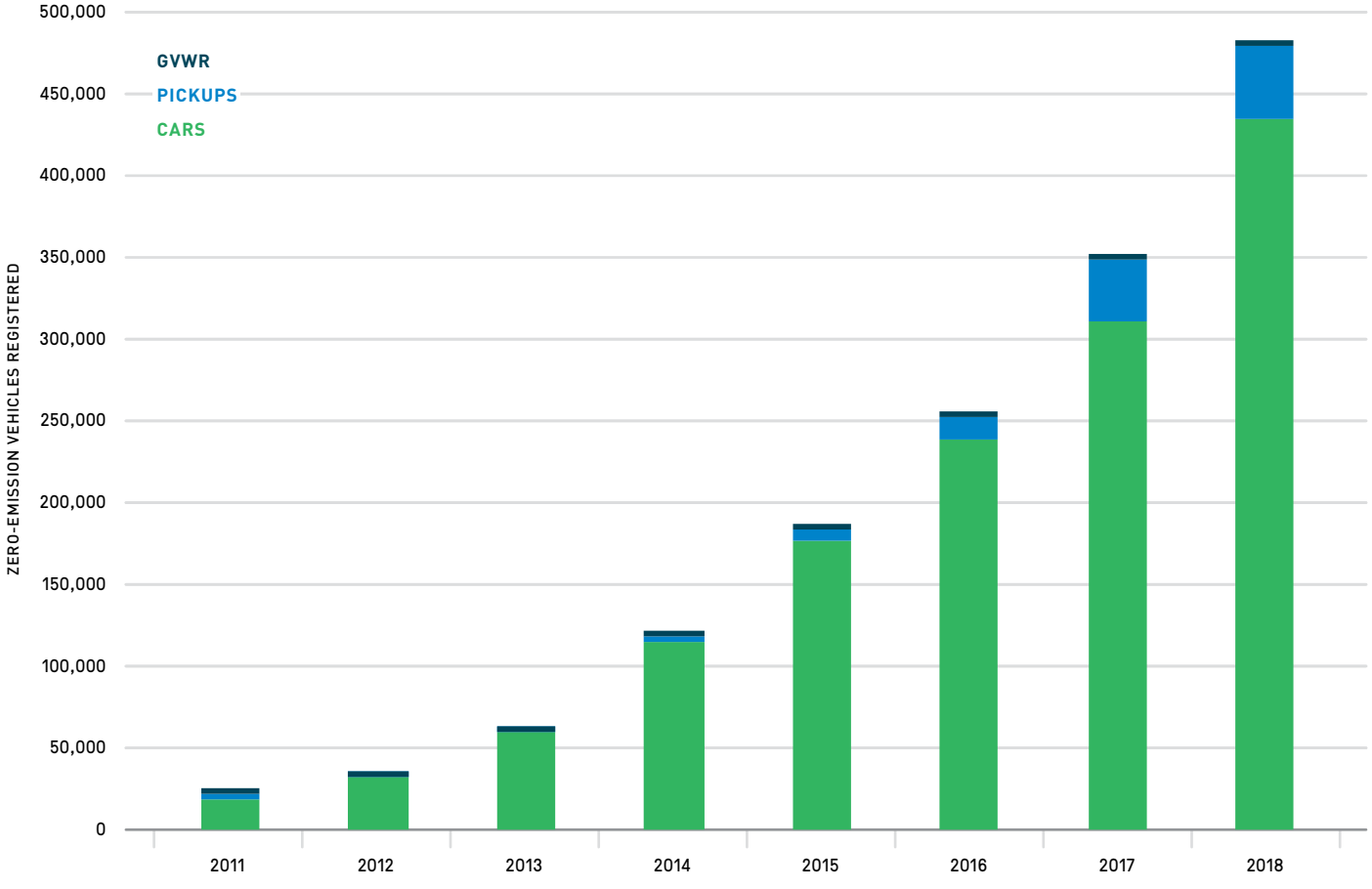
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

OPPORTUNITY:

To reach former Governor Brown's goal of 1.5 million ZEVs on the road in 2025, the number will need to increase by 17.7 percent annually, revised downward from 20.0 percent previously due to a higher growth rate this past year. While the year-over-year growth in ZEVs has been fairly consistent, notable obstacles—particularly waning federal subsidies and lack of charging stations[46]—may impede widespread ZEV adoption. However, there have been moves to help address these challenges at the state level. This year, the CPUC approved or has pending new utility infrastructure programs to expand charging ports for medium and heavy-duty vehicles with other programs that would support more than 50,000 ports[47] and a statewide "Clean Fuel Reward" program was also approved, providing point-of-purchase rebates (funded through LCFS credit proceeds) to help incentivize greater ZEV adoption in the state.[48]

Figure 32. Zero-Emission Vehicle Registrations by Vehicle Class

CALIFORNIA, 2011–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: New light vehicles only and does not include used vehicles and vehicles coming off lease. Cars include subcompact, compact, mid-size, large sedans and sports cars. Light trucks include pickup trucks, mini vans, large vans, and SUVs. GVWR are medium to heavy duty vehicles such as buses, ambulance. ZEVs include battery-electric vehicles, plug-in hybrid vehicles, and fuelcell electric vehicles. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

CHALLENGES:

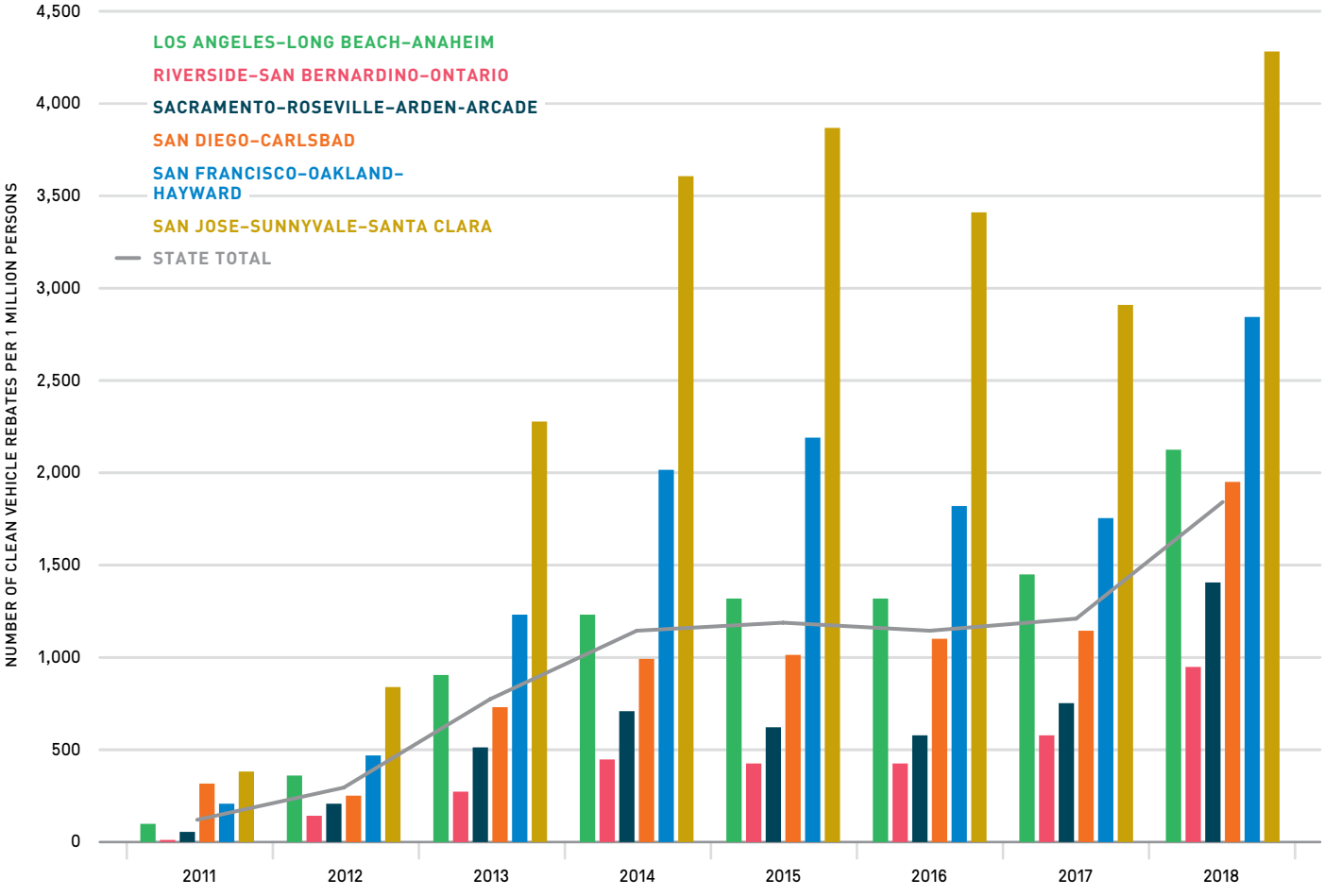
Most of the ZEVs currently on the road are light-duty cars, and while consumer preferences have shifted toward light-duty pickups and SUVs, there are not yet that many ZEV light-duty pickup truck and SUV models on the market. In 2018, registrations of ZEV cars outnumbered that of ZEV pickups by 9.5 to 1. Looking forward, there are several new models that will come online in 2020 and beyond. Many of these models will be SUVs, pickup trucks and crossovers.

OPPORTUNITY:

Electrification of medium and heavy-duty vehicles has been slow, making up just 0.3 percent of all ZEV registrations in 2018. Public transit agencies will do their part by meeting an ARB requirement to electrify all public bus fleets by 2040[49] and further gains could come through pending rate design reforms for commercial EV charging that could support medium and heavy-duty electrification.[50] The Air Resources Board is also currently developing the Advanced Clean Truck rule that will set a manufacturing sales target for zero-emission heavy duty vehicles to ensure they become an increasing percentage of sales from 2024 to 2030.[51]

Figure 33. Clean Vehicle Rebates per 1 Million Persons

SELECTED MSAs AND CALIFORNIA, 2011–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Ceneter for Sustainable Energy; California Air Resource Board Clean Vehicle Rebate Project; Department of Finance. NEXT 10 / SF · CA · USA

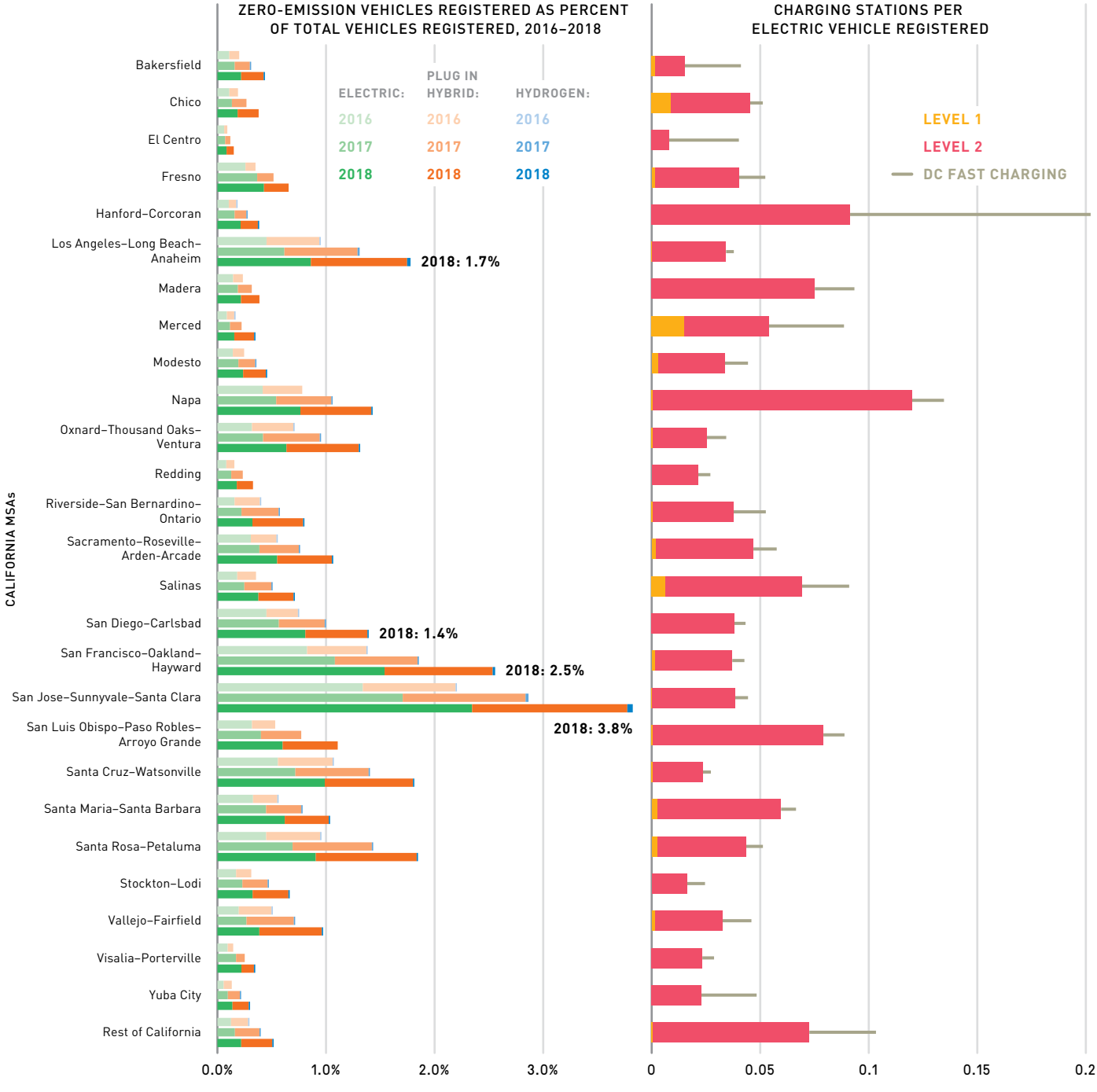
HIGHLIGHT:

Compared to 2017, the number of plug-in hybrid electric vehicle rebates and battery electric vehicle (BEV) rebates increased 39 percent and 67 percent, respectively, in 2018. The jump in BEV rebates is largely due to Tesla Model 3's ramped up production and delivery—clean vehicle rebates of non-Tesla battery-electric vehicles dropped 33 percent from 2017 to 2018.

CHALLENGE:

Even with the income cap and increased rebate amounts for lower-income people, ZEV rebates are still somewhat correlated with income. In 2018, San Jose-Sunnyvale-Santa Clara had the highest number of clean vehicle rebates per 1 million persons (4,268), followed by San Francisco-Oakland-Hayward (2,842) and Santa Rosa-Petaluma (2,400).

Figure 34. Zero-Emission Vehicles



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Vehicle registration as of end of 2018 and charging station data as of June 3, 2019. Not all electric vehicles can handle L3 fast charging (e.g., many plug-in hybrids). Data Source: California Energy Commission; Alternative Fuel Data Center, U.S. Department of Energy. NEXT 10 / SF · CA · USA

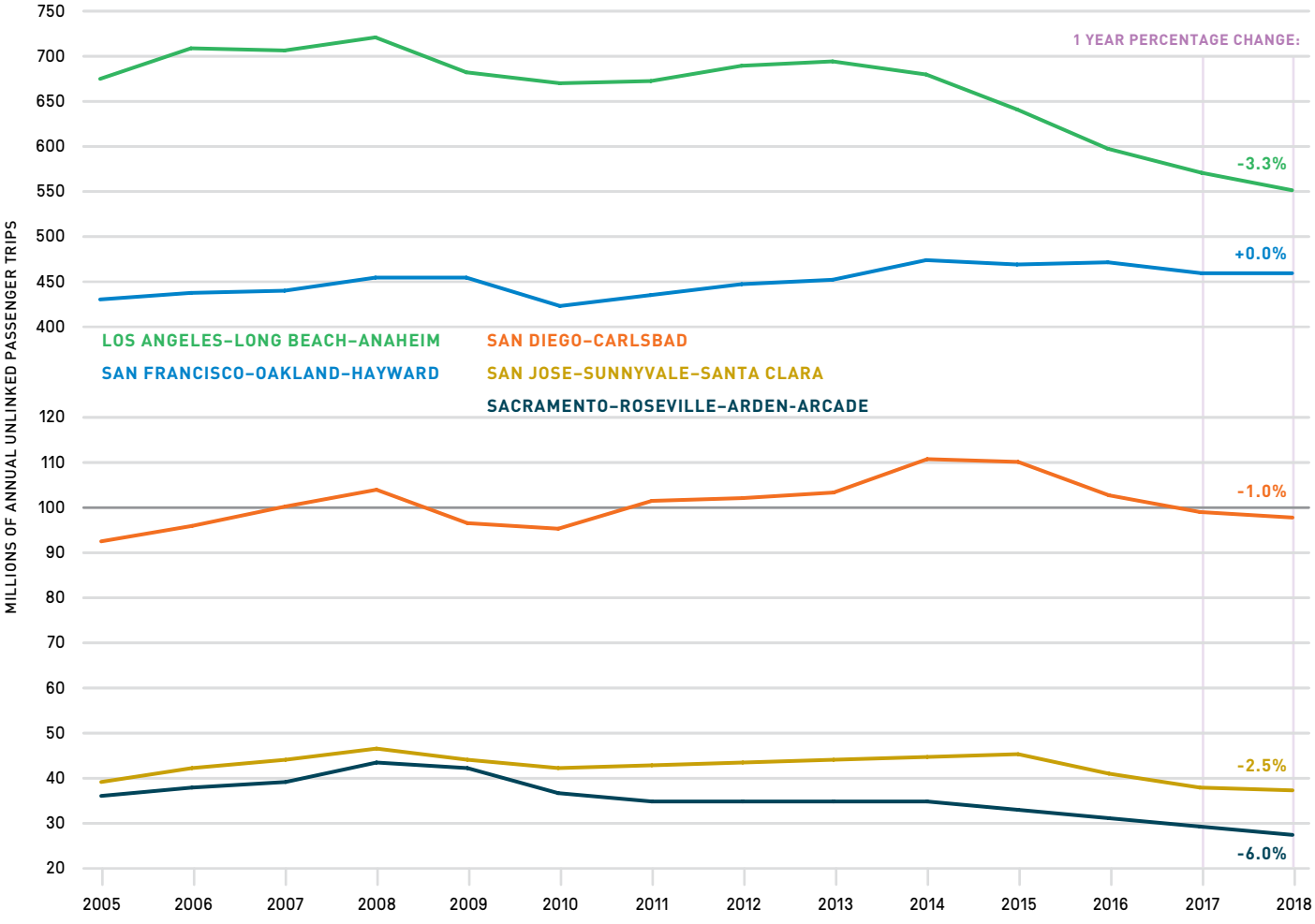
HIGHLIGHT:

The presence of ZEVs varied across the state; ranging from 3.8 percent of total vehicles registered in San Jose–Sunnyvale–Santa Clara to just 0.1 percent in El Centro in 2018. ZEV adoption is the highest in the large Bay Area metro areas, followed by large Southern California metro areas. ZEV penetration is far lower in more rural and less populous metro areas, yet they have a greater number of charging stations per electric vehicle. Napa has 8.3 electric vehicles per charging station, while San Francisco–Oakland–Hayward and San Jose–Sunnyvale–Santa Clara both have one charging station for approximately every 26 electric vehicles.

Public Transit Ridership

Figure 35. Total Annual Unlinked Passenger Trips (in Millions)

TOP 5 CALIFORNIA METRO AREAS BY TOTAL UNLINKED PASSENGER TRIPS, 2005–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: National Transit Database, Department of Transportation. NEXT 10 / SF · CA · USA

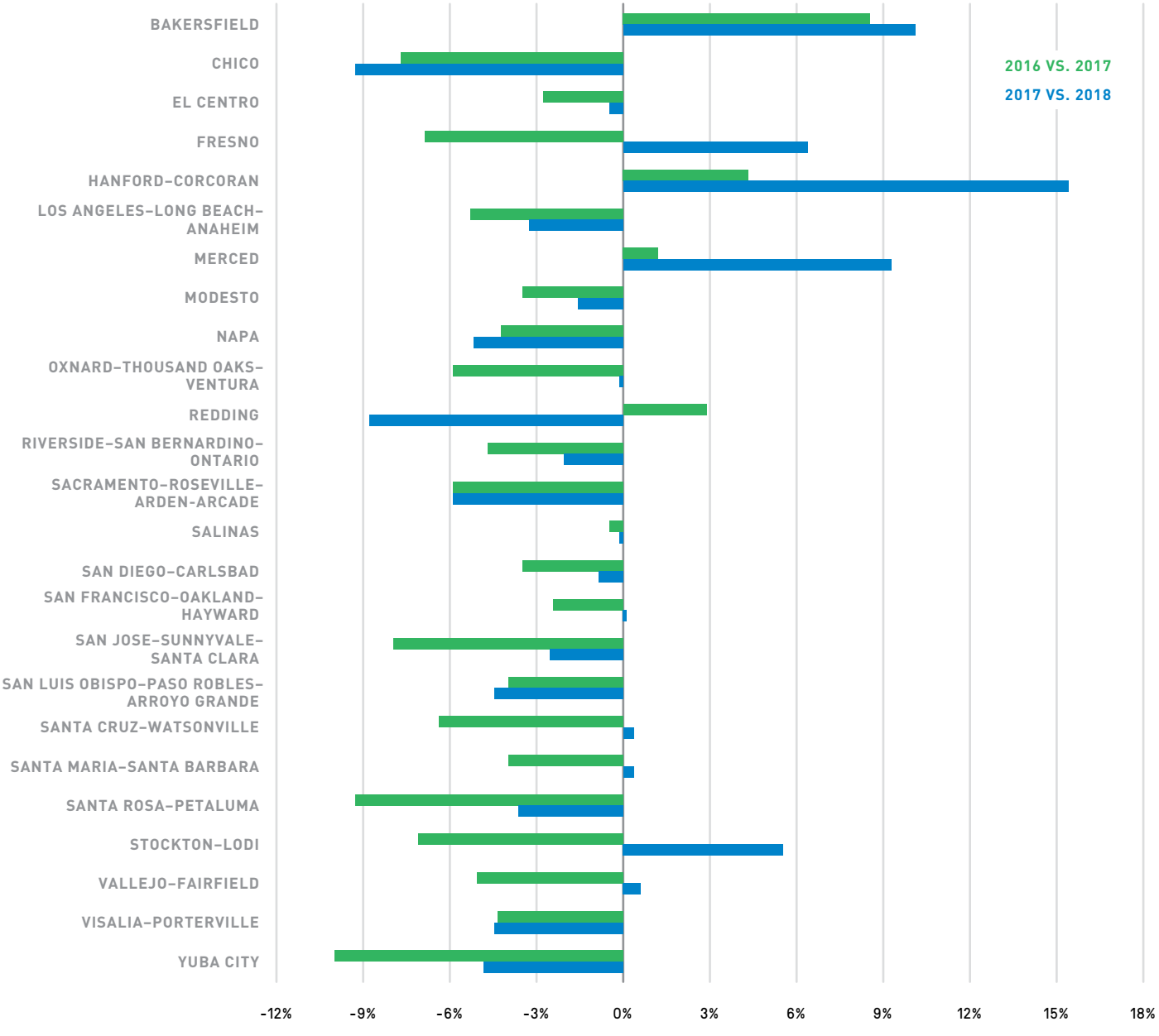
The transportation sector, particularly the light-duty passenger vehicle sub-sector, is one of the largest sources of greenhouse gas emissions in California. For most Californians, cars are the default mode of travel. In Los Angeles, a person who uses public transit solely or in conjunction with walking or biking the "last mile" is responsible for 8 to 21 times less greenhouse gases than those who drive alone, based on life-cycle assessment.[52] Unfortunately, public transit ridership continues its downward trend throughout California.

HIGHLIGHT:

In 2018, total unlinked passenger trips (UPTs, or trips on one transit vehicle, not including connections) have fallen in all top five metro areas except for San Francisco–Oakland–Hayward compared to 2017. UPTs in Sacramento–Roseville–Arden-Arcade MSA declined 6.0 percent, followed by Los Angeles–Long Beach–Anaheim (-3.3%). Together, UPTs in the top five MSAs totaled 1.17 billion in 2018, down 14.4 percent compared to 1.37 billion in 2008.

Figure 36. Change in Total Unlinked Passenger Trips

ALL MODES OF PUBLIC TRANSIT, 2016–2018



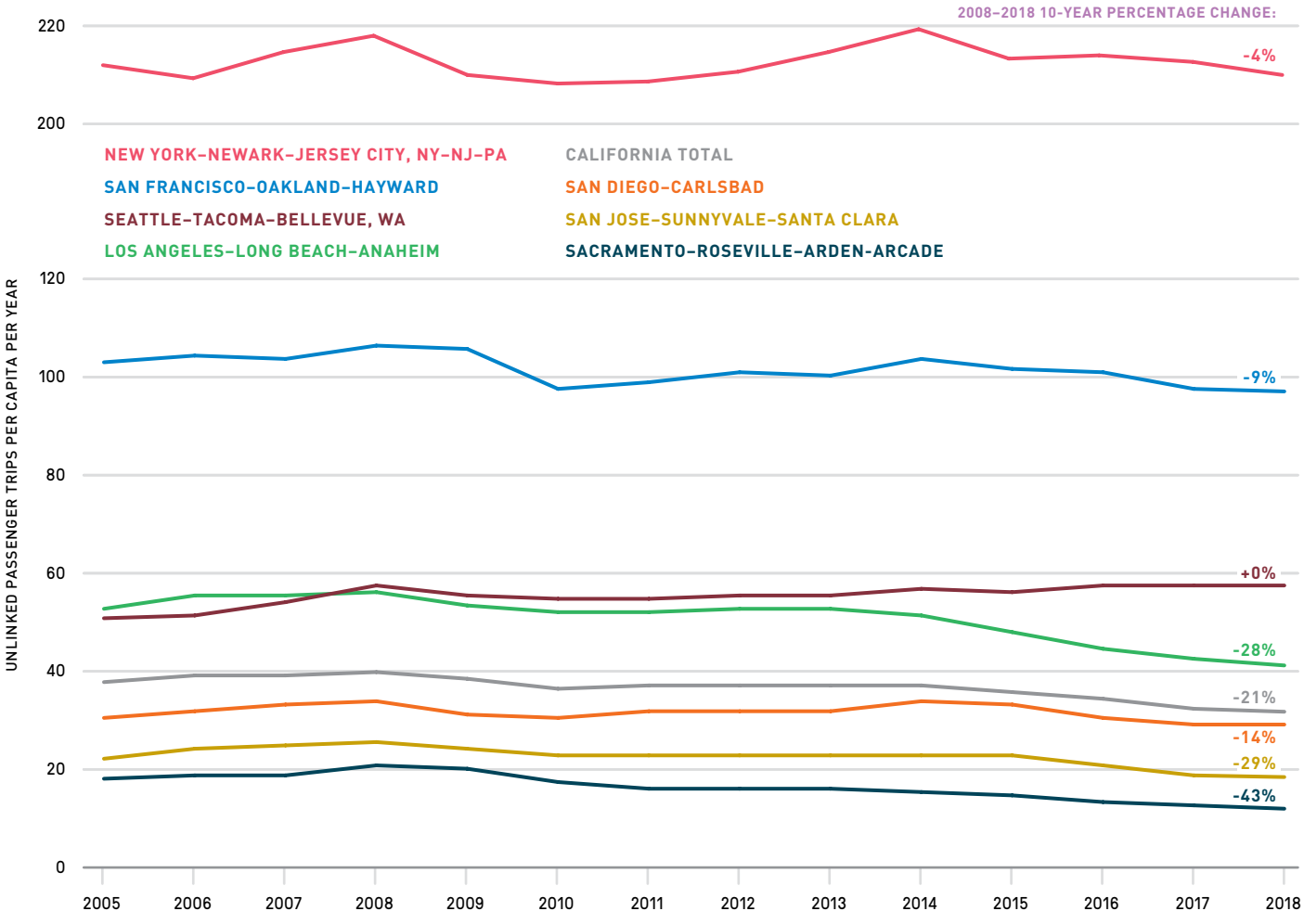
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Data for Madera MSA not available. Data Source: National Transit Database, Department of Transportation. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Of the 26 MSAs in California, only five recorded significantly higher total UPTs in 2018 than in 2017 and they are all in more rural areas of the state. Hanford–Corcoran leads the pack with a 15.4 percent yearly increase, followed by Bakersfield (+10.0%) and Merced (+9.2%). These three MSAs are also the only MSAs where public transit ridership was also higher the previous year.

Figure 37. Unlinked Passenger Trip per Capita, All Modes of Public Transit

SELECTED LARGE CALIFORNIA MSAs, SEATTLE, AND NEW YORK CITY MSAs, 2005–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: National Transit Database, Department of Transportation; California Department of Finance; U.S. Census Bureau. NEXT 10 / SF · CA · USA

CHALLENGE:

Public transit ridership per capita is falling everywhere in the U.S.—and California is no exception. The Los Angeles metro area, the largest in California by population, saw ridership per capita decline by 28 percent from 2008 to 2018. The New York metro saw a mild decline (-4%), while Seattle metro's ridership has held mostly steady. The standard factors that affect people's commuting preferences, such as increased income, better job prospects, lower gasoline prices, and increasing automobile ownership, offer partial explanations for the decline in ridership.[53] Other explanations include rising rents pushing transit patrons into outlying areas where public transit is no longer feasible. The decline, which is more pronounced in recent years, also coincides with the rise of ride-hailing services such as Uber and Lyft, which may have indicated have also contributed to reduced ridership.[54]

OPPORTUNITY:

Last year, Senate Bill 1014 was passed, establishing the Clean Miles Standard for transportation networked companies (TNCs) like Uber and Lyft. This bill requires all TNCs to work with ARB to, by January 2020, establish a baseline for passenger-miles traveled by zero-emissions means (including ZEVs, walking, biking, and other modes of active transportation) and set goals to increase the amount of zero-emission passenger miles.[55] This measure could result in increased ZEV adoption by TNC drivers, but could also have positive impacts for public transit links and forms of active transportation.

Energy Productivity

- Over the past five years, California's energy productivity–which measures GDP relative to energy consumption–grew at a pace of **3.1 percent each year** (average annualized growth rate), far outpacing the 1.7 percent annual improvement rate for rest of the U.S.
- While California's energy productivity **outpaces the U.S. average,** improvements will be necessary in order to meet the goal set by President Obama in 2013 to double energy productivity by 2030.[57]

Energy

California has a long history of leading on energy efficiency. Since 1990, the state has **reduced its per capita energy consumption by 10.2 percent** and kept its per capita electricity consumption essentially flat over the last 40 years, while per capita electricity consumption continued to rise across the rest of the country.[56]

Despite these gains over the long term, both total energy consumption and per capita energy consumption increased in California from 2015 to 2016 (the latest year for which data are available), largely the result of **increased energy usage in the transportation sector.**

Energy Consumption

- For the second year in a row, both total energy consumption and per capita energy consumption have **increased in California.** Consecutive increases in energy consumption and per capita energy consumption have not happened since 2002 and 1998, respectively.
- Driven by low fuel prices, the **transportation sector is the main contributor** to the increase in both total energy consumption and per capita energy consumption.

Energy Intensity

- The transportation sector is the only sector where **energy intensity increased year-over-year** from 2015 to 2016 (+0.4%), while the largest decrease was in the industrial sector (-2.8%).
- Overall, energy intensity in the transportation sector **fell 20 percent** from 2006 to 2016—roughly in line with all other sectors—while the largest decrease was in the residential sector (-20.9%).

Efficiency

Electricity Consumption

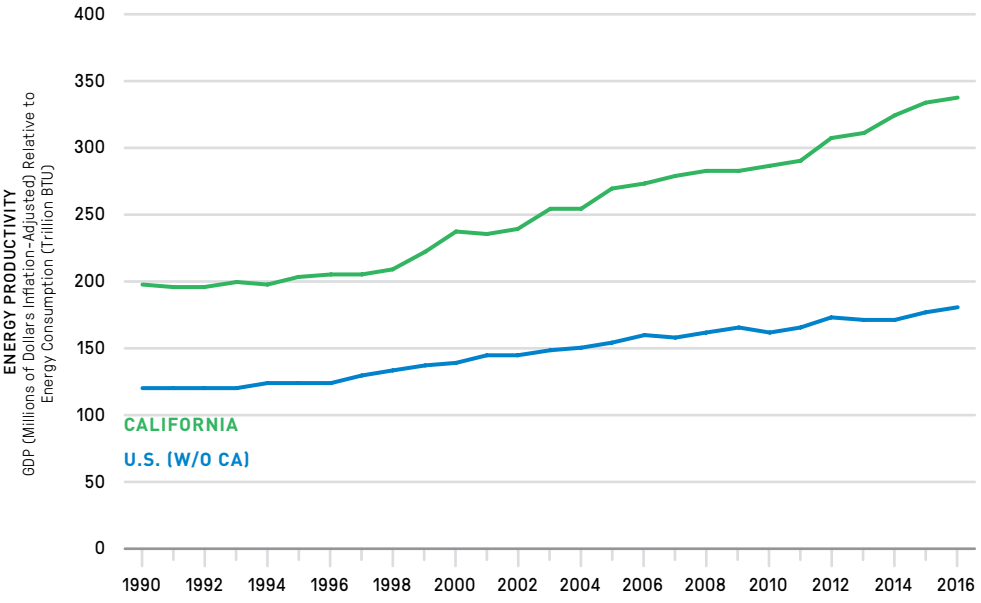
- Electricity consumption reached new highs in the residential and agricultural sectors in 2017. Electricity consumption in the residential sector **grew by 4.3 percent**—driven in part by an increase in plug-in electronic devices and EVs—and **by 2.9 percent** in the agricultural sector from 2016 to 2017. Total electricity consumption in 2017 reached highs not seen since 2008 at the start of the Great Recession.
- California has among the **lowest per capita electricity consumption** among the selected large states, along with New York. Unlike New York, however, in which per capita consumption has held steady, it continues to decrease in California.

Electricity Bill

- California has one of the **lowest per capita electricity bills** compared to other states, but the electricity bill per capita in 2017 is higher than that of 2016 due to electricity costs per kilowatt-hour.
- California's monthly residential and industrial electricity bills are **lower than the U.S.'** but its commercial electricity bill is higher than the U.S. average.

Figure 38. Energy Productivity (GDP Relative to Total Energy Consumption)

CALIFORNIA & THE REST OF THE U.S., 1900–2016



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis. NEXT 10 / SF · CA · USA

HIGHLIGHT:

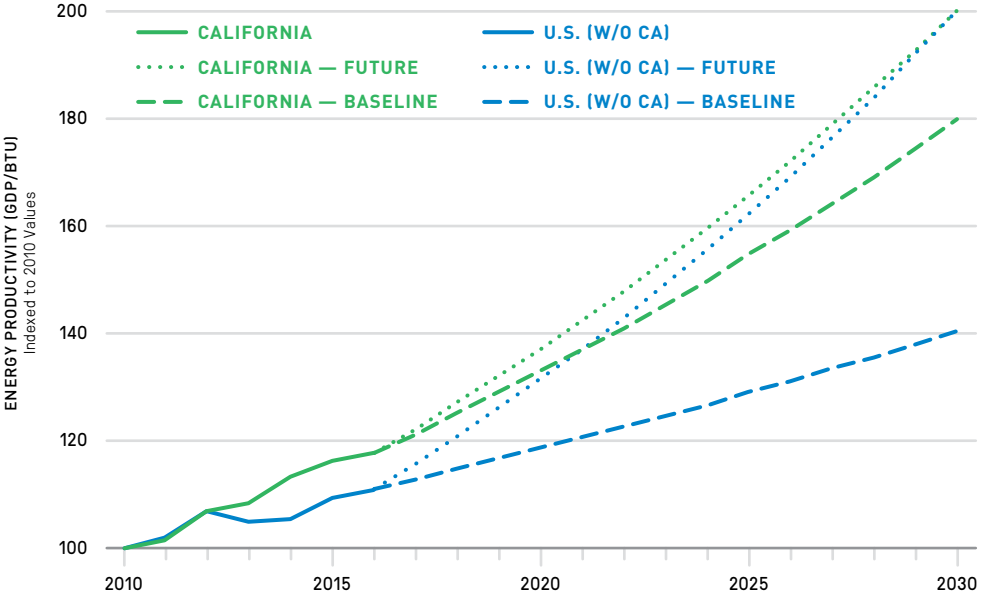
In 2016, California generated $3.38 of GDP (inflation-adjusted) for every 10,000 units of energy consumed, while the rest of the U.S. generated $1.80 for the same amount of energy consumed. Over the past five years, California's energy productivity grew at a pace of 3.1 percent compounded average growth rate (CAGR) compared to the 1.7 percent CAGR for rest of the U.S.

CHALLENGE:

Energy productivity grew a modest 1.1 percent in 2016 in California, the lowest since 2010, primarily due to an increase in energy consumption. To double energy productivity by 2030 relative to 2010 levels, California would need to increase its CAGR in energy productivity from 3.1 to 3.9 percent (for the U.S., from 1.7% to 4.3%).

Figure 39. Energy Productivity Since 2010 and Progress Towards Accelerate Energy Productivity

CALIFORNIA & THE REST OF THE U.S.



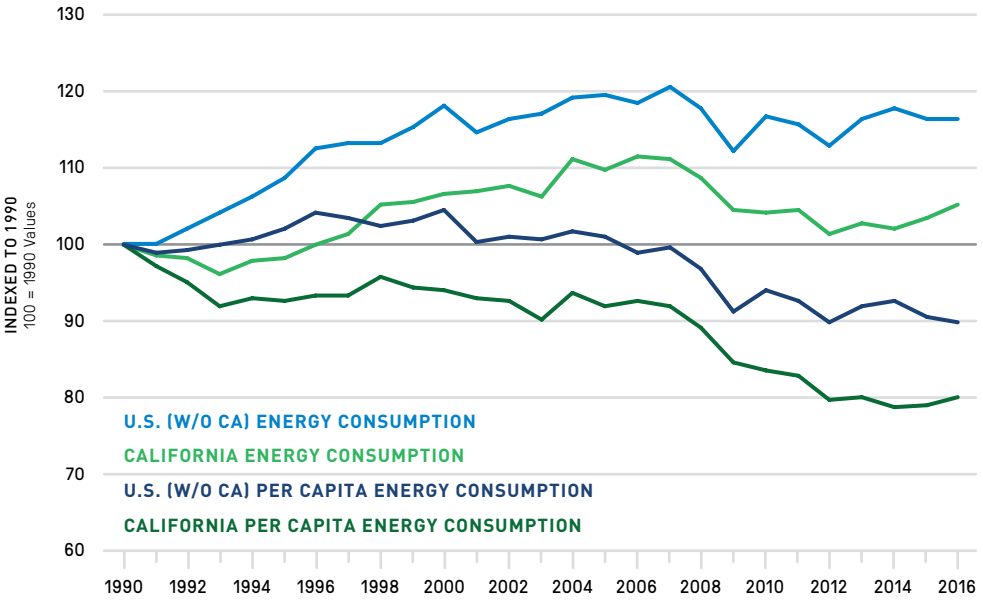
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis. NEXT 10 / SF · CA · USA

CHALLENGE:

At the current pace, energy productivity would be 79 percent higher in 2030 than it was in 2010. In 2013, President Obama called for doubling energy productivity by 2030 and soon after, an initiative called Accelerate Energy Productivity was launched between the U.S. Department of Energy, the Council on Competitiveness and the Alliance to Save Energy to help meet that goal.[58] Based on the current trajectory of energy productivity gains, the U.S. will fall slightly short of that goal.

Figure 40. Total and Per Capita Energy Consumption Relative to 1990

CALIFORNIA & THE REST OF THE U.S., 1990–2016



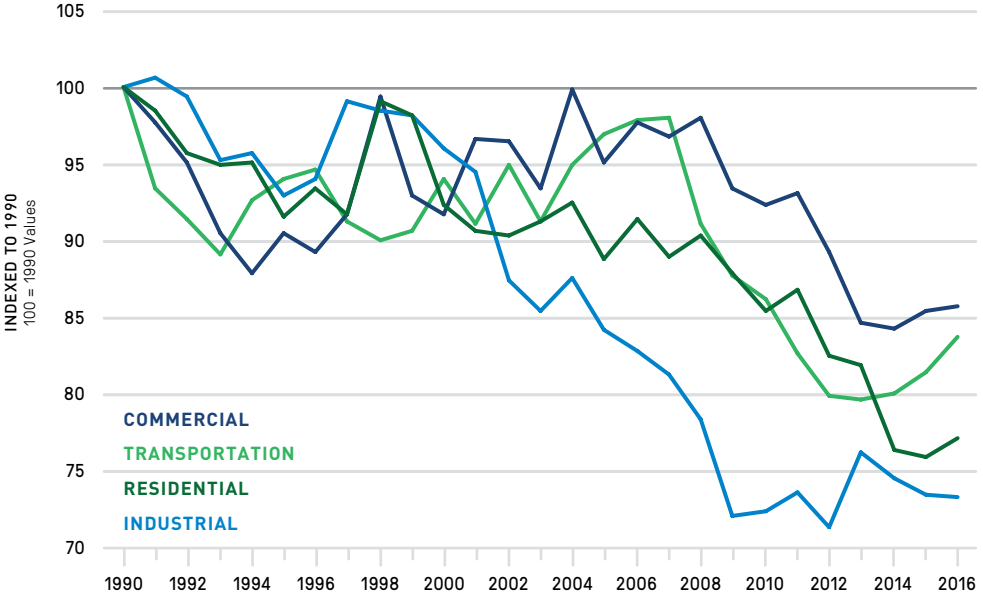
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Census Bureau, Population Estimates Branch. NEXT 10 / SF · CA · USA

CHALLENGE:

For a second year in the row, both total energy consumption and per capita energy consumption have increased in California. This is a phenomenon not seen since 2002 and 1998, respectively. Meanwhile, total energy consumption and per capita energy consumption decreased 0.3 percent and 0.9 percent, respectively, in the rest of the U.S., from 2015 to 2016.

Figure 41. Energy Consumption Per Capita by Sector Relative to 1990

CALIFORNIA, 1990–2016



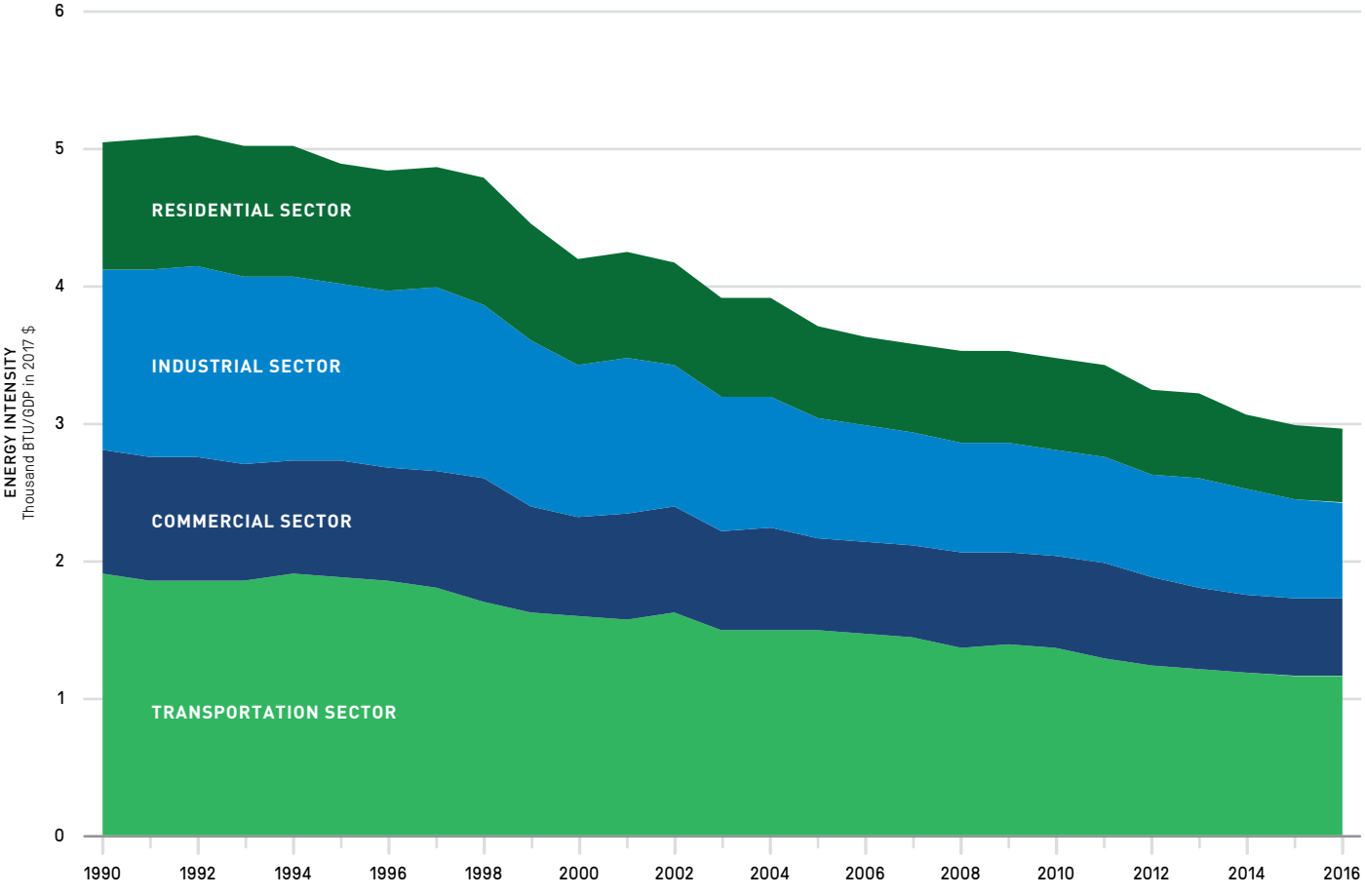
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Census Bureau, Population Estimates Branch. NEXT 10 / SF · CA · USA

CHALLENGES:

❶ The transportation sector is the main contributor to the increase in both total and per capita energy consumption. Total energy consumed by the transportation sector increased 3.4 percent year over year, while state population increased by only less than half of a percent. As a result, per capita energy consumed by the transportation sector increased 3.0 percent from 2015 to 2016—a percentage gain level not seen since 2004. ❷ Only the industrial sector recorded a per capita year-over-year percentage decrease (-0.3%), while the other sectors all recorded an increase: transportation (+3.0%), residential (+1.6%), and commercial (+0.4%). This is the first time since 2011 that at least three out of the four sectors have recorded a per capita energy consumption increase.

Figure 42. Energy Intensity

TOTAL ENERGY CONSUMPTION BY SECTOR RELATIVE TO GDP, CALIFORNIA, 1990–2016



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis.
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HIGHLIGHT:

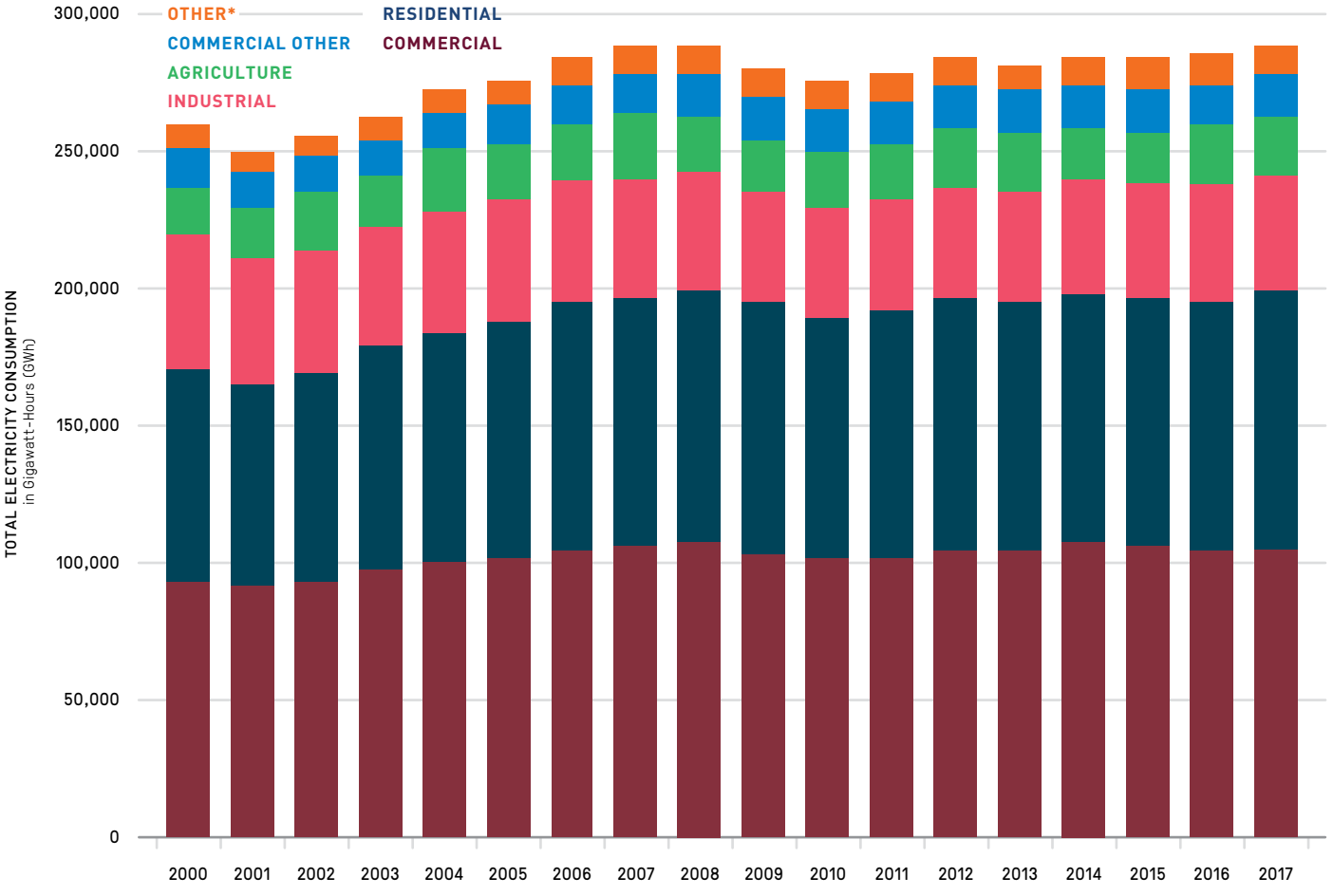
In 2016, energy intensity decreased by 1.1 percent compared to 2015, which was driven by a 2.8 percent reduction in the industrial sector and a 2.0 percent decrease in the commercial sector.

OPPORTUNITY:

The transportation sector is the only sector where energy intensity increased year-over-year (+0.4%), but overall, energy intensity in the transportation sector fell 20 percent from 2006 to 2016—which is in line with all other sectors. As the state works to meet its ambitious zero-emission vehicle (ZEV) goals (including having five million ZEVs on the road by 2030), energy intensity in the transportation sector should decrease as ZEVs begin to replace more energy-intensive vehicles on the road.

Figure 43. Total Electricity Consumption by Sector

CALIFORNIA, 2000–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. *Other includes Street Lighting and Mining. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT:

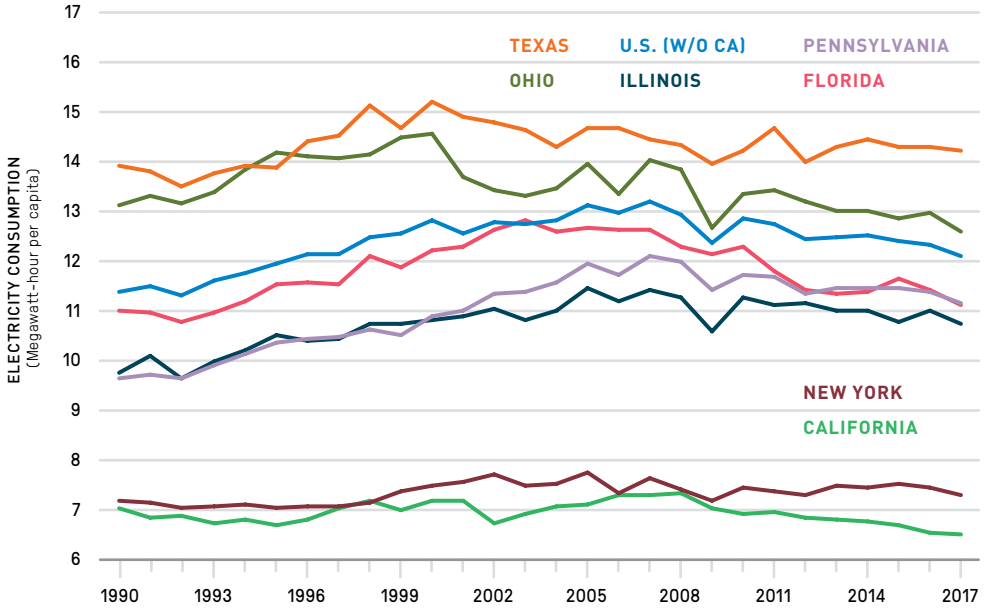
Electricity consumption reached a new high in the residential and agricultural sectors in 2017. Total electricity consumption increased by almost 4,000 gigawatt-hours, or 1.3 percent of the total, and the residential sector alone accounted for almost all the increase. After hovering around 90,000 gigawatt-hours per year since 2006, electricity consumption in the residential sector reached a total of 94,495 gigawatt-hours of electricity in 2017, a 4.3 percent spike. According to the CEC, increases in residential electricity consumption may be in part attributed to steady growth in "plug-in" appliances including cell phones and other electronics, and has also been bolstered by EVs.[59] Despite overall increases in electricity consumption, per capita consumption does trend downward over time.

OPPORTUNITY:

California has ambitious goals for reducing emissions from buildings, which represent a quarter of the state's greenhouse gas emissions, more than two-thirds of which come from burning gas for heating and cooking. Under Senate Bill 350, the state is required to double the efficiency of the state's buildings based on a 2010 baseline by 2030.[60] Building electrification—moving from fossil fuel appliances to efficient electric appliances powered by clean energy—has emerged as the lowest-cost, lowest-risk pathway to achieving lower emissions in buildings.[61] In response, more than fifty local governments in California are considering or have passed ordinances or updated building codes to prioritize all-electric new construction. In July, Berkeley became the first city in the nation to ban gas hookups in new construction, for health, safety and climate reasons.[62]

Figure 44. Statewide Electricity Consumption per Capita

CALIFORNIA, FLORIDA, ILLINOIS, NEW YORK, OHIO, PENNSYLVANIA, TEXAS, & U.S. WITHOUT CALIFORNIA, 1990–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Department of Energy, Energy Information Administration; U.S. Census Bureau. NEXT 10 / SF · CA · USA

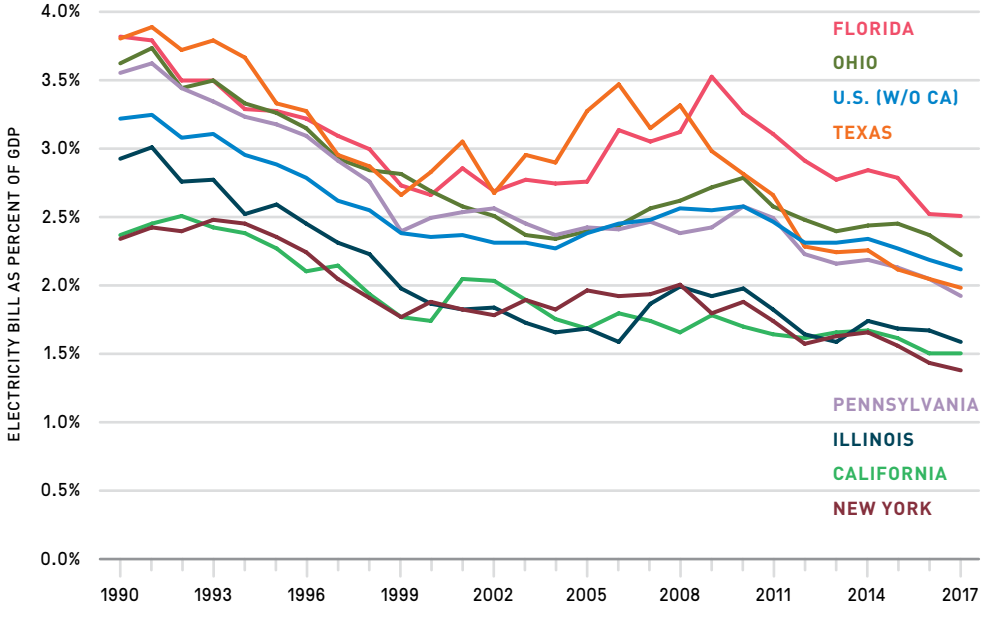
HIGHLIGHT:

California, along with New York, has one of the lowest per capita electricity consumption rates among the selected large states (those states with the largest populations). While New York's per capita electricity consumption has been steady around 7.2 to 7.5 MWh/person since the Great Recession, California's per capita consumption continues to fall to 6.5 MWh/person—despite the recent slight uptick in total consumption.

Electricity Bill

Figure 45. Statewide Electricity Bill as a Percent of GDP

CALIFORNIA, FLORIDA, ILLINOIS, NEW YORK, OHIO, PENNSYLVANIA, TEXAS, & U.S. WITHOUT CALIFORNIA, 1990–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Department of Energy, Energy Information Administration; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Despite a higher electricity cost than other states, electricity bills with respect to the state's GDP are generally lower in California than most other states due to lower per capita electricity consumption. However, 2017's electricity bill per capita is higher than that of 2016, reflecting the higher overall and per capita consumption discussed previously.

CHALLENGE:

In 2017, electricity bills accounted for 1.5 percent of California's GDP, compared to 2.1 percent in the rest of the U.S. While electricity bills are still declining in California, the rate of change has slowed—especially compared to New York, which also has low electricity bills as share of state GDP.

Table 2. Electricity Prices and Bills (Inflation-Adjusted) by Sector

CALIFORNIA AND THE REST OF THE U.S.

	REGION	PRICE PER kWh	AVERAGE MONTHLY BILL		
		2017	2007	2017	10YR % CHANGE
RESIDENTIAL	CALIFORNIA	$0.18	$98.83	$101.49	2.7%
	FLORIDA	$0.12	$154.24	$126.44	-18.0%
	ILLINOIS	$0.13	$94.59	$89.63	-5.2%
	NEW YORK	$0.18	$122.07	$103.22	-15.4%
	OHIO	$0.13	$104.74	$106.13	1.3%
	PENNSYLVANIA	$0.14	$113.08	$114.48	1.2%
	TEXAS	$0.11	$165.70	$122.47	-26.1%
	UNITED STATES	$0.13	$117.87	$111.67	-5.3%
INDUSTRIAL	CALIFORNIA	$0.13	$6,322.99	$3,490.99	-44.8%
	FLORIDA	$0.08	$5,163.17	$5,086.21	-1.5%
	ILLINOIS	$0.06	$50,209.42	$40,725.23	-18.9%
	NEW YORK	$0.06	$13,517.74	$12,568.45	-7.0%
	OHIO	$0.07	$15,751.95	$15,641.09	-0.7%
	PENNSYLVANIA	$0.07	$11,803.25	$11,887.05	0.7%
	TEXAS	$0.05	$4,931.36	$4,661.05	-5.5%
	UNITED STATES	$0.07	$8,155.70	$6,712.72	-17.7%
COMMERCIAL	CALIFORNIA	$0.16	$874.64	$911.53	4.2%
	FLORIDA	$0.09	$806.72	$608.19	-24.6%
	ILLINOIS	$0.09	$758.97	$618.88	-18.5%
	NEW YORK	$0.15	$1,146.95	$849.57	-25.9%
	OHIO	$0.10	$675.10	$616.53	-8.7%
	PENNSYLVANIA	$0.09	$645.75	$456.53	-29.3%
	TEXAS	$0.08	$760.46	$624.56	-17.9%
	UNITED STATES	$0.11	$730.79	$654.71	-10.4%
	REGION		GDP IN MILLIONS		
			2007	2017	10YR % CHANGE
GROSS DOMESTIC PRODUCT (MILLIONS OF 2017 DOLLARS)	CALIFORNIA		$2,301,358	$2,746,873	19.4%
	FLORIDA		$924,593	$967,337	4.6%
	ILLINOIS		$780,400	$820,362	5.1%
	NEW YORK		$1,372,302	$1,547,116	12.7%
	OHIO		$589,980	$649,127	10.0%
	PENNSYLVANIA		$659,446	$752,071	14.0%
	TEXAS		$1,301,069	$1,696,206	30.4%
	UNITED STATES		$17,047,881	$19,263,350	13.0%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Department of Energy, Energy Information Administration; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

HIGHLIGHT:

In 2017, California's average monthly residential and industrial electricity bills were 9.1 percent and 48.0 percent lower than the U.S., respectively.

CHALLENGE:

To achieve its goals of greater electrification, California will need to ensure affordable electricity rates and bills moving forward. Over the 2007 to 2017 10-year period, California's monthly bill in the residential sector increased 2.7 percent, while the U.S. average bill decreased 5.3 percent, adjusted for inflation. The monthly commercial electricity bill was 39.2 percent higher in California than the U.S. in 2017 and from 2007 to 2017, California's commercial electricity bill increased 4.2 percent, while the U.S.' decreased 10.4 percent, adjusting for inflation.

California has set ambitious goals for increasing its share of electricity from renewable sources, including a target set in 2018 to get 100% of the state's electricity from zero-carbon energy sources by 2045. And the state is well on its way: 2017 marked **the first time that a greater share of California's power mix came from renewable sources than it did from fossil fuel sources.**

Renewable

Renewable Portfolio Standards (RPS)

- At current pace of growth, California **should meet the 50 percent and 60 percent RPS goals** on time–by 2026 and 2030, respectively–with relative ease.
- The pace of renewables portfolio standard (RPS) projects coming online appears to have **flattened in recent years,** but not necessarily because of waning progress as the investor-owned utilities already surpassed the 2020 RPS goal of 33 percent in 2018.[63]
- Through the end of 2018, the cumulative operational and in-development capacity of RPS projects was **66,203 gigawatt-hours per year** (GWh/year), the equivalent of over eight million homes' electricity use for one year.

Solar and Wind Installations

- Interconnected solar installations peaked in 2016, with smaller annual capacity installed in 2017 and 2018. This is to be expected as the solar market nears maturity, and the cumulative capacity is at an **all-time high of nearly 7,000 megawatts** (MW) installed.
- As of the end of 2018, California accounted for **44 percent** of all small-scale solar photovoltaic (PV) net generation in the U.S. Small scale-solar PV generation increased 23 percent from 2017 to 2018 in both California and the rest of U.S.
- In California, cumulative installed wind capacity totaled **5,840 MW** in 2017 and has remained largely stagnant since 2012. Cumulative installed wind capacity continues to expand at a steady rate in the rest of the U.S.

Renewable Electricity Generation and Power Mix

- The share of the state's total energy generation from renewable sources continues to increase at a remarkable pace, **increasing from 25.5 percent in 2016 to 29.0 percent in 2017.**
- Between 2012 and 2017, solar accounted for just over **70 percent of the growth** in electricity generation from renewable sources, while generation from biomass and geothermal decreased slightly (-1%) and generation from wind increased more modestly (+22%).
- For the first time in 2017, the share of renewables including large hydroelectric (43.7%) **collectively made up a greater share** of the state's power mix than that of fossil fuels (38%), which includes coal, oil, and natural gas. In 2007, fossil fuels accounted for 62 percent of the state's power mix and renewables including large hydroelectric were 23 percent.
- Between 2007 and 2017, generation from coal **decreased 76 percent** while solar **increased over 4,000 percent.**
- In 2017, **26.5 percent** of California's net in-state generation came from renewable sources (up from 25.2% in 2016), the 8th-highest in the nation and down one spot compared to 2016. California has the largest share of solar (11.8%), while Iowa has the largest share of wind (36.9%).

Energy

Energy Storage

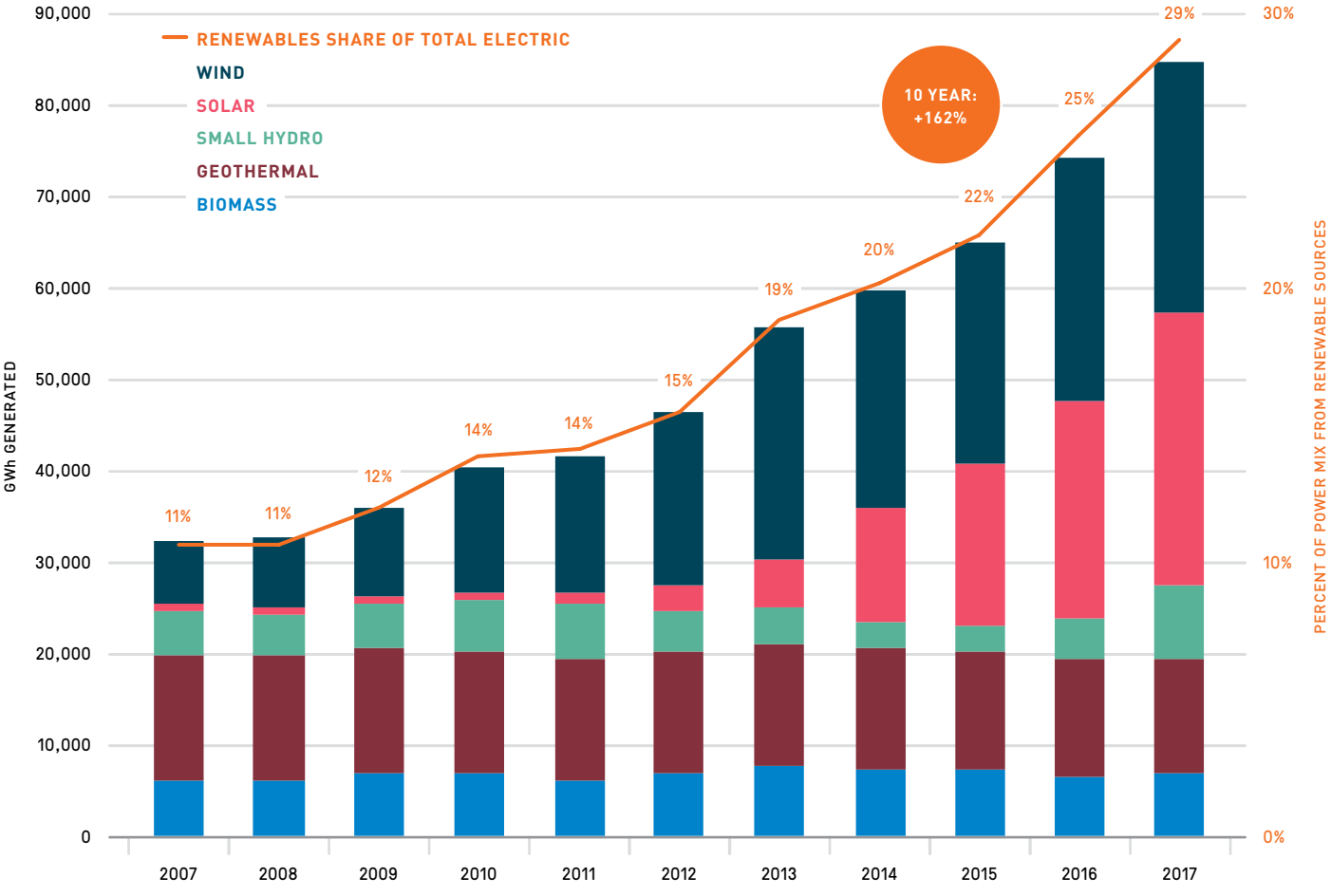
- Under California's landmark 2010 energy storage procurement mandate (AB 2514), investor-owned utilities have **met the 2020 procurement target of 1,325 MW a few years early**—but more will need come online in order to hit the 2024 target of 1,325 MW energy storage capacity installed.
- Lithium-ion batteries are by far the largest share of new energy storage procured under AB 2514, making up **over 75 percent of the storage capacity** procured to meet the target. Behind-the-meter battery storage is the second largest in terms of storage procured under the mandate.

Community Choice Aggregators (CCAs)

- Community Choice Aggregators are poised to become more commonplace. Estimated annual load reached **24,346 gigawatt-hours** (GWh) in 2018, almost doubling the annual load of 12,304 GWh in 2017.
- The California Public Utilities Commission (CPUC) expects CCAs—in combination with direct access providers and rooftop solar—to serve over **85 percent** of IOUs current customers by the mid-2020s.
- While CCAs are quickly growing, they still have a way to go to ensure they can procure adequate levels of resources to provide long-term reliability of clean energy on the grid. The CPUC states that statewide, CCAs would have to procure **roughly twice** of what they have procured to-date by 2022 and close to **six times** as much by 2030 in order to meet our clean energy and climate goals.

Figure 46. California Renewable Electricity Generation

GIGAWATT-HOURS BY SOURCE, 2007–2017



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

HIGHLIGHT:

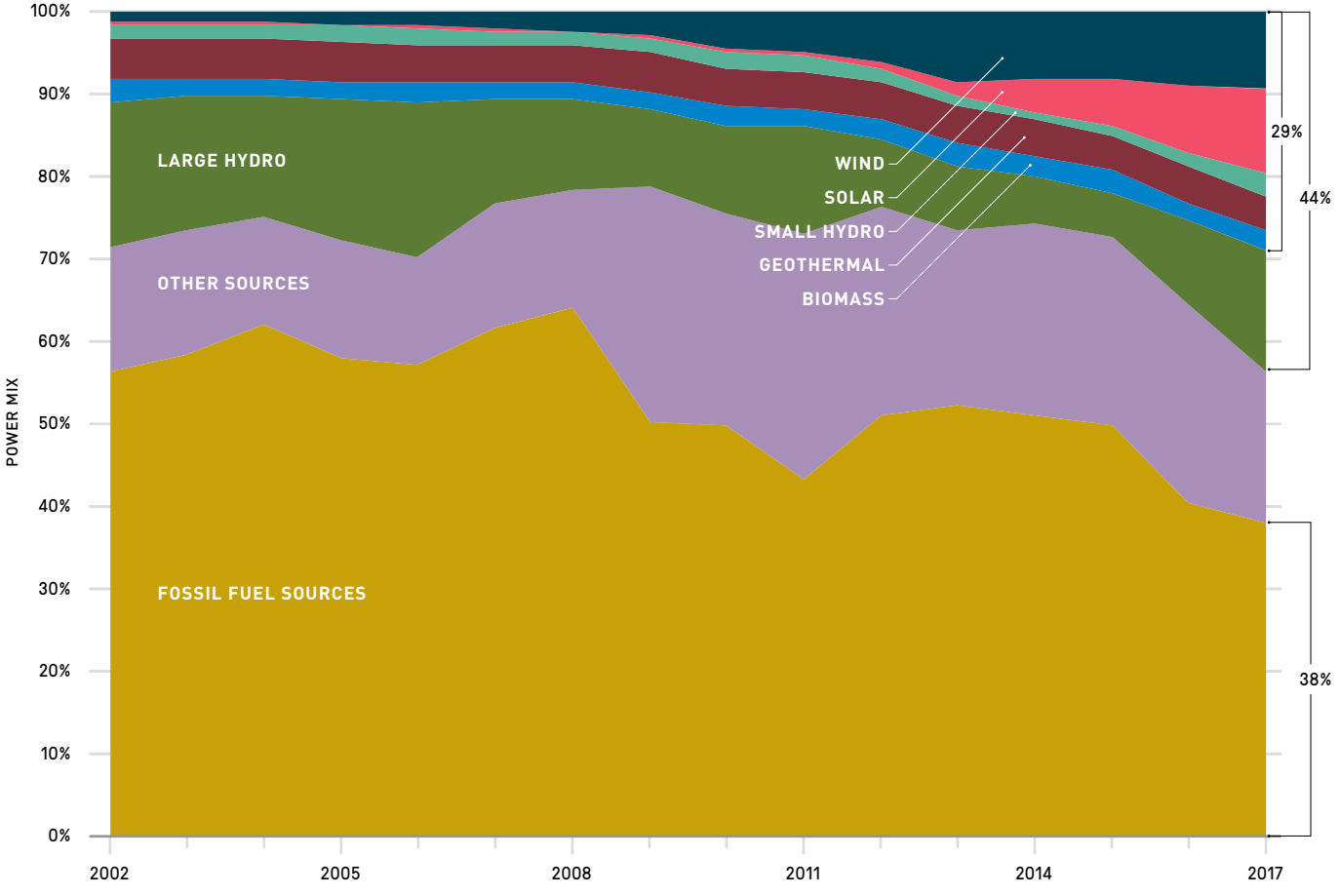
For the first time, solar has surpassed wind as the largest renewable source, making up 10.2 percent of the state's total power mix compared to 9.4 percent for wind. As the state recovered from drought, the share from small hydro has increased from 0.9 percent in 2015 to 2.7 percent in 2017.

CHALLENGE:

While the current mix of renewables is diverse, solar accounted for over 70 percent of the state's increased renewable energy from 2012 to 2017. Generation from biomass and geothermal remain stagnant, and wind demonstrated a smaller increase in generation (+22%). To meet more ambitious RPS goals, the state will need to further diversify sources to avoid over reliance on solar.

Figure 47. California Power Mix Percentage by Source

2002–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Fossil Fuel Sources = Coal, Oil, and Natural Gas; Other Sources = Nuclear, Unspecified, and Other. Data Source: California Energy Commission.
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HIGHLIGHT:

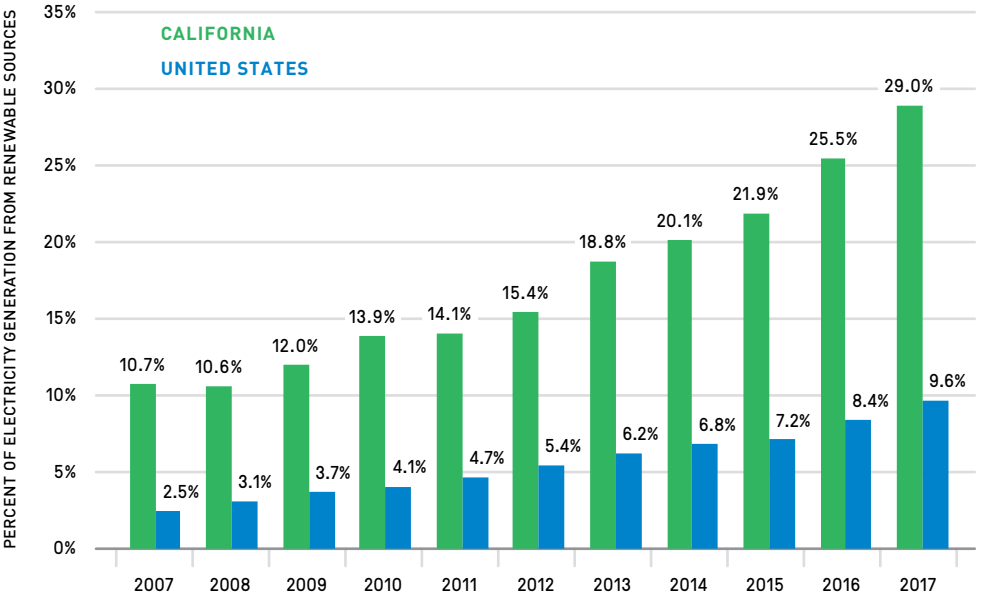
Hydroelectric, solar, and wind generation are increasingly displacing natural gas. 2017 was the first time that the share of fossil fuel sources—coal, oil and natural gas—fell below 40 percent of California's power mix. It was also the first time that the share of renewables plus large hydroelectric—which collectively made up 43.7 percent of the power mix—surpassed the combined share of fossil fuels (38%).

CHALLENGE:

The role of hydro must be carefully weighed. During drought years, hydroelectric generation drops off and has been traditionally replaced by generation from fossil fuels and other non-renewable sources. Yet droughts only pose half the challenge. Climate change has impacted hydropower's historic dependability—especially power dependent on dams. Swings in precipitation require dam operators to make tough choices: either reduce water levels in order to accommodate unseasonably wet weather and reduce capacity to generate electricity, or invest in reinforcing dams to withstand unseasonably heavy rains.

Figure 48. Percent of Total Electricity Generation from Renewable Sources

CALIFORNIA & THE REST OF THE U.S., 2007–2017



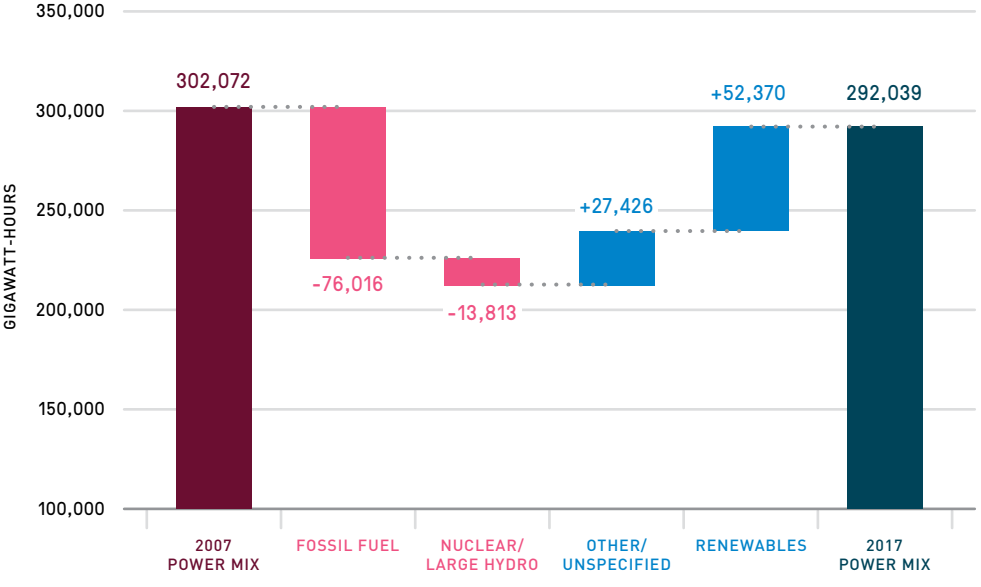
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Energy Commission; U.S. Department of Energy, Energy Information Administration. NEXT 10 / SF · CA · USA

HIGHLIGHT:

The percentage of the total power mix from renewable sources continues to increase at a breakneck pace, increasing 3.5 percent to 29.0 percent in 2017.[64] Renewables' share of generation as a percent of total generation holds steady at three times as large in California than in the rest of the U.S. At the current pace, California is poised to meet its 2020 RPS goal of 33 percent before 2020.

Figure 49. Ten Year Change in California Electricity Power Mix

BY FUEL SOURCE, 2007–2017



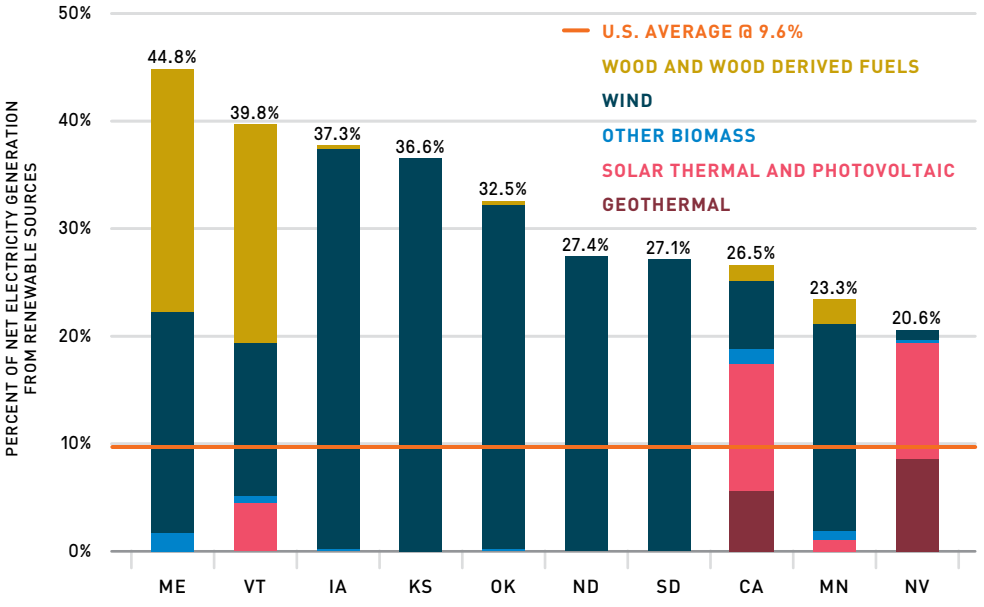
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Renewables do not include large hydros. Fossil Fuel = coal, oil and natural gas; renewables = biomass, geothermal, small hydro, solar and wind. Data Source: California Energy Commission; U.S. Department of Energy, Energy Information Administration. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Between 2007 and 2017, California's power mix from renewable sources increased by 52,370 gigawatt-hours (GWh), displacing most of the decline in generation from fossil fuel sources (-76,016 GWh). Total generation declined 3.3 percent despite population growth, a result of the state's improved energy efficiency standards. The combined decline in total generation and growth in renewable generation together accounted for more than 80 percent of the decline in fossil fuel generation.

Figure 50. Renewable Sources as Percentage of Net In-State Generation

TOP 10 STATES & U.S., 2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Department of Energy, Energy Information Administration.
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HIGHLIGHT:

In 2017, 26.5 percent of California's net in-state generation came from renewable sources (up from 25.2% in 2016), the eighth-highest in the nation and down one spot compared to 2016. While California doesn't have the largest share of in-state generation from renewable sources, its sources for renewable energy are cleaner than some of the top states. Maine and Vermont have the highest shares, but 22.5 percent and 20.4 percent of their generation, respectively, come from burning wood for biomass energy, which releases CO2 emissions. On the other hand, California has the greatest share of renewable in-state generation from solar (11.8%), followed by Nevada (10.9%).

Table 3. Recent Renewable Portfolio Standards Revisions from 2018

STATE	RPS REVISION
CALIFORNIA	Increased RPS to 60% by 2030 and added goal of 100% zero-carbon electricity by 2045 (SB 100)
CONNECTICUT	Increased and extended Class I target to 40% by 2030, reduced Class I ACP rate, and created a new long-term contracting program
MASSACHUSETTS	Increased Class I growth rate to 2% of retail sales per year over 2020–2029 period, and added a clean peak standard
NEVADA	50% RPS by 2030 and 100% carbon-free by 2050
NEW JERSEY	Increased and extended Tier I target to 50% by 2030, phases out solar carve-out, increased offshore wind energy carveout to 3,500 MW, and created new caps on RPS compliance costs
NEW YORK	Created offshore wind procurement program with a target of 2,400 MW by 2030
WASHINGTON	• 2025: Phase out coal-fired power • 2030: Carbon neutral electricity • 2045: Carbon free electricity

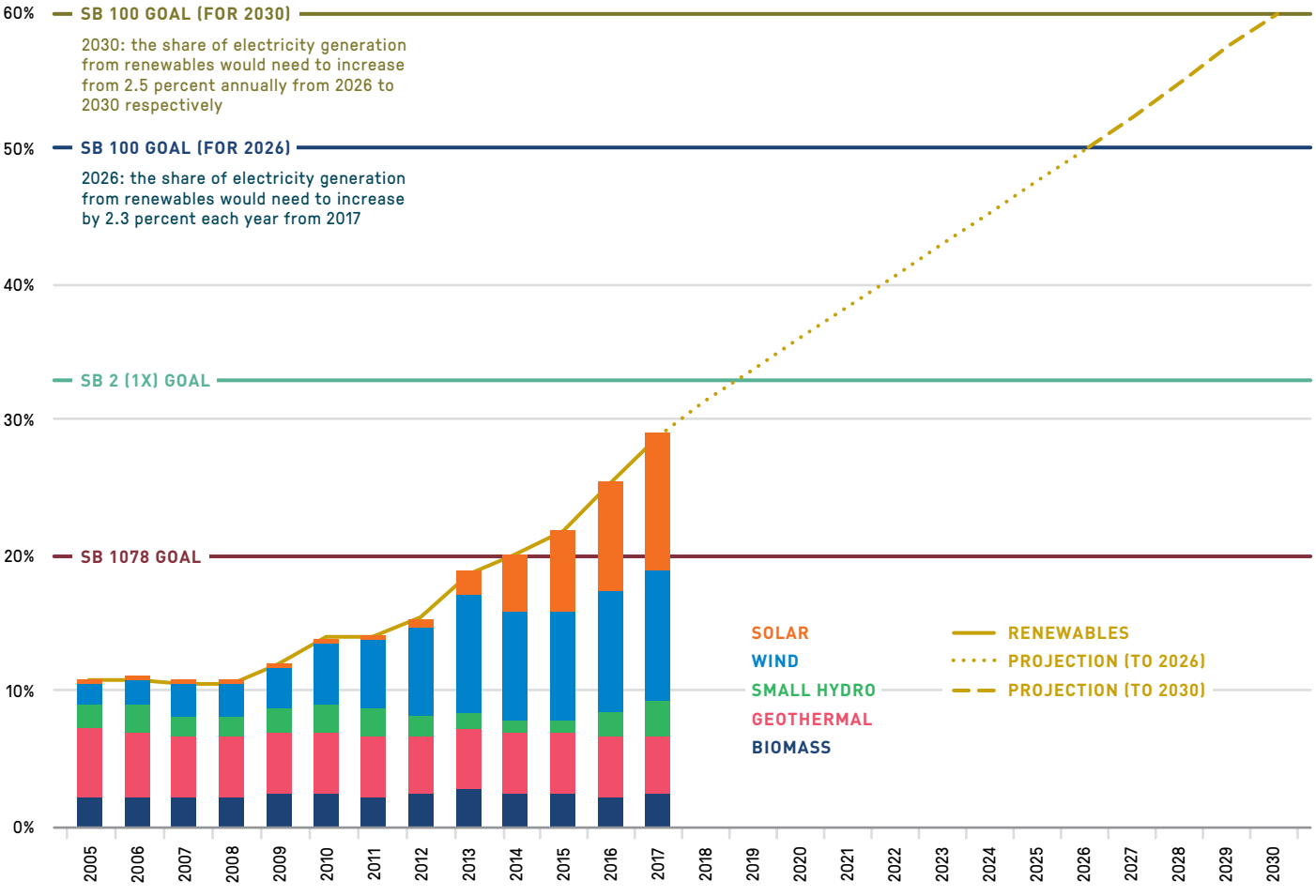
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Current as of May 2019. Data Source: Lawrence Berkeley National Laboratory; Database of State Incentives for Renewable Energy; National Conference of State Legislatures. NEXT 10 / SF · CA · USA

HIGHLIGHT:

In 2019, Nevada and Washington became the fourth and fifth states—along with California, Hawaii and New Mexico—to set a 100 percent clean electricity goal.

Figure 51. California's Path to 60% RPS Goal by 2030

ASSUMING LINEAR GROWTH



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Renewables do not include large hydros. Data Source: California Energy Commission; U.S. Department of Energy, Energy Information Administration.
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Targets

LEGISLATION	GOAL	TIME HORIZON
SB 1078 (SHER, 2002)	Established RPS program with initial requirement of 20% of electricity retail sales served by renewable resources	2017
SB 2 (1X) (SIMITIAN, 2011)	Requires both public- and investor-owned utilities to procure 33 percent of the electricity delivered to retail customers from renewable sources	2020
SB 350 (DE LEÓN, 2015)	Increased RPS goals: 50% of state's electricity from renewables	2030
SB 100 (DE LEÓN, 2018)	Increased RPS to 60% renewables by 2030 and 100% fossil-fuel free electricity by 2045	2030, 2045

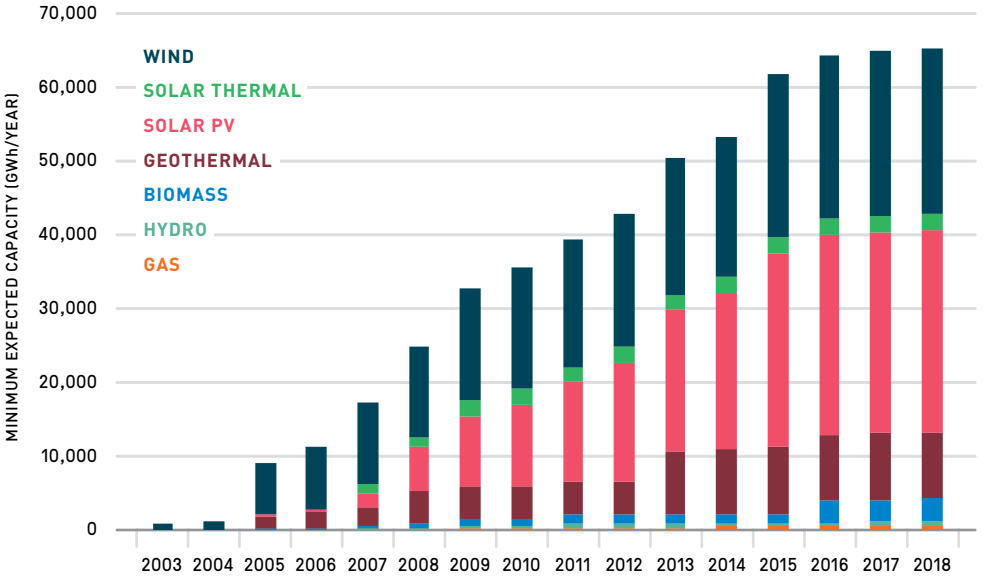
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Public Utilities Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT:

At current pace, California should meet the 50 percent and 60 percent RPS goals by 2026 and 2030, respectively. To meet the 2026 and 2030 goals, the share of electricity generation from renewables would need to increase by 2.3 percent each year from 2017 to 2026 and by 2.5 percent annually from 2026 to 2030. From 2016 to 2017, the percentage increase was nearly 4 percent.

Figure 52. Cumulative Operational and In-Development Capacity of Renewables Portfolio Standard Projects

BY INVESTOR-OWNED UTILITIES: CALIFORNIA, 2003–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: As of end of 2018. There are renewable energy credit (REC) sales whereby an IOU is selling their RECs to another party and not acquiring them, which represents the number of RECs leaving their portfolio as a result of a sale. This analysis excludes RECs. Data Source: California Public Utilities Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT:

The pace of renewable portfolio standards projects coming online has flattened in recent years. However, this is not because of waning progress, but rather that the investor-owned utilities already surpassed the 33 percent goal by 2020 in 2018.[65] As community choice aggregators (CCAs) take on load departing from IOUs, it will be critical that the state ensures the CCAs procure adequate amounts of renewable energy.

Table 4. Cumulative Sale of Renewable Energy Credit

BY EXPECTED ANNUAL GENERATION

	PPA - BILATERAL[66]	PSA - BILATERAL[67]
SDG&E	0	0
PG&E	0	10,091.6 GWh
SCE	808.0 GWh	0

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. California Public Utilities Commission. NEXT 10 / SF · CA · USA

HIGHLIGHT :

A utility may buy, sell, and trade renewable energy credits (RECs, or certificates of proof that a unit of energy was generated and delivered by an RPS-eligible renewable energy source) at any time as long as it obtains and retires sufficient levels of RECs to comply with RPS requirements. Since the three investor-owned utilities (IOUs) are ahead of schedule in meeting the RPS goals, these IOUs have elected to sell their RECs to other parties and have stopped acquiring any additional RECs. In 2018, Pacific Gas & Electric sold RECs from a number of RPS projects of various technologies that are either already online or in development—altogether, the RECs sold are expected to generate over 10,000 gigawatt-hours of RPS-eligible electricity. All of the REC sales are through power service agreements (PSA) and many of the sales are to community choice aggregators (CCAs).[68]

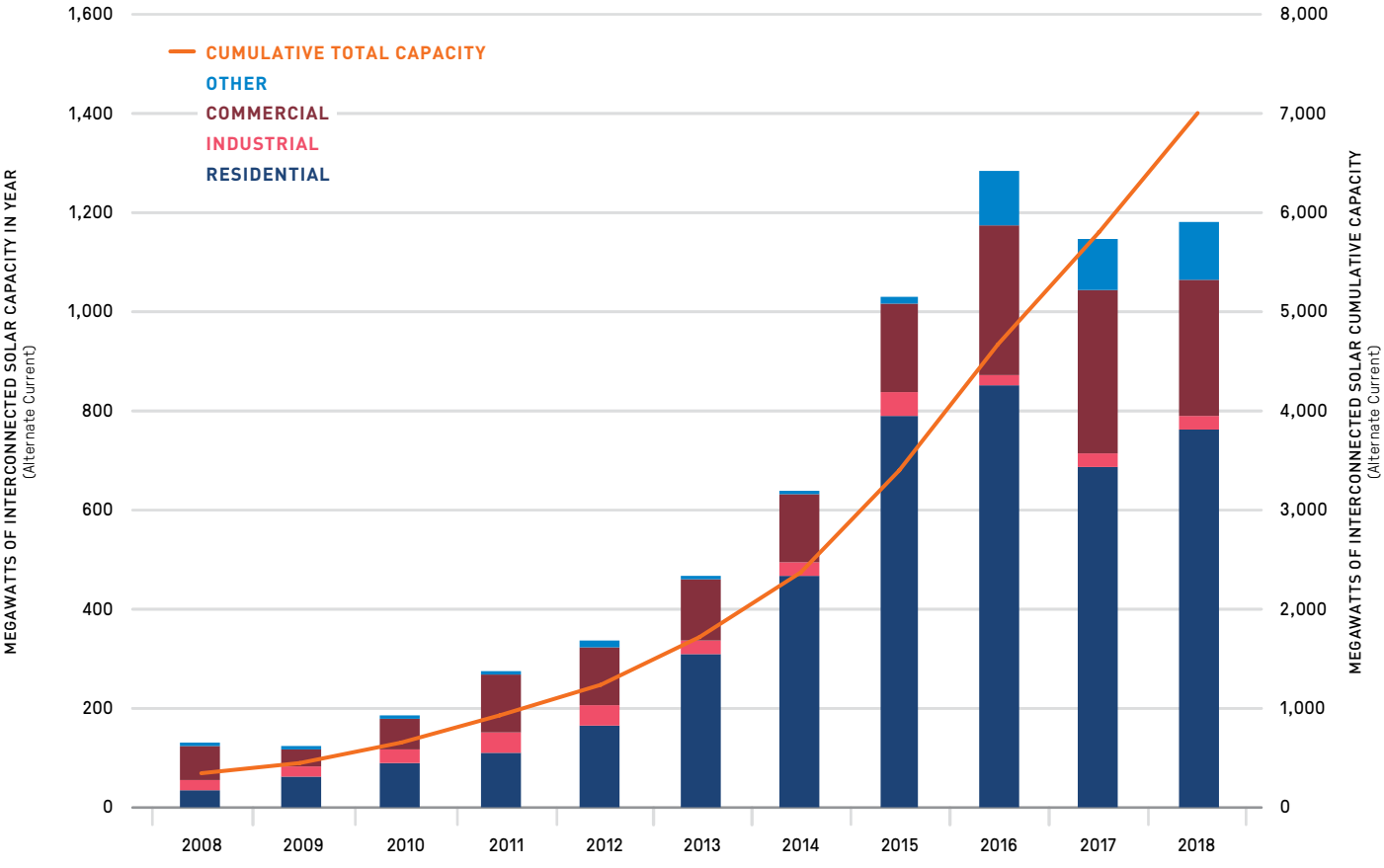
CHALLENGE:

Investor-owned utilities have built up considerable large-scale RPS-qualifying renewable projects over time. As more CCAs come on line and customers move from an IOU to a CCA, IOUs may be forced to sell more RECs.

SOLAR

Figure 53. Interconnected Solar in California

2008–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: The data set only includes interconnected solar PV Net Energy Metering (NEM) systems within PG&E, SCE and SDG&E service territories and presents the current "state of the world" in terms of how many interconnected solar PV projects and how many megawatts are installed in a given geographic area. Calculations based on "Application Approved Date." Other includes the educational, military, non-profit, and government sectors. Data Source: Currently Interconnected Data Set, California Solar Statistics. NEXT 10 / SF · CA · USA

HIGHLIGHT:

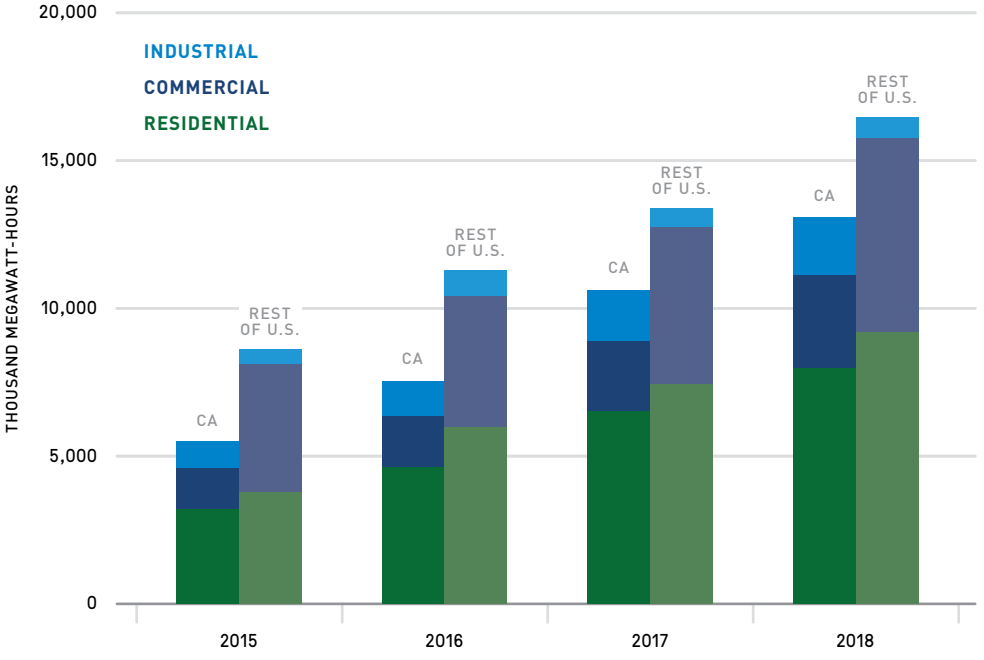
Interconnected solar photovoltaic (PV) Net Energy Metering (NEM) systems installations[69] within the three investor-owned utilities service territories totaled 1,182 megawatts (in alternate current) in 2018, a 3.4 percent increase from 2017. This is still lower than the peak in 2016, however. While the residential sector (+11.1%) and "other" sector (+14.0%) helped to reverse 2017's decline, installations in the industrial sector (-4.1%) declined for the third straight year. A leveling-off of new installations is to be expected as the renewables market nears maturation.

CHALLENGE:

In 2018, the state implemented new building energy efficiency standards that will mandate solar on most new residential buildings by 2020. However, lagging development of new housing, partly due to local opposition against development, could reduce the efficacy of the legislation. Furthermore, among the state's various solar incentive programs—California Solar Initiative, Single-family Affordable Solar Homes (SASH), Multi-family Affordable Solar Homes (MASH), and SB1 POU Programs—only SASH is currently enrolling new participants.[70] The state's new Solar on Multifamily Affordable Housing Program (SOMAH) provides financial incentives for installing solar PV energy systems on multifamily affordable housing in California, and it is the largest dollar investment for low-income multifamily solar to date with an up to $100 million per year budget and a total capacity target of 300 MW. The program, which improves on MASH, is already fully subscribed despite officially launching on July 1, 2019.[71]

Figure 54. Small Scale Net Generation from Solar PV

CALIFORNIA AND U.S. WITHOUT CALIFORNIA, 2015–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration. NEXT 10 / SF · CA · USA

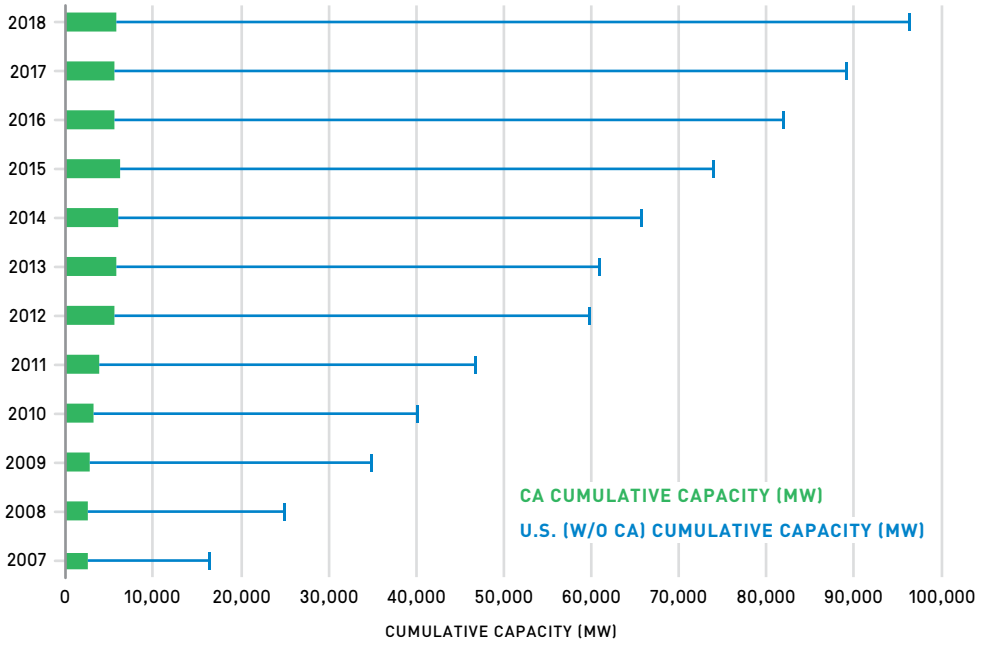
HIGHLIGHT:

As of 2018, California accounted for 44 percent of small-scale solar PV (less than one MW) net generation in the U.S., including a staggering 73 percent of industrial sector small scale solar PV generation. Small scale solar PV generation increased by 23 percent from 2017 to 2018 for both California and the rest of U.S. By sector, small scale solar PV generation grew 36 percent in the commercial sector, 22 percent in the residential sector, and 11 percent in the industrial sector in California from 2017 to 2018.

WIND

Figure 55. Cumulative Wind Capacity

CALIFORNIA VS. U.S., 2007–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Utility-scale wind capacity includes installations of wind turbines larger than 100-kW. Data Source: American Wind Energy Association. NEXT 10 / SF · CA · USA

HIGHLIGHT:

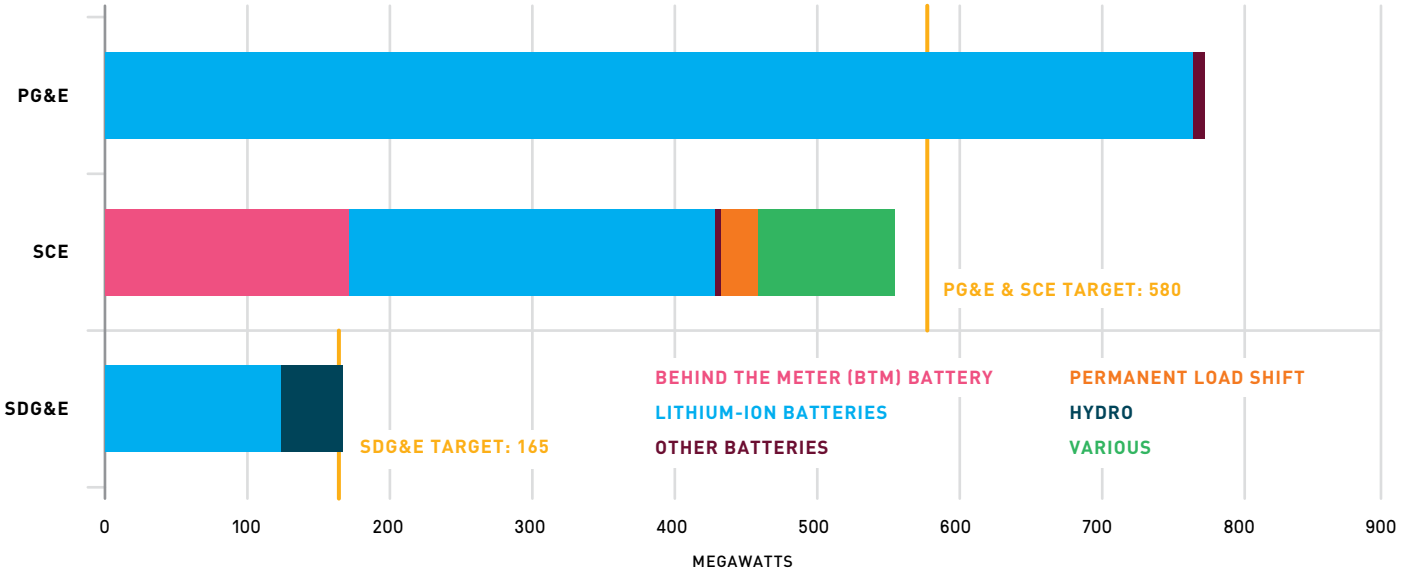
Cumulative installed capacity totaled 5,840 MW in California, up 285 MW from 2017. Total wind capacity has remained largely stagnant in California since 2012, but continues to expand in the rest of U.S. This is partly due to topological reasons; California has lower than average wind speed.

OPPORTUNITY:

While California's in-state wind generation has been declining, it could benefit from off-shore or out-of-state wind. The state has had to offload excess solar energy when solar generation is at its peak—in some cases, even paying other states to take the excess energy. Bringing in more out-of-state or off-shore wind energy that is more consistently available could help the state balance the intermittent supply of solar on the grid.

Figure 56. Current Status Towards Meeting AB 2514 Procurement Targets

APPROVED AND PENDING APPROVAL: ONLINE/IN PROGRESS/PRELIMINARY ACTIVITIES



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Public Utilities Commission; Documents filed to the CPUC by the three investor owned utility companies. NEXT 10 / SF · CA · USA

California has the largest energy storage market in the U.S. with 23 percent of the nation's contracted, operational, under construction, or offline/under repair energy storage projects located in the state. As battery costs decline and performance improves, the opportunities to utilize advanced energy storage technologies for improved solar and wind grid integration, increased demand from electric vehicles, and to help build grid resiliency have grown. Policies that have set targets for increased advanced energy storage procurement[72] and provided incentives for storage development have played an important role in spurring growth in this sector.

HIGHLIGHT:

Assembly Bill 2514 (Skinner, 2010) mandated that the three investor-owned utilities (IOUs) in the state would have to procure 1,325 MW of qualifying energy storage by 2020 and install that same amount by 2024. The state has already achieved its 2020 procurement target, but more will need to come online in order to hit the 2024 installation target. The California Public Utilities Commission (CPUC) has approved or is pending approval of 1,498 MW of AB 2514-eligible energy storage to be procured by the three IOUs. These projects are either online or in some phase of development. Lithium-ion battery is the dominant energy storage technology, making up 1,151 MW total and almost the entire portfolio of PG&E. Behind-the-meter (BTM) battery is the next largest energy storage technology, but is deployed solely by Southern California Edison. Other technologies include: other batteries,[73] permanent load shift,[74] hydro,[75] and various technologies from the Self Generation Incentive Programs,[76] which provide rebates for qualifying distributed energy systems installed on the customer's side of the utility meter.

OPPORTUNITY:

This past fall, the CPUC approved a total of 567.5 MW of battery storage in Moss Landing to replace retiring gas generators. These lithium-ion batteries, once completed, will be the two largest in service in the world. The projects were more cost-competitive than maintaining the natural gas facilities and provide added grid benefits to a transmission-constrained region of the state.[77] As transportation and electricity markets for lithium-ion batteries are increasingly linked, investments in lithium-ion battery manufacturing have helped reduce battery costs, which will help with even greater deployment of lithium-ion battery storage systems.[78]

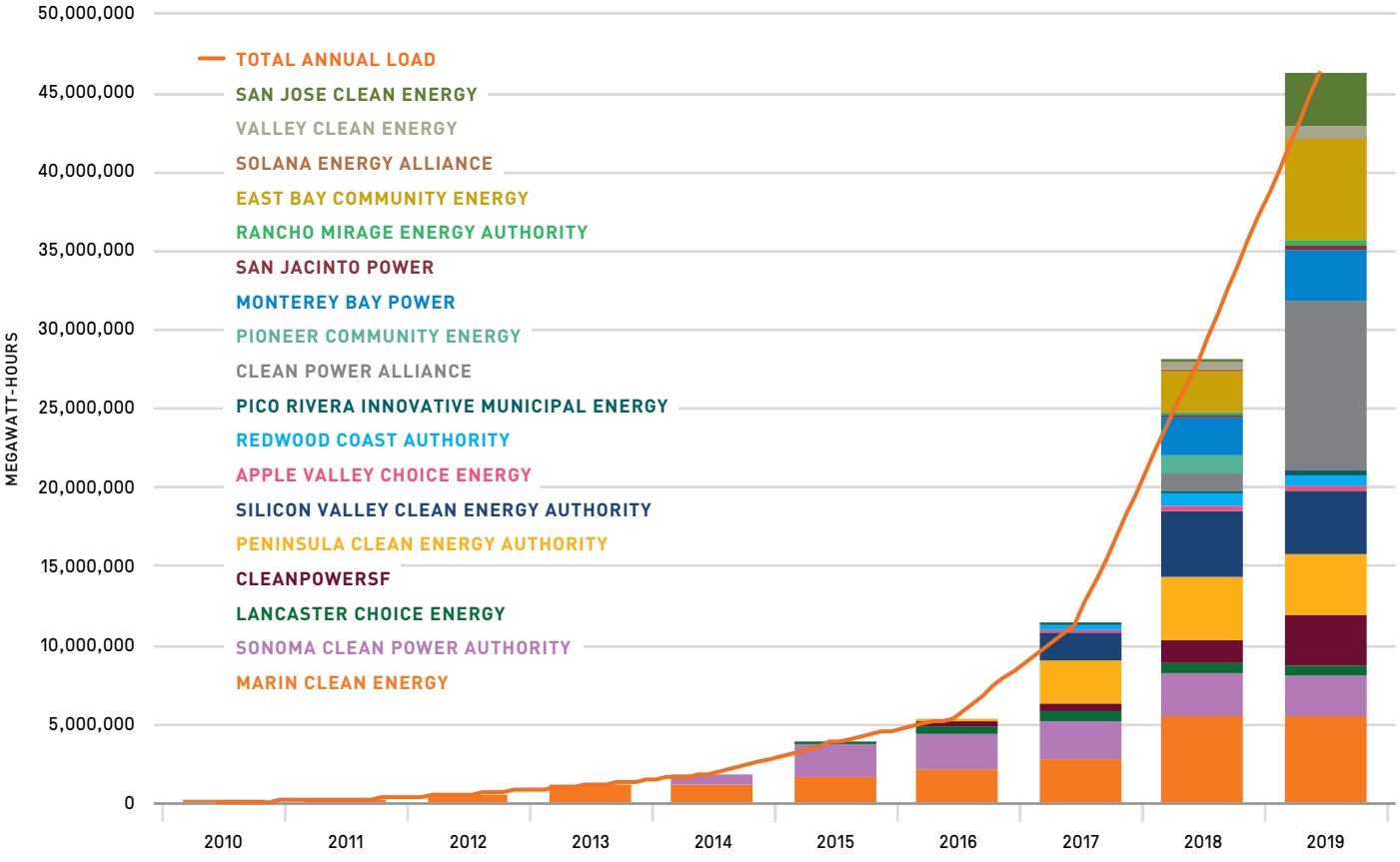
CHALLENGE:

While behind-the-meter energy storage has been on the rise in California, a recent CPUC report[79] indicated that this type of storage has actually increased greenhouse gas emissions as a result of insufficient price signaling to incentivize charging during periods of peak midday solar. Ensuring that batteries are charged at times when there is excess renewable energy on the grid is be critical to avoiding increased emissions, and incentives must be designed to encourage that behavior.

Community Choice Aggregators (CCAs)

Figure 57. California CCAs Annual Load

2010–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: CCA annual load data; Cal-CCA; Energy Information Administration Form EIA-861. NEXT 10 / SF · CA · USA

Community Choice Aggregators (CCAs) are local public agencies typically created by joint power agreements, or a city or county ordinance. The CCA model centers upon the value of including renewable and clean energy in customer's power mix, but the agency most often serves as a distributor and not generator of power, relying on the existing transmission and distribution lines of incumbent utilities to deliver electricity to their customers. The first California CCA (Marin Clean Energy) formed in 2010 and the number of CCAs formed has increased steadily since then.

HIGHLIGHT:

CCAs are becoming more commonplace. Estimated annual load reached 46,286 GWh in 2019, a 65 percent increase over 2018's annual load of 28,017 GWh. Between all communities with active CCAs, over 1 million California customers are no longer served by municipal or investor-owned utilities, having instead transitioned to a CCA.

CHALLENGE:

The California Public Utilities Commission (CPUC) expects CCAs—in combination with direct access providers and rooftop solar—to serve over 85 percent of IOUs current customers by the mid-2020s.[80] Ensuring that CCAs are able to provide the same capacity to procure and deliver clean energy resources over the long-term will be critical to meeting climate and energy goals. While IOUs have demonstrated that they have an adequate amount of RPS-qualifying energy procurement to meet the state's needs through 2030, it appears that CCAs may be behind. In the CPUC's decision on the latest Integrated Resource Plan, staff indicated that CCAs would have to procure roughly twice of what they have procured to date by 2022 and close to six times as much by 2030 in order to meet our clean energy and climate goals.[81] According to the CPUC, CCAs will also have to make improvements in terms of planning for resource adequacy to ensure that they can provide customers reliable power supply, and not rely primarily on variable wind and solar energy.

California is home to some of the world's top clean tech companies, particularly in the renewable energy and transportation sectors. The state has demonstrated and maintained leadership in clean tech innovation, with **top rankings for both investment and patents** across a majority of segments.

While venture capital investment is declining in certain sectors, such as Solar, where the markets are maturing, there is increasing activity in Energy Efficiency and Transportation.

Clean Tech

Clean Technology Patents

- In 2018, the number of clean tech patents registered **fell 7.0 percent** in California and 18.3 percent in the rest of the United States compared to 2017.
- California is **the clear leader in clean tech patent registration** in all major clean technology categories. For every one patent registered in Texas, the state with the second most patents registered in 2018, California had 3.5 patents.

Clean Technology Patents by Segment

- Some of the larger segments, such as Energy Efficiency (-54.3%), Renewable Energy Generation (-21.8%), and Transportation (-45.0%), saw **large decreases** in 2018 in California.
- On the other hand, Energy Storage patents in California **increased 65.6 percent year-over-year** in 2018.
- Within the Renewable Energy Generation segment, the number of patents registered across sub-segments **all declined notably** except for Water Power (+5.0%) and Solar (-0.2%).

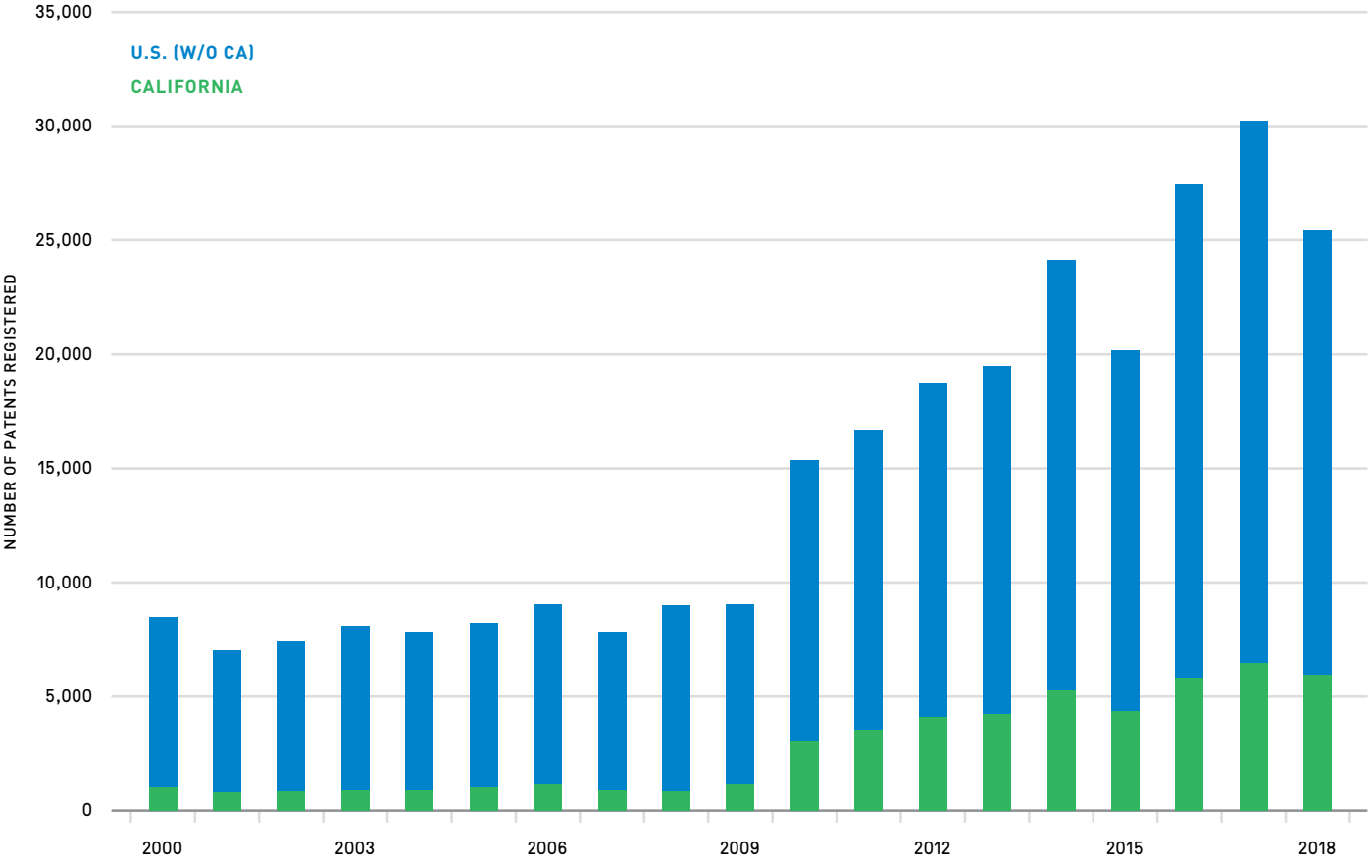
Innovation

Clean Technology Venture Capital Investments

- In 2018, venture capital investment in clean tech totaled **$5.8 billion** in the U.S., of which **58 percent** was in California.
- Compared to 2017, the dollar amount invested in California increased 137.1 percent, reaching **$3.4 billion in venture capital (VC) funding**– but the number of deals declined slightly by 4.3 percent to 133 deals in 2018.
    - The largest increase in dollars invested was in Recycling & Waste (+1,810%), followed by the Energy Efficiency (+279.2%), and Transportation (+206%) segments
- Despite the year-over-year increase, investments in several segments have **declined over time.** For example, VC investment in solar totaled just $122.2 million in California in 2018, less than one-tenth of the $1.43 billion investment the state saw in that sector in 2008.
- Only **22.6 percent of the deals** made in the U.S. were in California in 2018, down slightly compared to 23.5 percent in 2017.
    - While the total number of deals may have declined, the average investment has gone up. In 2018, the average deal in California was **$25.3 million** (up from $18 million in 2008) compared to $9.8 million in the U.S. (down from $14.8 million in 2008).
- California leads all other states in mergers & acquisitions (M&A) deals, with **a quarter of all deals** having taken place in the state in 2018. There were three times more deals in California than in the next runner-up, Texas, in 2018.

Figure 58. U.S. Clean Technology Patent Registrations By Residence of First Inventor

CALIFORNIA & THE REST OF THE U.S., 2000–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IP Checkups, CleanTech Patent Edge. NEXT 10 / SF · CA · USA

HIGHLIGHT:

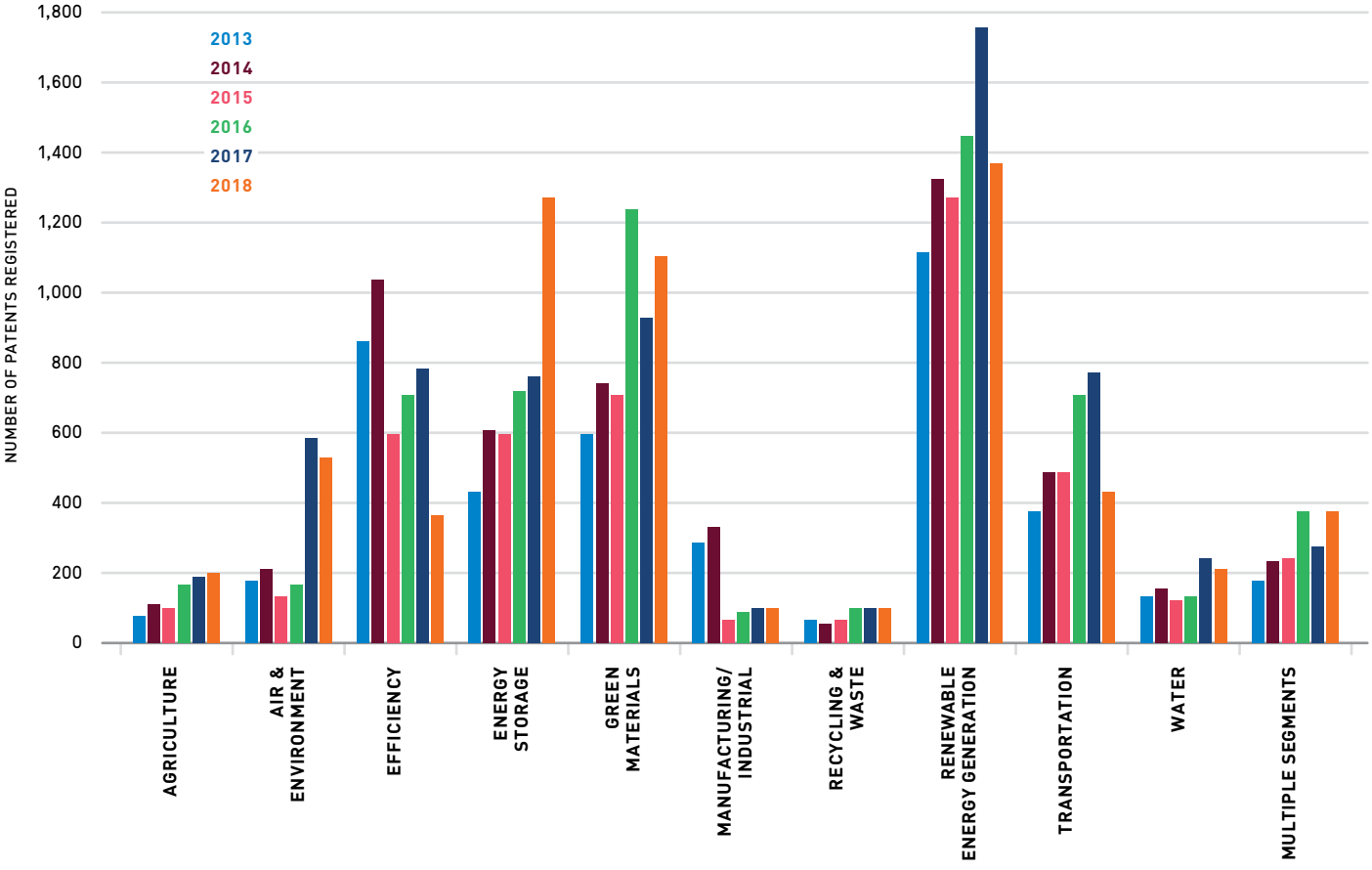
The number of clean tech patents registered were lower in 2018 than 2017 in both California and the rest of the United States. Compared to 2017, the number of clean tech patents registered fell 7.0 percent in California and 18.3 percent in the rest of the United States. Nearly a quarter (23.7%) of all clean tech patents registered in the U.S. in 2018 were registered in California.

CHALLENGE:

The dip in the number of patents registered in 2018 (compared to 2017 and 2016) might signal a slowdown in clean tech patent applications, not just in the U.S. but also globally. Recent analysis from the IEA and OECD found that while there was a significant ramp up in the number of clean tech patents registered globally leading up to 2011–2012, the number of patents registered in these categories has seen a significant drop-off since then.[82] From 2017 to 2018, global clean tech patent registrations declined by 12.53[83] percent. The lower rates of patent registration may be due to the increasing maturity of clean technologies like solar PV, resulting in reduced need for further innovation and patenting. While the stimulus under the Obama administration helped fund clean tech research and development, funding for clean tech research has declined under the current administration, potentially impacting the decline in related patent registrations. In order to meet not just clean energy goals but broader goals for GHG reductions and carbon neutrality, continued innovation in these clean tech categories will be needed.

Figure 59. Clean Technology Patent Registrations by Segment

CALIFORNIA, 2013–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Source: IP Checkups, CleanTech Patent Edge. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Clean tech patent registrations declined in many segments, but a few managed to hold steady. Green Materials patents rebounded from the 2017 slump, increasing 19.6 percent in 2018 and Energy Storage patents in California increased 65.6 percent year-over-year in 2018.

CHALLENGE:

Some of the largest segments, such as Energy Efficiency (-54.3%), Renewable Energy Generation (-21.8%), and Transportation (-45.0%), saw large decreases in 2018 compared to 2017. There were 426 patent registrations in the Transportation segment in 2018 compared to 775 in 2017, with all sub-segments posting a year-over-year decrease in patents of more than 30 percent except for the Transportation Efficiencies sub-segment (which includes logistics efficiency systems to help reduce VMT, increase fuel economy, or operate vehicles and fleets more efficiently), which posted a relatively modest 8 percent decline. Biofuel patent registrations showed a significant decrease (-62% between 2017 and 2018) which permeated across all sub-segments, including algae, biodiesel, biogas, biomass, ethanol, and microbes. As the state looks to reduce its transportation emissions and transition to cleaner fuels, greater innovation in these sectors will be critical.

CLEAN TECHNOLOGY PATENTS BY SEGMENT

Total Clean Technology Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	6,033
2	TEXAS	1,721
3	NEW YORK	1,549
4	MICHIGAN	1,473
5	MASSACHUSETTS	1,277
6	ILLINOIS	913
7	OHIO	904
8	FLORIDA	807
9	WASHINGTON	805
10	PENNSYLVANIA	756

Energy Storage Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	1265
2	MICHIGAN	465
3	TEXAS	258
4	NEW YORK	235
5	MASSACHUSETTS	232
6	ILLINOIS	152
7	WISCONSIN	151
8	WASHINGTON	148
9	CONNECTICUT	147
10	OHIO	138

Air & Environment Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	534
2	TEXAS	222
3	NEW YORK	140
4	MASSACHUSETTS	135
5	MICHIGAN	105
6	MINNESOTA	86
7	WASHINGTON	82
8	NORTH CAROLINA	81
9	FLORIDA	75
10	NEW JERSEY	72

Green Materials Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	1105
2	NEW YORK	469
3	TEXAS	367
4	MASSACHUSETTS	326
5	OHIO	258
6	PENNSYLVANIA	212
7	MINNESOTA	210
8	MICHIGAN	193
9	ILLINOIS	150
10	WASHINGTON	149

Efficiency Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	359
2	NEW YORK	83
3	NEW JERSEY	82
4	MICHIGAN	60
5	MASSACHUSETTS	59
6	TEXAS	59
7	PENNSYLVANIA	58
8	ILLINOIS	52
9	NORTH CAROLINA	47
10	MINNESOTA	47

Renewable Energy: Biofuels Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	156
2	MASSACHUSETTS	43
3	ILLINOIS	41
4	TEXAS	26
5	WISCONSIN	21
6	NEW YORK	18
7	NORTH CAROLINA	18
8	PENNSYLVANIA	18
9	MINNESOTA	17
10	FLORIDA	14

Renewable Energy: Solar Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	698
2	NEW YORK	148
3	COLORADO	87
4	TEXAS	78
5	NEW MEXICO	76
6	ARIZONA	68
7	MICHIGAN	54
8	MASSACHUSETTS	53
9	FLORIDA	51
10	ILLINOIS	44

Renewable Energy: Wind Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	81
2	NEW YORK	43
3	SOUTH CAROLINA	28
4	COLORADO	27
5	TEXAS	23
6	NORTH CAROLINA	18
7	WASHINGTON	18
8	FLORIDA	15
9	VIRGINIA	11
10	MASSACHUSETTS	11

HIGHLIGHT:

California is the undisputed leader in patent registrations in all major clean tech categories, edging out second place Texas by a factor of 3.5. California's lead is the most notable in Efficiency and Solar, having registered 3.3 and 3.7 patents for each patent registered in the respective segment by the runner-up New York.

CHALLENGE:

California's sizable lead is despite an overall drop in total number of clean tech patents registered, indicating the decline is nationwide and factors beyond state control are contributing to the decreases in clean tech patents. Total clean tech patent registrations fell 15.8 percent in the U.S. (including California). The year-over-year decline is consistent across the top patent states in the following segments: Air & Environment, Efficiency, Renewable Energy Generation, Transportation, and Water.

OPPORTUNITY:

There are bright spots, however. For example, there were more Energy Storage patents published in 2018 than in 2017 for all of the top ten states and, in California, energy storage-related clean tech patents increased by 66 percent. Energy storage segment's boom may be an example of the positive externality that arise from falling battery costs. As lithium-ion battery costs fall, electric vehicles become less costly, and at the same time, so too does energy storage that also utilize lithium-ion battery technology.[84]

Recycling & Waste Patent Ranking

TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	94
2	TEXAS	41
3	FLORIDA	33
4	ILLINOIS	32
5	MICHIGAN	29
6	OHIO	27
7	PENNSYLVANIA	27
8	GEORGIA	25
9	NEW YORK	25
10	WASHINGTON	24

Transportation Patent Ranking

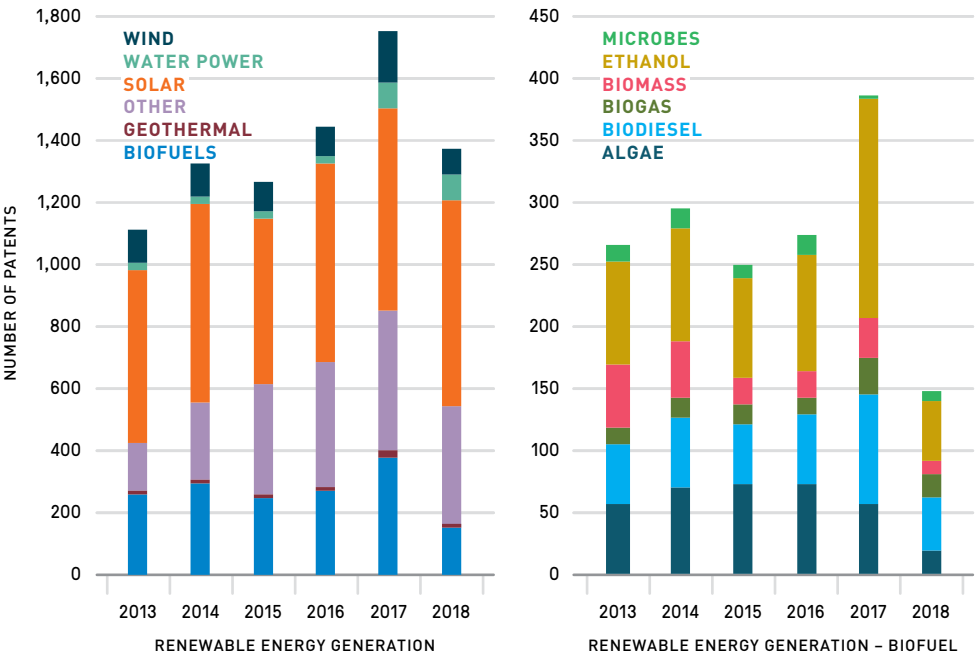
TOP RANKING STATES IN 2018

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	426
2	MICHIGAN	212
3	TEXAS	143
4	WASHINGTON	104
5	ILLINOIS	93
6	NEW YORK	73
7	FLORIDA	70
8	WISCONSIN	60
9	PENNSYLVANIA	56
10	INDIANA	55

RENEWABLE ENERGY GENERATION PATENTS

Figure 60. Clean Technology Patent Registrations

RENEWABLE ENERGY, CALIFORNIA, 2013–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IP Checkups, CleanTech Patent Edge. NEXT 10 / SF · CA · USA

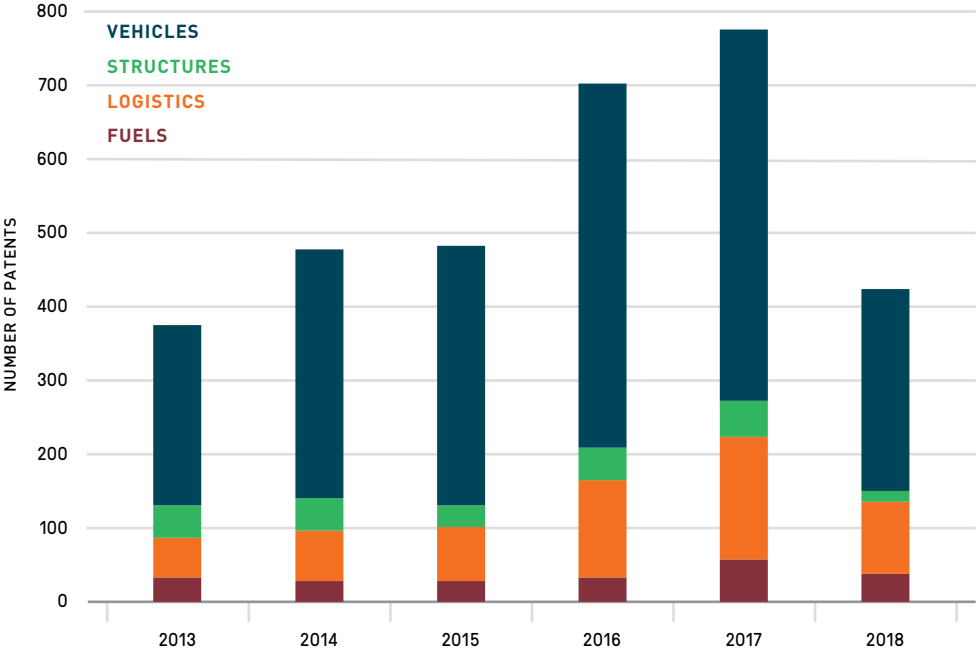
CHALLENGE:

Within clean technology, Renewable Energy Generation is one of the more mature segments and has seen a corresponding decrease in the number of patents registered. The number of patents registered declined significantly across all sub-segments aside from Water Power (+5.0%) and Solar (-0.2%). Biofuels (-61.7%) and Wind (-52.5%) saw the largest decreases from 2017 to 2018. Within the Biofuel sub-segment, the decline in patents registered permeated across all sub-segments. Ethanol, the most prolific sub-segment, posted the largest drop (-73%), followed by Biomass (-70%) and Algae (-64%). The decline in Biofuel patents may be unsurprising, as global Biofuel patent filings have been dropping since they peaked in the early 2010s.[85]

TRANSPORTATION PATENTS

Figure 61. Clean Technology Patent Registrations

TRANSPORTATION, CALIFORNIA, 2013–2018



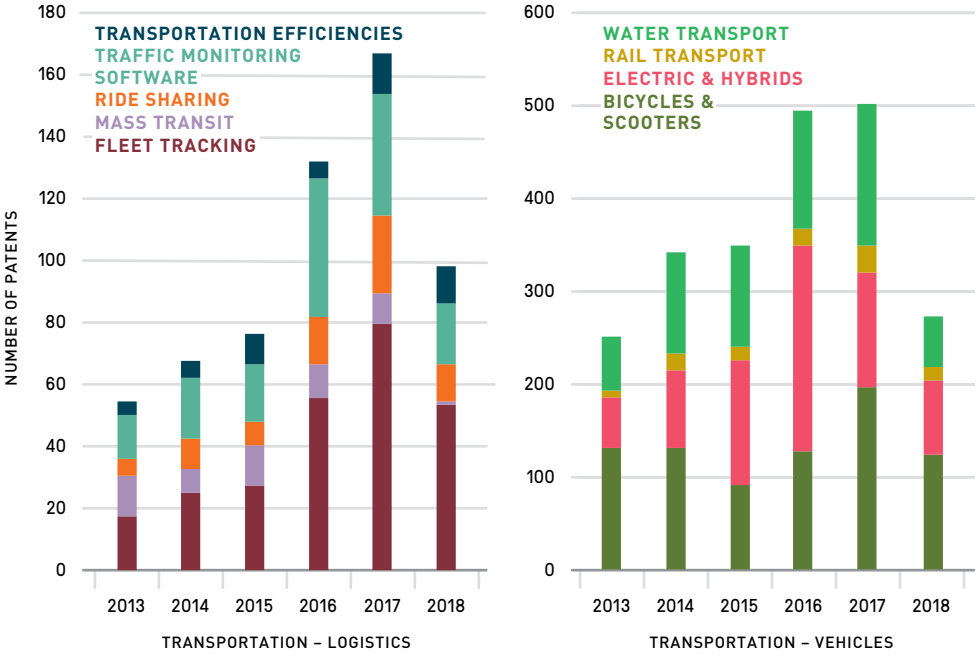
NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IP Checkups, CleanTech Patent Edge. NEXT 10 / SF · CA · USA

CHALLENGE:

Patent registrations similarly declined across the Transportation segment from 2017 to 2018, with a 45 percent decline to the below-2014 level of 481 patents registered. Vehicles, the largest Transportation sub-segment, saw patent registrations declining 46 percent compared to 2017, while Fuels (-36%), Logistics[86] (-41%), and Structures[87] (-64%) similarly declined. Continued innovation and efficiency gains in Transportation technology will be critical for the state to meet its ambitious climate goals as the transportation sector remains the largest source of emissions in the state.

Figure 62. Clean Technology Patent Registrations

TRANSPORATION, CALIFORNIA, 2013–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IP Checkups, CleanTech Patent Edge. NEXT 10 / SF · CA · USA

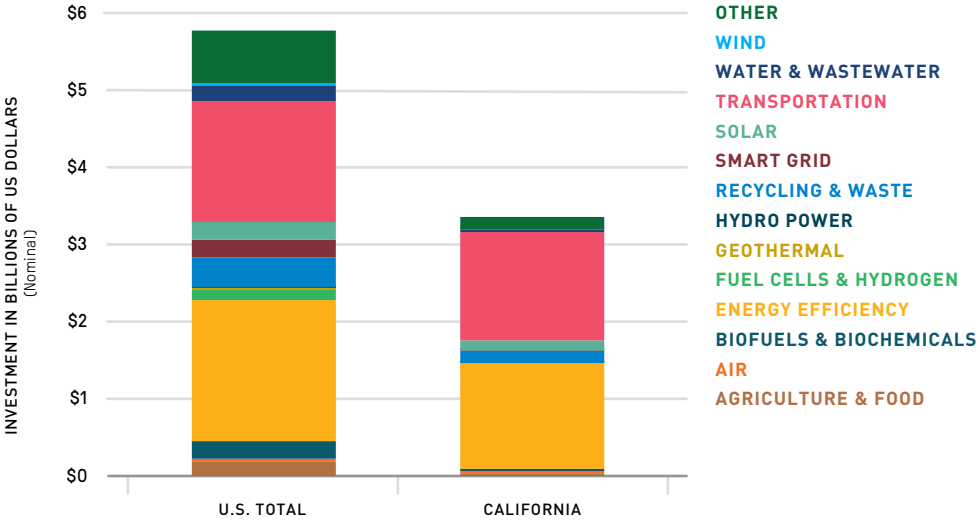
CHALLENGE:

The only Transportation sub-segment that did not have a decrease in patent registrations greater than 30 percent from 2017 to 2018 was Logistics – Transportation Efficiencies, which posted a relatively modest 8 percent decline. This sub-segment includes technologies for optimizing processes for goods movement and increasing automation and advancements in autonomous vehicles. The 2018 decline in Vehicles – Electric & Hybrids was substantial (-35%), as it is a consecutive decline following a large decrease (-45%) from 2016 to 2017. Declining patent registrations in these sub-segments could represent an obstacle to achieving the state's clean transportation goals.

Clean Technology Investments

Figure 63. Total Venture Capital Investment in Clean Technology

BY SEGMENT FOR U.S. AND CALIFORNIA, 2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Amount unadjusted for inflation. Data Source: PitchBook, LLC.
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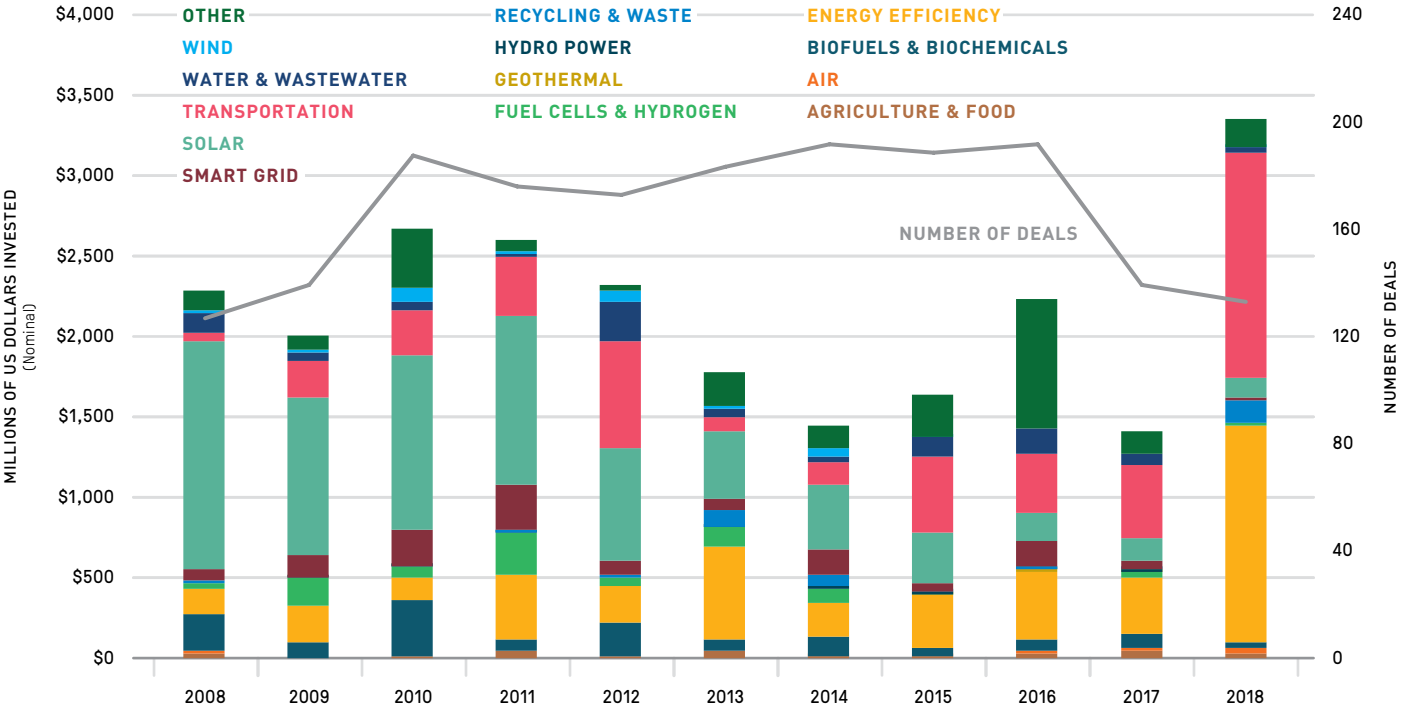
HIGHLIGHT:

Venture capital investment in clean technologies totaled $5.8 billion in the U.S. in 2018, of which 58 percent ($3.4 billion) was invested in California. Four of the five largest deals in the U.S., totaling $1.7 billion, took place in California.[88] The state's share of clean tech VC investment in the U.S. has been steady at around 60 percent, compared to years past.

Figure 64. Venture Capital Investment in Clean Technology by Segment

CALIFORNIA, 2008–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Amount unadjusted for inflation. Data Source: PitchBook, LLC. NEXT 10 / SF · CA · USA

HIGHLIGHT:

Last year saw a spike in venture capital (VC) dollars invested in clean tech, particularly in the Energy Efficiency and Transportation segments, but 2018 also had the fewest number of deals since 2008. Compared to 2017, the dollar amount invested increased 137.1 percent, reaching $3.4 billion, but the number of deals declined slightly by 4.3 percent to 133 deals in 2018. The largest dollar increase was in Recycling & Waste (+1,810%), followed by the Energy Efficiency (+279.2%), and Transportation (+206%) segments.

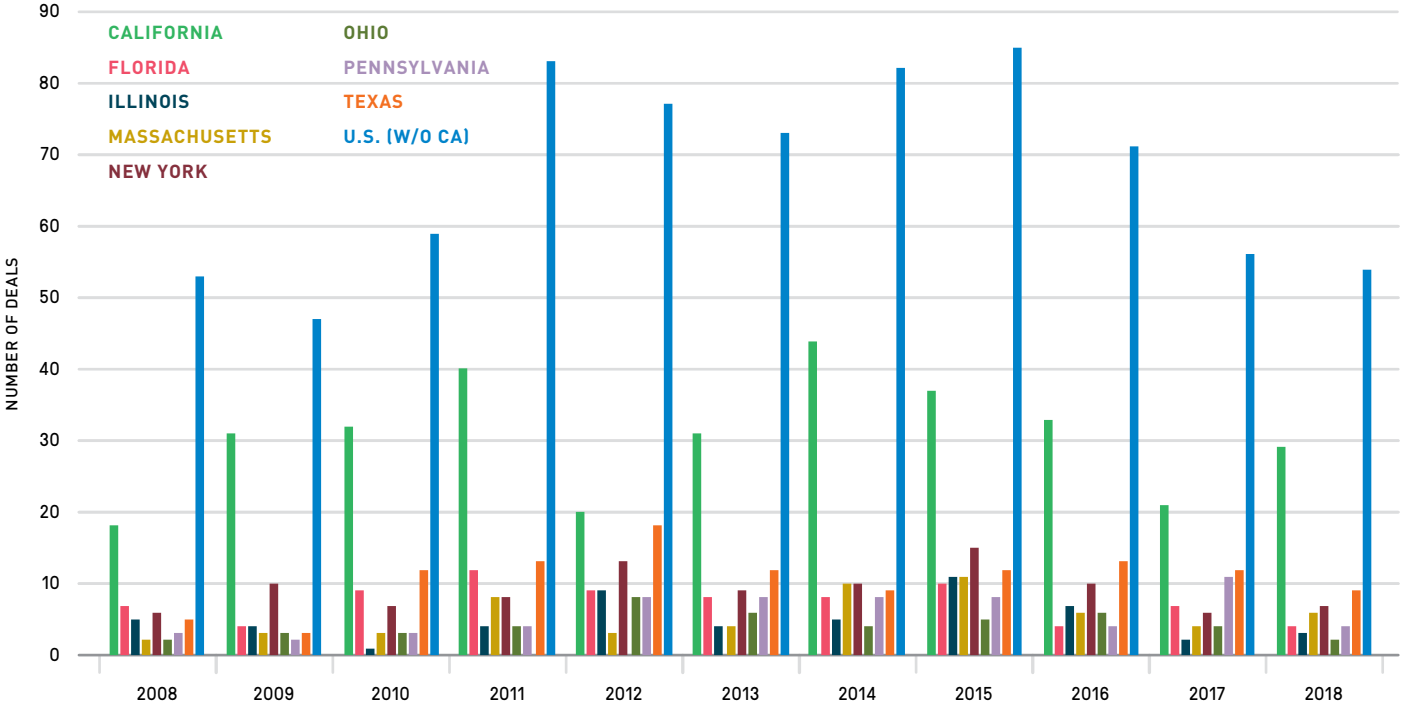
CHALLENGES:

❶ Over time, investments in several segments have declined. A shift away from capital-intensive projects (e.g. solar PV manufacturing and biofuels) has, in part, caused VC investment in clean tech to decline since its peak in 2011, with early stage clean energy investors focusing since then on companies and technologies with lower capital intensity and increased speed of adoption.[89] Venture capital investment in solar totaled just $122.2 million in 2018, less than one-tenth of the $1.43 billion investment in 2008. Venture capital investments in Fuel Cells & Hydrogen have averaged less than $40 million annually since 2015, after peaking in 2011 with $253 million raised. Similarly, VC investments in Biofuels & Biochemicals totaled just $27 million in 2018, less than one-tenth of its peak in 2010, when $253 million was raised. For Solar, the decline is unsurprising; annual installation of solar PV[90] and solar patents have also stalled in recent years. These are all signs to pointing solar approaching maturity as a technology.

❷ In terms of number of deals made, only 22.6 percent of the deals made in the U.S. occurred in California in 2018, which is down slightly from 23.5 percent in 2017. This represents a substantial decline over time—30 percent to 40 percent of the deals from 2008 to 2016 occurred in California. This implies that fewer deals are being made in California, but the deals continue to be larger on average compared to the rest of the U.S. In 2018, the average deal in California was $25.3 million (up from $18 million in 2008) compared to $9.8 million in the U.S. (down from $14.8 million in 2008). The fewer number of deals combined with higher dollar amount invested implies deals are increasingly larger, but are going to fewer startups. In 2018, there were 11 deals of at least $100 million, compared to just three deals at that level in 2017 and five deals in 2016, reflecting a global trend toward larger "supergiant" VC rounds.[91] As VC funds are trending toward greater concentration, the need to ensure the right innovations are being supported to help reduce emissions will become even more critical.

Figure 65. Mergers & Acquisitions of Clean Technology Companies

BY STATE OF TARGETED COMPANIES, 2008–2018



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: PitchBook, LLC. NEXT 10 / SF · CA · USA

NOTABLE DEALS & INVESTMENTS IN 2018

Farasis Energy (Bay Area, $790 million): Within the Biofuels & Biochemicals segment, this company is a developer of lithium-ion batteries intended to provide longer range, greater power, improved cooling technology and longer service life. Farasis Energy raised $790 million of Series C venture funding from Chinese investors in February 2018.[92]

Zoox (Bay Area, $500 million): Within the Transportation segment, Zoox is a developer of an autonomous mobility ecosystem that includes self-driving vehicles, control systems, artificial intelligence (AI) and a ride-sharing service designed to improve urban mobility. The company raised $500 million of Series B funding from lead investor Grok Ventures in July 2018.[93]

These two deals alone accounted for more than one-third of the venture capital amount raised in California in 2018.

Congruent Ventures (new VC company with $92 million initial investment): Founded with Prelude Ventures and the University of California, the fund targets four key sectors: clean energy, urbanization and mobility, food and agriculture, and industrial supply-chain innovation. The creation of the fund represents the shift in the clean tech VC space away from the early-stage energy plays of the late 2000s to low-overhead, easily scalable businesses based more on software than hardware.[94]

HIGHLIGHT:

Highlight: California leads all other states in mergers & acquisitions (M&A) deals of clean tech companies, where a quarter of them took place in 2018. Of the 118 clean tech M&A deals in the U.S. last year, 29 of them were in California. This is three times greater than in runner-up Texas, where nine M&A deals clean technology companies took place.

Similar to clean technology patents, the number of mergers & acquisitions of clean technology companies have trended down in recent years. In 2018, the amount of clean tech M&A deals in the U.S. overall was down slightly (-4%) from 123 deals in 2017. Since 2008, 2014 saw the most M&A deals with 180 in the U.S. overall, 44 of which were in California.

Regional Scorecards

Energy Productivity and Consumption

Metro areas with higher gross metropolitan product maintained higher rankings for both electricity and natural gas productivity. Top rankings for lowest natural gas consumption also held steady for both residential and non-residential uses, though a number of metropolitan statistical areas (MSAs) made significant gains in rankings for lowest electricity consumption. For the residential sector, Salinas again held the top spot for lowest electricity consumption per capita in 2017 (the latest year for which data are available), and Santa Barbara–Santa Maria maintained its number two spot. Los Angeles–Long Beach–Anaheim jumped from seventh to third, while San Jose–Sunnyvale–Santa Clara fell from third to seventh, in 2017. The top five-ranking MSAs for lowest electricity consumption per capita in the non-residential sector all maintained their rankings in 2017, with Santa Cruz–Watsonville again coming in first, followed by Santa Rosa–Petaluma (2nd), Chico (3rd), Yuba City (4th), and San Diego–Carlsbad (5th).

Solar Photovoltaic Capacity Installations

Many of the top-performing regions in terms of the most solar photovoltaic (PV) capacity installed (in alternate current) maintained high rankings in 2018, compared to 2017. The Inland Empire performed well across all sectors, with the Riverside-San Bernardino-Ontario MSA ranking second in commercial, industrial, and residential installations—though the San Bernardino County Board of Supervisors also this year approved a ban for new utility scale solar development in that county.[95] San Diego-Carlsbad had the most commercial solar PV capacity added with 40.7 megawatts (MW) installed (up from second place in 2017), while Riverside-San Bernardino-Ontario moved up from sixth place in 2017 with 30.8 MW installed. For the industrial sector, San Francisco–Oakland–Hayward added the most solar PV capacity with 5.45 MW installed in 2018. Notably, Santa Rosa-Petaluma installed the most industrial capacity in 2017, but fell to the 13th spot in 2018 with no new industrial PV installations. San Diego-Carlsbad also had the most residential solar PV capacity installed in 2018, up from third place in 2017, with 125.2 MW added.

While many of the state's largest metro regions scored well in terms of total capacity installed, on a per capita basis, the Central Valley and rural California had the most total solar PV capacity installed in 2018. Madera installed the most solar capacity per capita (0.12 KW/person), followed by Yuba City (0.085 KW/person), and Visalia–Porterville (0.08 KW/person).

Zero-Emission Vehicles

While clean vehicle rebates continued to be concentrated in the more urban metro areas in 2018, smaller, more rural areas saw a greater increase year-over-year. Los Angeles–Long Beach–Anaheim maintained the top spot with 28,642 rebates (+46.4% compared to 2017), followed by San Francisco–Oakland–Hayward with 13,418 (+63.9%), and San Jose–Sunnyvale–Santa Clara with 8,573 (+48%). On the other hand, clean vehicle rebates more than doubled in two smaller metro areas—increased by 110.4 percent in Chico and by 103.8 percent in Yuba City—from 2017 to 2018.

Los Angeles–Long Beach–Anaheim had the most electric vehicles registered (178,741), but the rankings change when looking at electric vehicles as a share of total vehicles registered. In that case, San Jose–Sunnyvale–Santa Clara takes the number one spot with 37,517 electric vehicles registered per one million vehicles, followed by San Francisco–Oakland–Hayward (25,140) and two smaller MSAs—Santa Rosa–Petaluma (17,714) and Santa Cruz–Watsonville (17,533)—in 2018. Over time, increasing clean vehicle rebates and charging infrastructure could help facilitate greater electric vehicle adoption in the more rural areas of the state.

Commute Time by Driving

As high housing costs push residents farther from job centers, commute times by driving increased in most metro areas across the state from 2016 to 2017 (the latest year for which data are available). Redding had the shortest average commute with 18.7 minutes, while Santa Barbara–Santa Maria fell to the number two spot with 19.3 minutes, in 2017. Riverside–San Bernardino–Ontario continued to have the longest commute (31.5 minutes), followed by San Francisco–Oakland–Hayward (31.4 minutes) and Stockton–Lodi (31.3 minutes). Smaller metro areas saw the greatest year-over-year increase—Napa (+12.2%), Modesto (+11.6%), and Oxnard–Thousand Oaks–Ventura (+10.4%)—from 2016 to 2017. While most commute times went up, six MSAs saw a decrease in their commute time by driving: San Luis Obispo–Paso Robles–Arroyo Grande (-6.6%), Redding (-4.6%), and Salinas (-3.4%), El Centro (-2.7%), Visalia–Porterville (-1.0%), and Riverside–San Bernardino–Ontario (-0.3%).

Public Transportation

While San Francisco–Oakland–Hayward, Los Angeles–Long Beach–Anaheim, and San Diego–Carlsbad continued to maintain the top three spots for greatest public transit ridership, over half of the state's MSAs saw a decline in unlinked passenger trips (UPTs, or trips on one transit vehicle not including connections) from 2017 to 2018. The greatest decreases in public transit ridership were in rural parts of the state, with Chico seeing the largest decline (-10.7%), followed by Redding (-9.5%) and Modesto (-7.1%). Only five MSAs saw a significant increase in public transit ridership from 2017 to 2018. In 2018, Hanford–Corcoran, with 26.9 UPTs, saw the largest increase (+13.5%), followed by Merced (+9.7%), and Fresno (+8.4%).

Regional Economic & Environmental Indicators: Rankings

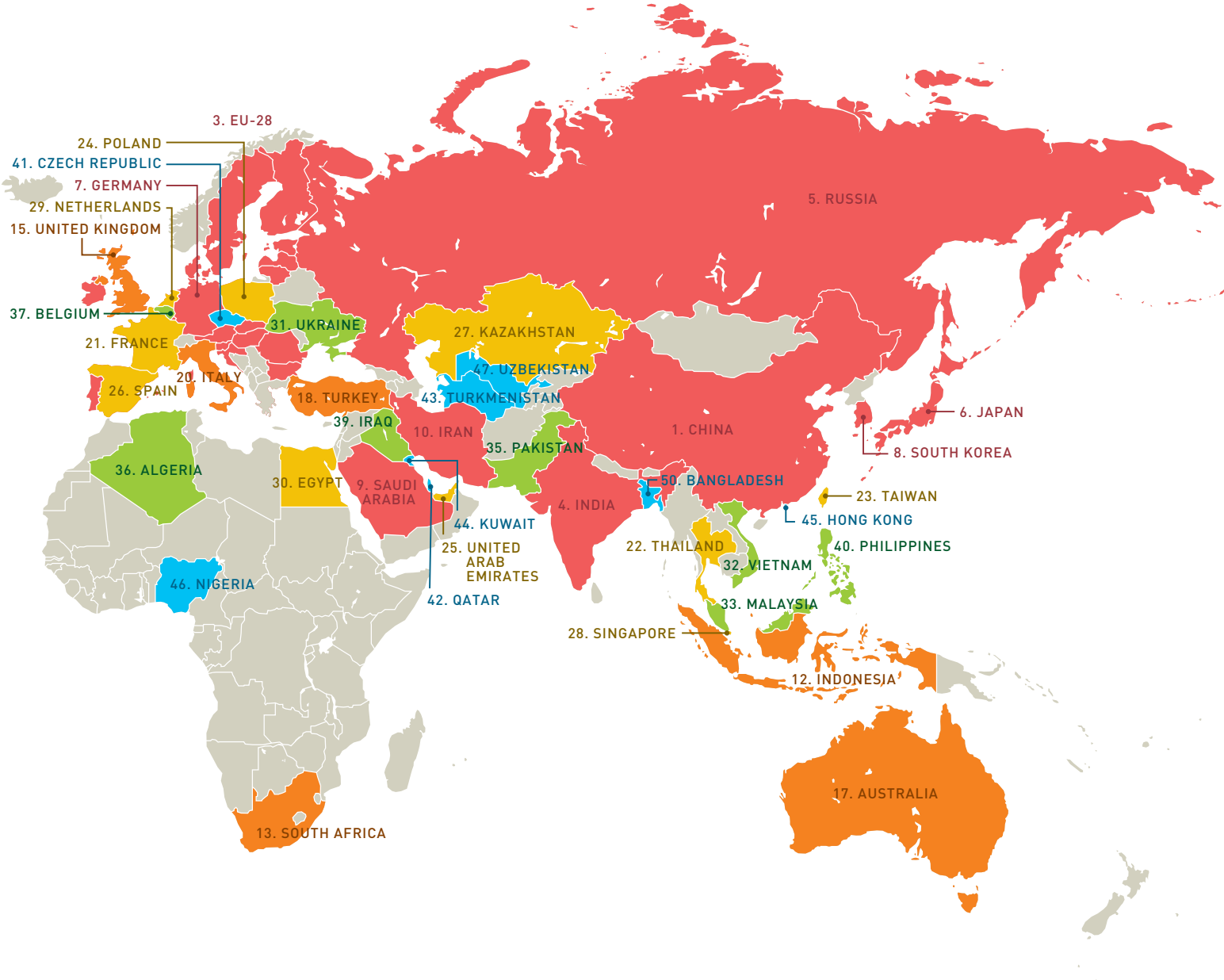
REGION	Highest Electricity Productivity	Highest Natural Gas Productivity	Lowest Electricity Consumption per Capita: Residential	Lowest Electricity Consumption per Capita: Non-Residential	Lowest Natural Gas Consumption per Capita: Residential	Lowest Natural Gas Consumption per Capita: Non-Residential	Shortest Commute Time by Driving	Most Green Technology Patents	Most Clean Vehicle Rebates	Electric Vehicles Registered	Electric Vehicles Registered per 1 million persons	Electric Vehicles Registered per 1 million vehicles	Highest Solar Capacity Installed: Commercial	Highest Solar Capacity Installed: Industrial	Highest Solar Capacity Installed: Residential	Highest Public Transportation Ridership per Capita
BAKERSFIELD	26	26	13	26	8	26	8	11	15	15	20	18	5	4	7	13
CHICO	15	14	24	3	18	4	4	21	20	20	18	20	20	13	13	21
EL CENTRO	21	17	22	11	1	17	6	25	26	26	26	26	26	13	26	22
FRESNO	14	19	19	15	7	20	9	21	9	9	16	16	3	3	5	9
HANFORD-CORCORAN	24	24	12	24	5	23	5	23	24	25	23	21	15	5	19	4
LOS ANGELES–LONG BEACH–ANAHEIM	4	4	3	14	11	14	22	3	1	1	5	5	4	11	3	2
MADERA	23	22	20	23	2	22	12	19	25	23	21	19	9	7	18	–
MERCED	25	25	17	25	4	24	16	18	21	21	22	23	13	13	17	25
MODESTO	19	20	23	19	12	19	21	12	17	17	17	17	22	13	24	19
NAPA	6	5	14	18	25	11	14	17	18	18	6	6	21	13	25	11
OXNARD–THOUSAND OAKS–VENTURA	10	3	8	10	17	6	17	8	7	7	8	8	19	13	12	20
REDDING	20	12	26	13	9	9	1	23	22	22	19	24	25	12	22	23
RIVERSIDE–SAN BERNARDINO–ONTARIO	17	16	18	7	10	8	26	6	5	5	13	13	2	2	2	16
SACRAMENTO–ROSEVILLE–ARDEN-ARCADE	12	6	25	8	23	5	15	5	6	6	10	10	8	13	6	8
SALINAS	9	10	1	9	14	12	10	13	16	16	14	14	11	13	21	10
SAN DIEGO-CARLSBAD	3	2	5	5	3	1	13	4	4	4	7	7	1	13	1	3
SAN FRANCISCO–OAKLAND–HAYWARD	2	9	6	17	26	21	25	1	2	2	2	2	6	1	4	1
SAN JOSE–SUNNYVALE–SANTA CLARA	1	1	7	22	20	10	19	2	3	3	1	1	12	9	8	6
SAN LUIS OBISPO–PASO ROBLES–ARROYO GRANDE	11	15	9	6	21	16	6	15	14	14	9	9	18	13	16	12
SANTA CRUZ–WATSONVILLE	5	7	4	1	16	3	20	7	12	10	4	4	23	13	23	5
SANTA MARIA–SANTA BARBARA	8	11	2	12	19	15	2	9	13	12	11	11	24	13	20	7
SANTA ROSA–PETALUMA	7	8	15	2	24	7	11	10	8	8	3	3	16	13	15	15
STOCKTON–LODI	18	18	11	20	15	13	24	15	10	11	15	15	10	8	9	14
VALLEJO–FAIRFIELD	13	23	10	16	22	25	23	13	11	13	12	12	14	6	10	18
VISALIA–PORTERVILLE	22	21	16	21	6	18	3	20	19	19	24	22	7	10	11	24
YUBA CITY	16	13	21	4	13	2	18	25	23	24	25	25	17	13	14	17

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Most recent year is 2017 for all metrics EXCEPT for Green Technology Patents, Clean Vehicle Rebates, Solar Capacity Installed, Electric Vehicles Registered per 1 million vehicles, and Public Transit Ridership, where the most recent year is 2018. Real GDP: Inflation adjusted GDP where base year is 2017. Solar Capacity Installed: Unit based on alternate current in megawatts. Electric vehicles on road include neighborhood electric vehicles, battery electric vehicles, plug-in hybrid electric vehicles, and fuelcell electric vehicles. Data Sources: Solar, California Solar Statistics: Vehicle Rebates: California Clean Vehicle Rebate Project; Patents: IPCheckups, CleanTech Patent Edge; Gas Consumption: California Energy Commission; Electric Consumption: California Energy Commission; Population: U.S. Census Bureau; Commute Time: U.S. Census Bureau, American Community Survey; GDP: U.S. Department of Commerce, Bureau of Economic Analysis. NEXT 10 / SF · CA · USA

International Scorecards

Relative to the other top 50 polluters across the globe, California's carbon economy profile improved in most areas in 2016—the latest year for which internationally comparable data were available. California had the 19th-highest level of energy-related carbon emissions in 2016, down one place from the previous year. However, this shift was due to Turkey leaping three places from 21st to 18th—ahead of California, Italy and France—as a result of the country's carbon emissions increasing by 11.2% from 2015 to 2016. In addition to improving in its emissions ranking, California also improved in terms of energy productivity (GDP relative to energy consumption). The state ($327.5 USD GDP/million BTU) overtook Japan ($311.5 USD GDP/million BTU) to have the 6th-highest energy productivity ranking.

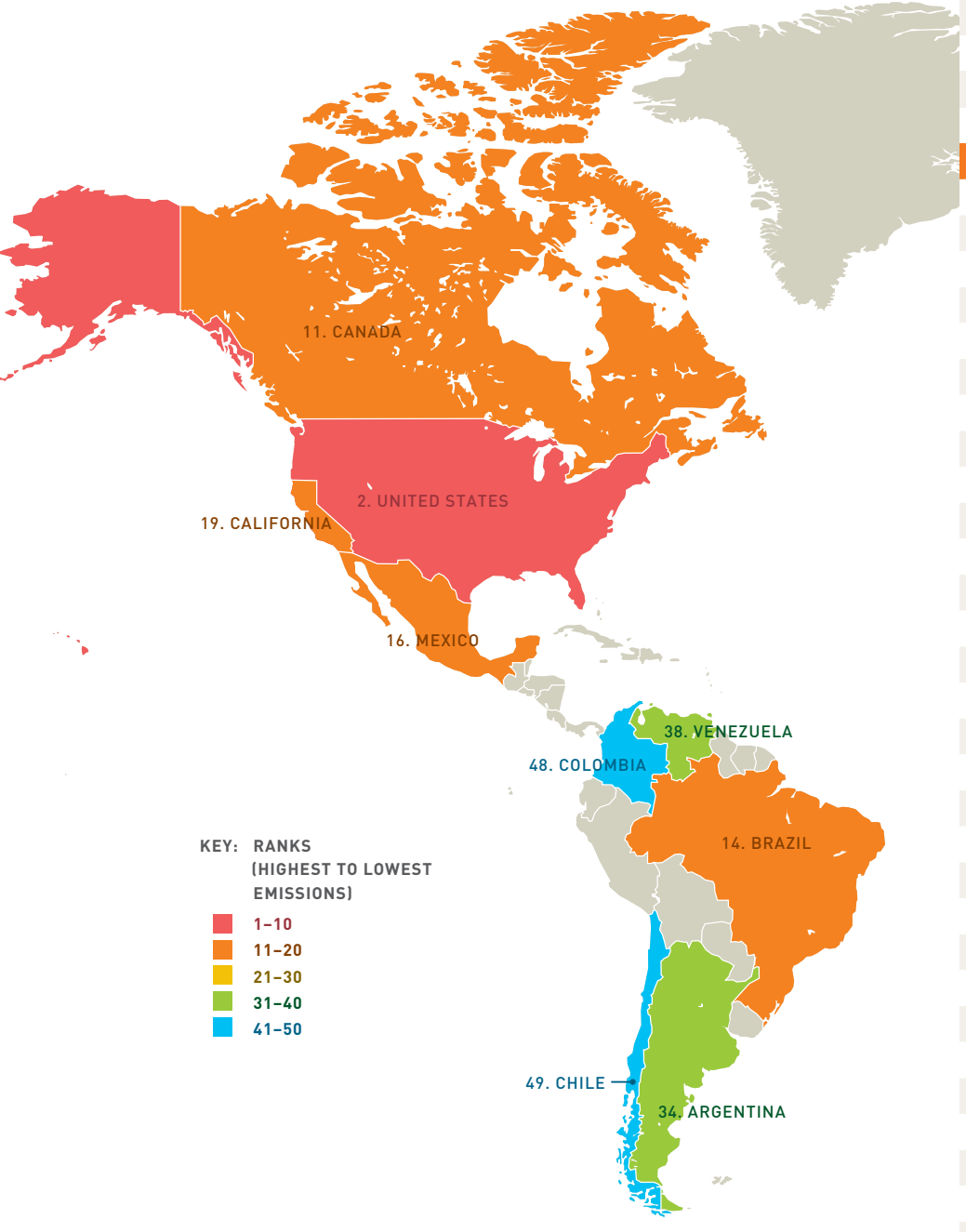
California also improved on a number of indicators at the per capita level. California's energy consumption per capita improved one place from 37th to 36th and the state's electricity consumption per capita (6,550 kWh/person) improved two places from 38th to 36th, surpassing Germany (6,646 kWh/person) and France (6,745 kWh/person). California's ranking on emissions per capita (where one is the lowest) went up four places from 34th to 30th. From 2006 to 2016, the state reduced its emissions per capita by 16 percent while the U.S.



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: *OECD Member Countries. Analysis and data sources the same as in previous sections; rankings are out of the top 50 polluters of GHG emissions from energy consumption. NEXT 10 / SF · CA · USA

(including California) saw a decrease of 19 percent. Over that same period, both India and China increased their emissions per capita by 50 percent.

Most notably in 2016, California's share of electricity generation from renewable sources excluding hydroelectric (27.90% of total generation) leaped five places—ahead of Spain (26.03%), the United Kingdom (25.97%), Italy (24.66%), EU-28 (20.30%) and Belgium (18.72%)—from the 7th-highest share to 2nd place, trailing closely behind Germany (28.51%).



RANK	REGION	MILLION $MTCO_2e$
1	CHINA	10592.8
2	UNITED STATES*	5172.4
3	EU-28	3752.3
4	INDIA	2154.8
5	RUSSIA	1766.6
6	JAPAN*	1202.5
7	GERMANY*	826.4
8	SOUTH KOREA	771.1
9	SAUDI ARABIA	656.6
10	IRAN	638.5
11	CANADA*	633.4
12	INDONESIA	513.1
13	SOUTH AFRICA	510.8
14	BRAZIL	492.5
15	UNITED KINGDOM*	480.7
16	MEXICO*	452.6
17	AUSTRALIA*	411.7
18	TURKEY*	366.1
19	CALIFORNIA	363.3
20	ITALY*	356.1
21	FRANCE*	354.1
22	THAILAND	342.3
23	TAIWAN	326.3
24	POLAND*	307.4
25	UNITED ARAB EMIRATES	288.9
26	SPAIN*	286.1
27	KAZAKHSTAN	279.3
28	SINGAPORE	255.2
29	NETHERLANDS*	248.7
30	EGYPT	229.4
31	UKRAINE	224.0
32	VIETNAM	218.8
33	MALAYSIA	215.7
34	ARGENTINA	194.1
35	PAKISTAN	175.7
36	ALGERIA	138.7
37	BELGIUM*	137.6
38	VENEZUELA	130.2
39	IRAQ	120.5
40	PHILIPPINES	110.7
41	CZECH REPUBLIC*	106.3
42	QATAR	102.5
43	TURKMENISTAN	99.0
44	KUWAIT	98.4
45	HONG KONG	98.3
46	NIGERIA	97.1
47	UZBEKISTAN	92.9
48	COLOMBIA	87.7
49	CHILE*	83.5
50	BANGLADESH	79.2

Ranking Summary of the Top 50 Polluters of GHG Emissions From Energy Consumption

RANK	TOTAL GHG EMISSIONS FROM ENERGY CONSUMPTION RANKING		CARBON ECONOMY RANKING	GHG EMISSIONS PER CAPITA RANKING	ENERGY PRODUCTIVITY RANKING
	Highest Total Emissions in 2016 ($MTCO_2e$)	2016 GDP per Capita, 2016 US $	Lowest Carbon Intensity ($MTCO_2e$/U.S. $10,000 GDP) in 2016	Lowest Emissions Per Capita ($MTCO_2e$/person) in 2016	Highest Energy Productivity (GDP in 2016 USD/BTU) in 2016
1	CHINA	$8,002	VENEZUELA	BANGLADESH	VENEZUELA
2	UNITED STATES*	$55,135	ARGENTINA	NIGERIA	ARGENTINA
3	EU-28	$38,038	FRANCE*	PAKISTAN	NIGERIA
4	INDIA	$2,621	BRAZIL	PHILIPPINES	UNITED KINGDOM*
5	RUSSIA	$19,904	CALIFORNIA	INDIA	ITALY*
6	JAPAN*	$48,315	NIGERIA	COLOMBIA	CALIFORNIA
7	GERMANY*	$51,421	UNITED KINGDOM*	INDONESIA	JAPAN*
8	SOUTH KOREA	$27,813	ITALY*	VIETNAM	GERMANY*
9	SAUDI ARABIA	$22,895	EU-28	BRAZIL	FRANCE*
10	IRAN	$14,334	COLOMBIA	EGYPT	BRAZIL
11	CANADA*	$55,657	SPAIN*	UZBEKISTAN	EU-28
12	INDONESIA	$5,284	JAPAN*	IRAQ	TURKEY*
13	SOUTH AFRICA	$10,909	GERMANY*	ALGERIA	SPAIN*
14	BRAZIL	$17,307	TURKEY*	MEXICO*	COLOMBIA
15	UNITED KINGDOM*	$46,516	BELGIUM*	VENEZUELA	AUSTRALIA*
16	MEXICO*	$12,544	CHILE*	ARGENTINA	HONG KONG
17	AUSTRALIA*	$66,415	NETHERLANDS*	TURKEY*	NETHERLANDS*
18	TURKEY*	$20,340	AUSTRALIA*	CHILE*	CHILE*
19	CALIFORNIA	$65,395	UNITED STATES*	THAILAND	BELGIUM*
20	ITALY*	$35,722	MEXICO*	UKRAINE	PHILIPPINES
21	FRANCE*	$44,167	HONG KONG	FRANCE*	MEXICO*
22	THAILAND	$6,642	BANGLADESH	ITALY*	INDONESIA
23	TAIWAN	$21,309	CANADA*	SPAIN*	BANGLADESH
24	POLAND*	$15,937	PHILIPPINES	MALAYSIA	UNITED STATES*
25	UNITED ARAB EMIRATES	$58,057	INDONESIA	EU-28	CZECH REPUBLIC*
26	SPAIN*	$30,377	CZECH REPUBLIC*	UNITED KINGDOM*	POLAND*
27	KAZAKHSTAN	$16,903	EGYPT	CHINA	CANADA*
28	SINGAPORE	$52,042	POLAND*	IRAN	EGYPT
29	NETHERLANDS*	$54,237	PAKISTAN	POLAND*	MALAYSIA
30	EGYPT	$5,033	SOUTH KOREA	CALIFORNIA	INDIA
31	UKRAINE	$6,793	IRAN	SOUTH AFRICA	PAKISTAN
32	VIETNAM	$2,539	MALAYSIA	JAPAN*	SOUTH KOREA
33	MALAYSIA	$12,332	ALGERIA	CZECH REPUBLIC*	TAIWAN
34	ARGENTINA	$47,112	RUSSIA	GERMANY*	IRAN
35	PAKISTAN	$1,720	INDIA	BELGIUM*	SOUTH AFRICA
36	ALGERIA	$5,703	TAIWAN	RUSSIA	ALGERIA
37	BELGIUM*	$48,943	QATAR	HONG KONG	IRAQ
38	VENEZUELA	$126,684	IRAQ	TAIWAN	RUSSIA
39	IRAQ	$4,542	UZBEKISTAN	NETHERLANDS*	KAZAKHSTAN
40	PHILIPPINES	$3,128	UKRAINE	SOUTH KOREA	SINGAPORE
41	CZECH REPUBLIC*	$23,158	THAILAND	KAZAKHSTAN	THAILAND
42	QATAR	$66,554	UNITED ARAB EMIRATES	UNITED STATES*	QATAR
43	TURKMENISTAN	$8,397	KUWAIT	AUSTRALIA*	CHINA
44	KUWAIT	$40,944	SINGAPORE	CANADA*	UKRAINE
45	HONG KONG	$43,167	SOUTH AFRICA	TURKMENISTAN	VIETNAM
46	NIGERIA	$3,672	KAZAKHSTAN	SAUDI ARABIA	UNITED ARAB EMIRATES
47	UZBEKISTAN	$4,236	VIETNAM	KUWAIT	KUWAIT
48	COLOMBIA	$9,622	CHINA	SINGAPORE	UZBEKISTAN
49	CHILE*	$18,484	SAUDI ARABIA	QATAR	SAUDI ARABIA
50	BANGLADESH	$1,593	TURKMENISTAN	UNITED ARAB EMIRATES	TURKMENISTAN

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: *OECD Member Countries. Analysis and data sources the same as in previous sections; rankings are out of the top 50 polluters of GHG emissions from energy consumption. NEXT 10 / SF · CA · USA

RANK	ENERGY PER CAPITA RANKING Least Total Energy Consumption per Capita (BTU/Person) in 2016	ELECTRICITY PER CAPITA RANKING Least Total Electricity Consumption per Capita (KWh/Person) in 2016	TOTAL RENEWABLE ELECTRICITY GENERATION RANKING Most Total Renewable Electricity in 2016	SHARE OF ELECTRICITY FROM RENEWABLE RANKING Highest Share of Renewables (Renewable Electricity/Total Electricity) in 2016
1	NIGERIA	NIGERIA	EU-28	GERMANY*
2	BANGLADESH	BANGLADESH	CHINA	CALIFORNIA
3	PAKISTAN	PAKISTAN	UNITED STATES*	SPAIN*
4	PHILIPPINES	PHILIPPINES	GERMANY*	UNITED KINGDOM*
5	INDIA	INDONESIA	JAPAN*	ITALY*
6	INDONESIA	INDIA	INDIA	EU-28
7	VIETNAM	IRAQ	BRAZIL	BELGIUM*
8	COLOMBIA	ALGERIA	UNITED KINGDOM*	PHILIPPINES
9	EGYPT	COLOMBIA	ITALY*	NETHERLANDS*
10	IRAQ	VIETNAM	SPAIN*	BRAZIL
11	ALGERIA	UZBEKISTAN	CALIFORNIA	CHILE*
12	UZBEKISTAN	EGYPT	CANADA*	POLAND*
13	BRAZIL	MEXICO*	FRANCE*	THAILAND
14	MEXICO*	VENEZUELA	TURKEY*	JAPAN*
15	TURKEY*	BRAZIL	AUSTRALIA*	CZECH REPUBLIC*
16	THAILAND	THAILAND	THAILAND	UNITED STATES*
17	CHILE*	ARGENTINA	POLAND*	AUSTRALIA*
18	ARGENTINA	TURKMENISTAN	MEXICO*	TURKEY*
19	UKRAINE	TURKEY*	NETHERLANDS*	FRANCE*
20	VENEZUELA	IRAN	BELGIUM*	INDIA
21	CHINA	UKRAINE	PHILIPPINES	CANADA*
22	MALAYSIA	SOUTH AFRICA	SOUTH KOREA	CHINA
23	POLAND*	POLAND*	INDONESIA	MEXICO*
24	ITALY*	CHINA	CHILE*	INDONESIA
25	SOUTH AFRICA	CHILE*	CZECH REPUBLIC*	SINGAPORE
26	SPAIN*	MALAYSIA	SOUTH AFRICA	SOUTH AFRICA
27	UNITED KINGDOM*	ITALY*	TAIWAN	SOUTH KOREA
28	EU-28	UNITED KINGDOM*	RUSSIA	TAIWAN
29	IRAN	SPAIN*	ARGENTINA	COLOMBIA
30	FRANCE*	KAZAKHSTAN	EGYPT	ARGENTINA
31	JAPAN*	EU-28	COLOMBIA	PAKISTAN
32	CZECH REPUBLIC*	HONG KONG	UKRAINE	EGYPT
33	GERMANY*	CZECH REPUBLIC*	SINGAPORE	UKRAINE
34	HONG KONG	RUSSIA	PAKISTAN	MALAYSIA
35	KAZAKHSTAN	NETHERLANDS*	MALAYSIA	ALGERIA
36	CALIFORNIA	CALIFORNIA	ALGERIA	KAZAKHSTAN
37	TAIWAN	GERMANY*	KAZAKHSTAN	RUSSIA
38	RUSSIA	FRANCE*	UNITED ARAB EMIRATES	UNITED ARAB EMIRATES
39	NETHERLANDS*	BELGIUM*	IRAN	HONG KONG
40	BELGIUM*	JAPAN*	VIETNAM	BANGLADESH
41	SOUTH KOREA	SINGAPORE	BANGLADESH	VIETNAM
42	AUSTRALIA*	SOUTH KOREA	HONG KONG	IRAN
43	UNITED STATES*	AUSTRALIA*	VENEZUELA	KUWAIT
44	TURKMENISTAN	TAIWAN	KUWAIT	NIGERIA
45	SAUDI ARABIA	SAUDI ARABIA	IRAQ	VENEZUELA
46	CANADA*	UNITED STATES*	NIGERIA	IRAQ
47	KUWAIT	CANADA*	QATAR	QATAR
48	SINGAPORE	QATAR	UZBEKISTAN	UZBEKISTAN
49	UNITED ARAB EMIRATES	UNITED ARAB EMIRATES	SAUDI ARABIA	SAUDI ARABIA
50	QATAR	KUWAIT	TURKMENISTAN	TURKMENISTAN

Endnotes

[1] The California Air Resources Board Greenhouse Gas Inventory provides estimates of the amount of GHGs emitted to the atmosphere by human activities within California. This project utilizes the 2019 edition of the inventory. The inventory includes estimates for carbon dioxide hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs)—which are often referred to as the "six Kyoto gases"—nitrogen trifluoride (NF_3), hexafluoroethane (C_2F_6), octafluoropropane (C_3F_8), and octafluorocyclobutane (C4F8). Note: In each new edition of the inventory, recalculations are made to correct errors, incorporate new methodologies, or—most commonly—to reflect changes in statistical data supplied by other agencies. Emission estimates are recalculated for all previous years to maintain a consistent time-series following IPCC recommendations for developing GHG inventories. The 2019 inventory may report a different emission level for an earlier year than previous inventory versions.

[2] The GHG inventory was developed in accordance with the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories, the internationally recognized standard for developing national GHG inventories. There exist other categories besides included emissions: excluded emissions, carbon dioxide from biogenic materials, emissions and removals from forest lands and wood products, and other emissions. Excluded emissions are discussed elsewhere in this chapter.

[3] Inflation-adjusted in 2016 dollars.

[4] According to the Air Resources Board, excluded emissions are tracked for informational purposes, but not included in the GHG inventory. Following Intergovernmental Panel on Climate Change (IPCC) guidelines, emissions from international aviation and water-borne navigation should be reported in an excluded category. In the case of a state-level rather than a national inventory, this raises the question of how to treat emissions from interstate flights. Based upon jurisdictional interpretation of IPCC protocols, ARB staff opted to estimate, but not include, emissions resulting from aviation fuel purchased in California and used for interstate flights, as is done for international flights.

[5] Based on AB 341's measurement system. Source: Statewide Diversion and Per Capita Disposal Rate Statistics, CalRecycle. Retrieved from: https://www.calrecycle.ca.gov/lgcentral/goalmeasure/disposalrate

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[67] A bilateral agreement between a Generation Company (GenCo) and a Distribution Utility (DU) for the purchase and supply of power.

[68] Some of PG&E's sales to CCAs include: Clean Power Alliance, East Bay Community Energy, Monterey Bay Community Power, and Silicon Valley Clean Energy.

[69] Note that total system electric generation for interconnected solar installations is limited to projects rated at 1 megawatt (MW) and larger. Most solar photovoltaic systems on residential households and commercial buildings are less than one MW, and together these small scale solar PV projects account for a sizable amount of electricity generated in California. The Energy Information Administration (EIA) has recently started to include estimates for small-scale solar PV electricity generation installations, which it defines as having a generating capacity of less than one MW.

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[86] Logistics category could include things like monitoring and controlling a heavy-duty vehicle's course or courses to optimize the use of the load capacities.

[87] Structures category could include things like a segmental tube section of the hyperloop or advances in freight container technology.

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Appendix

GENERAL REFERENCES

Inflation Adjustment

Inflation-adjusted figures are converted into current dollars using the U.S. city average Consumer Price Index (CPI) of all urban consumers, published by the Bureau of Labor Statistics. For state level comparisons, inflation-adjusted figures are converted into current dollars based on state-specific deflators, published by the Bureau of Economic Analysis, U.S. Department of Commerce.

Gross Domestic Product

Nominal gross domestic product (GDP) data for California, U.S. states and the U.S. are sourced from the Bureau of Economic Analysis, U.S. Department of Commerce. Country GDP is at market prices in current 2016 dollars, expressed per U.S. dollar, from the World Bank's World Development Indicators. Gross Domestic Product by State is also referred as Gross State Product (GSP).

Population

Population data from California used to calculate per capita figures are from the California Department of Finance's: E-4 Population Estimates for Cities, Counties and the State, with 2000 and 2010 Census Counts. U.S., state and "U.S. without California" population data are from the U.S. Census Bureau, Population Estimates Branch. Country population data are from the U.S. Department of Agriculture's Economic Research Service, calculated from the Census Bureau International Population Database.

THE CARBON ECONOMY

Global Fossil Fuel Combustion, Carbon Economy, and Emissions Per Capita in California and Other Regions

Data for carbon dioxide emissions from the consumption of energy are from the U.S. Department of Energy – Energy Information Administration (EIA), International Energy Statistics. State level emissions data come from EIA's State CO_2 Emissions. Data for carbon dioxide emissions from the consumption

of energy include emissions due to the consumption of petroleum, natural gas, and coal, and also from natural gas flaring. Energy consumption data are based on the consumption of each primary energy source, and data are gathered from a variety of national and organization reports that collate data from energy users. Carbon dioxide emissions are calculated for each individual fuel by applying carbon emission coefficients to convert to million $MTCO_2e$ dioxide emitted per quadrillion BTU of fuel consumed. Calculations used GDP and Population data where applicable, as described above.

Unless otherwise noted, emissions data only include energy-related emissions, and therefore do not include emissions from sources such as agriculture, waste combustion, and industrial gases, because it is the most up-to-date information available. While these other emissions are important to track and reduce, the Green Innovation Index focuses on energy emissions, given the importance of energy-related indicators and the availability of recent data. A comparison of World Resources Institute's 2011 total world emissions data shows that energy-related emissions account for about 75 percent of global emissions. In addition, the ranking for the top emitters are similar when comparing total and energy-related emissions, and the rankings of the top six emitters are identical.

GHG Emissions and Gross Domestic Product, Total California Greenhouse Emissions, Emissions by Source, Emissions by Detailed Source Greenhouse gas (GHG) emissions data for these figures are from California Air Resources Board's "California Greenhouse Gas Inventory – by Sector and Activity" (August 2019). The 1990–1999 emissions include "gross emissions" and the 2000–2017 emissions are "included emissions" only unless otherwise noted. Calculations used GDP and Population data where applicable, as described above.

Disposal Rate

Data on waste disposal (landfilled or exported) in tons are from CalRecycle's Disposal Reporting System. The Disposal Reporting System (DRS) is the set of guidelines that tracks the origin of waste disposed in California's landfills, and waste sent from California to out-of-state landfills. DRS tracks disposal tonnages (including alternative daily cover (ADC), alternative intermediate cover (AIC), and beneficial reuse) and transformation sent to facilities in the state. Disposal and alternative daily cover (ADC) tonnage is subject to change due to revisions.

ENERGY EFFICIENCY

Energy Productivity and Energy Consumption per Capita

Energy data are from the U.S. Department of Energy – EIA, International Energy Statistics and State Energy Data System. Data is for total primary energy consumption, in British Thermal Units (BTU), of petroleum, dry natural gas, coal, and net nuclear, hydroelectric, and non-hydroelectric renewable electricity. Energy productivity divides GDP by total energy consumption. Primary energy is in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy (for example, coal is used to generate electricity). Calculations used GDP and Population data where applicable, as described above.

Electricity Consumption per Capita

Electricity consumption data are from the U.S. Department of Energy – EIA, International Energy Statistics and State Energy Data System. For the United States, total electric power consumption is equal to the data in the Total column under End Use from Table 8.1of the EIA's Annual Energy Review. For all other countries except the United States, total electric power consumption is equal to total net electricity generation, plus electricity imports, less electricity exports and less electricity transmission and distribution losses. Data are reported as net consumption as opposed to gross consumption. Net consumption excludes the energy consumed by the generating units. Calculations used Population data where applicable, as described above.

Electricity System Energy Losses

Electricity system energy losses are incurred through the generation, transmission, and distribution of electricity, which are allocated to each end-use sector.

RENEWABLE ENERGY

Renewable Energy Generation

Data for total electricity generation and renewable electricity generation by source are from the U.S. Department of Energy – EIA, International Energy Statistics. Data are for both utility and nonutility sources, and are reported as net generation (as opposed to gross generation). Renewable electricity data are for non-hydroelectric renewable, including geothermal, solar, tide, wave, wind, biomass and waste.

California renewable energy data is from the California Energy Commission, "Net System Power Reports" 2002–2017, Total System Power in Gigawatt Hours (GWh). U.S. data in the California section on total electricity generation data is from the U.S. Department of Energy, EIA, Electric Power Monthly reports. Annual totals from "Table 1.1 Net Generation by Energy Source: Total (All Sectors)," and "Table 1.1.A. Net Generation by Other Renewables: Total (All Sectors)." Because of different renewable energy definitions between California and the U.S., data represented for the U.S. do not include any hydro.

Renewable Portfolio Standard Cumulative Operational Capacity

Data are from the California Public Utilities Commission "RPS Project Status Table" released in February 2019. Projects include those Approved and Online, Approved in Development, Delayed but likely to be completed per CPUC, and those in the Renewable Auction Mechanism and Investor-Owned Utility Solar Photovoltaic programs. Projects are classified as online, in development, expired, or terminated. Years are based on origination year.

New Solar Installations, New Solar Installations by Sector

Solar capacity installed data are provided by Solar Energy Industries Association® (SEIA) and California Solar Initiative. SEIA data were taken from the U.S. Solar Market Insight Reports, 2007–2018. California Solar Initiative (CSI) data include municipal utility, and other utility-scale installations and Net Energy Metering (NEM) Interconnection Data.

Wind Installations

Wind capacity installed and cumulative data are provided by the American Wind Energy Association. Data is taken from quarterly and annual U.S. Wind Industry Market Reports, 2007–2018.

Energy Storage (for AB2514 Procurement)

AB 2514 eligible energy storage data of the three investor owned utilities are from California Public Utilities Commission. On April 2, 2015, the California Public Utilities (CPUC or Commission) opened an Order Instituting Rulemaking (OIR) in response to the enactment and ongoing implementation of legislation Assembly Bill 2514 (Skinner, Stats. 2010 - Ch. 469) and to continue to refine policies and program details, which established the Energy Storage Procurement Framework and Program and approved the utilities' applications in implementing the program. This rulemaking considers recommendations included in the California Energy Storage Roadmap, an interagency guidance document which was jointly developed by the California Independent System Operator, the California Energy Commission and the CPUC.

TRANSPORTATION

Emissions, Surface Transportation, Vehicle Miles Traveled

Total Vehicles and GHG Emissions from Surface Transportation and Vehicle Miles Traveled CARB's "California Greenhouse Gas Inventory – by Sector and Activity." Surface Transportation emissions sources include passenger vehicles, motorcycles and light and heavy duty trucks. Vehicle Miles Traveled (VMT) is defined as total distance traveled by all vehicles during a selected time period in geographic segment. VMT estimates for 1995–2007 are from the California Department of Transportation's "2008 California Motor Vehicle Stock, Travel and Fuel Forecast." VMT data for 2008–2017 are from the California Department of Transportation's Highway Performance Monitoring System's "California Public Road Data." Calculations use Population data sources where applicable.

New Light Vehicle Registration

Data for new light vehicle registration in California are from California New Car Dealers Association's Quarterly California Auto Outlook, which are sourced from IHS Markit. Light Vehicles include cars and light trucks. Cars are comprised of the following categories: subcompact, compact, sports/pony cars, mid-size, large, entry luxury, near luxury, luxury and high end sports cars. Light trucks are comprised of the following categories: compact/mid-size pickup, full size pickup, minivan, large van, subcompact SUV, compact SUV, mid-size SUV, large SUV, luxury subcompact SUV, luxury compact SUV, luxury mid-size SUV and luxury large SUV.

Alternative Vehicle Registrations

Data are from the California Energy Commission (CEC), compiled using vehicle registration data by fuel type from the California Department of Motor Vehicles. Alternative fuel types include all hybrid (gasoline and diesel), electric, plug-in hybrid, hydrogen, propane, biofuels, and natural gas. Zero-emission fuel-types include electric, plug-in hybrid, and hydrogen.

Electric Vehicle Charging Station

Data on alternative fueling station, which encompasses electric vehicle charging station, are from Alternative Fuel Data Center, U.S. Department of Energy. The data in the Alternative Fueling Station Locator are gathered and verified through a variety of methods. The National Renewable Energy Laboratory (NREL) obtains information about new stations from trade media, Clean Cities coordinators, a Submit New Station form on the Station Locator website, and through collaborating with infrastructure equipment and fuel providers, original equipment manufacturers (OEMs), and industry groups.

Public Transit Ridership

Unlinked Passenger Trips Data uses monthly American Public Transportation Association (APTA) data for the transit component of Transportation Safe Institute (TSI) for years prior to 2010, and data from FTA (Federal Transit Administration)'s NTD (National Transit Database) for 2010 and beyond. FTA is an agency of the United States Department of Transportation. The number of unlinked passenger trips is the measure used for the TSI.

Transit modes, include, among others, bus, trolleybus, vanpool, jitney, and demand response service; and heavy rail transit, light rail transit, commuter rail (including Amtrak contract commuter service), automated guideway transit, inclined plane, cable car, monorail, aerial tramway, and ferryboat. Monthly data is reported to NTD by transit agencies.

CLEAN TECHNOLOGY INNOVATION

Investment, M&As, and IPOs in Clean Technology

Clean technology investment data are provided by PitchBook Data, Inc. and includes disclosed investment deals in private companies. Data is through December 2018. VC data includes Seed, Series A-E+, and Growth Equity series types. Debt includes loan guarantees from the federal government, as well as structured debt and loans from private investors such as banks, investment funds, and financial services groups. Totals may not be the same across charts because of different investment types included. Dollar amounts are unadjusted for inflation (nominal). M&As are by location of the targeted company (e.g., not the buyer) in the year the deal was announced. IPOs are by location of the company and in the year the IPO was listed.

Clean Technology Patents

Global Clean Technology Patents are sourced from IP Checkups through the CleanTech Patent Edge™ database, which includes clean technology patent data including both granted patents and published patent applications from the U.S. Patent and Trade Office (USPTO) and the European Patent Office (EPO), and published patent applications from the World Intellectual Property Organization (WIPO, which includes 189 member countries). Patent counts by country included in this analysis reflect the location of the first named inventor in the earliest published patent within a patent family, as defined in INPADOC (International Patent Documentation). Inventors frequently file on the same invention in multiple patent systems (such as USPTO and also EPO), and analysis at the patent family level (i.e. the set of related patents for an invention, across systems) rather than at the individual patent level reduces double-counting of the same intellectual property. If country of first inventor was unclear and could not be interpolated from other documentation, the patent family was excluded from the analysis.

IP Checkups classifies patents into clean technology segments based on patent classification codes and key word searches. Some patents fell into multiple segment and sub definitions, and if these segments were equally applicable – as defined by IP Checkups and Beacon Economics – a patent was termed "multiple." Ranking analyses by segment includes any patent families classified into that segment, including those within family members which also apply to other segments. In contrast, total clean technology analysis includes only the dominant segment category, or the "multiple" designation to reduce double-counting. Assignee companies reflect the assignee at time of patent publication.

SPECIAL TOPIC: WILDFIRES

Acres Burned and Structures Destroyed by Wildfire

Data on acres burned and number of structures destroyed come from California Department of Forestry & Fire Protection (CalFire) Fact Sheets. Data are as of March 19, 2019. The data does not include fire jurisdiction and regardless of whether the fires were state, federal, or local responsibility. Structures include homes, outbuildings (barns, garages, sheds, etc.) and commercial properties destroyed.

Emergency Fund Fire Suppression Expenditures

Emergency fund fire suppression costs data is from CalFire, and is expressed in fiscal year instead of calendar year. Suppression costs are inflation-adjusted using monthly CPI data in which the months from July 2017 to June 2018 are averaged and used as the base year. Expenditures for FY 2018–2019 are estimates.

Wildfire Emissions

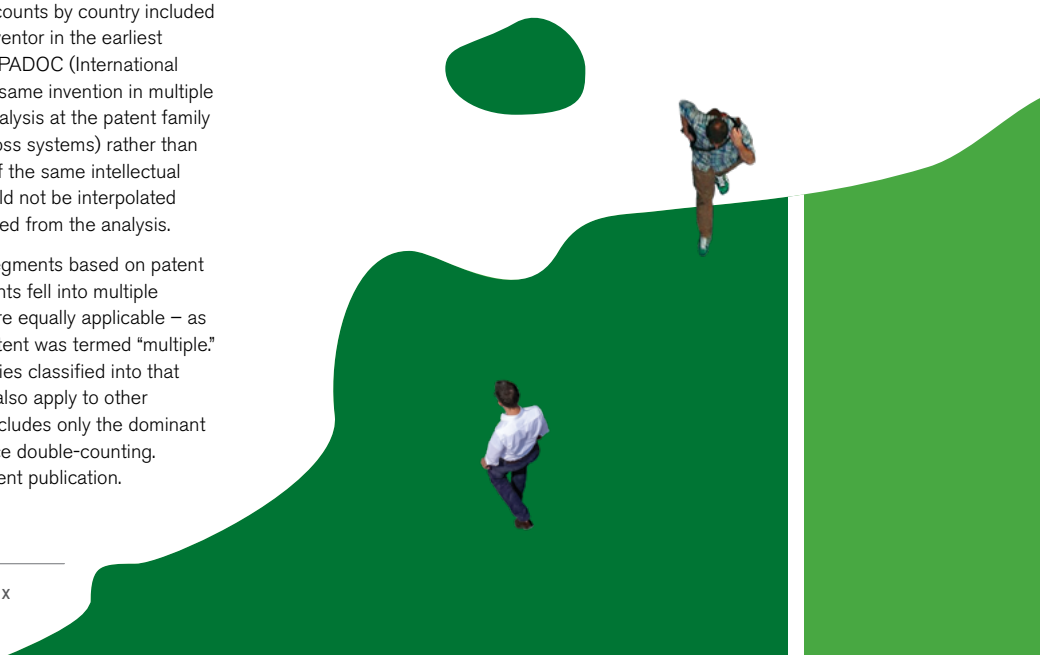
California CO_2 emissions (annual) from wildfires are estimates by California Air Resources Board using the First Order Fire Effects Model (FOFEM) and CalFire's fire footprints. FOFEM does not model agricultural and developed lands. FOFEM is a computer program for predicting tree mortality, fuel consumption, smoke production, and soil heating caused by prescribed fire or wildfire. First order fire effects are those that concern the direct or indirect or immediate consequences of fire. First order fire effects form an important basis for prediction secondary effects such as tree regeneration plant succession, and changes in site productivity, but these long-term effects generally involve interaction with many variables (for example, weather, animal use, insects, and disease) and are not predicted by this program. Currently, FOFEM provides quantitative fire effects information for tree mortality, fuel consumption mineral soil exposure, smoke and soil heating.

Fire and Wildfire Programs Appropriations

Funding for fire and wildfire programs are appropriated from the Greenhouse Gas Reduction Fund (GGRF), which are deposited from the State's Cap-and-Trade auction proceeds. Data on the amounts appropriated are from California Air Resources Board's California Climate Investments Annual Reports (2015 to 2019).

Firefighter, Forest Fire Inspectors and Prevention Specialists Workforce

Firefighter, forest fire inspectors and prevention specialists employment data are from Bureau of Labor Statistics' Occupational and Employment Statistics (OES) for California. The OES program produces employment and wage estimates annually for over 800 occupations (organized by Standard Occupational Classification codes). These estimates are available for the nation as a whole, for individual states, and for metropolitan and nonmetropolitan areas.



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