2018 California Green Innovation Index

10th Edition

NEXT 10

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 2018 Index is the tenth 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 IN MILLION METRIC TONS OF CO_2 EQUIVALENT

2016
429.35[1]

2015
441.4

AVERAGE ANNUAL GROWTH IN EMISSIONS

1990–2016
-0.01%
Average annual growth

2006–2016
-1.17%
Average annual growth

2015–2016
-2.73%
One year growth

PER CAPITA GHG EMISSIONS

2016
10.94
Metric tons of CO_2 equivalent

TARGETS: TOTAL GHG EMISSIONS IN MILLION METRIC TONS OF CO_2 EQUIVALENT

by 2020
431

by 2030
259

by 2050
86

Greenhouse Gas Data Source: California Air Resources Board, "2016 California Greenhouse Gas Inventory – by Sector and Activity." California Department of Finance.

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Dear Californians,

AUGUST 2018

At the time of this writing, climate change-fueled forest fires are ravaging our state – setting records, destroying homes and communities, and racking up billions in damages. We are no longer trying to avoid the worst impacts of climate change; we are experiencing them with increasing severity each year.

Yet while California has seen hard times from extended drought and wildfire seasons, we have made progress advancing our climate and clean energy goals. This summer, the state hit its 2020 greenhouse gas mitigation goal four years early and, by 2020, the state's Energy Commission projects that we will hit our renewable energy goal ten years early, as well.

Since the passage of California's landmark climate bill AB 32 in 2006, the state has consistently managed to reduce its emissions while growing its economy. Between 2006 and 2016, California had greater emissions reductions (-11.1%) than the U.S. as a whole (-10.2%) while also achieving greater economic output (15.9% growth compared to 11.6%). Ten years of data from our *California Green Innovation Index* show that it is possible to address climate change without impacting economic growth and, in fact, the cost of not addressing climate change would likely be much worse.

While the political commitment to prioritizing the clean-energy economy has changed at the federal level, California's leadership – at all levels of government – has demonstrated an unwavering commitment to action. In the last year, we have extended our partnerships and collaborations with other states, nations, businesses, and subnational actors to address climate change and advance innovative clean technologies. At the same time, we have developed new policy mandates at home to drive emissions reductions and innovation, including a first-in-the-nation mandate to install rooftop solar on all new residential buildings starting in 2020. Governor Jerry Brown has set a goal of increasing the number of electric vehicles on the road to 5 million by 2030, and bills before the legislature are calling for 100 percent renewable energy by 2050, as well as increased utilization of distributed energy technologies and electric vehicles to help further decarbonize our energy and transportation sectors.

Emissions from the transportation sector remain a significant challenge for the Golden State. While our overall greenhouse gas emissions continue to decline, emissions from transportation were again on the rise – up 2.1 percent from 2015 to 2016, but down 8.8 percent from 2006 to 2016 (the latest year of available data). While fuel economy standards have done much to reduce emissions, there are more cars on the road today and, in the last few years, those cars have been driving farther distances as housing costs push people farther from job centers. Should the federal administration succeed in its attempt to roll back fuel efficiency standards and California's tailpipe emissions standards, annual greenhouse gas emissions could increase substantially and local air quality could deteriorate.

California is not an island. Even if we are to succeed in achieving all of our ambitious climate and clean energy goals, we are but one small part of a global problem, with just 1.1 percent of the world's total emissions coming from our state. If we are to stave off the worst impacts of climate change and remain competitive in a global economy increasingly fueled by clean energy, it will be critical that California not only tackle its greatest climate challenges like transportation, but also work across borders to leverage our success and learn from our peers. This September, California will share its successes and collaborate with other leading states and stakeholders at the Global Climate Action Summit in San Francisco. With a federal government that has not only abandoned advancement of national and international climate action but also worked to undermine existing progress, California has committed to help convene and leverage climate leadership from across the globe to advance the clean energy economy.

It is in this complex environment that we look forward to launching the tenth edition of the California Green Innovation Index. We hope that our trend analysis and data-driven report can help shed light on how far we've come, and what important challenges remain.

Sincerely,

F. Noel Perry

F. Noel Perry, Founder

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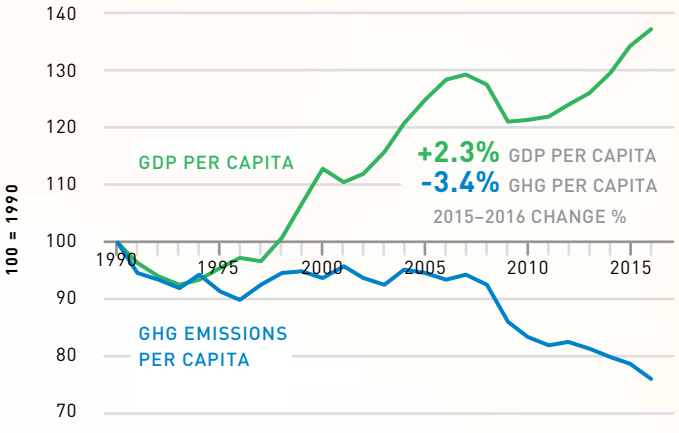
AT A GLANCE

GDP & EMISSIONS

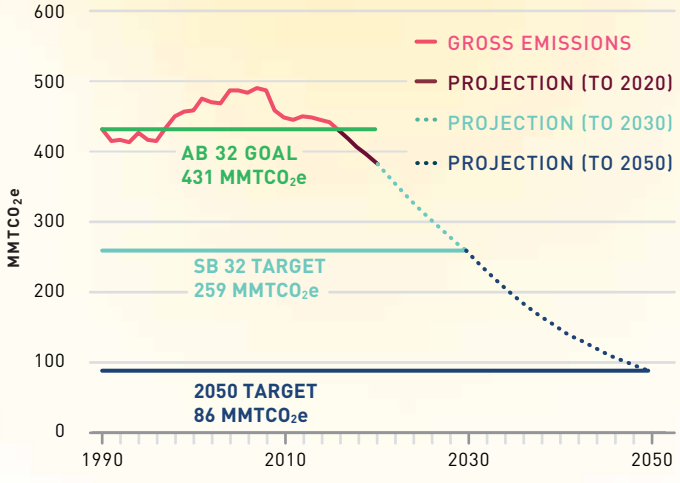
CALIFORNIA, IN 2016 $



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

GHG EMISSIONS

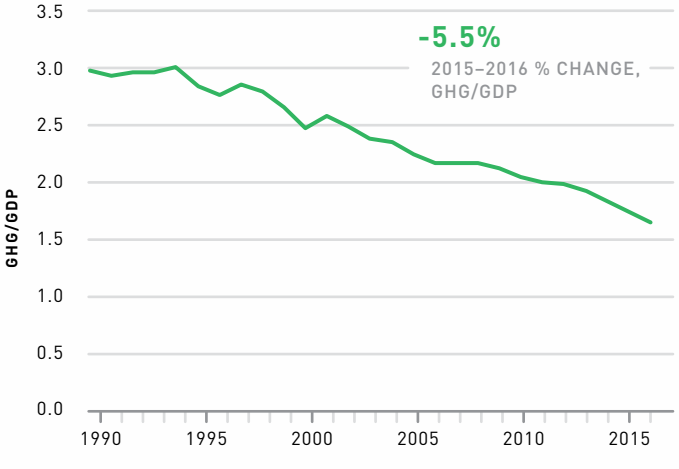
AND PROJECTED REDUCTION GOALS



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

CARBON ECONOMY

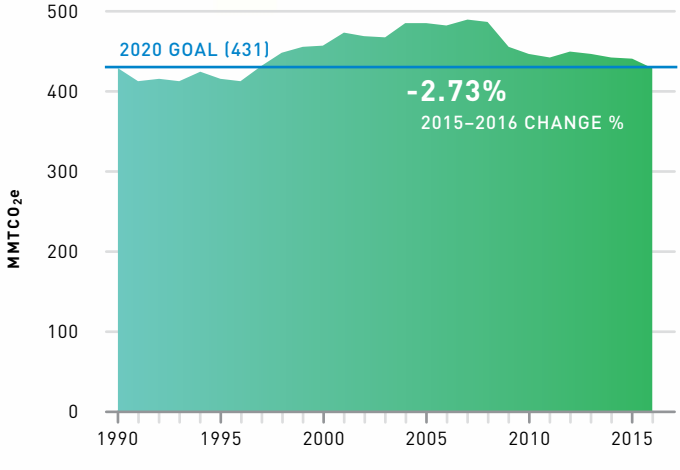
CALIFORNIA, IN 2016 $



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

GHG EMISSIONS

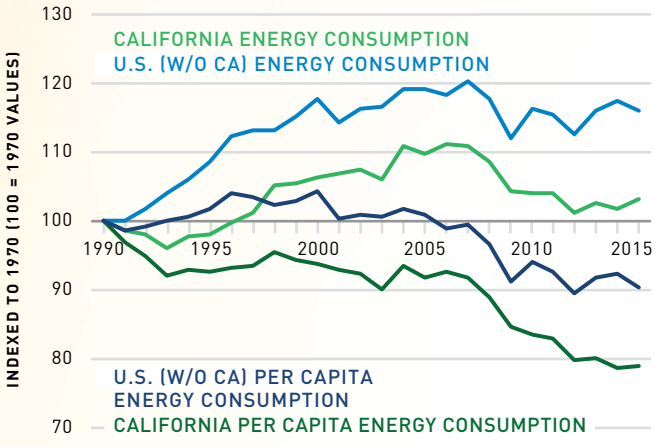
CALIFORNIA



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

TOTAL ENERGY CONSUMPTION RELATIVE TO 1990

TOTAL CONSUMPTION & PER CAPITA, CALIFORNIA & REST OF U.S.



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration, State Energy Data System; U.S. Census Bureau, Population Estimates Branch.
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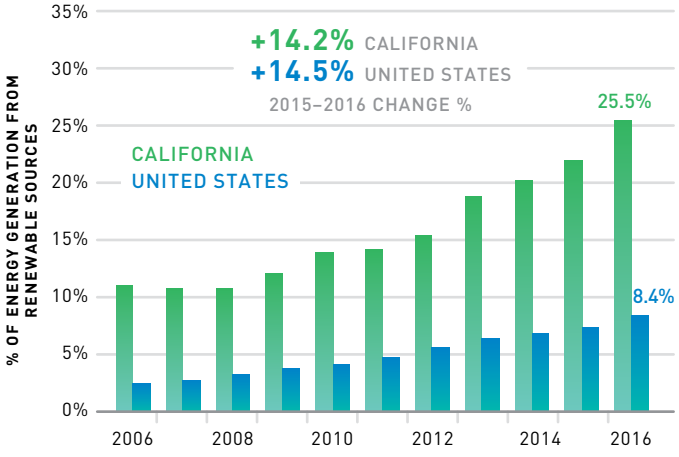
PERCENT OF TOTAL ENERGY GENERATION FROM RENEWABLE SOURCES

CALIFORNIA & U.S., 2006–2016



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

ALTERNATIVE FUEL AND ZERO-EMISSION VEHICLE REGISTRATIONS

CALIFORNIA

	2017	% CHANGE 17–16	% CHANGE 16–15
ELECTRIC	181,001	34.43%	35.46%
PLUG-IN HYBRID	164,286	41.80%	35.46%
NATURAL GAS	4,820	-9.52%	-67.62%
HYBRID	1,049,853	7.50%	9.75%
HYDROGEN	3301	252.67%	408.70%
TOTAL ALTERNATIVE FUEL VEHICLES	1,403,261	13.77%	13.22%
TOTAL ZEV	348,588	38.64%	37.36%
TOTAL VEHICLES	30,986,273	1.18%	3.81%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Zero-Emission Vehicles include electric, plug-in hybrid, and hydrogen vehicles. Data Source: California Energy Commission.
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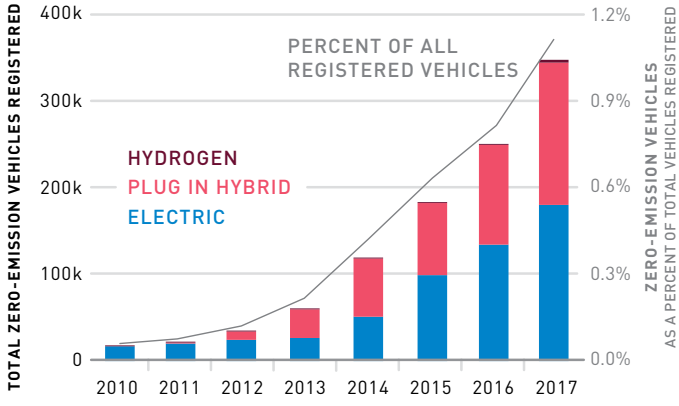
TRENDS IN TOTAL ZERO-EMISSION VEHICLE REGISTRATION

CALIFORNIA



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Energy Commission.
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TOTAL CLEAN TECHNOLOGY PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	4,200
2	TEXAS	1,473
3	NEW YORK	1,231
4	MICHIGAN	1,143
5	MASSACHUSETTS	948
6	ILLINOIS	825
7	OHIO	724
8	PENNSYLVANIA	717
9	FLORIDA	687
10	WASHINGTON	679

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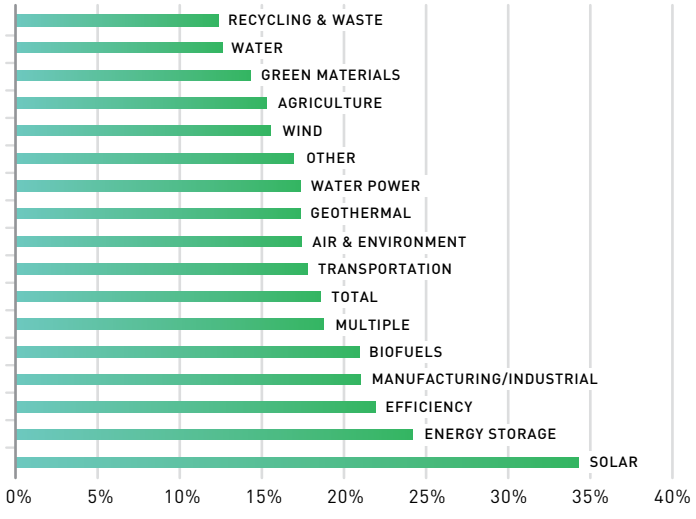
CALIFORNIA % OF U.S. PATENTS

2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IP Checkups, CleanTech Patent Edge.
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A DECADE OF DATA

When California passed AB 32 in 2006, many were skeptical that the state could reach its ambitious climate goals without sacrificing economic growth. Next 10 launched the *California Green Innovation Index* to track the economic and environmental impact of this and subsequent policies aimed at accelerating the state's transition to a clean energy economy.

Ten years later not only did California reach its goal of reducing emissions to 1990 levels by 2020 four years early, but did so while achieving one of the longest economic expansions in state history.[2] Total emissions fell even as population in the state grew by 8.5 percent. In May 2018, just a few months before the California Air Resources Board announced California had beaten its own deadline for emissions reduction, the state surpassed the United Kingdom and became the world's fifth-largest economy.[3]

As Governor Jerry Brown convenes national and subnational leaders from across the world at the Global Climate Action Summit this September, the tenth edition of the *Index* provides important food for thought around global action. The data reveal a virtuous cycle of policy, investment, technology innovation, emissions reduction and economic growth. But while California is a world leader when it comes to emissions reductions and economic growth, the state represents a fraction of the world's total emissions and population. Global collaboration is critical to continued progress worldwide, and California has much to be leveraged by other governments.

California has much to learn, too, from other states and nations. Looking to the next ten years, the state must make progress decarbonizing transportation the same way it has the energy sector in the face of critical challenges. Population continues to increase while housing supply has not kept pace with demand, and Californians are traveling longer distances between home and work. At the same time, the federal government has announced its intention to rollback California's vehicle emissions standards. Partners – at home and abroad – are more critical than ever to California, and the world's, success.

FROM POLLUTION TO POLICY

Well before the passage of AB 32, California was at the forefront of innovative policy to address serious environmental issues. Smog was defined in and by Los Angeles' severe air quality issues in the 1950s. California responded with ongoing innovative policies that reduced toxic emissions from vehicles and stationary sources (see Policy Timeline section). The federal government followed the state's lead, passing clean air legislation and acknowledging California's first mover authority. In fact, the U.S. developed more stringent tailpipe emissions regulations modeled after those in California beginning with model year (MY) 2012 vehicles as well.

California's Global Warming Solutions Act of 2006 (AB 32) was no less innovative. Tasked with implementation, the California Air Resources Board oversees ongoing development of a mix of standards and incentives, along with strong emissions targets, designed to reduce emissions efficiently while still growing the economy.

INVESTMENT & TECHNOLOGY

Over the past ten years, the *Index* has tracked implementation of these policies alongside economic indicators. One essential finding: Policy creates market certainty and helps drive investment and technology advancement.

Significantly, California beats all but China and the U.S. as a whole, when it comes to clean technology investment. In 2017, California attracted the third largest inflow of global clean technology venture capital funding ($1.42 billion). In California, investment in the Agriculture & Food segment increased 1,243.7 percent, investment in Transportation

TABLE 1. CLEAN TECHNOLOGY VENTURE CAPITAL INVESTMENT

TOP REGIONS IN BILLIONS OF US DOLLARS

RANK	REGION	2017
1	CHINA	$4.12
2	UNITED STATES (W/ CALIFORNIA)	$2.48
3	CALIFORNIA	$1.42
4	EU-28	$0.47
5	TAIWAN	$0.30
6	CANADA	$0.15
7	UNITED KINGDOM	$0.14
8	GERMANY	$0.10
9	SWEDEN	$0.08
10	KENYA	$0.06
WORLD TOTAL		$7.77

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increased 798.1 percent, and investment in Recycling & Waste increased by 527.6 percent between 2007 and 2017. All told, the state pulled in over $22 billion in clean technology venture capital funding in the ten years from 2007 to 2017. During this same period, global clean technology venture capital funding increased 121.2 percent, topping out in 2017 at $7.78 billion. California's share of this total has ranged from 46 percent to 18 percent.

Investment spurs technology innovation. In 2017, California captured more clean technology patents globally (more than 5%) than China (4%). The U.S. (not including California) had the most patents globally, with 24 percent, followed by South Korea, which produced 6 percent of global patents. California's share of global patents increased from 4.2 percent in 2007 to 5.4 percent in 2017.

Globally, the most patents were in Renewable Energy (17,931), followed by Green Materials (12,997) and Energy Storage (11,177) in 2017. The number of California clean technology patents increased 342 percent between 2007 and 2017. This number is compelling, because California was already producing a high number of clean tech patents in 2007. The global number of clean technology patents increased 243.8 percent during the ten-year period from 2007 to 2017 from 21,008 to 77,376.

ECONOMY AND EMISSIONS

Innovation in policy and technology is delivering results for both the environment and the economy. Between 2006 and 2016, California had greater emissions reductions (-11.1%) than the U.S. as a whole (-10.2%) while also achieving greater economic output (15.9% growth compared to 11.6%). The European Union (EU-28) achieved a greater decrease (16.9%) than California from 2006 to 2016, but its real economic output was almost half (8.8 percent) that of California's.

On a per capita basis, California's output increased by 6.8 percent over the ten years compared to a 3.2 percent increase in the U.S. as a whole. EU-28's real output per capita increased 5.6 percent during the time period. California reduced emissions by 18 percent per capita compared to 17 percent in the U.S. and 19.6 percent in the EU.

When looking at the global level, California was still the 18th-largest polluter in terms of carbon dioxide emissions from fossil fuel activities among the top 50 global polluters in 2015 (the latest year for which globally comparative data are available).

TABLE 2. REAL OUTPUT

INFLATION-ADJUSTED GDP/GSP, BILLIONS OF 2016 USD

REGION	2006	2016	10 YEAR % CHANGE
CALIFORNIA	$2,234.60	$2,602.70	15.9%
UNITED STATES	$16,243.80	$18,201.80	11.6%
EU-28	$17,857.40	$19,420.9	8.8%

REAL OUTPUT PER CAPITA

REGION	2006	2016	10 YEAR % CHANGE
CALIFORNIA	$62,109.00	$66,310.70	6.8%
UNITED STATES	$54,360.20	$56,284.20	3.2%
EU-28	$35,700.20	$37,706.50	5.6%

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TABLE 3. GHG EMISSIONS

MILLION METRIC TONS CO_2 EQUIVALENT

REGION	2006	2016	10 YEAR % CHANGE
CALIFORNIA	482.7	429.4	-11.1%
UNITED STATES	7,251.8	6,511.3	-10.2%
EU-28	5,344.1	4,440.1	-16.9%

GHG EMISSIONS PER CAPITA

METRIC TONS CO_2 EQUIVALENT PER PERSON

REGION	2006	2016	10 YEAR % CHANGE
CALIFORNIA	13.4	10.9	-18.0%
UNITED STATES	24.3	20.1	-17.0%
EU-28	10.7	8.6	-19.3%

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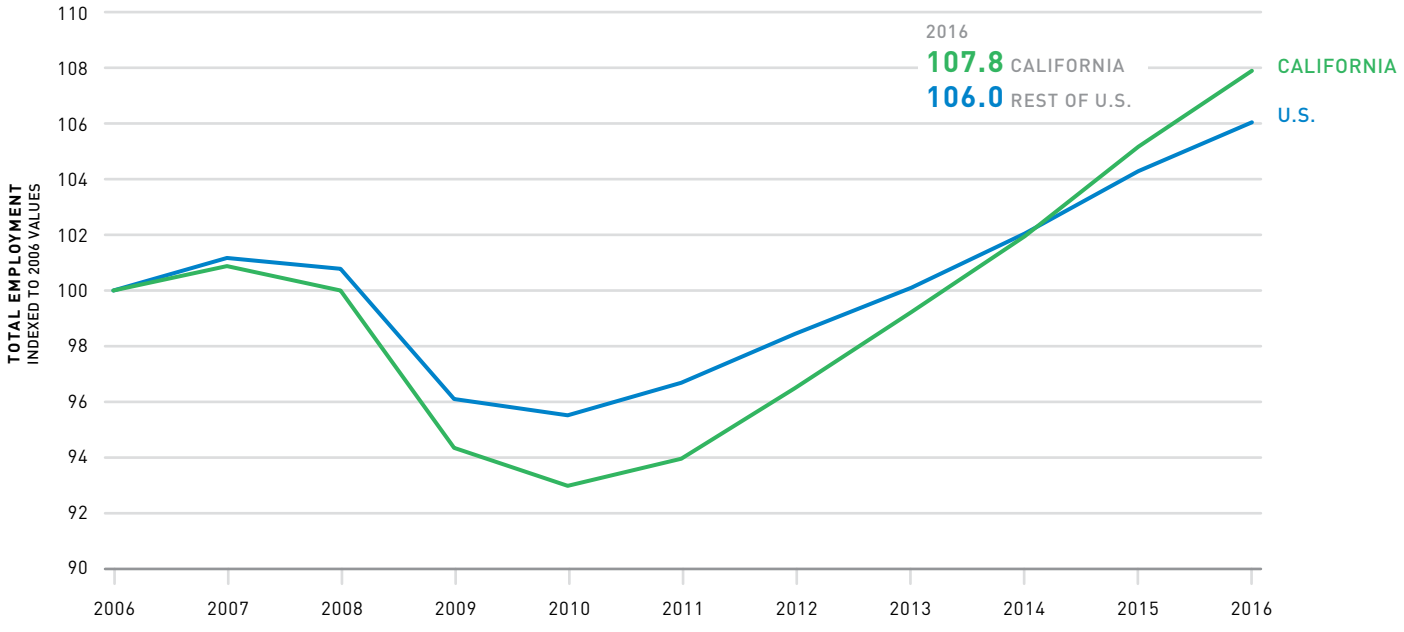
Global emissions rose by 4.2 billion $MTCO_2e$, or 15 percent, over the same period to 32.7 billion $MTCO_2e$, led by China's 3.13 billion $MTCO_2e$ (74%) share of the increase followed by India's 704 $MMTCO_2e$ (17%) and Iran's 204 $MMTCO_2e$ (5%), making California's reduction over the ten years equivalent to 0.08 percent of the total 2015 global emissions.

JOBS & WAGES

Over the last decade of data, California's economy not only grew more than the U.S. economy as a whole – the state also

FIGURE 1. TOTAL EMPLOYMENT

CALIFORNIA VS UNITED STATES, 2006–2016 INDEXED TO 2006 VALUES



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

experienced more job and wage growth. California increased employment 7.8 percent in 2016 compared to 2006, while the U.S. increased employment 6.0 percent. As of June 2018, California had the 7th-highest nonfarm employment percent increase among the fifty states since the previous employment peak.[4]

Employment gains were also coupled with higher wages for California workers compared to their U.S. counterparts in 19 out of 20 major industries. Agriculture is the only industry where the average annual wage was lower in California than in the U.S. – by a modest 3.0 percent. However, as the comparative wage data is annualized over a full year, this wage difference may be due to the fact that many farm workers in California work less than full time or year-round.[5]

ENERGY & ELECTRICITY PRODUCTIVITY

California has remained competitive in rankings of energy productivity (measured by GDP relative to energy consumption) and energy consumption. In 2015, California ranked seventh among the top 50 polluters in terms of energy productivity and 37th in terms of lowest energy

FIGURE 2. ENERGY PRODUCTIVITY

GDP RELATIVE TO TOTAL ENERGY CONSUMPTION, 2005 AND 2015

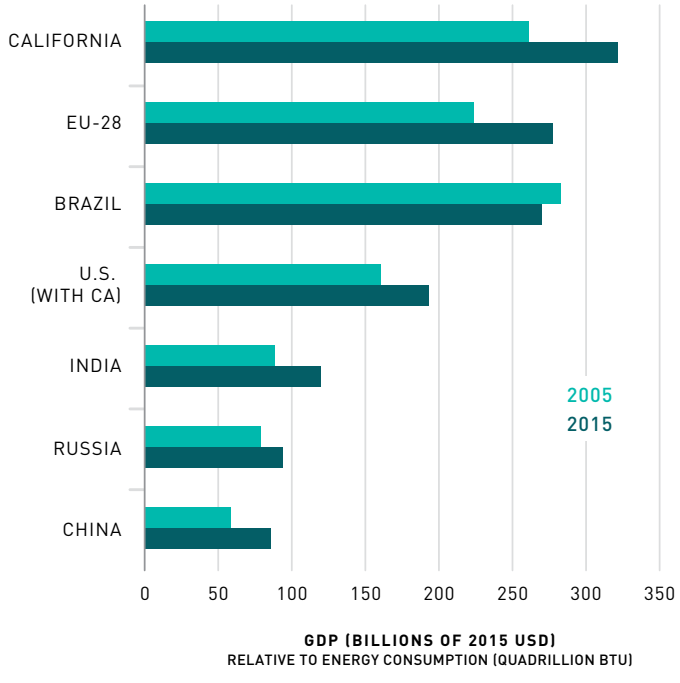


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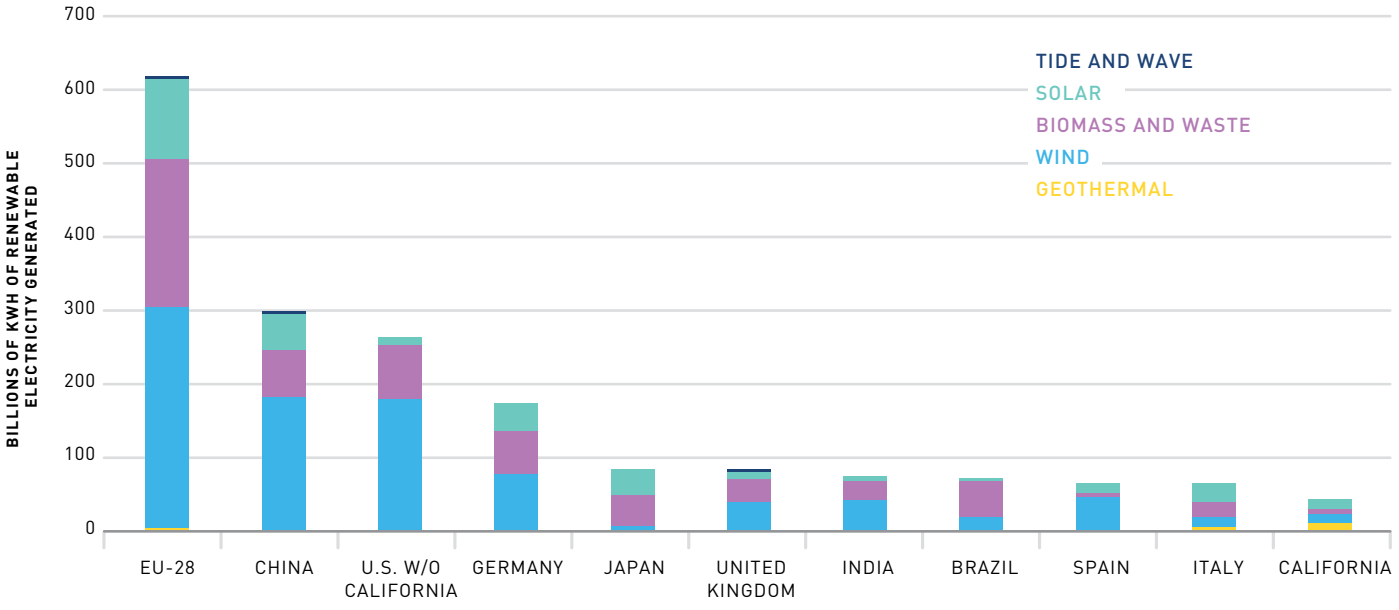
FIGURE 3. TOTAL RENEWABLE ELECTRICITY GENERATION BY SOURCE, 2015

TOP TEN REGIONS PLUS CALIFORNIA



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Renewables not including large hydro. Data Source: U.S. Energy Information Administration; California Energy Commission. NEXT 10 / SF · CA · USA

consumption per capita, beating out the U.S. as a whole which ranked 20th in energy productivity and 43rd in energy consumption per capita. Since 2005, many of the world's leading economies have seen an increase in energy productivity, with California and the EU-28 countries enjoying the largest gains and Brazil falling behind.

California's electricity consumption decreased by 2.3 percent between 2006 and 2016, while per capita consumption decreased by 10.6 percent. As a result of decreased consumption and increased efficiency, electricity bills in the state also went down. The largest reduction was in the industrial sector (-47.2%), followed by residential (-5.4%), and commercial (-2.1%).

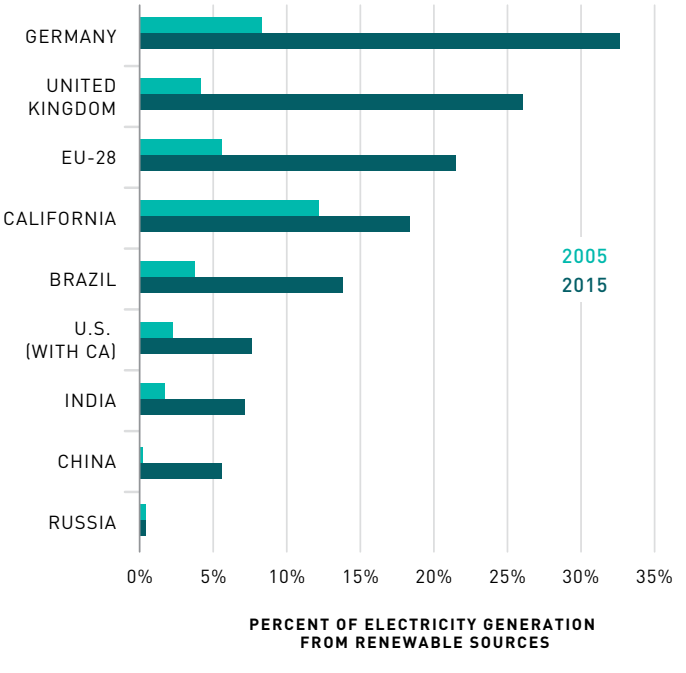
California also increased its energy productivity 23.4 percent between 2005 and 2015. China had the largest improvement in energy productivity in this time period, experiencing a 48.7 percent gain, followed by the UK (+36%) and India (+35.9%).

RENEWABLE ENERGY

California currently has a more diverse renewable energy mix than many of its peers, including much more geothermal energy compared to the other top ten regions. In 2015,

FIGURE 4. PERCENT OF TOTAL ELECTRICITY GENERATION FROM RENEWABLE SOURCES

2005 AND 2015



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Renewables not including hydroelectric large hydroData Source: U.S. Energy Information Administration; California Energy Commission.
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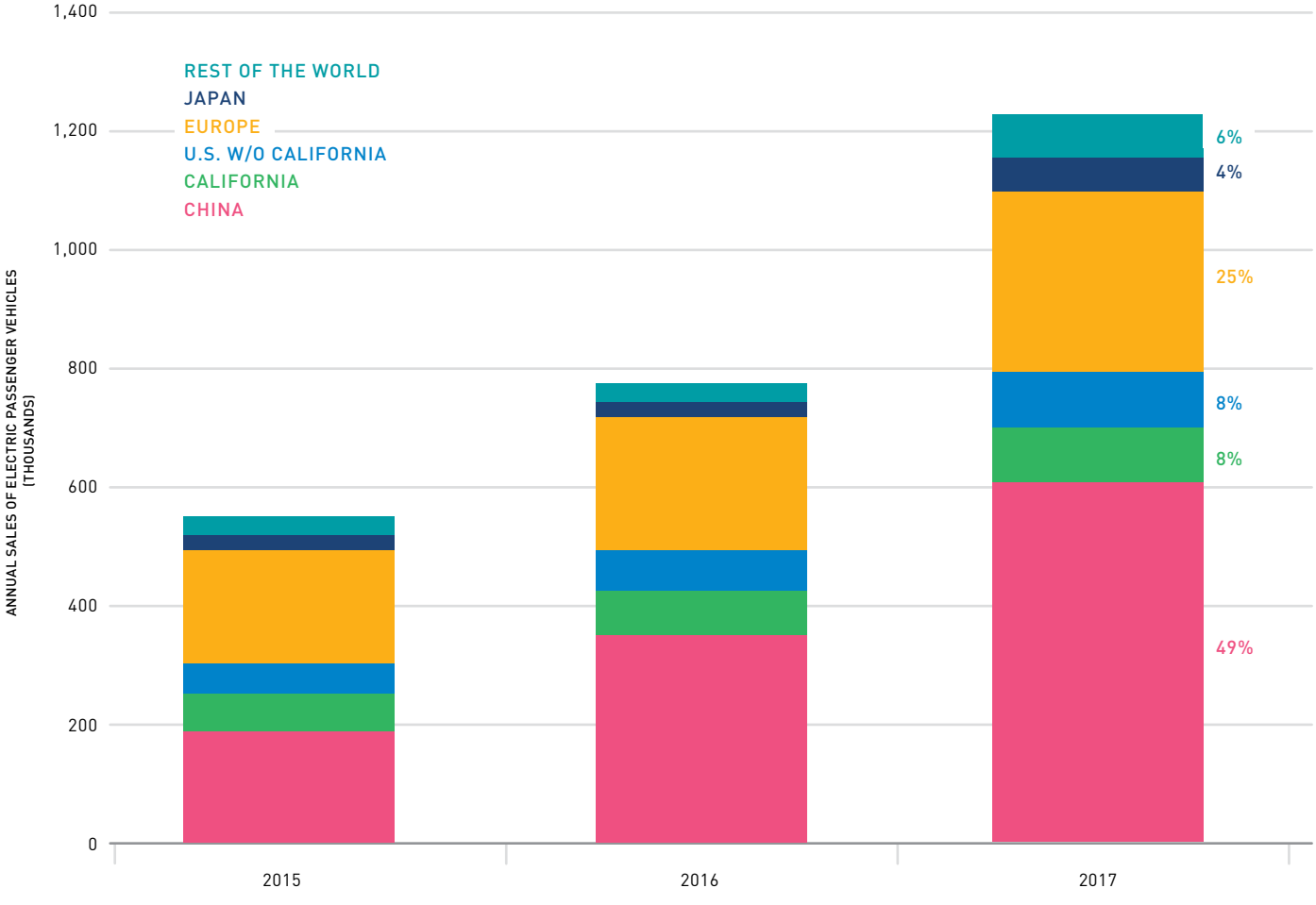
California's renewable energy mix was 31.3 percent from solar, 25 percent from geothermal, 25.4 percent from wind, and 13.3 percent from biomass and waste. In comparison, China's renewable energy mix was 63 percent from wind, 21.6 percent from biomass and waste, and 15.3 percent from solar. California's renewable energy generation increased 130 percent between 2006 to 2016, reaching roughly 73,961 gigawatt hours (GWh).

In this same period, China increased its renewable electricity generation a whopping 6,279 percent, while India increased its generation by 777 percent. The United States increased its generation by 238 percent, while the EU-28 saw an increase of 281 percent. Globally, renewable energy generation increased 339 percent between 2005 and 2015.

While also having a greater renewable energy mix, California has also brought a lot more renewable capacity online over the last ten years. The cumulative capacity of interconnected solar projects in California increased 1,254 percent between 2007 and 2017, while the state's cumulative wind capacity increased by 127.8 percent during the same period.

All states and nations experienced a huge boom in solar energy generation between 2005 and 2015. California experienced an increase of 2,571 percent. From 2006 to 2016, the increase was even larger, at 3,727 percent.

FIGURE 5. GLOBAL SALES OF ELECTRIC VEHICLES LIGHT-DUTY PASSENGER VEHICLES*
2015 TO 2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: IHS Markit; Alliance of Automobile Manufacturers; Japan Automobile Dealers Association; International Council on Clean Transportation.
*Excludes neighborhood vehicles. NEXT 10 / SF · CA · USA

Solar generation increased 61,049 percent in China, 29,584 percent in India, over 4,424 percent in the U.S., and 7,235 percent in EU-28. Globally, solar generation increased 6,327 percent in those ten years.

Wind power experienced smaller but significant increases between 2005 and 2015, jumping 701 percent globally. This includes a 9,060 percent jump in China, 970 percent increase in the U.S., 442 percent in California, and 325 percent in EU-28.

In 2015, California ranked seventh in share of electricity from renewable sources, overtaken by Belgium, which moved from the seventh to the sixth spot in the rankings. However, in 2005, California's share of electricity from renewable resources was 12.2 percent and has increased to 18.4 percent in 2015.

CLEAN TRANSPORTATION

Over the last decade, California has also increased the number of electric vehicles (EVs) on the road, with 8 percent of the global total by the end of 2017 – the same as the rest of the U.S. combined. China has recently implemented policies to spur electric vehicle sales in the country and is on pace to hit one million in annual sales in 2018.[6] In order to achieve the country's goal of two million electric vehicle sales by 2020, China has ramped up incentives and placed restrictions on traditional internal combustion engine (ICE) vehicles. As a result of these policies and their large population, China accounted for 49 percent of total EV sales in 2017 – the most in the world, and nearly twice that of the next top EV adopter (Europe).

In addition to EVs, increased public transit ridership also helps to reduce transportation-related emissions. Unfortunately, the public transit ridership in California has actually decreased between 2006 and 2016 in all of five of the major metropolitan areas aside from one. Ridership decreased in Los Angeles-Long Beach-Anaheim (-19.1%), Sacramento-Roseville-Arden-Arcade (-25.5%), San Diego-Carlsbad (-1.1%), and San Jose-Sunnyvale-Santa Clara (-13.9%). San-Francisco-Oakland-Hayward increased by 4.8 percent.

THE NEXT 10 YEARS

As state, national and international leaders converge on San Francisco for the Global Climate Action Summit, there are important lessons from California's experience to share. The tenth edition of the *California Green Innovation Index,* provides an overview of what the state has achieved while identifying opportunities for improvement.

While California is a world leader when it comes to cutting emissions while growing the economy, it cannot go it alone. The state's annual GHG emissions from energy consumption represent only 1.1 percent of the global total – even if the state were to reduce its emissions to zero, 98.9 percent of global emissions from energy consumption would still be released.[7] Global collaboration is critical to continued progress toward climate change mitigation worldwide.

California is not alone in its commitment to advance clean energy technologies, investment, and policies, and there are opportunities to learn from other global leaders. While the state has enjoyed great progress and success in incentivizing investment and innovation paired with ambitious climate goals over the last decade, many leading global economies have also seen rapid progress in these areas – some even eclipsing the Golden State in key areas like electric vehicle adoption (China).

The *Index* looks beyond just California's or the United States' borders to track progress across key environmental and economic indicators. Identifying progress internationally is critical to understanding where global trends on climate action may be heading and how collaboration may advance emissions reductions and spur greater clean energy innovation.

As this *Index* chronicles, California has much work ahead if it is to continue to hit its ambitious climate change goals – achieving steep reductions in emissions in the transportation sector chief among them. Emissions from surface transportation increased 2.1 percent in 2016 over 2015, but the emissions are 8.8 percent lower than in 2006. Transportation currently makes up 40.5 percent of the state's emissions, the largest sector, and it has been ticking up over recent years as vehicle miles traveled increase despite improvements in fuel economy due to California's stringent emissions regulations.

But as this 10th edition of the *California Green Innovation Index* also makes clear: Subnational, national and international coordination have the potential to spark a virtuous cycle globally, with innovative policy spurring investment and technological advancements to reduce emissions and grow economies. California is a good example of how the combination of these factors can produce real emissions reductions without sacrificing economic growth and prosperity.

UNDER2 COALITION

UNITED KINGDOM+
- City of Bristol
- Greater Manchester City
- Scotland
- Wales*

FRANCE+
- Alsace
- Auvergne-Rhône-Alpes
- The Department of Bas-Rhin
- Brittany
- La Réunion
- Midi-Pyrénées
- Nouvelle-Aquitaine
- Pays de la Loire

SPAIN
- Andalusia
- Basque Country
- Catalonia*
- Navarra

PORTUGAL+
- Azores
- Madeira

THE NETHERLANDS+
- Drenthe
- North Brabant
- North Holland
- South Holland

LUXEMBOURG+

BELGIUM
- Wallonia

DENMARK+

GERMANY+
- Baden-Württemberg*
- Bavaria
- Hesse
- Lower Saxony
- North Rhine-Westphalia
- Rhineland-Palatinate
- Schleswig-Holstein
- Thuringia

SWITZERLAND
- Basel-Landschaft
- Basel-Stadt

SENEGAL
- City of Guédiawaye

NIGERIA
- Cross River State

IVORY COAST
- Assemblée des Régions de Côte d'Ivoire

KENYA
- Laikipia County

MOZAMBIQUE
- City of Nampula
- City of Quelimane

SOUTH AFRICA
- KwaZulu-Natal
- Western Cape

ITALY+
- Abruzzo
- Basilicata
- Emilia-Romagna
- Lombardy
- Piedmont
- Sardinia
- Veneto

GREECE
- Attica

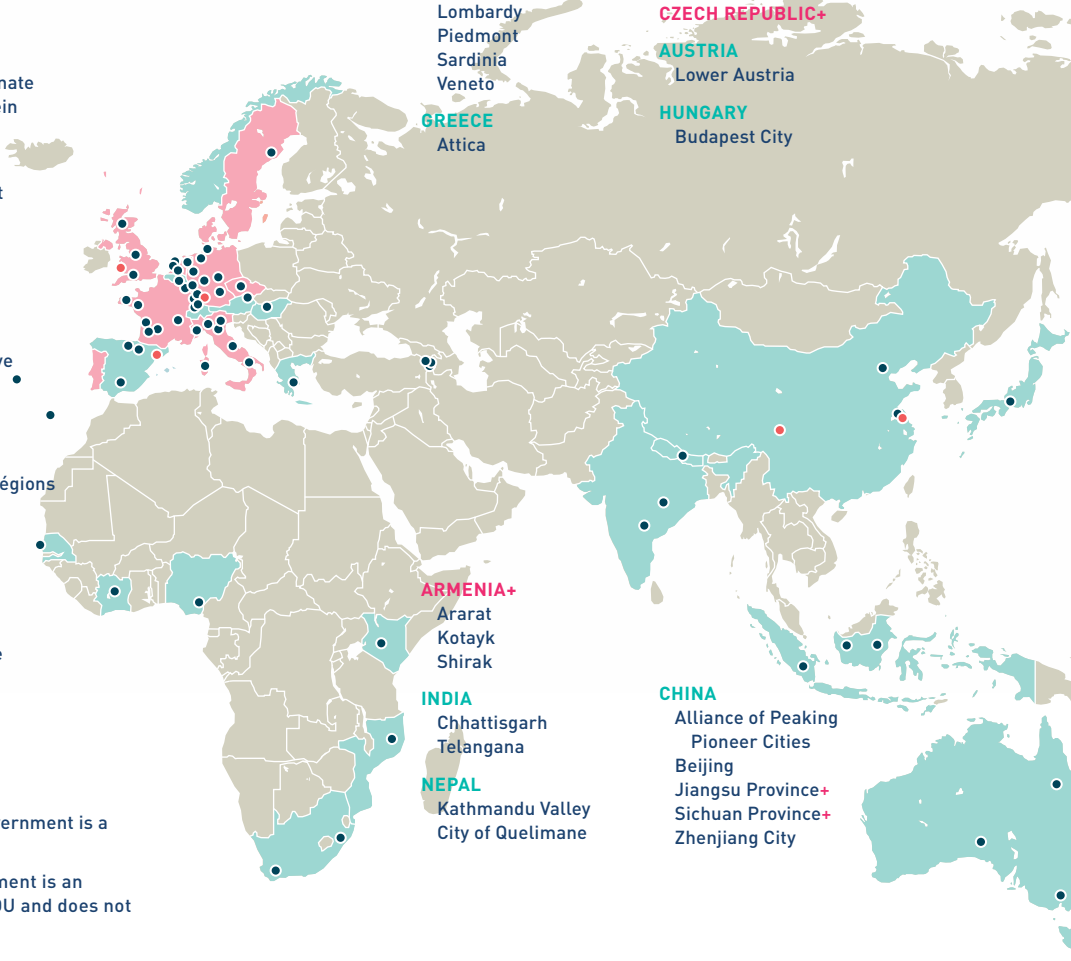
NORWAY+

SWEDEN+
- Jämtland Härjedalen

CZECH REPUBLIC+

AUSTRIA
- Lower Austria

HUNGARY
- Budapest City



ARMENIA+
- Ararat
- Kotayk
- Shirak

INDIA
- Chhattisgarh
- Telangana

NEPAL
- Kathmandu Valley
- City of Quelimane

CHINA
- Alliance of Peaking Pioneer Cities
- Beijing
- Jiangsu Province+
- Sichuan Province+
- Zhenjiang City

* An asterisk denotes the government is a Founding Signatory.

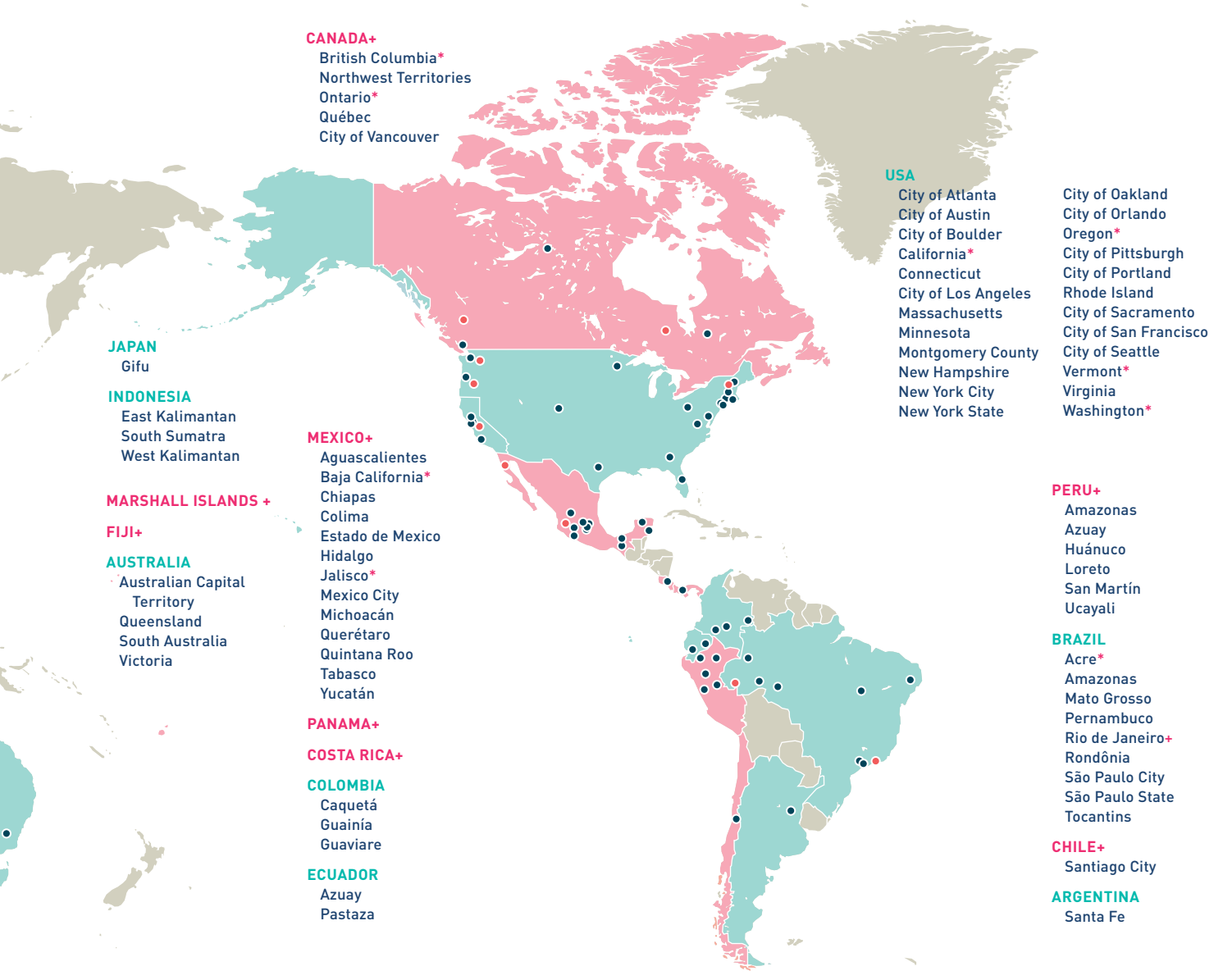
\+ A plus denotes the government is an endorser of the Under2 MOU and does not provide an appendix.

SUBNATIONAL GOVERNMENTS LEADING CLIMATE ACTION

On May 19, 2015, Governor Brown signed the Under2 MOU, a first-of-its-kind agreement, alongside leaders from 11 other states, regions and provinces around the world. Under the international agreement, signatories commit to reducing greenhouse gas emissions by 80 to 95 percent compared to 1990 levels, or limiting to 2 annual metric tons per capita, by 2050. The Under2 Coalition is driven by a group of state and regional governments committed to keeping global temperature rises to under 2 degrees Celsius.

The Under2 Coalition focuses on three key work streams:

- Deep decarbonization pathway planning: supporting governments to develop robust medium and long-term (2050) emissions reduction plans in line with the goals of the Paris Climate Agreement.
- Scaling innovative policy solutions: spreading best climate policies and developing new policies to ensure full decarbonization.
- Mainstreaming transparency: supporting governments so they have the expertise and systems in place to assess their emissions accurately, track progress and ensure policies remain fit for delivering against climate targets.



So far, many Under2 Coalition members are on track to deliver emissions-reduction goals ahead of their 2020 target dates.[8] Carinthia (Austria), Catalonia (Spain), Connecticut (U.S.), Lombardy (Italy), Madeira (Portugal), Provence-Alpes-Côte d'Azur (France), and Wallonia (Belgium) have already met their 2020 reduction goals ahead of time. In addition, Blekinge (Sweden), Hesse (Germany), Lower Austria (Austria), and Scotland (U.K.) are very close to meeting their 2020 goals. As of July 2018, there were a total of 206 jurisdictions, representing 43 countries and six continents that had signed or endorsed the Under2 MOU. The Under2 Coalition represents more than 1.3 billion people and $30 trillion in GDP – equivalent to 17 percent of the global population and 40 percent of the global economy.

RECENT EVENTS

July 10, 2018: California, the Under2 Coalition and global partners launched the Zero Emission Vehicle (ZEV) Challenge to help leverage purchasing and policy influence to accelerate ZEV adoption.[9]

June 14, 2018: Governor Brown welcomed Portugal as the 20th national endorser of the Under2 Coalition.[10]

May 19, 2018: The Under2 Coalition celebrated its three-year anniversary.[11]

November 14, 2017: The Under2 Coalition surpassed over 200 jurisdictions during the United Nations climate change conference, COP23, in Bonn.[12]

California Policy Timeline

1947
- Los Angeles Air Pollution Control District created ★

1959
- California created Bureau of Air Sanitation mandated to establish air quality standards and set necessary controls on motor vehicle emissions of air pollutants

1963
- Clean Air Act is first federal legislation to pertain to "controlling" air pollution by establishing a federal program within the U.S. Public Health Service and authorizing research into techniques for monitoring and controlling air pollution

1965
- National Emissions Standards Act

1966
- California established the first tailpipe emissions standard in the nation ★

1967
- Bipartisan Mulford-Carrell Act signed by Gov. Ronald Reagan merged the Bureau of Air Sanitation and California Motor Vehicle Pollution Control Board to create California Air Resources Board (CARB) ★
- Federal Air Quality Act of 1967 enacted, recognizes California's authority to continue to set its own more stringent air quality rules due to unique geography, weather and population. It also allows other states to choose to follow California or federal standard. Today, 13 states and the District of Columbia have adopted these standards.

1970
- Environmental Protection Agency created by Presidential Executive Order

1971
- California adopts the nation's first tailpipe emissions standards for oxides of nitrogen ★

1974
- California Energy Commission created

1975
- 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) ★

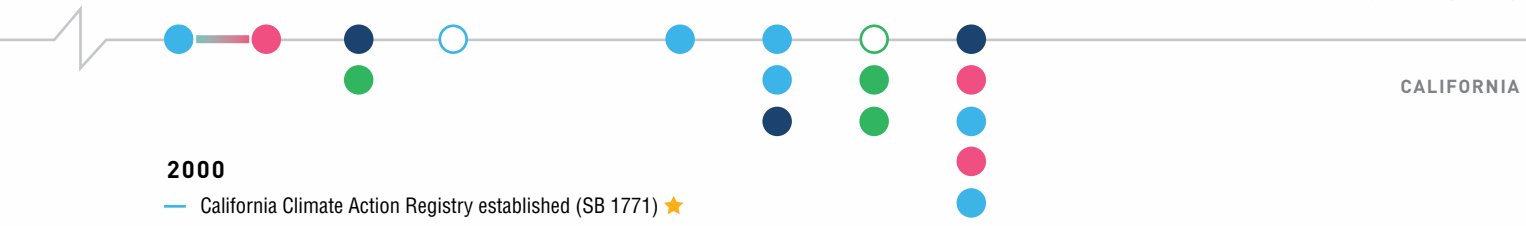
1978
- Efficiency standards for new buildings (Title 24) ★

1982
- California Public Utilities Commission (PUC) orders separation of electricity sales from revenues for the investor owned utilities, which removes barriers to energy efficiency investments (decoupling) ★
- California adopts the nation's first tailpipe emissions standards for particulate matter from diesel-fueled vehicles ★

1987
- National Appliance Energy Conservation and Efficiency Act

For decades, California has been a national and global leader in developing innovative environmental and energy policies. The state has led the way as an early promoter of a clean energy future – implementing standards and policies to reduce pollution, improve energy efficiency, and incentivize clean energy and innovative technological development that have been replicated both across the U.S. and globally. California's landmark climate change legislation (AB 32) in 2006 set a new standard for climate accountability and a commitment to emissions reductions that has served as a model for other states across the country.

Today, while the federal government has stepped away from the United States' previous commitment to climate action, California has shown no intention of following suit. This summer, it was announced that the state met its AB 32-mandated 2020 climate change goal four years early. Now, in order to achieve further goals, the state will need to implement policies aimed at tackling harder-to-achieve emissions reductions, including those from the transportation sector. The policies in the subsequent timeline reflect decades of collaboration and innovation to address climate and air quality concerns while simultaneously developing one of the world's largest economies.



2000

- California Climate Action Registry established (SB 1771) ★

2000–2001

- California energy crisis

2001

- Flex Your Power initiated

2002

- California passes the state's first Renewable Portfolio Standard (RPS), requiring 20% of total electricity procured from renewables by 2017 (SB 1078)
- California sets standards for emissions of CO_2 and other greenhouse gases from autos and light duty trucks (Pavley Act) ★

2003

- West Coast Governors launch the Global Warming Initiative (CA, OR, WA)

2005

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

2006

- California Global Warming Solutions Act of 2006 (AB 32) ★
- California greenhouse gas performance standards for power plants (SB 1368)
- California Solar Initiative established out of the Governor's "Million Solar Roofs" vision to provide a solar rebate for California consumers (SB 1)

2007

- President Bush signs Energy Independence and Security Act which mandates a 20% reduction in gasoline consumption (35 mpg) by 2020

2007

- Governor Schwarzenegger establishes Low Carbon Fuel Standard regulations to reduce carbon intensity of transportation fuel 10% by 2020 (S-01-07)
- California legislation establishes a fund for clean vehicle and equipment projects and provides incentives to develop and deploy innovative technologies in support of the state's greenhouse gas goals (AB 118)

2008

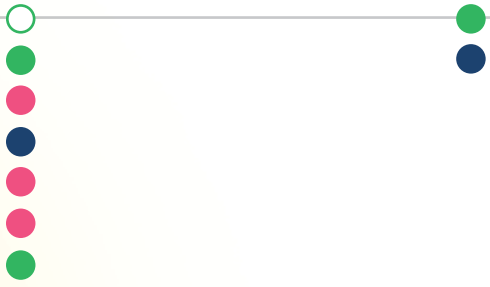
- California PUC approves feed-in tariff to incentivize the development of small-scale solar installations (AB 1969)
- California adopts green building codes ★
- Land use strategy requirements mandated to reduce GHG emissions (SB 375) ★
- Green Collar Jobs Council established (AB 3018)
- California Air Resources Board adopts a Scoping Plan to reduce greenhouse gas emissions levels to 1990 level by 2020

KEY

- AIR & ENVIRONMENT
- ENERGY EFFICIENCY
- CLEAN TRANSPORTATION
- RENEWABLE ENERGY
- UNITED STATES POLICY
- CALIFORNIA POLICY
- ★ FIRST IN U.S.

2009

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



2009

- California Air Resources Board adopts Low Carbon Fuel Standard regulations to reduce carbon intensity of transportation fuel 10% by 2020
- California adopts efficiency standards for 23 categories of appliances including clothes washers and audio and visual products
- California legislation revises net energy metering to require utilities to reimburse customers for up to 2.5% of the excess demand from power generated from customer's solar and wind power systems (AB 920)
- California Energy Commission established regulation to increase building energy efficiency and lower operation costs (AB 758)
- The California Energy Commission set the world's most rigorous efficiency standards for televisions, cutting electricity needs for new flat-panel sets by about 50% ★
- California establishes the Clean Vehicle Rebate Project and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project

2010

- California Air Resources Board finalizes regulation of Pavley Act for greenhouse gas emissions from passenger vehicles ★
- California raises cap on net metering from 2.5% to 5% (AB 510)

2011

- U.S. Department of Transportation, U.S. EPA and CARB announce a unified timeframe for CAFE and greenhouse gas standards for cars and trucks model year 2017–2025, creating a single national program
- 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
- The Western Climate Initiative Inc., a nonprofit corporation with officials from Canada and California, is formed to support the implementation of greenhouse gas emissions trading programs

2011

- California legislation increases the state's RPS to require all retail sellers of electricity and all publicly owned utilities to procure at least 33% of electricity delivered to their retail customers from renewable resources by 2020, the most ambitious standard in the country (SB X1-2)
- California legislature passes the Renewable Energy Equity Act (SB 489), which expands the net energy metering program to all eligible forms of renewable energy, allowing small-scale renewable energy producers to participate
- Governor Brown announces the Clean Energy Jobs Plan which calls for 12,000 megawatts to come from localized energy sources and 8,000 megawatts of large scale renewable & necessary transmission lines by 2020
- California legislation extends the Self-Generation Incentive Program (AB 1150), which provides a bridge for clean energy technologies to scale up and drive down costs
- California legislation aims to reduce pollution and waste by more than 15 million tons annually (AB 341), setting the most aggressive goal in the nation

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UNITED STATES

2012

- U.S. Environmental Protection Agency and the National Highway Traffic Safety Administration issued a final rule that raises average CAFE standards for cars and light-duty trucks to 54.5 miles per gallon by 2025

2013

- U.S. Environmental Protection Agency proposes a carbon emissions standard for new fossil fuel-fired electric utility power plants
- California joins seven other states in an initiative to put 3.3 million zero-emission vehicles on the road by 2025

CALIFORNIA

2012

- California Air Resources Board passes the Advanced Clean Car Rules to be attained by 2025, including mandates for zero-emission vehicles production and pollution reduction
- Governor Brown reinforces the Air Resources Board's clean car rules by issuing an executive order for 1.5 million zero-emission vehicles and supporting infrastructure to be operating in California by 2025 (B-16-12)
- California PUC potentially doubles the amount of solar power utilities will purchase from homeowners and businesses by adjusting how electricity generation is calculated under the net metering program
- California Air Resources Board issues final regulations on the Low Carbon Fuel Standard
- California established the Greenhouse Gas Reduction Fund as a special fund to collect cap-and-trade auction revenues (SB 1018)
- California passes two laws to establish a process for spending revenue generated from the cap-and-trade program, with an emphasis on improving air quality and benefiting disadvantaged communities (AB 1532 and SB 535)
- California standardizes and limits the fees city and county governments can charge on building permits for rooftop solar (SB 1222)
- Voters pass Prop 39, the Clean Energy Jobs Act, to provide an estimated $500 million annually for five years for energy efficiency and clean energy programs, such as retrofits of schools and government buildings
- California Air Resources Board conducts its first quarterly auction for emissions allowances in the cap-and-trade program as authorized by AB 32
- California PUC approves nearly $2 billion in energy efficiency program financing over the next two years
- California PUC approves a plan to distribute 85% of revenue from the sale of greenhouse gas allowances from the state's three investor owned utilities to households in a semi-annual credit on their energy bill, a type of "climate dividend" ★

2013

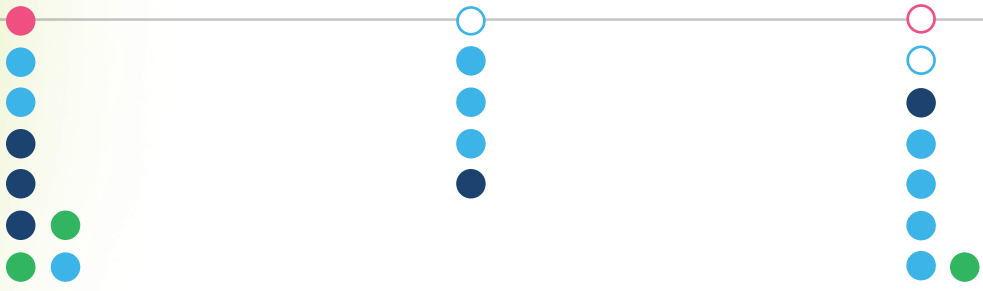
- Governor Brown releases the Zero Emission Vehicle Action Plan that identifies specific strategies and actions that state agencies will take to meet milestones of the executive order for 1.5 million zero-emission vehicles in California by 2025
- California PUC mandates that the state's three investor owned utilities add a combined 1.3 gigawatts of energy storage by 2020 ★
- California signs three national and international agreements to cooperate on reducing greenhouse gases and align policies, with China, Quebec, and the Northwestern states/provinces of Oregon, Washington and British Columbia
- California extends to 2024 key auto emissions reductions programs, including the Alternative and Renewable Fuel and Vehicle Technology Program, Air Quality Improvement Program, and the Carl Moyer Program (AB 8)
- California PUC adopts the Efficiency Savings and Performance Incentive program for investor owned utilities to earn up to $89 million a year as a reward for helping customers achieve long-term energy savings
- California improves access to electric vehicle charging stations through two laws, requiring infrastructure for stations at new multi-family housing and non-residential developments, and simplifying access to stations (AB 1092 and SB 454)
- California creates a voluntary green tariff that allows utility ratepayers who cannot install their own renewable energy generation to purchase energy from shared renewable facilities and receive bill credits (SB 43)
- California protects net metering and removes the 33% ceiling on the RPS (AB 327)

2016

- The U.S. Supreme Court ruled to support the Federal Energy Regulatory Commission's Order 745, which is expected to open the demand response market to reduce energy use
- 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

2015

- 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 2°C and implement programs to support that goal



2014

- California Energy Commission announces it will update energy efficiency standards for 15 appliances over the next two years
- California residential and small business customers start seeing a Climate Credit from utilities on their electricity bills, which can be used to help cut their energy use
- California Air Resources Board approves the first update to the 2008 Scoping Plan with key focus areas to reduce greenhouse gas emissions levels to 1990 level by 2020
- California extends the property tax exclusion for solar systems to 2025 (SB 871)
- California extends the Self-Generation Incentive Program funding to 2019, which helps customers switch to clean energy and provides a bridge for clean energy technologies to scale up and drive down costs (SB 861)
- California passes a law to streamline permitting and inspection for small solar systems to help lower soft costs of installing solar (AB 2188)
- California lawmakers pass a bundle of bills to grow the electric vehicle market, including providing higher incentives for low-income individuals and improving access to charging stations for property renters
- California passes law to accelerate the development and deployment of zero- and near-zero-emission trucks, buses, and freight vehicles and equipment (SB 1204)
- California holds its first joint carbon auction with the Canadian province of Quebec, creating the biggest carbon market in North America

2015

- The California cap-and-trade program starts to cover fuel distributors, including distributors of heating and transportation fuels
- 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 2°C
- California passes a law to increase the RPS for renewable energy to 50% and double energy efficiency in buildings (SB 350)

2016

- California PUC enacted a new Net Energy Metering tariff for net-metered customers to earn retail-rate payments for their surplus solar energy and starts a move towards time to use rates
- California extends emission limits from AB 32 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)
- The California legislature passed a bill to create the Transformative Climate Communities Program, which funds implementation of neighborhood-level climate community plans and projects to benefit disadvantaged communities (AB 2722)
- 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) ★
- California PUC is granted the authority to require investor-owned utilities planning to build fossil fuel generation plants to seek bids for sites outside of highly polluted communities and to demonstrate that they have tried to meet electricity needs through cleaner options (AB 1937)
- The 2013 ZEV Action Plan is updated and expanded to establish a target of getting 1.5 million ZEVs on the road by 2025 by ensuring ZEVs are accessible to a broad range of consumers and businesses

UNITED STATES

2017

- The Trump administration announces its intention to withdraw from the Paris Climate Agreement
- California joins Washington and New York to form the U.S. Climate Alliance, which now includes 17 U.S. states – representing 40 percent of the U.S. population – committed to achieving the goals of the Paris Agreement and the federal Clean Power Plan

2018

- The Trump administration announces a 30 percent tariff on imported solar panels, following an ITC ruling that the importation of cheap solar panels is unfairly harming U.S. solar panel producers
- The IRS extends a 30 percent tax credit for four years to developers of solar projects as long as they've begun construction by the end of 2019

CALIFORNIA

2017

- In April, the 3rd District Court ruled California's landmark system for curbing greenhouse gases can continue through at least 2020. The California Supreme Court reaffirmed the decision in June, ensuring greater stability for the program
- California implements new vehicle registration fees and increases the gas tax to fund a 10-year, $52 billion transportation reinvestment package to improve road conditions and build new public transit (SB 1)
- California and Germany agree to jointly fight climate change following the U.S.'s decision to withdraw from the Paris Agreement
- California legislature extends cap-and-trade program beyond 2020 to 2030 (AB 398)
- California passes air quality improvement legislation to reduce toxic and criteria emissions from mobile and stationary sources with a focus on areas most affected by pollution (AB 617)
- California Air Resources Board celebrates its 50th anniversary
- California considers a ban on new registrations of internal combustion engine vehicles beginning January 1, 2040, excluding heavy duty commercial vehicles and vehicles bought out of state
- California announces it will work with the European Union to continue to combat climate change despite the US withdrawal from the Paris 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
- CalEPA releases its third assessment of climate change's effects in the past nine years and finds that climate change will mean more extreme droughts, wildfires, and rising sea levels
- 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 ★
- California joins a global initiative to accelerate the global manufacture of zero-emission vehicles in order to reduce transportation emissions
- CARB announces that the state has surpassed the 2020 emissions goal of 431 $MMTCO_2e$ four years ahead of schedule
- California to host the first Global Climate Action Summit in San Francisco to reaffirm commitment to combatting climate change despite US inaction

KEY

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THE CARBON ECONOMY

California Has Achieved Landmark GHG Goal Four Years Early

California's efforts to reduce greenhouse gas emissions (GHG) are paying off. In 2016, the State's greenhouse gas emissions totaled 429.35 million metric tons of CO_2-equivalent ($MMTCO_2e$).[13] For the first time since 1996, the state's GHG emissions are lower than the 431 $MMTCO_2e$ emitted in 1990, the year that serves as the baseline for California's emissions reduction goals.

Transportation is the largest contributor to GHG emissions and the **sector remains California's biggest challenge**. The state must take substantial steps to cut emissions from transportation activities to ensure attainment of the next GHG goal set by Senate Bill 32 (SB 32) by 2030.

Why is it Important?

There has been a continuous decline in emissions from carbon-based energy sources in the United States, gradually but surely.[14] The nationwide drop, which has been ongoing since the mid-2000s, is due in large part to changes in the electric power sector as it shifts away from coal and towards less carbon-intensive fuels. This shift has been accelerated by cheaper natural gas prices and increasingly cost-competitive renewable energy resources. The commercial, industrial, and residential sectors have also seen decreasing trends in carbon dioxide emissions from energy consumption.

As states across the nation adjust to a new energy landscape, California continues to be a leader in implementing innovative carbon reduction policies and reducing greenhouse gas emissions, while consistently achieving economic growth. Statewide policy has incentivized creativity and innovation in business and continues a tradition of innovation in solving pressing problems. As this report indicates, there is still work to be done in finding ways to meet the state's goals for reducing emissions. However, California provides a strong template for others to follow in sustaining economic growth while pursuing aggressive climate policies.

Carbon Economy Indicators

California's success in reducing emissions below 1990 levels ahead of schedule demonstrates that it is possible to both reduce carbon emissions while boosting the economy. California's cap-and-trade program continues to be a success and was extended to run through 2030 in 2017. Now that California has achieved its first emissions goal set by Assembly Bill 32 (AB 32), the state should be ever more diligent in its continued progress towards the more stringent 2030 greenhouse gas target established by SB 32. Between 1990 and 2016, California's emissions per dollar of gross domestic product (GDP) dropped by 44.6 percent. This means for the same amount of economic activity, the state produced significantly fewer emissions. As for carbon dependency, in 2015 California held steady as the fourth least carbon-dependent state economy in the U.S. behind New York, Connecticut, and Massachusetts.[15]

BURNING FOSSIL FUELS FOR ENERGY

California ranks highly among the most efficient and least carbon intensive economies compared to other U.S. states. California's emissions from fossil fuel consumption per real dollar of gross domestic product (GDP) dropped by 42 percent between 1990 and 2015.[16]

In 2015, $1,000 of economic activity in the U.S. excluding California resulted in 0.317 metric tons of CO_2-equivalent ($MTCO_2e$) produced. In comparison, the same $1,000 of economic activity in California resulted in only 0.148 $MTCO_2e$ produced – roughly 54 percent less than the rest of the nation.[17] Compared to 2014, California's carbon dependency improved

TABLE 4. NATIONAL CARBON ECONOMY RANKING*

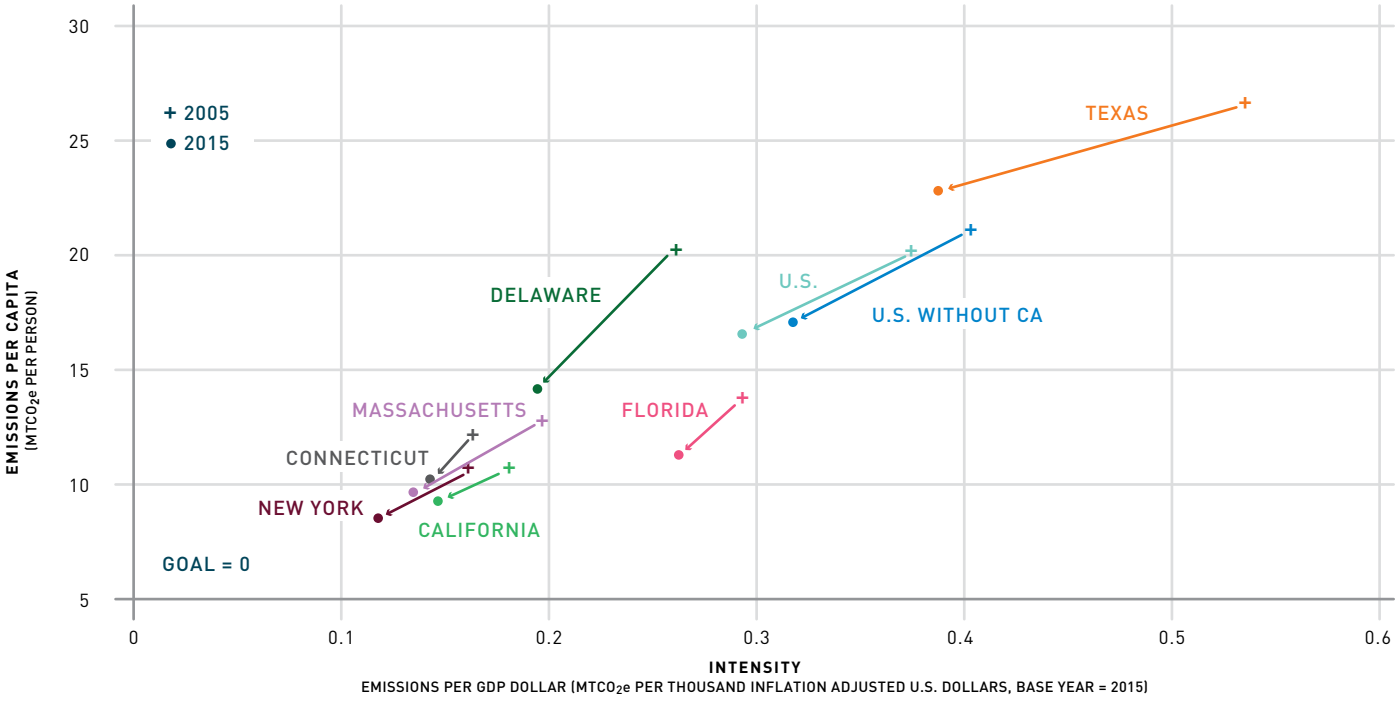
LOWEST CARBON ECONOMY (EMISSIONS/GDP)

STATE	2015	2014	1990
NEW YORK	1	1	3
CALIFORNIA	**4**	**4**	**4**
FLORIDA	17	17	16
ILLINOIS	21	23	15
PENNSYLVANIA	27	29	32
OHIO	30	31	33
TEXAS	32	32	41

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. *All 50 U.S. states excluding D.C.
Data Source: Energy Information Administration, U.S. Department of Energy; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

FIGURE 6A. CARBON INTENSITY AND EMISSIONS PER CAPITA

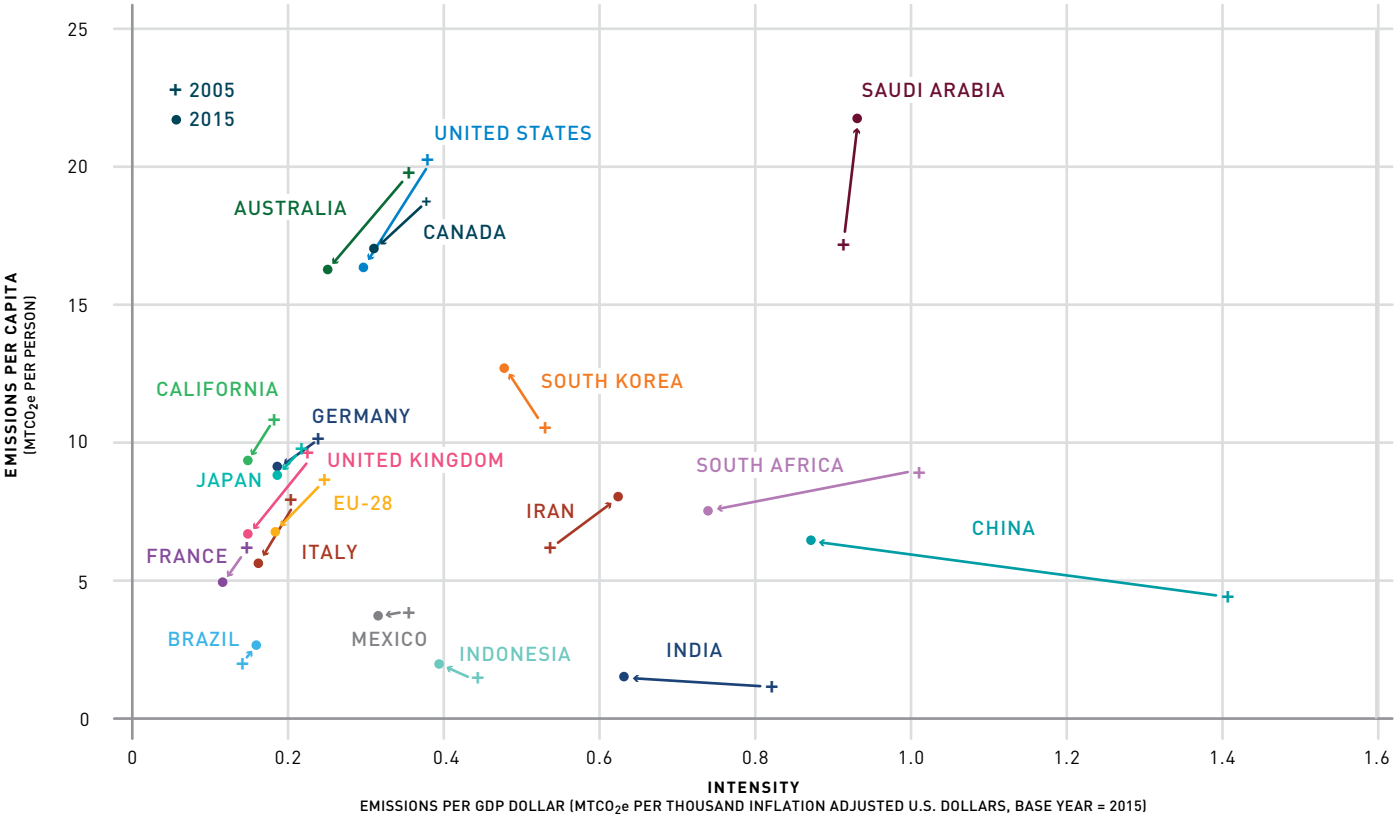
SELECTED U.S. STATES, 2005 VS. 2015



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: GDP in Real 2015 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. NEXT 10 / SF · CA · USA

FIGURE 6B. CARBON INTENSITY AND EMISSIONS PER CAPITA

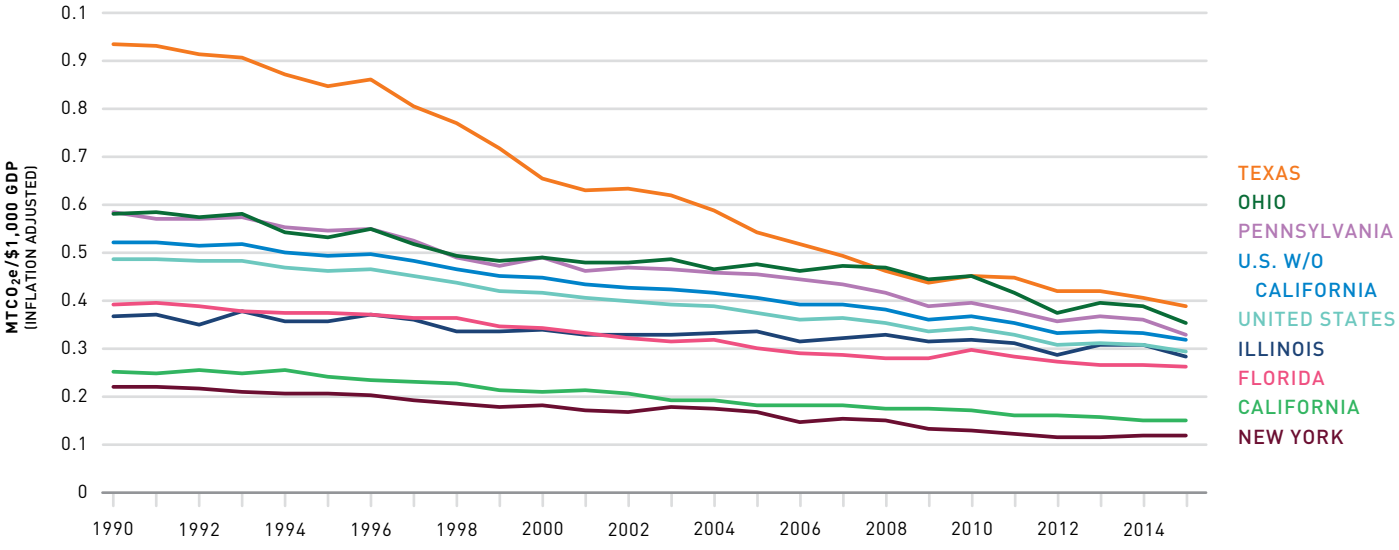
INTERNATIONAL, 2005 VS. 2015



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: U.S. Energy Information Administration; U.S. Bureau of Economic Analysis; USDA Economic Research Services; U.S. Census Bureau; California Department of Finance. NEXT 10 / SF · CA · USA

FIGURE 7. THE CARBON ECONOMY IN CALIFORNIA AND OTHER STATES

CARBON EMISSIONS (METRIC TONS) PER 1,000 DOLLARS GDP (2015 DOLLARS)



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. *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

by 2.3 percent. While California continues to improve its carbon intensity, the state improved at a slower rate compared to the previous year. In contrast, the U.S. excluding California improved its carbon dependency by 5.1 percent. Still, California's economy was less carbon-dependent than the national average, as well as other large states, as illustrated in Figure 7.

Globally, California still performs relatively well (see Figure 6b). California's emissions per $1,000 of GDP in 2015 dollars was 0.15 $MTCO_2e$ in 2015, similar to the United Kingdom's. Between 2005 and 2015, California's carbon intensity decreased by 20 percent. Over the same period, California's carbon efficiency also improved, with per capita emissions decreasing 14 percent. By comparison, Texas sustained one of the highest levels of total emissions in the U.S., yet its carbon efficiency improved by 15 percent (see Figure 6a). In 2015, advanced economies continued to trend towards a carbon free economy while per-capita emissions rose in carbon-intensive developing economies such as China and India.

In 2015, California's carbon emissions were composed of 64 percent petroleum, 35 percent natural gas and, for the first time, less than 1 percent coal. The lack of coal use in California, used almost exclusively by the industrial sector, starkly contrasts with the next largest states, where coal continues to contribute to a sizable percentage of carbon emissions. Despite the larger use of coal in Ohio (38%), Illinois (37%), Pennsylvania (35%), and Texas (20%), all of these states actually had notable reductions of carbon emissions from coal compared to 2014.[18]

While California continues to excel at maintaining low carbon emissions, there are a few areas of concerns. The largest concern by far may be that carbon emissions from fossil fuel consumption have been gradually creeping up after a period of relatively sharp decline during and shortly after the Great Recession.

MORE THAN CARBON: OVERALL GREENHOUSE GAS EMISSIONS IN CALIFORNIA

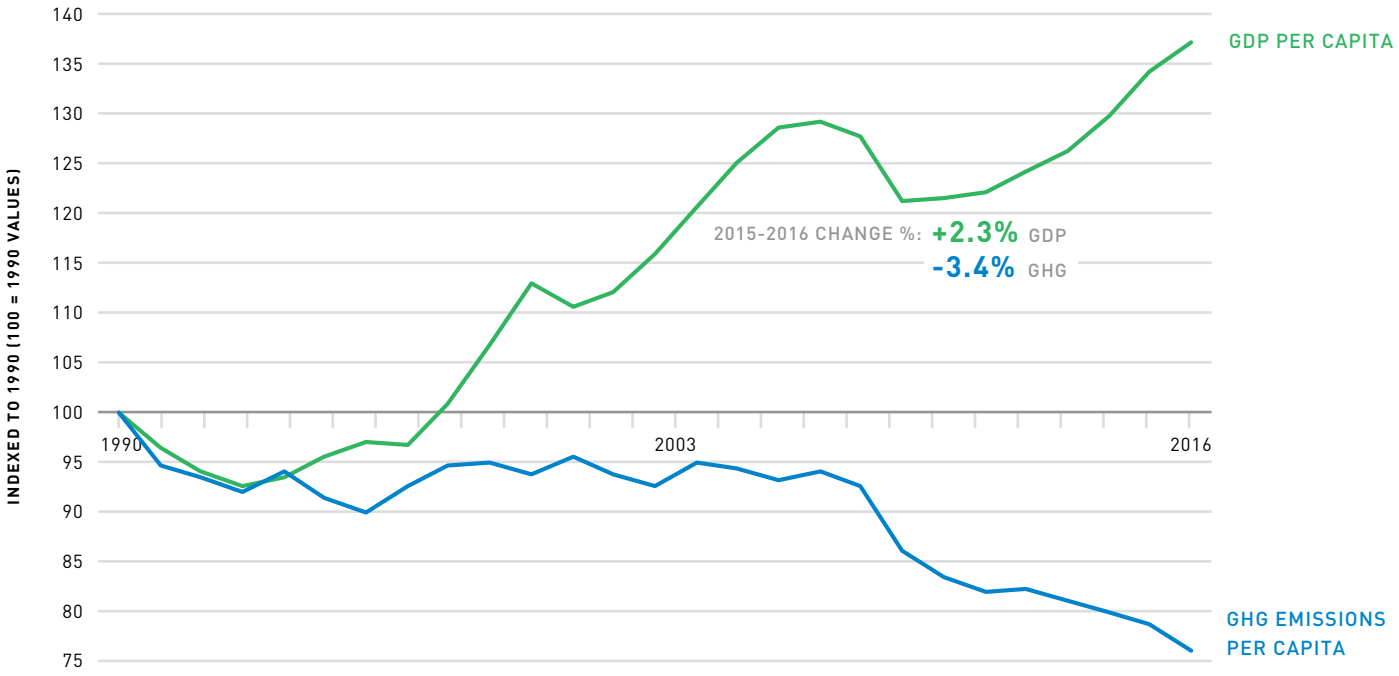
Examining carbon dioxide emissions from burning fossil fuels is important when trying to understand climate change. While carbon dioxide is the most abundant greenhouse gas, there are other GHGs such as nitrous oxide and methane that are vastly more potent than carbon dioxide.

Energy-related carbon dioxide emissions per capita in California totaled 10.94 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2016 – dipping below 11 $MTCO_2e$ /person for the first time. This represents a decrease of 3.4 percent or 0.4 $MTCO_2e$ compared to 2015 as overall emissions decreased while population increased slightly. Since 1990, GHG emissions per capita have dropped 24 percent and seem poised to continue to decline (see Figure 8). During the same period, California's economy grew by 37 percent (inflation-adjusted).

California shows that achieving long-term efficiency improvements while growing the economy is not only possible, but accomplishable. The carbon intensity (emissions per GDP) of the California economy continues to decline, with emissions of 0.165 $MTCO_2e$ per $1,000 of GDP (inflation-adjusted to

FIGURE 8. GREENHOUSE GAS EMISSIONS AND GROSS DOMESTIC PRODUCT

CALIFORNIA RELATIVE TRENDS SINCE 1990: GREENHOUSE GAS EMISSIONS ($MTCO_2e$) & 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

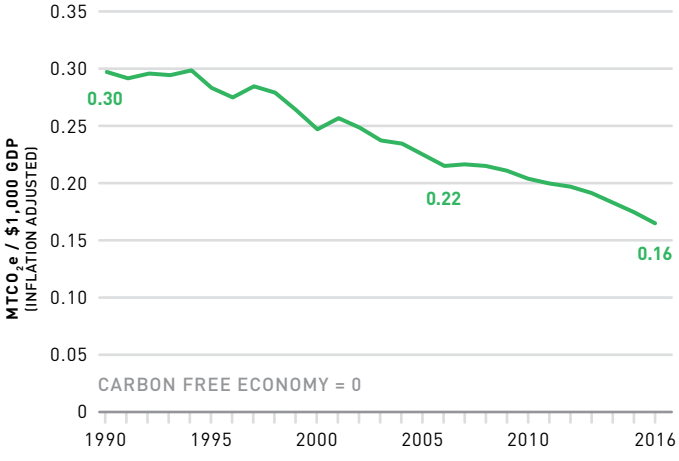
2015 dollars) generated in 2016, a 5.5 percent improvement compared to 2015. Compared to ten years ago, carbon intensity has fallen by 23.6 percent. Overall, from 1990 through 2016 California has seen a 44.6 percent drop in emissions per GDP.

Total greenhouse gas emissions in California fell 12.1 million $MTCO_2e$ or 2.7 percent in 2016 compared to 2015 to 429.35 million $MTCO_2e$ – the largest percentage decrease since 2009.[19] Electricity generation (in-state and imports) contributed the lion's share of decreases. Hydropower is an emissions-free energy source for Californians and when there is lower availability of hydroelectric power, the state is forced to generate electricity from natural gas in order to meet demands. As the California drought became less severe, hydroelectric power generation in the state bounced back to 2012 levels. Compared to 2015, in-state electricity generation from large hydro and small hydro increased 111 percent and 88 percent, respectively, for a combined increase of 107 percent.[20]

In addition, California's dependency on electricity from natural gas continues to trend down. Compared to 2015, both in-state generation and overall power mix (in-state generation plus imports) of electricity generated from natural gas were down 15.9 percent and 18.3 percent, respectively, in 2016. As the drought came to an end in April 2017, electricity generation from hydroelectric will continue to climb while natural gas will continue to decrease.[21]

FIGURE 9. CARBON ECONOMY

GROSS EMISSIONS RELATIVE TO GROSS DOMESTIC PRODUCT, CALIFORNIA

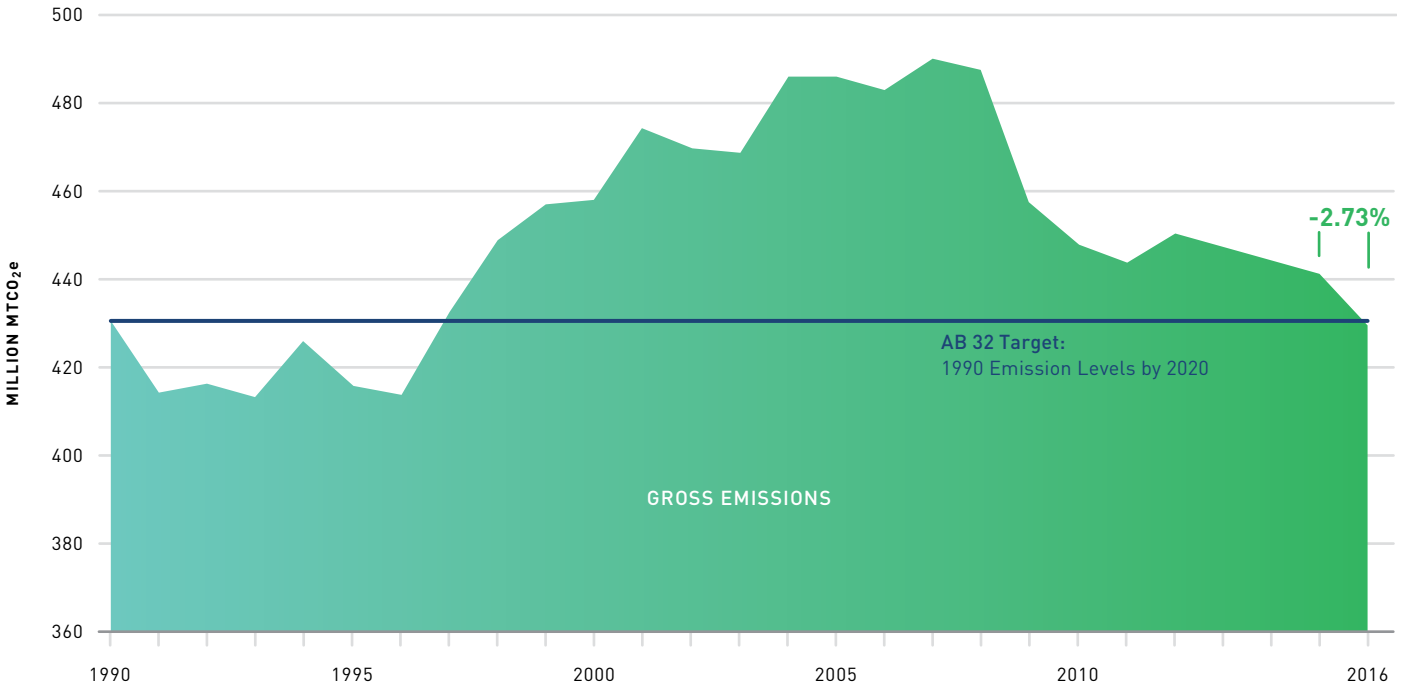


NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity; Bureau of Economic Analysis, U.S. Department of Commerce. NEXT 10 / SF · CA · USA

The transportation sector continued to account for the largest portion (40.5%) – and climbing quickly – of California's greenhouse gas emissions, followed by the industrial (23.4%) and in-state and imported electric power sectors (16.1%). The California Air Resources Board collects greenhouse gas emissions data by direct source of emissions rather than by end-user.

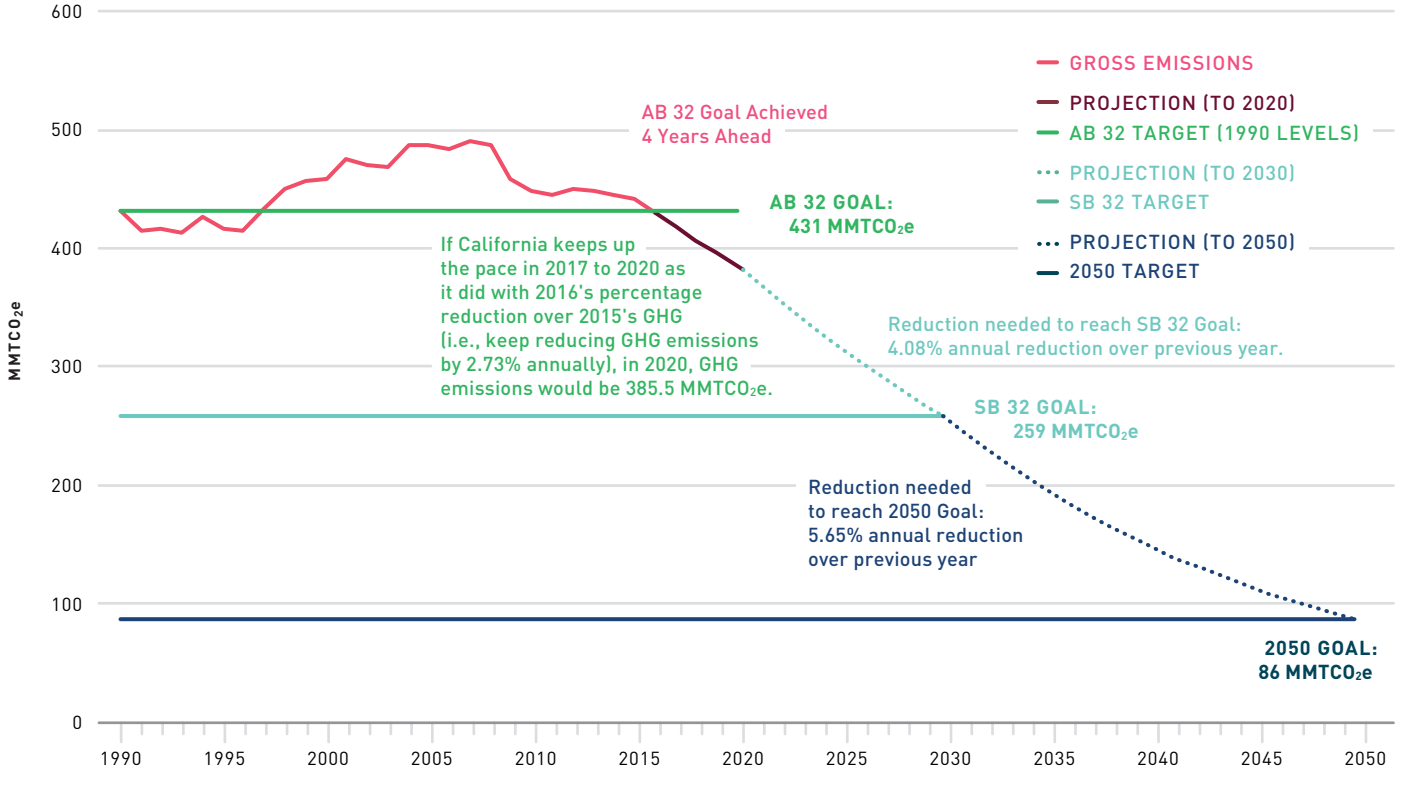
FIGURE 10. TOTAL CALIFORNIA GREENHOUSE GAS EMISSIONS

GROSS ANNUAL EMISSIONS



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

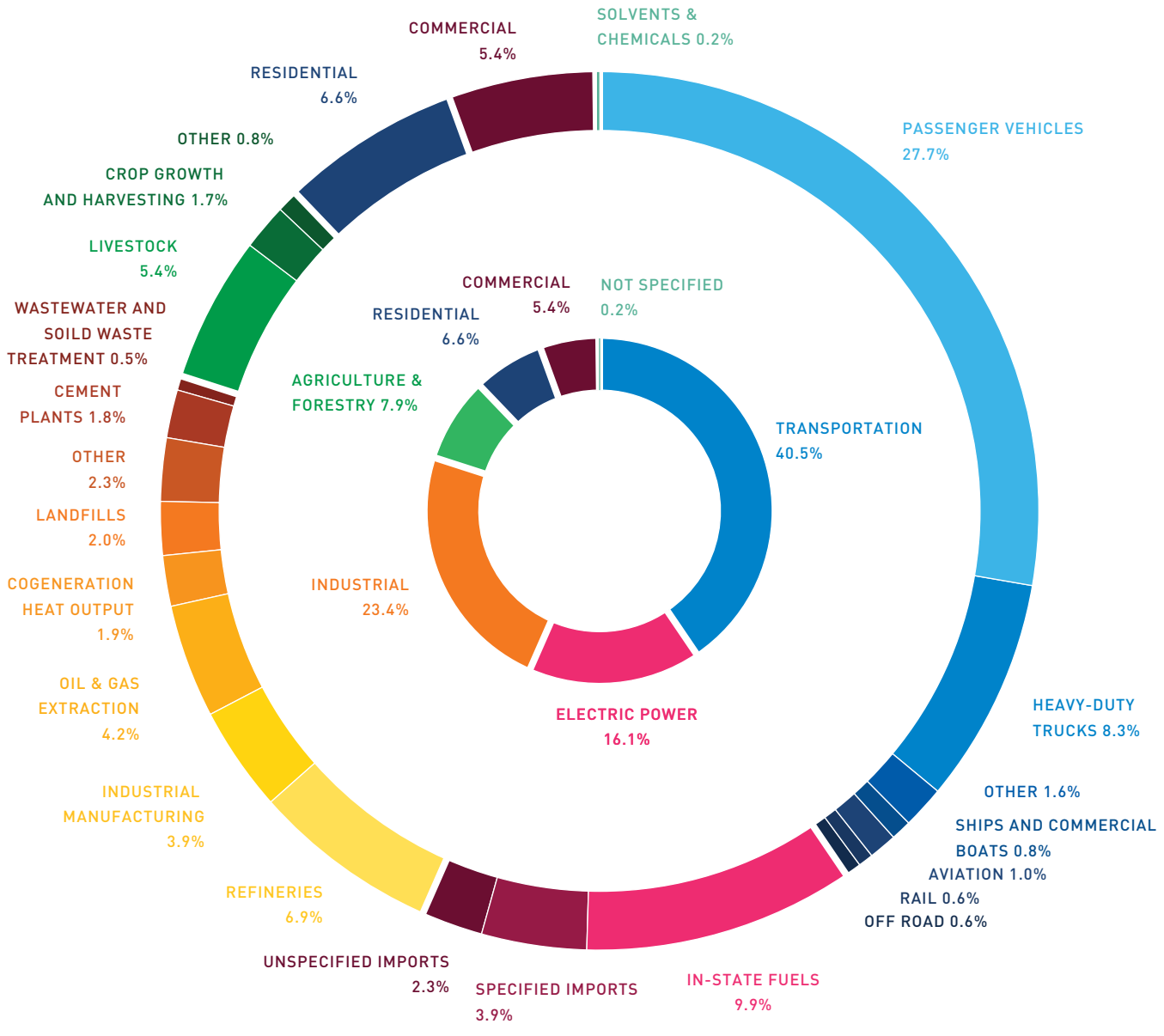
FIGURE 11. GHG EMISSIONS AND PROJECTED REDUCTION GOALS



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

FIGURE 12. GREENHOUSE GAS EMISSIONS BY SOURCE

CALIFORNIA, 2016



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

Transportation 40.5%: Emissions from all transportation sources accounted for 40.5 percent (174.01 $MMTCO_2e$) of California's total emissions, **up** from 38.7 percent of the total in 2015. On-road passenger vehicles, which consist of light-duty vehicles and other unspecified vehicles that are not heavy-duty vehicles, alone accounted for 67.8 percent of the transportation sector's GHG emissions. On-road heavy-duty vehicles make up 20.5 percent of the sector's total GHG emissions. In other words, on-road vehicles alone were responsible for 88.9 percent of the sector's GHG emissions. Other sources – namely ships and commercial boats, rail, off-road vehicles, and aviation – accounted for the remaining 11.1 percent of total transportation emissions.

Industrial 23.4%: Industrial activities contributed roughly 23.4 percent of California's emissions in 2016, **up** 0.3 percent of the total from 2015. Petroleum refining and hydrogen production (29.53 $MMTCO_2e$) were responsible for 29.4 percent of the sector's GHG emissions, followed by oil & gas extraction (17.9%) and industrial manufacturing (16.5%). Other emissions from industrial sources included landfills (8.4%), cogeneration (8.0%), cement plants (7.6%), and wastewater and solid waste treatment (2.3%).

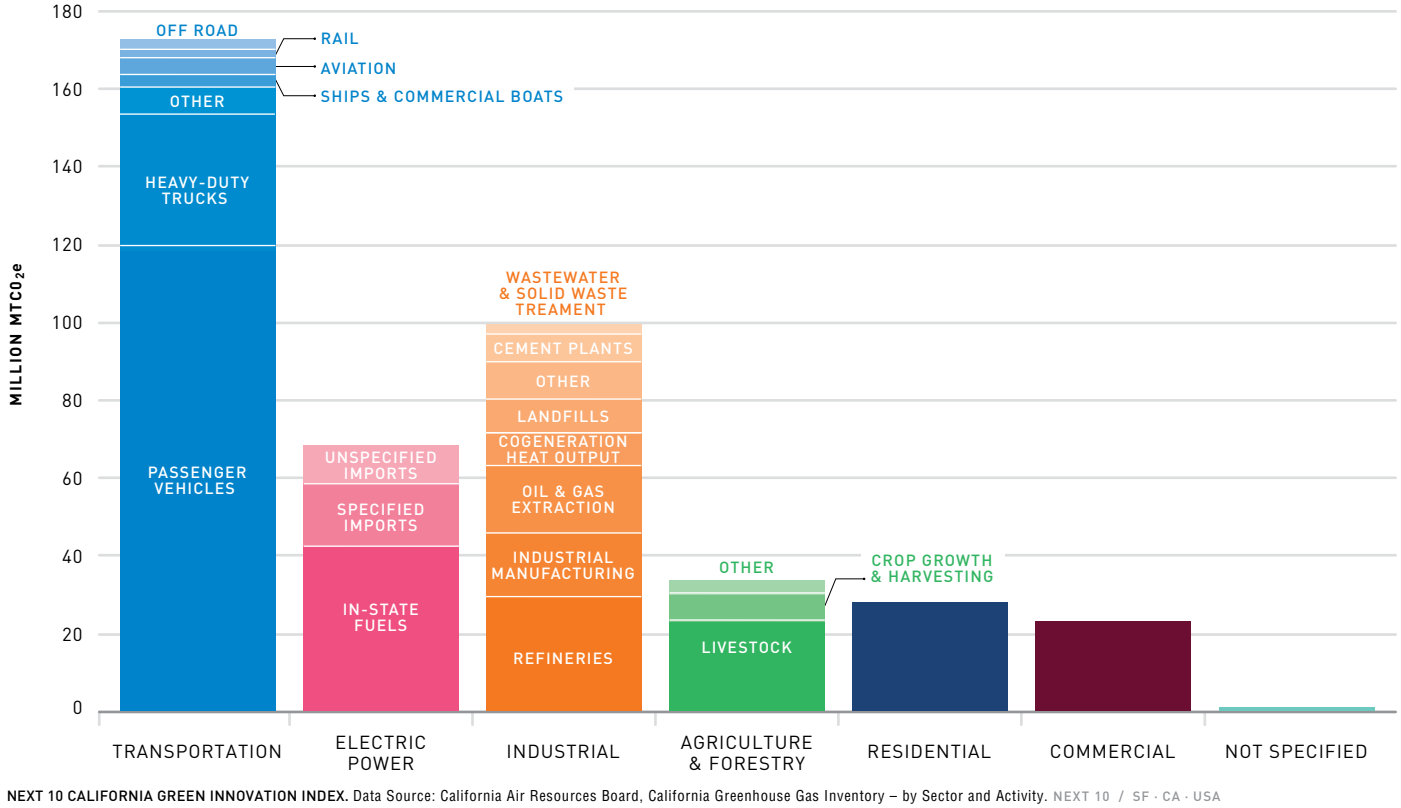
Electric Power 16.1%: Greenhouse gas emissions related to electricity generation contributed 16.1 percent to California's total emissions in 2013, **down** 3.0 percent from 2015. The electric power sector's share of GHG emissions is the fastest dropping sector over the past ten years, thanks to the state's commitment to generation from increasingly renewable sources. Emissions from imports are falling faster than those from in-state generation compared to ten years ago. Compared to 2006, GHG emissions from imports and in-state generation are down 52 percent and 15 percent, respectively, in 2016.

Agriculture and Forestry 7.9%: Emissions from agriculture & forestry represented roughly 8 percent of California's total emissions in 2016, almost unchanged compared to 2015. Livestock emitted 68.3 percent of total agriculture and forestry emissions.[22] Crop growth and harvesting accounted for 21.5 percent of emissions, while the remainder (10.3%) came from other sources such as soil cultivation and agricultural residue burning.

Residential 6.6%: The residential sector comprised 6.6 percent of total emissions in the state in 2016, **up** from 6.1 percent in 2015. Residential sector emissions are largely from combustion of natural gas and other fuels to heat houses and buildings, prepare food, and heat water. Landscaping (specifically, the use of nitrogen fertilizer on turf) accounted for just 3.0 percent of the sector's GHG emissions. While emissions from refrigeration and air conditioning, aerosols, and foams accounted for only 11.6 percent of the residential sector's GHG emissions in 2016, the proportion of the total residential emissions is increasing. By comparison, these activities accounted for just 2.1 percent of the sector's GHG emissions in 2006.[23]

Commercial 5.4%: Emissions from commercial fuel combustion and cogeneration heat output accounted for 5.4 percent of emissions statewide in 2015, **up** 0.4 percent compared to 2015. The commercial sector is the only other sector besides transportation where GHG emissions have been trending up. GHG emissions from the commercial sector stood at 23.04 $MMTCO_2e$ in 2016, which represents a 39.3 percent increase

FIGURE 13. GREENHOUSE GAS EMISSIONS BY DETAILED SOURCE
CALIFORNIA, 2016



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

compared to ten years ago, when the sector's GHG emissions were just 16.54 $MMTCO_2e$. The majority of these emissions (59.6%) were from combustion of natural gas and other fuels for uses such as heating buildings and the usage of substitutes for ozone depleting substances. Similar to the residential sector, emissions from refrigeration and air conditioning, aerosols, fire protection, and foams in the commercial sector have been increasing rather quickly – up 218% compared to 2006.

Non-Specified: 0.2%: Fugitive emissions made up 0.2 percent of total GHG emission in 2016.[24] These emissions came largely from evaporative losses of chemicals and solvents.

Sector-Specific Emissions – A Ten-Year Comparison

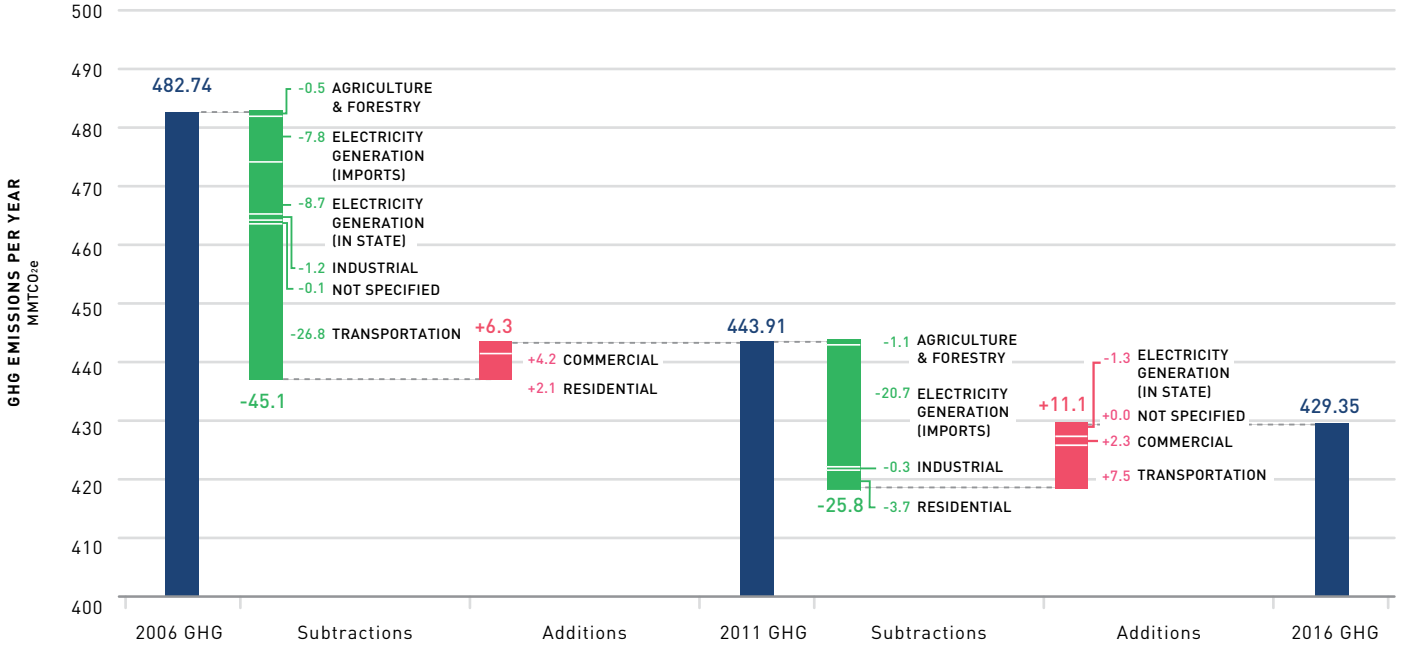
California has come very far compared to even just ten years ago. Compared to 2006, total GHG emission from all sectors is down 11.1 percent. As Figure 14 shows, the electricity generation sector has made significant progress in reducing GHG emissions while the agricultural sector has also seen some GHG reduction. The residential and industrial sectors have had mixed results thus far. As the second largest emitting sector, the industrial sector's GHG emissions in 2016 were only 1.4 percent lower than in 2006. After reaching a record low of 97.1 $MMTCO_2e$ in 2009, the sector's GHG emissions climbed by 7.4 percent to 104.2 $MMTCO_2e$ in 2014 before declining again. The newly implemented Community Air Protection Program may help to reduce the industrial sector's emissions further.[25]

On the other hand, while GHG emissions from the transportation sector were lower in 2016 compared to 2006, the figure is very dependent on the economy. Between 2006 (the height of the subprime mortgage bubble) and 2011 (immediately following the Great Recession), GHG emissions from the transportation sector dropped by 26.8 $MMTCO_2e$ or 13.9 percent. However, as the economy continued to recover and expand beyond pre-recession levels, emissions increased along with economic growth.

Greenhouse gas emissions from the commercial sector continued to climb, as well – even during the recession. Although the commercial sector was only responsible for 5.4 percent of the total emission in 2016, this represented a 2 percent increase over the sector's 3.4 percent share of total emissions in 2006.

FIGURE 14. CONTRIBUTIONS TO GREENHOUSE GAS BY SECTOR

CALIFORNIA: 2006, 2011 AND 2016



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

California's Key Climate Challenge: Reducing Emissions from the Transportation Sector

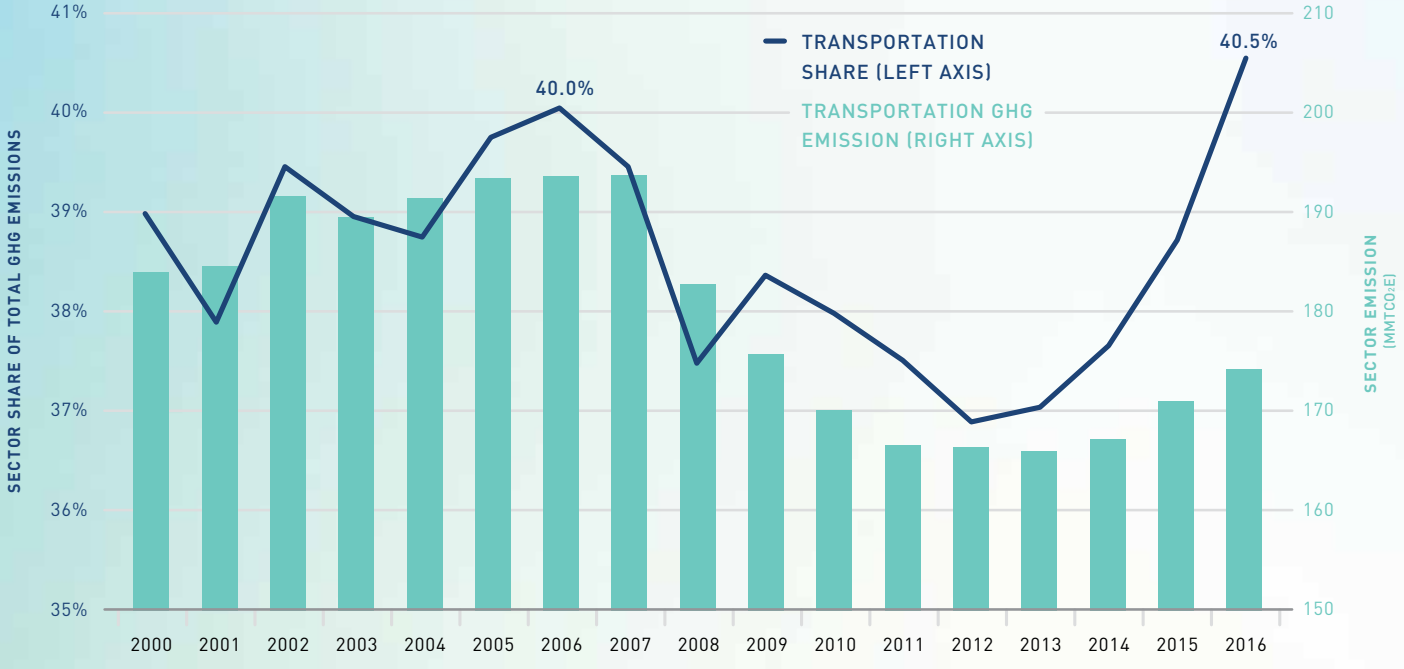
While the Golden State's success in achieving AB 32's emission reduction goal ahead of schedule is a cause for celebration, it has become clear that the transportation sector is heading in the wrong direction. A notable increase in GHG emissions in recent years means the sector is now California's largest source of total emissions. The accompanying chart depicts a worrisome trend: not only is the transportation sector's share of GHG emissions (40.5%) the highest since 2006, the share has been climbing with no signs of slowing down since 2012.

The transportation sector's GHG emissions stood at 174.01 $MMTCO_2e$, 3.11 $MMTCO_2e$ higher than in 2015. On-road transportation (+3.12 $MMTCO_2e$) accounted for the lion's share of the increase, of which 2.63 $MMTCO_2e$ came from light-duty vehicles.[26] Greenhouse gas emissions from on-road light-duty vehicles totaled 117.97 $MMTCO_2e$, similar to 2008's level of 118.15 $MMTCO_2e$. By comparison, total GHG emissions from heavy-duty vehicles in 2016 were 13.1 percent below 2008's level. Despite increasing adoption of alternative-fuel vehicles – especially electric vehicles – GHG emissions from the light-duty vehicles subsector remains the biggest hurdle for the state to meet the next 2030 emissions goal of a 40 percent reduction compared to the 1990 level of 431 $MMTCO_2e$.

As the chart on the next page illustrates, in 2016 GHG emissions from the transportation sector increased by 3.11 $MMTCO_2e$ or 1.8 percent compared to 2015. This is an improvement compared to the 2.2 percent increase between 2014 and 2015. Most of the increase was due to an increase in emissions from on-road transportation, which jumped 3.1 percent year-over-year. Last year's *Green Innovation Index* explored some likely

GHG EMISSIONS FROM TRANSPORTATION SECTOR AND AS SHARE OF TOTAL GHG EMISSIONS

CALIFORNIA, 2000–2016



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

GREENHOUSE GAS EMISSIONS BY SOURCE, CALIFORNIA, 2016

EMISSIONS IN MILLION METRIC TONS CO_2-EQUIVALENT

	2015	2016	YoY CHANGE	YoY CHANGE %
AGRICULTURE & FORESTRY	34.41	33.84	-0.57	-1.7%
COMMERCIAL	22.07	23.04	0.97	4.4%
ELECTRICITY GENERATION (IMPORTS)	33.88	26.28	-7.60	-22.4%
ELECTRICITY GENERATION (IN STATE)	50.21	42.67	-7.54	-15.0%
INDUSTRIAL	102.10	100.37	-1.73	-1.7%
NOT SPECIFIED	0.79	0.79	0.01	0.8%
RESIDENTIAL	27.05	28.34	1.30	4.8%
TRANSPORTATION	**170.89**	**174.01**	**3.11**	**1.8%**

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

TRANSPORTATION SECTOR PERCENTAGE CHANGE

EMISSIONS IN MILLION METRIC TONS CO_2-EQUIVALENT

	2015	2016	YoY CHANGE	YoY CHANGE %
TRANSPORTATION	**170.89**	**174.01**	**3.11**	**1.8%**
AVIATION	4.22	4.44	0.22	5.2%
NOT SPECIFIED	6.82	6.69	-0.13	-1.9%
OFF ROAD	2.53	2.63	0.10	3.9%
ON ROAD	151.52	154.64	3.12	2.1%
RAIL	2.38	2.37	-0.02	-0.7%
WATER-BORNE	3.42	3.24	-0.19	-5.4%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board, California Greenhouse Gas Inventory – by Sector and Activity.
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ON ROAD TRANSPORTATION PERCENTAGE CHANGE BREAKDOWN

EMISSIONS IN MILLION METRIC TONS CO_2-EQUIVALENT

	2015	2016	YoY CHANGE	YoY CHANGE %
ON ROAD	151.52	154.64	3.12	2.1%
HEAVY-DUTY VEHICLES	35.19	35.62	0.43	1.2%
HEAVY-DUTY TRUCKS	33.00	33.56	0.55	1.7%
BUSES	1.47	1.39	-0.08	-5.7%
MOTORHOMES	0.72	0.67	-0.04	-5.8%
LIGHT-DUTY VEHICLES	115.33	117.97	2.63	2.3%
LIGHT-DUTY TRUCKS & SUVS	57.34	58.94	1.59	2.8%
MOTORCYCLES	0.51	0.52	0.01	1.7%
PASSENGER CARS	57.48	58.51	1.03	1.8%
NOT SPECIFIED	0.99	1.06	0.06	6.4%
NONE	0.99	1.06	0.06	6.4%

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

explanations for the worrisome trend such as decreasing public transit usage and lower gasoline prices. Increasing vehicle miles traveled (VMT) is also another contributing factor. As the housing crisis in the state worsens, Californians are having to drive further to get from their homes to their jobs, contributing (along with other factors) to an increase in VMT. Finally, fueled by lower gas prices in recent years, consumer preferences have shifted from passenger cars (sedans and compact vehicles) to pick-up trucks and SUVs.

Similar to the previous year, emissions from light-duty vehicles accounted for all of the increases in GHG emissions from the on-road transportation subsector. On the other hand, emissions from heavy-duty vehicles continued to drop. Unfortunately, the decrease did little to offset the overall increases. In addition, emissions from light-duty trucks and SUVs increased faster year-over-year than passenger cars, a result of shifting consumer preferences toward larger vehicles.

CAP AND TRADE OVERVIEW

OVERVIEW

Designed to meet California's greenhouse gas emissions reduction goals while delivering major economic, environmental, and public health benefits, California's cap-and-trade program facilitates and coordinates investments throughout California. The cap-and-trade program involves setting a limit or a "cap" on emissions and issues "allowances" that gives entities permission to emit a specified amount of emissions. Private entities may trade these allowances to match their emissions levels and can achieve their limit on emissions by purchasing extra allowances from other private entities or upgrading to more efficient technologies. Proceeds from the cap-and-trade auctions are held in the Greenhouse Gas Reduction Fund (GGRF) and allocated to projects that further the goals of the Global Warming Solutions Act (AB 32) of 2006. As of May 2018, California has held twenty-three quarterly auctions, fifteen of which are jointly held with Québec's Ministry of Sustainable Development, Environment and the Fight against Climate Change (MDDELCC). The quarterly auctions in 2017 added an additional $2.4 billion in appropriations for a cumulative total of $6.1 billion.[27]

As some of the state's largest GHG-emitting facilities are disproportionately located in disadvantaged communities,[28] California has moved to ensure that funds from the GGRF are prioritized for these areas to help optimize the benefits of the state's GHG reduction efforts while reinvesting proceeds into these communities to create environmental and health co-benefits.[29] Today, approximately one-third of the funding appropriated from the GGRF is targeted to benefit disadvantaged communities, as mandated by 2012's Senate Bill 535 (De León).

UPDATES

The fifteenth quarterly joint auction held on May 15, 2018 resulted in the sale of 90.59 million in current vintage allowances and 6.06 million in advanced vintage allowances. This means all available vintages for the current compliance year and just under half of the vintages for a future compliance year were sold. After a period of slow demand for vintages in 2016 and early 2017, every current vintage allowance has been sold at the auctions since May 2017. However, allowances do not expire, and firms can stock up on current allowances without necessarily making commitments to reduce their emissions in the future. To guard against this potential drawback, the state could ensure that the number of banked allowances does not exceed the 2030 annual target.[30]

Assembly Bill 398 (Eduardo Garcia), signed into law in 2017, extends the state's cap-and-trade program until 2030, whereas previously it went to 2020. Passed along with AB 398, Assembly Bill 617 (Cristina Garcia) created the Community Air Protection Program to reduce community-level air pollution in areas with high cumulative exposure and to strengthen air quality monitoring. In FY 2017–18, $267 million was appropriated from the GGRF for this new program. AB 617 also requires accelerated retrofitting of pollution controls on industrial sources.

The Budget Act of 2017 created the Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program, which seeks to reduce GHG emissions from the agricultural sector. Through local air districts, the FARMER Program will provide funding from the GGRF for cleaner harvesting equipment and other tools and equipment used in agricultural operations.

In the wake of the recent wildfires that devastated parts of California last year, $75 million in GGRF funding was appropriated to the Wildfire Prevention Program, which administers services and programs to reduce the risk of wildfire to communities, evacuation routes, and infrastructure. An additional $25 million from the GGRF was appropriated for the Wildfire Response and Readiness Program, which provides local assistance grants to fire departments within High Hazard Severity Zone.[31] While the emissions from wildfires are not included in the state's GHG Inventory, the emissions from longer and more severe wildfire seasons can negate GHG emission reduction progress the state has made thus far. Rising temperatures will also make wildfires more prevalent.

In FY 2017–18, the Legislature and Governor appropriated over $2.4 billion in GGRF funding for existing and new programs – more than double the amount appropriated in FY 2016–17. As of December 2017, $6.1 billion in climate investments had been appropriated, $2 billion of which has been cumulatively implemented to-date. These implemented projects are estimated to reduce lifetime GHG emissions by 23 $MMTCO_2e$ (approximately a 5% reduction compared to 2016 total emissions).[32] Of the $2 billion implemented so far, 51 percent of the funds benefit disadvantaged communities. The accompanying table provides details of the programs and the amounts appropriated for FY 2017–18.

TABLE 5. APPROPRIATIONS FOR CALIFORNIA CLIMATE INVESTMENTS FY 2017–18 AND CUMULATIVE

ADMINISTERING AGENCY	PROGRAM	APPROPRIATIONS ($ MILLIONS)	
		FY 2017–18	CUMULATIVE TOTAL
CALIFORNIA AIR RESOURCE BOARD	COMMUNITY AIR PROTECTION PROGRAM	$267	$267
	FUNDING AGRICULTURAL REPLACEMENT MEASURES FOR EMISSION REDUCTIONS PROGRAM	$85	$85
	LOW CARBON TRANSPORTATION PROGRAM	$571	$1,266
CALTRANS	ACTIVE TRANSPORTATION PROGRAM	$0	$10
	LOW CARBON TRANSIT OPERATIONS PROGRAM*	$71	$231
CALIFORNIA HIGH SPEED RAIL AUTHORITY	HIGH-SPEED RAIL PROJECT	$356	$1,287
CALIFORNIA STATE TRANSPORTATION AGENCY	TRANSIT AND INTERCITY RAIL CAPITAL PROGRAM*	$142	$575
CALIFORNIA STRATEGIC GROWTH COUNCIL	AFFORDABLE HOUSING AND SUSTAINABLE COMMUNITIES; SUSTAINABLE AGRICULTURAL LANDS CONSERVATION PROGRAM*	$285	$959
	CALIFORNIA CLIMATE INVESTMENTS TECHNICAL ASSISTANCE PROGRAM	$0	$2
	CLIMATE CHANGE RESEARCH PROGRAM	$11	$11
	TRANSFORMATIVE CLIMATE COMMUNITIES PROGRAM	$10	$150
CALIFORNIA AIR RESOURCES BOARD	WOODSMOKE REDUCTION PROGRAM	$0	$5
CALIFORNIA DEPARTMENT OF COMMUNITY SERVICES AND DEVELOPMENT	LOW-INCOME WEATHERIZATION PROGRAM	$18	$192
CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE	ALTERNATIVE RENEWABLE FUELS PROGRAM	$0	$3
	STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM	$0	$66
CALIFORNIA DEPARTMENT OF WATER RESOURCES	STATE WATER PROJECT TURBINES	$0	$20
	WATER-ENERGY GRANT PROGRAM	$0	$50
CALIFORNIA ENERGY COMMISSION	FOOD PRODUCTION INVESTMENT PROGRAM	$60	$60
	RENEWABLE ENERGY FOR AGRICULTURAL PROGRAM	$6	$6
CALIFORNIA CONSERVATION CORPS	TRAINING AND WORKFORCE DEVELOPMENT PROGRAM	$5	$5
CALIFORNIA DEPARTMENT OF FISH & WILDLIFE	WETLANDS AND WATERSHED RESTORATION PROGRAM	$15	$42
CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE	ALTERNATIVE MANURE MANAGEMENT PROGRAM; DAIRY DIGESTER RESEARCH AND DEVELOPMENT PROGRAM	$99	$161
	HEALTHY SOILS	$0	$8
CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION	FOREST HEALTH PROGRAM, FIRE PREVENTION PROGRAM, AND URBAN AND COMMUNITY FORESTRY PROGRAM	$220	$302
	WILDFIRE PREVENTION PROGRAM	$75	$75
DEPARTMENT OF RESOURCES RECYCLING AND RECOVERY (CALRECYCLE)	WASTE DIVERSION PROGRAM	$41	$112
CALIFORNIA NATURAL RESOURCES AGENCY	URBAN GREENING PROGRAM	$26	$106
STATE OF CALIFORNIA COASTAL CONSERVANCY	CLIMATE READY PROGRAM AND COASTAL RESILIENCE PLANNING	$6	$6
STATE OF CALIFORNIA WILDLIFE CONSERVATION BOARD	CLIMATE ADAPTATION AND CONSERVATION EASEMENTS	$20	$20
CALIFORNIA GOVERNOR'S OFFICE OF EMERGENCY SERVICES	WILDFIRE RESPONSE AND READINESS	$25	$25
	TOTAL	$2,414	$6,107

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Notes: 1. Appropriations from previous fiscal years may be retroactively adjusted to account for Budget Control Sections or for special legislation (e.g., Trailer Bills). As a result, reported cumulative appropriations may not reflect summations of Budget Act line items. 2. SB 862 states that $400 million shall be available to the High-Speed Rail Authority beginning in FY 2015–16, as repayment of a loan from the GGRF to the General Fund. This money shall be repaid as necessary, based on the financial needs of the High-Speed Rail Project. This loan amount is not included in the reported $1.29 billion cumulative appropriation. Data Source: California Air Resource Board. 2017, March. Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2018_cci_annual_report.pdf. NEXT 10 / SF · CA · USA

ENERGY EFFICIENCY

Why is it Important?

Energy efficiency enables consumers to optimize their energy use and consume less energy for the same level of output. Energy efficiency can help businesses, governments, and consumers save money and create investment opportunities across the economy, while generating jobs and reducing the environmental impact of energy use. For low-income communities that spend a larger share of their incomes on energy than more affluent households, energy efficiency programs have been critical in helping reduce energy bills. Indicators that measure California's change in electricity and overall energy consumption, while factoring in changes in population and the economy, can show how the state is progressing towards making energy more affordable and efficient.

As paragon of energy efficiency, California has various policies in place and is continuously adding new programs to improve energy efficiency. The California Department of Community Services & Development (CSD), the California Public Utilities Commission (CPUC), and the California Energy Commission (CEC) have instituted programs across a variety of sectors and end-uses to promote appliance efficiency, new and existing building efficiency, efficiency in food production and water use, reduction of wood smoke, and programs to support weatherization in low-income communities. In addition, the CEC provides low cost loans to local governments and schools to fund comprehensive energy efficiency programs.

Energy Efficiency Indicators

PRODUCTIVITY

Since the 1990s, California has implemented various energy-related policies that improve energy productivity. Since 2012, California's GDP has increased at a much faster rate than its energy use, leading to ever-greater energy productivity.

In 2015, California generated $3.29 of gross domestic product (GDP, inflation-adjusted) for every 10,000 British Thermal Units (BTU) of energy consumed, while the rest of the U.S. generated $1.75 of economic output for the same amount of energy consumed. California had 1.9 times as much economic activity while consuming the same amount of energy, compared with 1.75 times as much in 2005.

Energy productivity in the U.S. (excluding California) improved 9.3 percent between 2010 and 2015 and improved 48.2 percent since 1990. By comparison, energy productivity in California reached a 16.5 percent improvement between 2010 and 2015 and a 69.4 percent rise since 1990.

EFFICIENCY

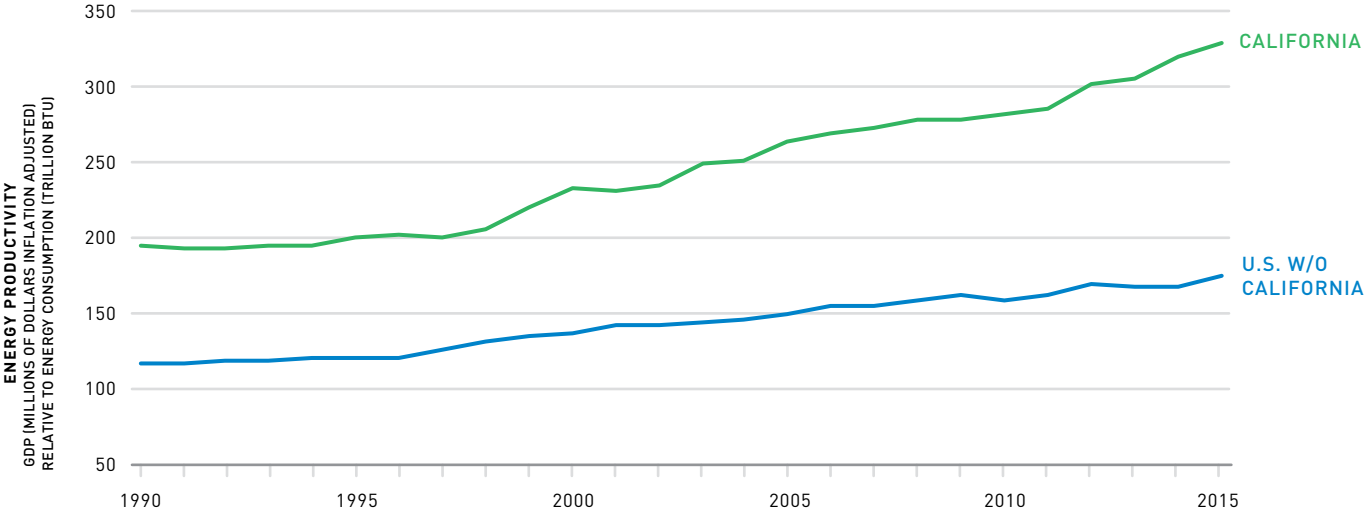
California has generally performed well in curbing energy consumption compared to the rest of U.S. In 2015, per capita energy consumption was down 21.1 percent in California compared to 1990.

Per capita energy consumption in the rest of U.S. has also decreased relative to 1990, albeit at a slower rate compared to California. In 2015, per capita energy consumption was down 9.5 percent in the rest of the U.S. compared to 1990.

Despite a consistent, gradual decline in per capita energy consumption in California, total energy consumption did not start declining until 2006, the year that Assembly Bill 32 (AB 32) – the state's landmark climate change legislation – was signed into law. In both 2005 and 2006 California passed measures (SB 1037 and AB 2021) requiring all utilities to procure energy efficiency prior to exploring additional resources to serve California consumers. In 2006, energy consumption was 50.8 percent higher than the 1970 level and 11.4 percent higher than the 1990 level. Since 2006, total energy consumption has declined consistently, leaving the state 39.6 percent higher in total energy consumption in 2015 relative to 1970 and just 3.1 percent higher relative to 1990. The rest of U.S. also exhibited a somewhat similar trend initially: gradual increase until 2007, when energy consumption was 49 percent higher than in 1970, and decreasing slightly since then. The Great Recession began in December 2007 and coincided with the period of decreased energy consumption that followed. In 2015, the total energy consumption level of the rest of the U.S. was 43.9 percent higher than in 1970 and 16.2 percent higher than in 1990. While California's AB 32 law may have contributed to energy savings in the state, the Great Recession likely played a role more broadly – both in California and across the U.S. – in driving down energy consumption starting in 2007.

FIGURE 15. ENERGY PRODUCTIVITY

GDP RELATIVE TO TOTAL ENERGY CONSUMPTION: 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.
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FIGURE 16. TOTAL ENERGY CONSUMPTION RELATIVE TO 1990

TOTAL CONSUMPTION & PER CAPITA: CALIFORNIA & THE REST OF THE U.S., 1990–2015

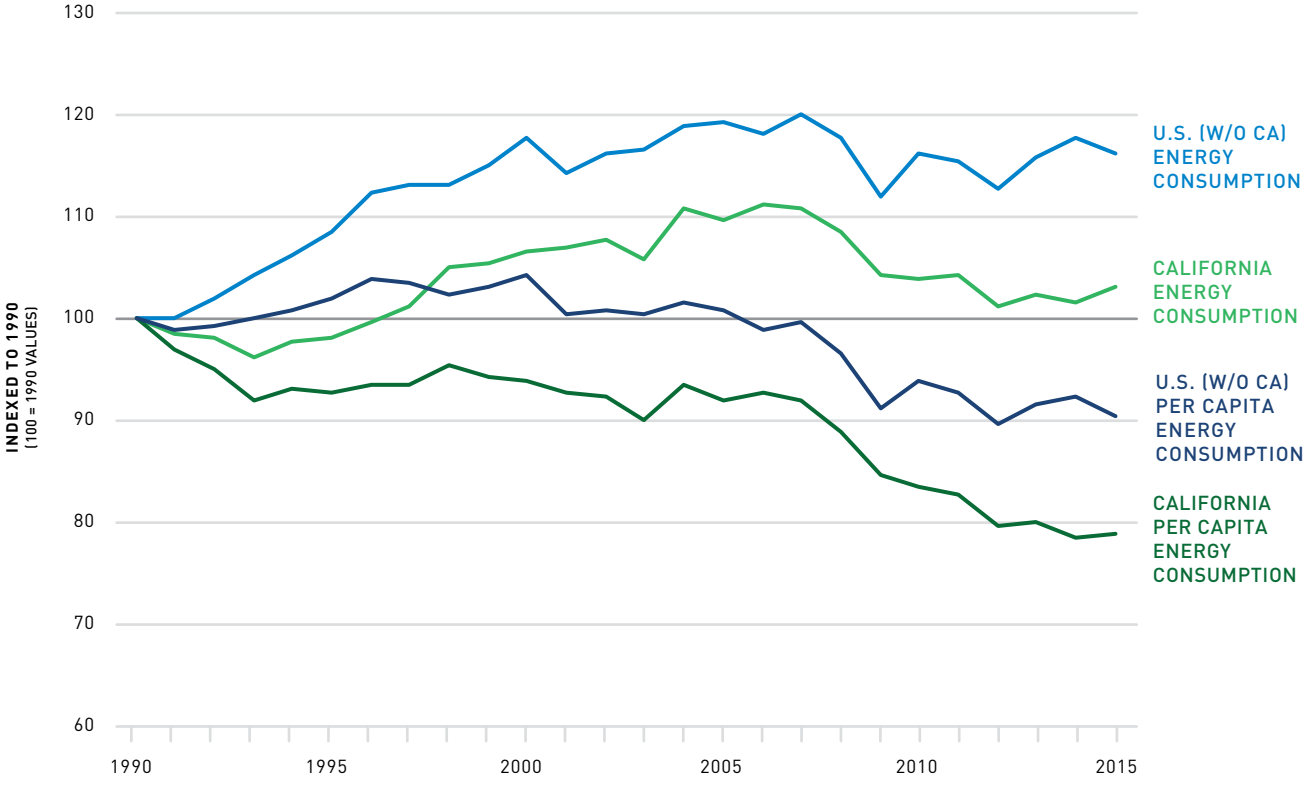

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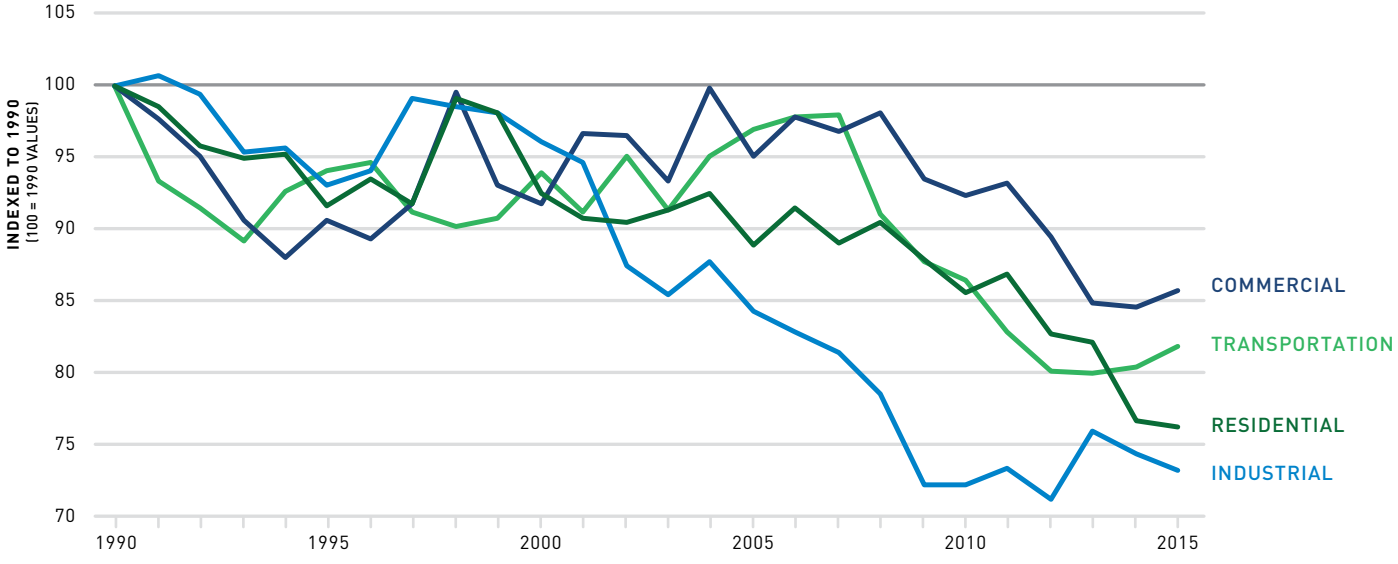
FIGURE 17. ENERGY CONSUMPTION PER CAPITA

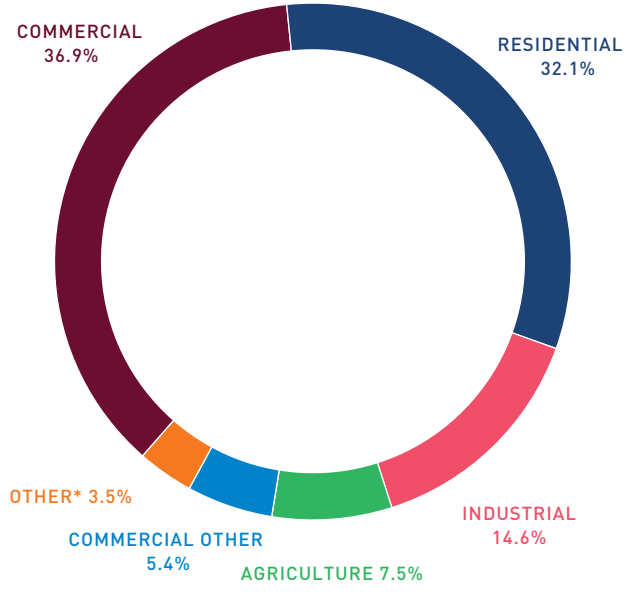
BY SECTOR RELATIVE TO 1990 CALIFORNIA, 1990–2015



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

FIGURE 18. ELECTRICITY CONSUMPTION BY SECTOR

BY GWh, 2016



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

Relative to 1990, California's per capita energy consumption declined much faster than the rest of the U.S. over time. However, the recent uptick since 2012 in per capita energy consumption (across all fuel types) – especially in the transportation sector, which has been trending up for three years in a row – may be concerning.

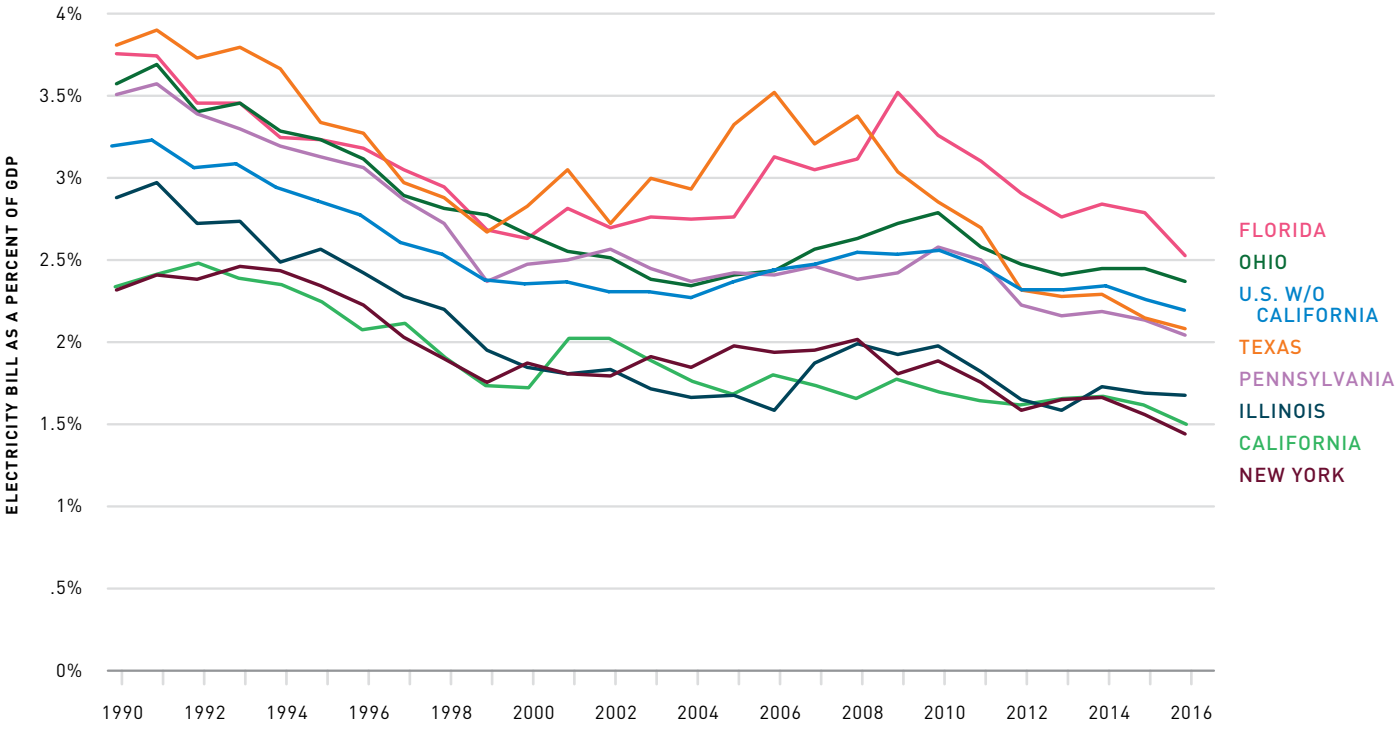
Lower oil prices, which also started to fall in 2012, are the chief cause for the recent increase in transportation sector energy consumption as driving has become more affordable.[33] There are also secondary reasons, including longer commutes as people move farther away from job centers due to rising housing costs, that have also contributed to the rise of energy consumption in the transportation sector.[34]

THE ELECTRICITY BILL

Electricity in California was used by a variety of sectors in 2016, with the commercial sector consuming 36.9 percent of the electricity, down 1.1 percent from 2015. The residential sector was the next largest (32.1%), followed by the industrial sector (14.6%). Electricity consumption from the agriculture sector saw a notable jump from 6.7 percent in 2015 to 7.5 percent in 2016, due mostly to the increase of electricity usage from the Department of Water Resources.[35] This increase may have been fueled by increased energy usage to pump groundwater and

FIGURE 19. STATEWIDE ELECTRICITY BILL AS A PERCENT OF GDP

CALIFORNIA, FLORIDA, ILLINOIS, NEW YORK, OHIO, PENNSYLVANIA, TEXAS, & U.S. WITHOUT CALIFORNIA, 1990–2016



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.
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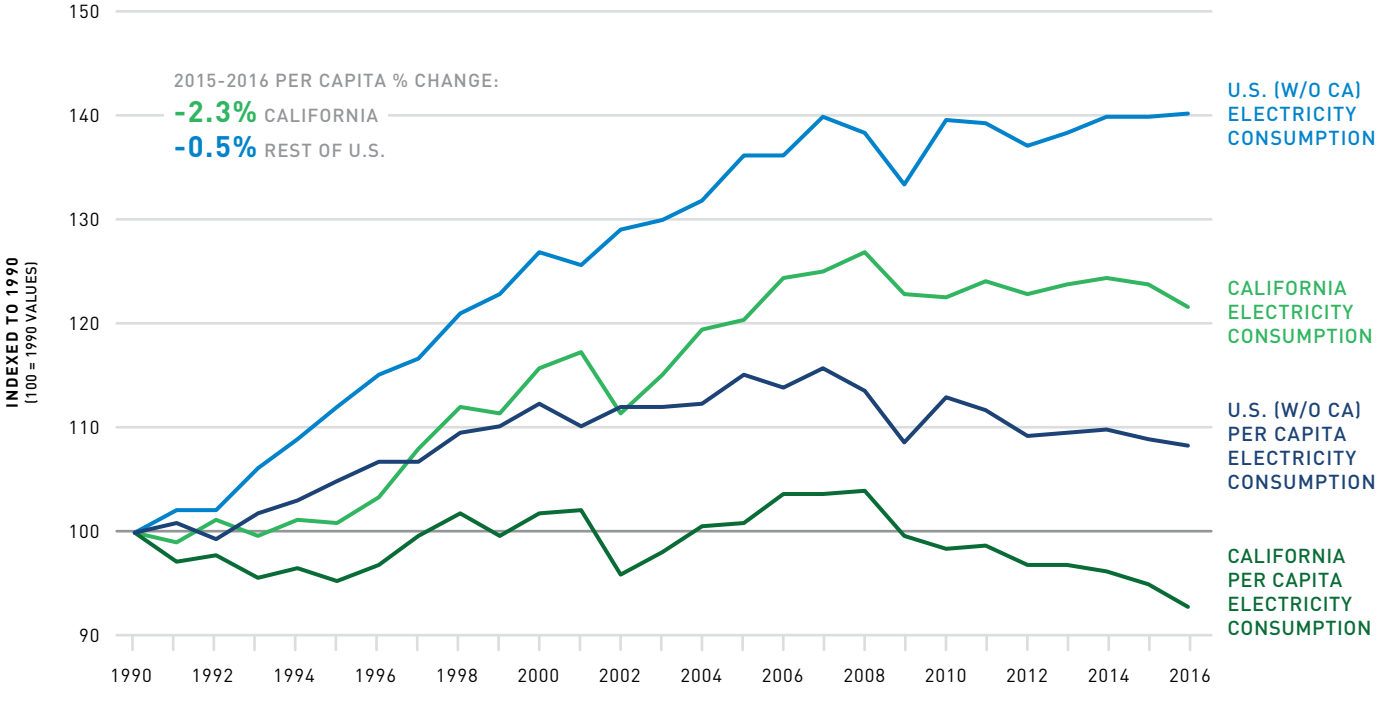
FIGURE 20. ELECTRICITY CONSUMPTION RELATIVE TO 1990

TOTAL CONSUMPTION & PER CAPITA: CALIFORNIA & REST OF U.S., 1990–2016



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

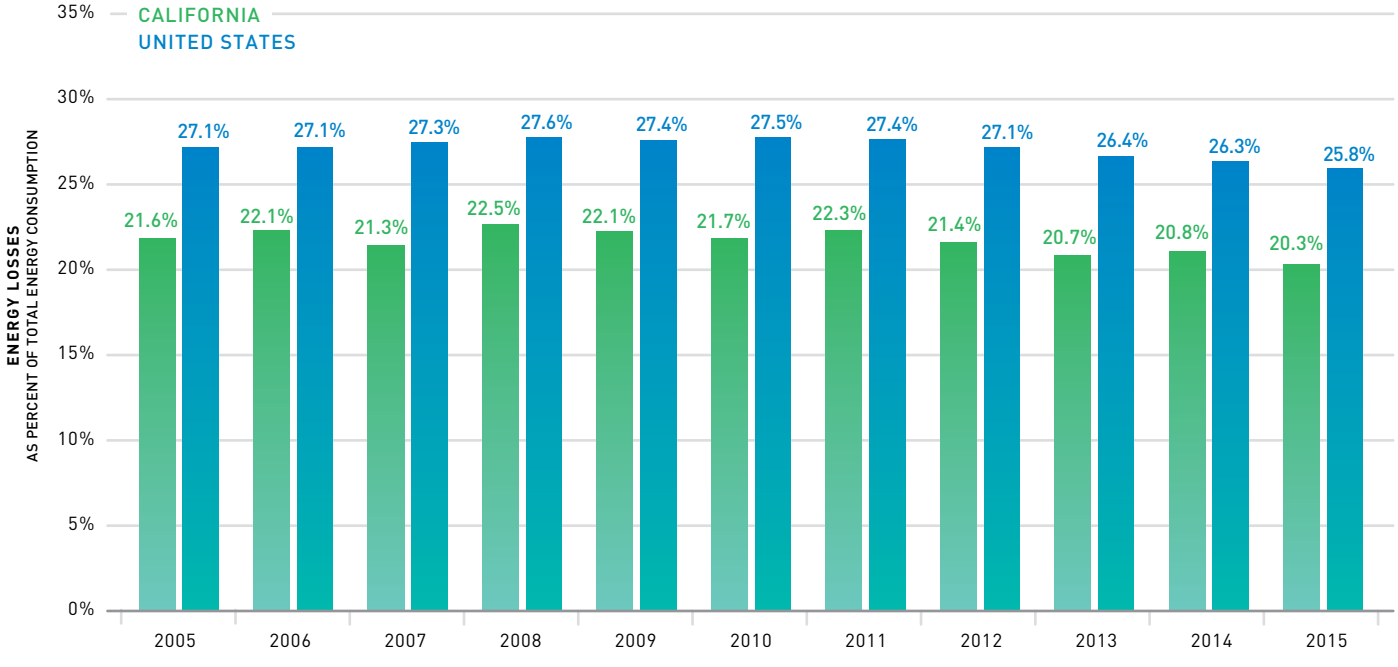
convey water throughout the state during what was the final year of an extended drought in the state. Overall, the mix of electricity consumption by sector remained fairly constant in recent years.

In 2016, the electricity bill (i.e., total cost of electricity) as a percent of GDP was at the lowest since 1990 for both California as well as the rest of the U.S. Electricity bill as a percent of GDP was 1.5 percent in 2016 in California, a 0.1 percent improvement compared to 2015. By comparison, electricity bill as a percent of GDP was 2.2 percent in 2016 in the U.S., which is a 0.8 percent decrease compared to 2015. Of the most populous states, New York, California, and Illinois had the lowest electricity bill as percentage of GDP in 2016 (1.4%, 1.5%, and 1.7%, respectively), while Florida (2.5%) and Ohio were among the highest (2.4%). Compared to all other states, California had the third lowest electricity bill as a percent of GDP in 2016, after New York and Washington. In all three states, coal is a very small source of electricity generation. Conversely, states where coal is the predominant source of electricity generation – such as West Virginia, Wyoming, and Kentucky – tend to have high statewide electricity bill as a percent of GDP. Electricity bill as percentage of the state inflation-adjusted GDP for these three states were 3.9, 3.6, and 3.2 percent, respectively, in 2016.

California's electric utilities also outperformed the rest of the nation in terms of electricity bill per capita. In 2016, California used 7.2 percent less electricity per capita than it did in 1990, while total electricity consumption increased 21.7 percent.[36] On the other hand, the efficiency gap between California and the rest of the U.S. continues to persist. The rest of the U.S. used 8.4 percent more electricity per capita than it did in 1990 while total electricity consumption increased 40.1 percent. On a year-over-year basis, California has become more efficient in terms of both total consumption and per capita consumption. In fact, in 2016, California had the lowest electricity consumption per capita composite of all sectors: residential, industrial, commercial, transportation, and other miscellaneous sectors. In California, per capita electricity consumption decreased 2.3 percent year over year and total electricity consumption decreased 1.7 percent year over year in 2016.[37] In the rest of the U.S., per capita electricity consumption decreased 0.5 percent year over year but total electricity consumption actually increased 0.2 percent year over year.

FIGURE 21. TOTAL ELECTRICAL SYSTEM ENERGY LOSSES AS PERCENT OF TOTAL ENERGY CONSUMPTION

CALIFORNIA & U.S., 2000–2015



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

TABLE 6. ELECTRICITY PRICES AND BILLS (INFLATION-ADJUSTED) BY SECTOR

CALIFORNIA & REST OF U.S.

	REGION	PRICE PER kWh	AVERAGE MONTHLY BILL		
		2016	2006	2016	10 YEAR % CHANGE
RESIDENTIAL	CALIFORNIA	$0.17	$100.66	$95.20	-5.4%
	FLORIDA	$0.11	$158.70	$123.37	-22.3%
	ILLINOIS	$0.13	$77.21	$91.83	18.9%
	NEW YORK	$0.18	$118.85	$104.58	-12.0%
	OHIO	$0.12	$97.36	$111.15	14.2%
	PENNSYLVANIA	$0.14	$102.43	$116.67	13.9%
	TEXAS	$0.11	$177.73	$127.10	-28.5%
	UNITED STATES	$0.13	$113.88	$112.59	-1.1%
INDUSTRIAL	CALIFORNIA	$0.12	$6,458.24	$3,408.93	-47.2%
	FLORIDA	$0.08	$4,893.08	$5,073.56	3.7%
	ILLINOIS	$0.07	$32,078.45	$39,088.23	21.9%
	NEW YORK	$0.06	$15,309.84	$11,637.64	-24.0%
	OHIO	$0.07	$14,431.66	$15,311.71	6.1%
	PENNSYLVANIA	$0.07	$11,155.23	$11,631.69	4.3%
	TEXAS	$0.05	$5,837.78	$4,769.84	-18.3%
	UNITED STATES	$0.07	$8,137.79	$6,569.55	-19.3%
COMMERCIAL	CALIFORNIA	$0.15	$885.47	$866.81	-2.1%
	FLORIDA	$0.09	$823.39	$590.80	-28.2%
	ILLINOIS	$0.09	$702.55	$630.43	-10.3%
	NEW YORK	$0.14	$1,164.19	$858.60	-26.2%
	OHIO	$0.10	$638.19	$636.24	-0.3%
	PENNSYLVANIA	$0.09	$608.13	$480.53	-21.0%
	TEXAS	$0.08	$729.17	$661.24	-9.3%
	UNITED STATES	$0.10	$710.10	$654.98	-7.8%
	REGION		GDP IN MILLIONS		
			2006	2016	10 YEAR % CHANGE
GROSS DOMESTIC PRODUCT (MILLIONS OF 2016 DOLLARS)	CALIFORNIA		$2,234,649.80	$2,602,672	16.5%
	FLORIDA		$907,399.93	$926,817	2.1%
	ILLINOIS		$758,660.01	$791,608	4.3%
	NEW YORK		$1,336,763.63	$1,487,998	11.3%
	OHIO		$579,075.75	$625,715	8.1%
	PENNSYLVANIA		$626,300.70	$724,936	15.7%
	TEXAS		$1,199,270.79	$1,616,801	34.8%
	UNITED STATES		$16,470,916.42	$18,456,292	12.1%

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.
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AVERAGE ELECTRICITY RATES

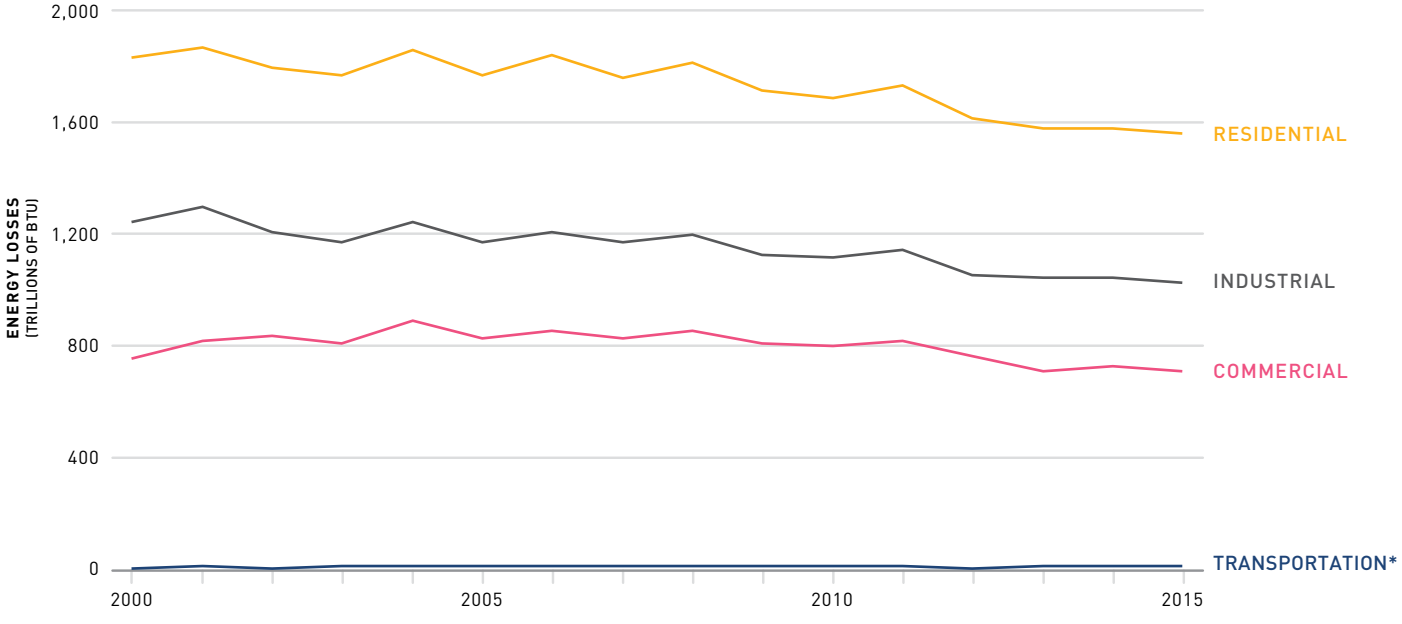
Despite having one of the highest electricity bill per kilowatt-hour, Californians find their overall inflation-adjusted electricity bill to be lower than most U.S. states due to having higher efficiency and lower usage, thanks in part to the state's more temperate climate. In 2016, California had the fifth lowest total electricity usage per customer across all sectors. In 2016, California's average monthly residential electricity bill was 15.4 percent lower than the U.S. ($95.20 per residential customer per month in California vs. $112.59 per residential customer per month for the U.S.), and Industrial bills were 48.1 percent less than the U.S. ($3,408.93 per industrial customer per month in California vs. $6,569.55 per industrial customer per month for the U.S.)

Energy Efficiency by Sector

California has also become more energy efficient in terms of reducing electrical system energy losses that are incurred in the generation, transmission, and distribution of electricity. In 2015, 1.55 quadrillion BTU of energy, or 20.3 percent of total energy consumed was lost, as illustrated in Figure 21. By comparison, 25.8 percent of all energy consumed in the United States was lost in 2015. Compared to the previous year, California reduced its energy losses by 1.5 percent or 24.2 trillion BTU while the United States (including CA) had a 2.8 percent or 726.6 trillion BTU reduction at the same time. In the span of ten years, California has reduced its electrical system energy losses by 265 trillion BTU. While California utilities cannot claim reductions in line losses as part of their energy efficiency portfolio, they are required to report the associated greenhouse gas emissions as a result of those line losses. As such, any improvements to line losses can result in emissions savings for the utilities, as well.

At the sectoral level, California has made consistent reductions in energy losses across the four major sectors: transportation, commercial, industrial, and residential. In 2015, the commercial sector scored the largest year-over-year reduction at 1.9 percent, followed by the industrial sector with a 1.6 percent decrease. In the course of the last ten years, all of these sectors have made considerable reductions in electrical system energy losses – commercial (-13.7%), residential (-10.6%), and industrial (-10.4%) – which contributed to a reduction in total energy consumed by 1.8, 6.7, and 5.3 percent, respectively.

FIGURE 22. ELECTRICAL SYSTEM ENERGY LOSSES BY SECTOR
CALIFORNIA, 2000–2015



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. *Represents less than 0.5% of losses. Data Source: U.S. Energy Information Administration, State Energy Data System. NEXT 10 / SF · CA · USA

Why is it Important?

Renewable energy provides an unlimited source of energy that leverages replenishable natural resources and produces fewer emissions when compared to fossil fuel energy sources.[38] Renewable energy offers a great way to increase or maintain an energy supply while reducing greenhouse gas emissions and environmental impacts from energy use. Indicators that track trends in renewable energy illustrate California's shift to a cleaner energy supply.

Renewable Electricity Generation

While there have been overtures from the current federal administration to support non-renewable resources like coal and nuclear energy, the low cost of natural gas, paired with increasingly cost-competitive renewable resources, have continued to drive the shuttering of coal plants and the growth of solar and wind plants across the U.S. In 2017, electricity production from coal slipped by 3.0 percent while renewable production (excluding conventional hydropower) increased 4.8 percent (by 1.9 terawatt-hour) year over year nationwide.[39] California's Renewable Portfolio Standard (RPS) program, which began in 2002, has long been a template for other states to emulate. Below is an outline of the most recent and upcoming goals enshrined by California's RPS:

End of 2016: 25% – Goal Achieved

End of 2020: 33%

End of 2024: 40%

End of 2027: 47%

End of 2030: 50%

Twenty-nine states and Washington, D.C. now have RPS policies in place. In recent years, a handful of RPS states have increased their overall targets as illustrated in Table 7. Between 2016 and 2017, the states listed in Table 7 made material revisions that either bolstered or extended their RPS. California is also currently considering a bill (SB 100) that would extend its RPS to 60 percent renewables by 2030 and move to decarbonize the remaining 40 percent through other "zero-carbon" resources by 2045.

TABLE 7. MAJOR RECENT RPS REVISIONS

STATE	NEW RPS	OLD RPS
WASHINGTON, D.C.	Increased and extended its Tier 1 RPS to 50% by 2032 and the solar requirement to 5% by 2032	20% by 2023 (and the solar requirement to 2.5 by 2023)
ILLINOIS	Created requirements for "new" solar and wind, with additional carve-outs; IPA takes over procurement for retail suppliers	25% by 2025–2026
MARYLAND	Increased and accelerated RPS to 25% by 2020	20% by 2022
MASSACHUSETTS	Created requirements for off-shore wind (1,600 MW by 2027) and new solar procurement program (1,600 MW)	No off-shore wind and new solar procurement requirements previously; 21% by 2020
MICHIGAN	Increased and extended RPS to 15% by 2021	10% by 2015
NEW YORK	Increased and extended RPS to 50% by 2030 plus expanded coverage statewide	29% by 2015
OREGON	Increased and extended RPS to 50% by 2040 for large IOUs	25% (large utilities) and 5%-10% (small utilities) by 2025
RHODE ISLAND	Increased and extended RPS to 38.5% by 2035	14.5% by 2019

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: Lawrence Berkeley National Laboratory; Database of State Incentives for Renewable Energy; National Conference of State Legislatures.
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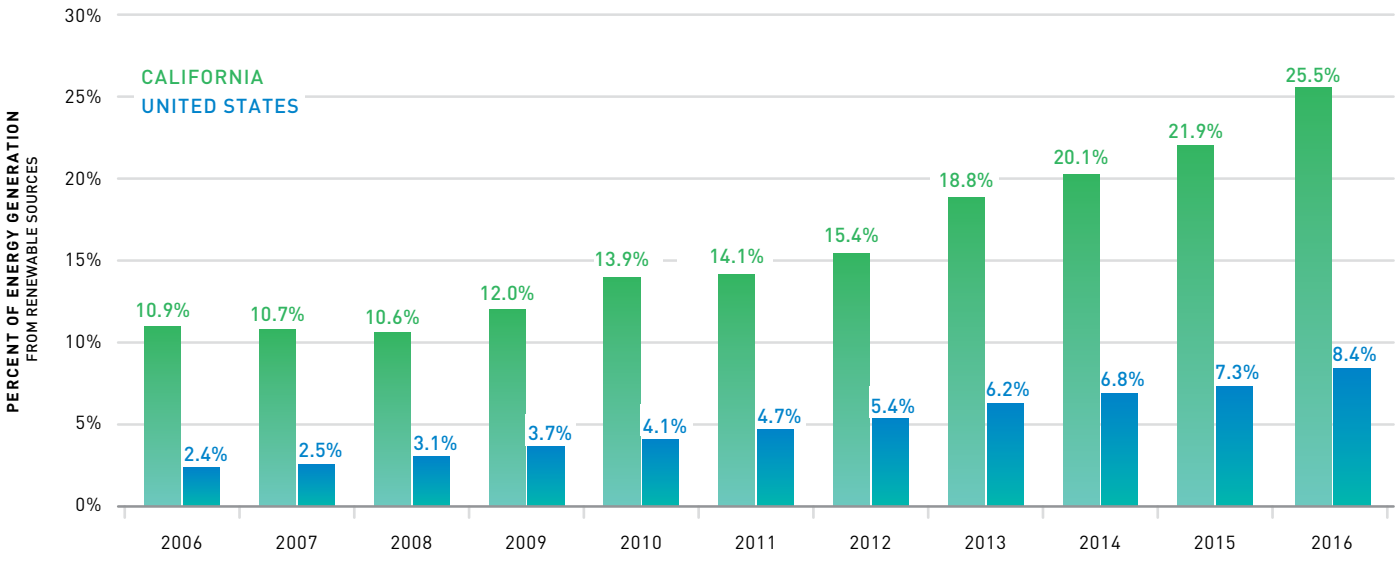
FIGURE 23. PERCENT OF TOTAL ENERGY GENERATION FROM RENEWABLE SOURCES

CALIFORNIA & U.S., 2006–2016



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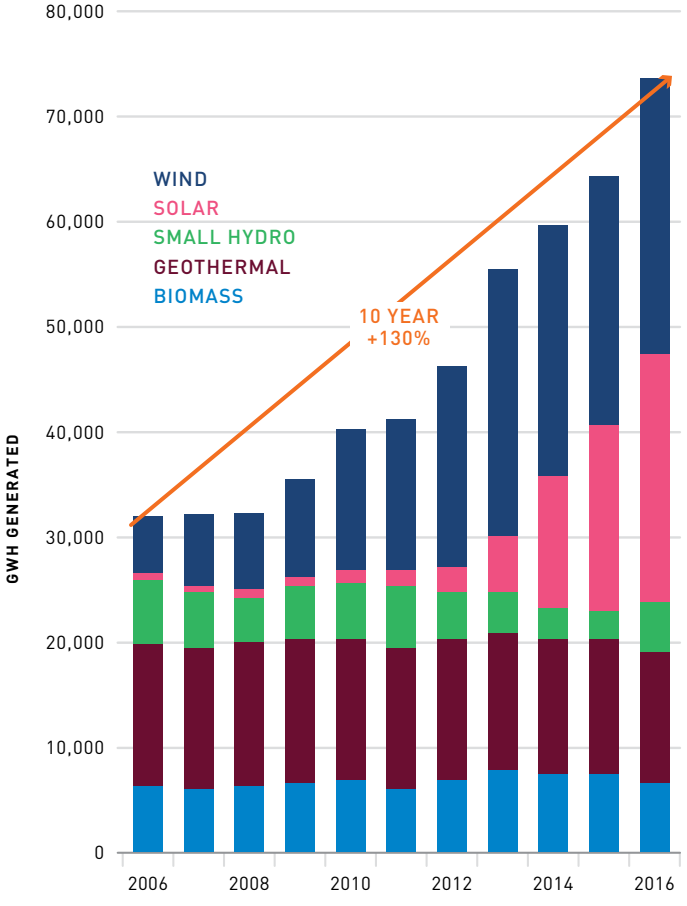
California's RPS is one of the most ambitious renewable energy standards in the country. The Golden State has made great strides toward increasing electricity generation from renewable sources and was successful in meeting its 2016 RPS goal of 25 percent of total generation. In 2016, the latest year for which national comparative data are available, California renewable generation reached 25.5 percent of total electricity generation, up 3.6 percent compared to 2015. At this pace, California is poised to meet the 2020 RPS goal of 33 percent. By comparison, the U.S. experienced a much slower increase of 1.1 percent compared to 2015 and trails California with only 8.4 percent of total electricity generation from renewable sources in 2016. Nevertheless, this is a notable improvement over the previous year's year-over-year increase of just 0.5 percent. Looking forward, market trends indicate that renewable sources will become even more ubiquitous in both California as well as the United States as a whole, despite the current federal administration's efforts to expand declining resources like coal and nuclear.[40] Indeed, the California Public Utilities Commission forecasts that the state's investor-owned utilities will meet the 2030 RPS target of 50 percent renewables ten years early – by 2020.[41] Looking back, the state has increased its renewable energy generation (from in-state and out-of-state sources) by 130 percent compared to ten years ago.

In 2016, California's in-state renewable electricity generation increased 14.2 percent from the year before, with solar (+33.7%) continuing to increase in leaps and bounds while

FIGURE 24. CALIFORNIA RENEWABLE ELECTRICITY GENERATION

GIGAWATT HOURS BY SOURCE, 2006–2016



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

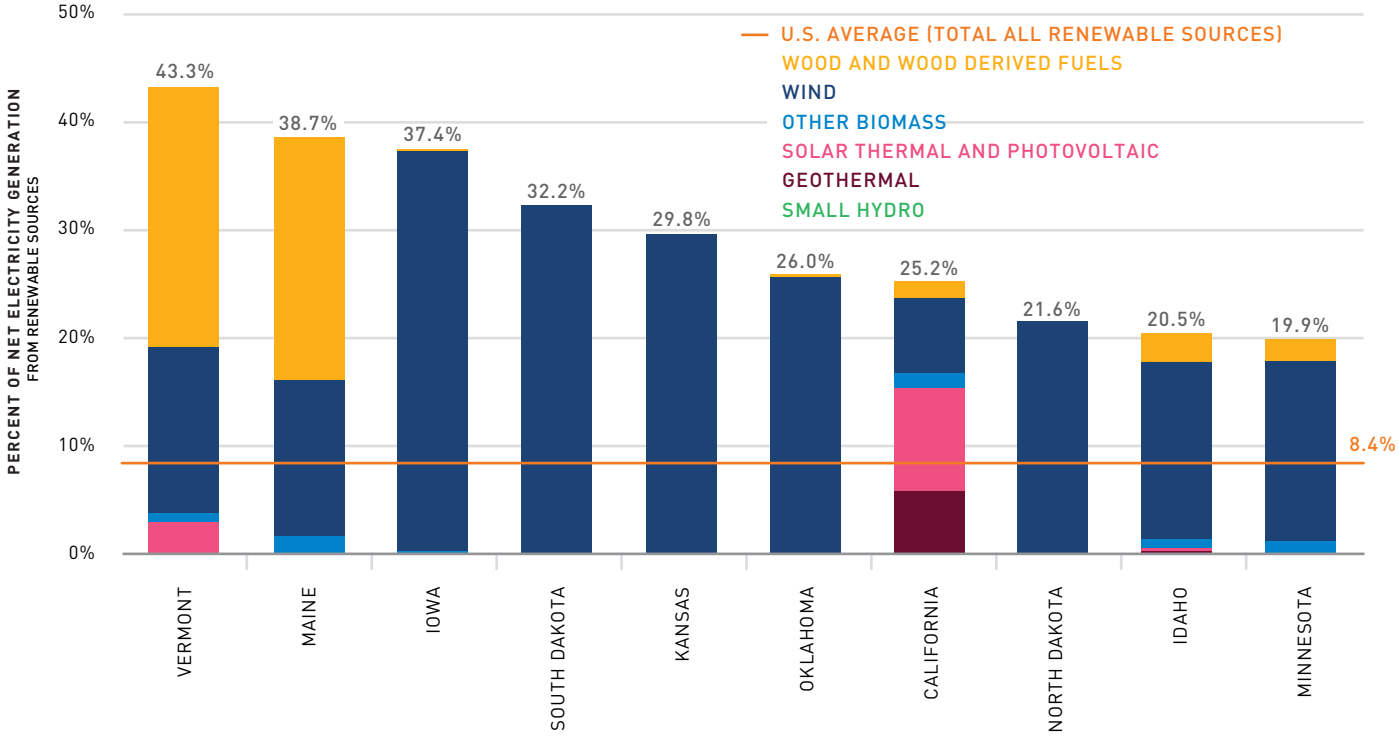
small hydro (+83.3%) was back to an output level last seen in 2012 after three years of consecutive decline caused by an extended drought in the state. California's renewable electricity generation surged 130 percent between 2006 and 2016, reaching roughly 73,961 gigawatt hours (GWh). The California Energy Commission's (CEC) tracking progress report on renewable energy estimates that in 2017, 30 percent of its electricity retail sales (from in-state and out-of-state generation) were served by renewable energy generated from renewable sources.[42] While wind comprised the largest proportion of renewable electricity generation (35.6%) in 2016, solar is poised to take over as the largest renewable source in the very near future,[43] after having overtaken geothermal as the second largest source of renewable electricity generation in 2015. In fact, the same CEC report estimated that in 2017, RPS-eligible generation for solar totaled 27,000 GWh (36%) while wind was 23,000 GWh (31%).

While California currently has the most diverse portfolio of renewable energy sources (see Figure 25),[44] in recent years, solar has been the dominant driver in increasing renewable electricity generation. Based on its current resource mix, California may need to tap into other renewable resources in order to meet its more rigorous future RPS goals. Solar and wind – the two largest renewable sources in the state – are weather-dependent, and therefore less consistently reliable. Currently, California relies on natural gas to back up the grid. As the state gradually weans itself off of natural gas, increasing the use of energy storage and/or imports of renewable energy will be essential to maintain grid reliability and achieve its next RPS goals. From 2015 to 2016, total capacity for thermal energy storage systems and battery energy storage systems in California increased more than threefold, representing a major surge in storage growth.[45]

However, installation of new renewable capacity appears to have slowed down in recent years. In 2017, 13 projects

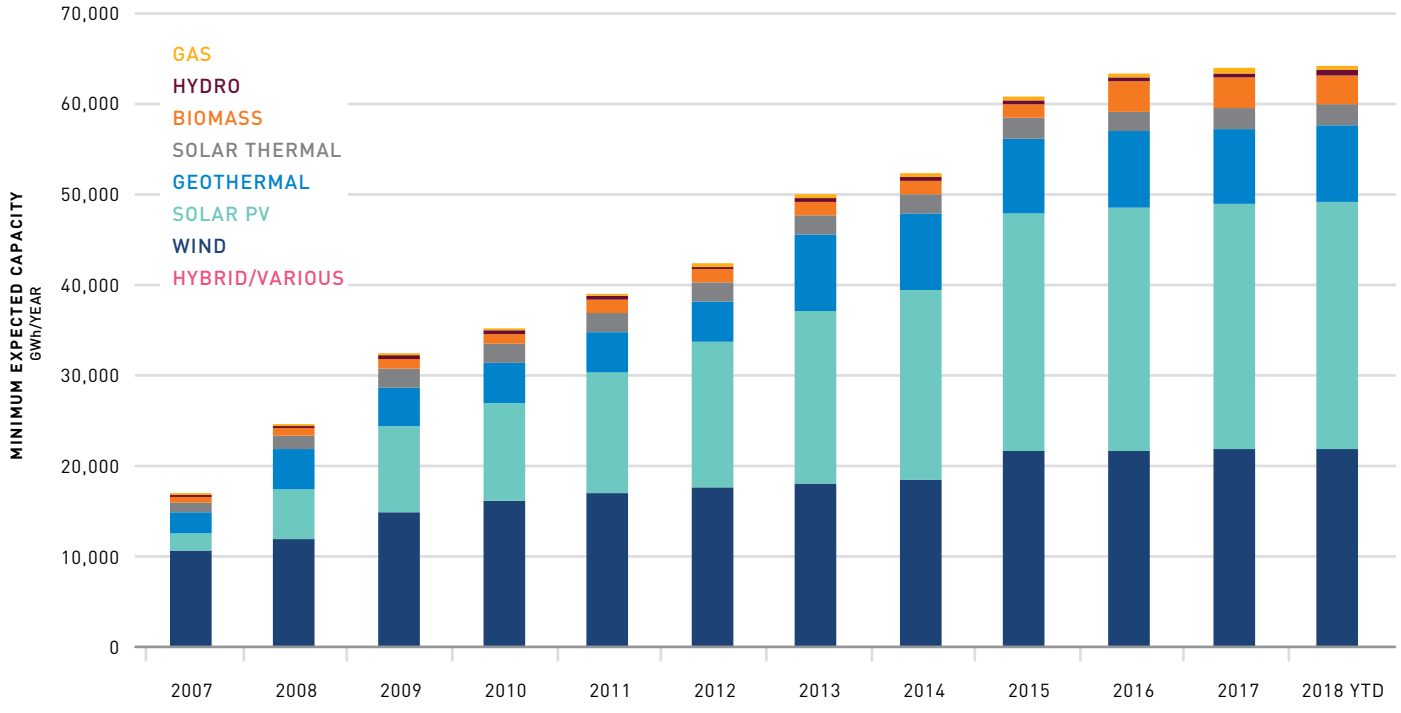
FIGURE 25. RENEWABLE SOURCES AS PERCENTAGE OF NET GENERATION

TOP 10 STATES & U.S., 2016



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

FIGURE 26. CUMULATIVE OPERATIONAL CAPACITY OF RENEWABLES PORTFOLIO STANDARD PROJECTS
BY INVESTOR-OWNED UTILITIES, CALIFORNIA



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: 2018 year-to-date as of April 30, 2018. Gas includes Landfill Gas, Digester Gas, and Biogas. Hydro includes Small Hydro and Conduit Hydro.
Data Source: California Public Utilities Commission. NEXT 10 / SF · CA · USA

were brought online, bringing an additional 82.7 GWh per year – a sharp drop compared to the 1,812.2 GWh that were brought online in 2016. Of the 82.7 additional gigawatt-hours of electricity generated annually, most (32.6 GWh) are originated under the Renewable Feed-In Tariff Program (ReMAT)[46], a program for small renewable energy generators, and the Qualifying Facilities and CHP Program Settlement. But the slowdown in new RPS projects coming online is not a harbinger of the state lagging behind its own goals. In 2017, all three investor-owned utilities (IOUs) were far ahead of the state's RPS goals. RPS generation was 33.7 percent, 33.9 percent, and 46.3 percent for PG&E, SCE, and SDG&E, respectively.[47] Indeed, California is well on track to meeting the 2020 33 percent RPS goal. The slowdown in renewable projects is likely due to a number of reasons, including the rapidly-changing trends in purchasing. As costs for renewables continue to decline, utilities may be avoiding locking in a higher price with a new investment by waiting for prices to come down further in the future. The role of rapidly expanding community choice aggregation (CCA) programs in the state is also changing how and when utilities buy more power, as IOUs are facing a significant amount of load departure as a result of CCA growth.

Solar and Wind Installations

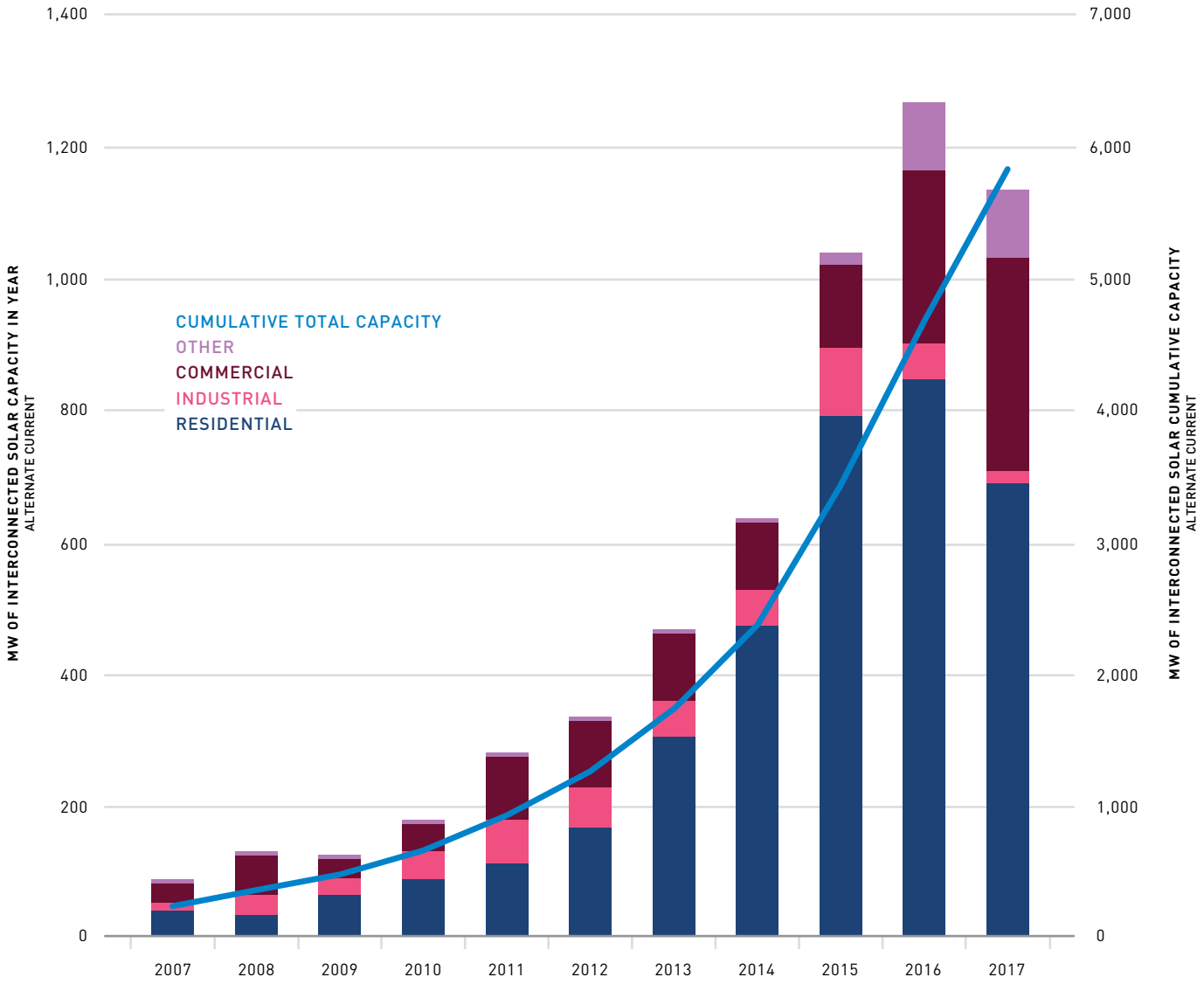
SOLAR

In 2017, new net energy metering (NEM) solar photovoltaic (PV) capacity was 1,1,34.4 MW, down 10.5 percent from 2016.[48] This marks the first time when new capacity installed did not exceed the previous year. A plausible reason is that Tesla-owned SolarCity has reduced its marketing spending and growth in 2017 to concentrate on profitability.[49] Another potential driver of the decline may be that interconnected solar customers in 2017 faced new regulations under "NEM 2.0" tariff pricing, which allows the customer to keep retail rate payments they receive for selling energy back to the grid, but transitioned customers to a time-of-use (TOU) rate. As TOU rates vary depend on level of demand throughout the day, this change had some solar industry experts concerned that the economics of rooftop solar investments might be less predictable, which could thereby impact the amount of new interconnections. Whatever the main drivers for the decline of interconnected solar may have been in 2017, it is not necessarily a bad sign for the state, as this trend might simply reflect that California's solar market has reached a point of maturity.

Of the major sectors – residential, industrial, and commercial – the commercial sector was the only sector with more capacity

FIGURE 27. INTERCONNECTED SOLAR IN CALIFORNIA

2007–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: The data set only includes interconnected solar PV Net Energy Metering (NEM) projects 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." It does not include utility-scale solar installations.
Data Source: Currently Interconnected Data Set, California Solar Statistics. NEXT 10 / SF · CA · USA

installed in 2017 than in 2016. The commercial sector had 328 MW of interconnected solar in 2017, representing a 26.3 percent increase compared to 2016. Meanwhile, new installations in 2017 were 689.6 MW for the residential sector, down 18.6 percent compared to 2016. Despite the lower new installations in 2017, California has much to celebrate: cumulative capacity stood at almost 6,000 GW – an almost 2,500 percent increase compared to ten years ago when it had a mere 227.6 GW of cumulative capacity.

The recently approved Measure 2019-RES-PV-D, an update to California's Title 24 building energy efficiency standards that requires all new residential construction starting in 2020 to have solar panels, may help to increase solar PV installation in the future (see sidebar for more detail).[50] However, post-recession housing construction in the state has been slow, with an average of only 73,000 permits issued annually between 2008 and 2017 – far lower than the average of 135,000 permits issued annually from 1991 to 2007.[51] Accelerated housing development could help the state meet its housing goals and realize greater benefits from the new rooftop solar measure.

In recent years, there has been a surge in solar PV installation in smaller sectors: educational, military, non-profit, and government. The educational sector is responsible for most of the solar installed among these sectors in recent years. In 2017, of the 99.6 MW of NEM solar photovoltaic capacity installed

outside of the three major sectors, the educational sector alone accounted for 72.2 MW (or 72.5%) installed. Indeed, not only does California lead the nation in the number of solar schools by state, solar installation is becoming an increasingly popular choice across schools nationwide. Solar capacity installed has nearly doubled in just the three years since 2014, according to the Solar Foundation.[52] This recent surge in solar installations in the educational sector may be driven by funding made available through the California Clean Energy Jobs Act (Prop 39), which made up to $550 million available annually for five fiscal years ending in 2018 to fund energy efficiency improvements and clean energy generation in schools.[53]

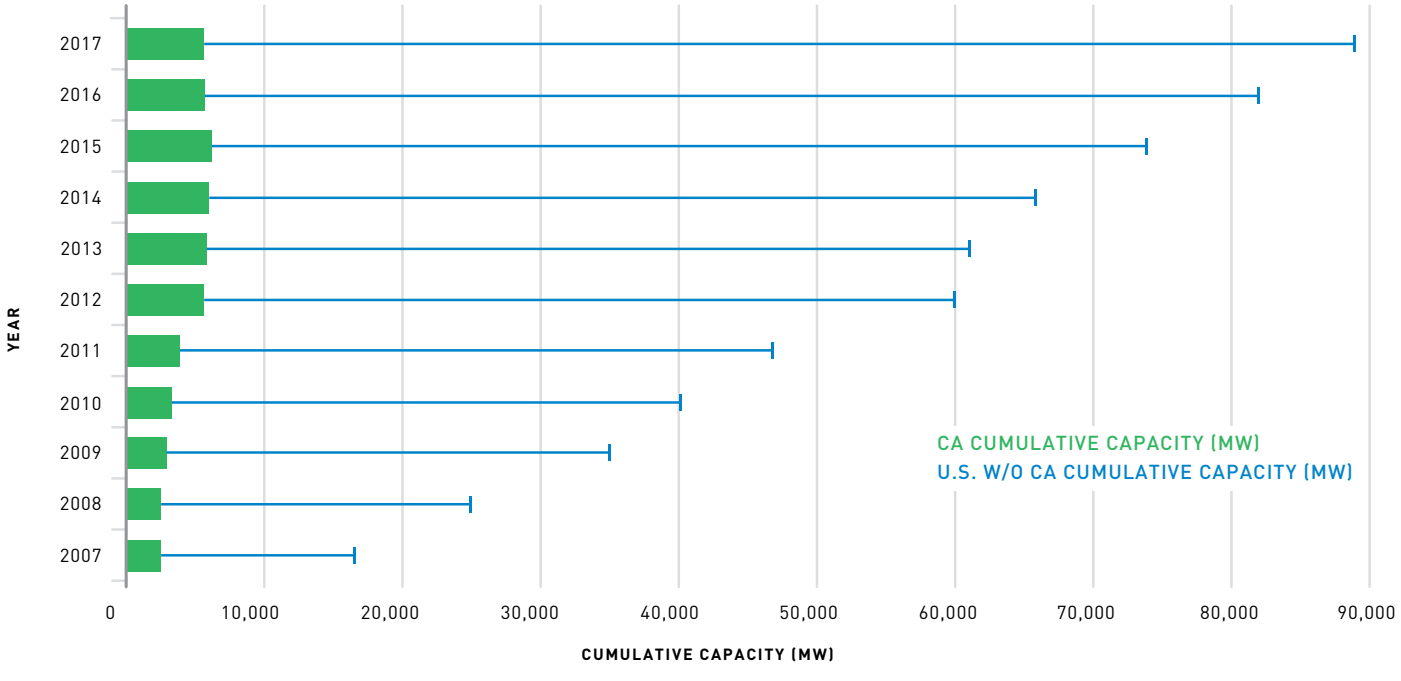
WIND

In 2016, in-state electricity generation from wind totaled 13,499 GWh, a 10.7 percent increase compared to 2015. On the other hand, cumulative capacity decreased by 469 MW between 2015 and 2016 and by another 107 MW between 2016 and 2017, bringing California's cumulative wind capacity down to 5,555 MW at the end of 2017.[54] While there has been a recent decrease in the state's wind capacity, compared to ten years ago cumulative wind capacity installed is up by 128 percent. Furthermore, electricity generation from wind actually increased due to improving capacity factor – the ratio of actual output of electricity generated vs. total maximum potential capacity. After a brief slump during and shortly after the Great Recession, the capacity factor for wind finally returned to its pre-recession levels. Nationwide, wind capacity factor trends have largely followed a similar trajectory, with efficiencies in generation helping improve annual output. In 2017, the U.S. added 7,017 MW of wind capacity, increasing its cumulative capacity to 89,160 MW at the end of 2017.

Though wind generation in California has marginally declined, it remains the largest renewable energy source in-state.[55] Despite having one of the lowest average wind speed compared to other states,[56] California had the 18th highest share of electricity generated from wind in 2016. The potential for an expanded regional energy market in the West (currently being debated in the state legislature) could also increase California's wind energy imports, helping get the state closer to its future RPS goals.

FIGURE 28. WIND CAPACITY

CALIFORNIA VS. U.S.



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: American Wind Energy Association. NEXT 10 / SF · CA · USA

California Becomes First State to Mandate Residential Rooftop Solar

On May 9, 2018, California became the first state to require rooftop solar (solar PV) on new homes starting January 1, 2020. The move could be a significant boon to the state's goal of having all new residential construction meet a zero net energy standard by 2020. With an on-site source of renewable power, residential homes could, beginning in 2020, now be able to produce more energy than they consume. For homes where solar generation is not suitable due to location, homeowners have the option to identify other efficiency measures or participate in a community solar program to compensate. The new measure – which has been incorporated as a code change to the state's building energy efficiency standards (Title 24) – builds upon rooftop solar mandates currently in place in several California cities: Culver City, Lancaster, San Francisco, San Mateo, Santa Monica, and Sebastopol.

In a study prepared by Energy and Environmental Economics (E3) for the California Energy Commission (CEC), researchers estimated that this rooftop solar mandate would result in 323 GWh in electricity savings statewide in the first year of implementation. The E3 study also found that the measure would be cost effective in every climate zone throughout the state, even when accounting for changes to net energy metering rates that could result in homeowners receiving less for the energy they generate. Those savings would work out to more than $1.4 billion dollars ($1,410,600,000) in energy savings statewide in the first year.

According to the study, the rooftop solar measure would also mitigate 114,019 metric-tons of carbon dioxide equivalent (CO_2e) emissions statewide in the first year of implementation, equivalent to CO_2e savings from taking more than 24,000 cars off the road for a year.[57] E3 also estimates that the building code update could create 5,423.7 jobs during the construction and installation period, and 41.4 jobs ongoing. The study did not analyze net economic impacts for rooftop solar, but other analysis has indicated that rooftop solar can provide net job growth and net economic growth.[58] Based on a weighted average prototype, the 30-year cost savings range from $15,900 to $33,911 depending on the climate, resulting in a net benefit for all climate groups.[59]

While the benefits for reducing greenhouse gas emissions and increasing solar PV generation are clear, critics of the move warn that this policy measure should not be considered in isolation. The year one energy savings from the rooftop solar mandate (323 GWh) represent approximately 0.1 percent of the state's total annual electricity consumption. The carbon savings are about 0.4 percent of the state's total residential sector greenhouse gas emissions (based on 2015 data). While the costs of these installations will pay for themselves in savings over the lifecycle of a solar array, opponents of the solar measure worry that it will drive up rates for customers elsewhere in the state and could possibly drive up prices for prospective new home buyers. However, given the current high home prices in California, the added upfront cost of a solar installation is marginal compared to the cost price differential between California homes and homes in other states.[60]

All the new solar on the grid as a result of this measure will mean the state will have to further manage challenges with more energy being generated during the day, despite demand being highest at night when the sun is not shining. Currently, the state is still reliant on natural gas plants to bridge that gap. This challenge, paired with changes to billing rate structures, could actually help drive greater utilization of energy storage or demand shifting. While critics have in effect said that this measure is too expensive for too little benefit, the impacts on consumer behavior could generate significant induced benefits. To optimize outcomes from this new mandate, California will have to carefully manage grid impacts as well as economic impacts to both residential customers and industry.

TRANSPORTATION

Despite California's efforts to reduce GHG emissions from transportation through several programs targeting light-[61] , medium-, and heavy-duty vehicles,[62] emissions from on-road passenger vehicles have ticked up continuously since 2013. Emissions and vehicle miles traveled trends are not on track to meeting the 2020 SB 375 (Chapter 728, Statutes of 2008) GHG target.[63] While vehicle emissions have lagged behind vehicle miles traveled thanks to advances in technology and fuels, Table 9 indicates that from 2005 to 2016, the state has just managed to achieve a 5.4 percent per capita VMT reduction.

For light-duty vehicles, the state's Advanced Clean Cars Program seeks to spur GHG reductions and advance the zero-emissions vehicles (ZEV) marketplace. ZEVs are key, given their potential to dramatically cut greenhouse gas emissions. Battery Electric Vehicles (BEVs) in California have the additional benefit of accessing an electricity grid that is among the cleanest in the country. Based on the current electricity power-mix, a BEV would emit just 31 percent of the emissions of a gasoline hybrid vehicle and 17 percent of the emissions from a gasoline vehicle.[64]

California's SB 32 requires the state to reduce emissions 40 percent below 1990 by 2030. Given that transportation is the largest emitting sector, tackling transportation emissions will be critical if the state is to meet its overall emissions goals.[65] Reducing vehicle miles traveled and increasing the percent of the electricity on the grid from renewable sources – in order to make the electrification of transit cleaner – will help to further reduce transportation emissions. [66]

California has prioritized greater ZEV adoption by setting goals of 1.5 million ZEVs on the road by 2025 and 5 million ZEVs by 2030.[67] At the current pace of adoption, the state should be able to meet its 1.5 million ZEVs on road by 2025. [68]

Transportation Indicators

Greenhouse gas emissions from surface transportation in California were 154.6 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in 2016 – a 2.1 percent increase from 2015 but 8.8 percent lower than in 2006. While the increase in surface transportation GHG from 2006 to 2016 was outpaced by that of vehicle miles traveled (VMT; +10.9%), the 2.1 percent increase outpaced the one-year increase in total vehicle miles traveled (VMT) from 2015 to 2016 (+1.4%). For the 10-year period from 2006 to 2016, the total number of vehicles registered increased 12.3 percent, which also outpaced surface transportation emissions.

While cars are getting cleaner in California, transportation emissions still increased in 2016 because there are more cars on the road. The California population grew 9.2 percent from 2006 to 2016, resulting in over three million more vehicles registered in 2016 compared to 2006. While VMT per capita increased by less than 1 percent between 2015 and 2016, it has decreased 4 percent since 2000.

Why is it Important?

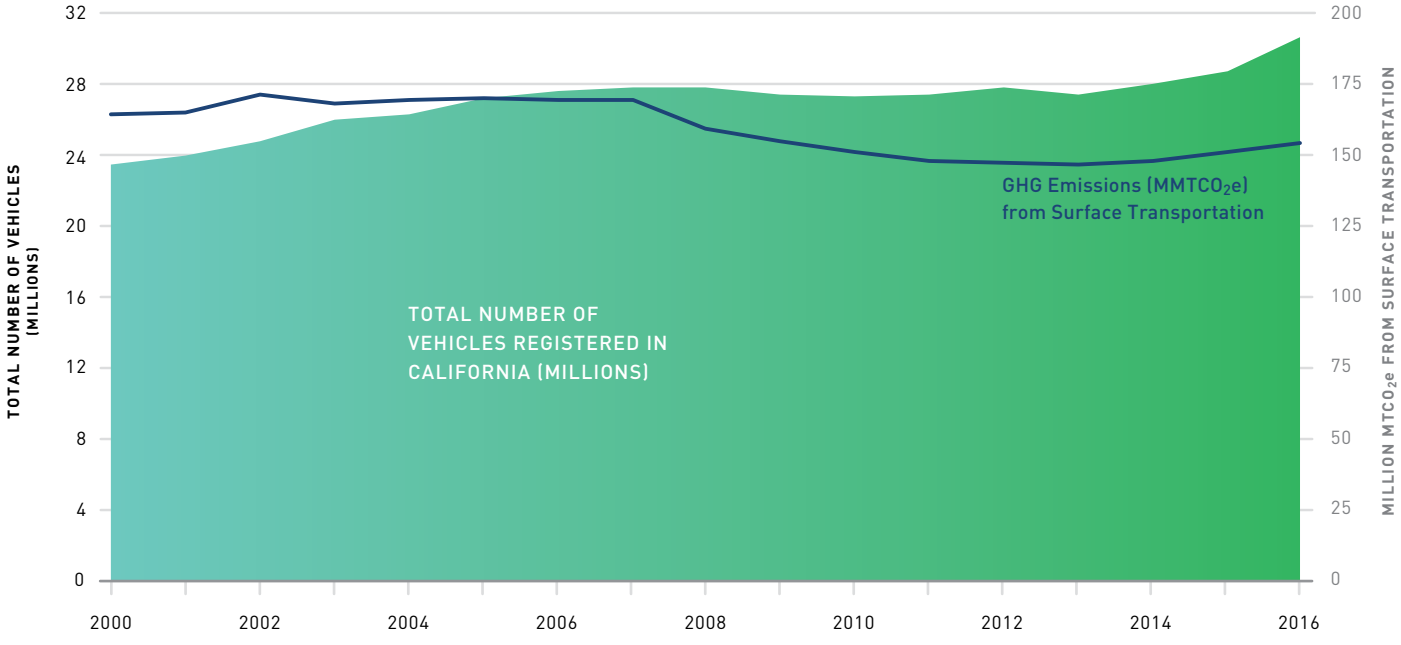
California's extensive transportation network is vital to facilitating economic activity in the state and around the world. Despite being responsible for almost half of the zero-emission vehicles sales in the country, with annual sales growing rapidly, most transportation in California still relies on burning petroleum. In order to meet the state's goals for reducing emissions, California must continue to find cleaner ways to transport California's products and people.

In 2016, the transportation sector accounted for more than 40 percent (40.5%) of the state's greenhouse gas emissions, the highest they've been since 2006. Of those transportation emissions, on-road passenger vehicles accounted for 68.4 percent of the transportation sector's GHG emissions, or 27.7 percent of the state's total GHG emissions in 2016. Making passenger vehicles more efficient is essential to the state achieving its next emissions reduction goal in 2030, as is further incentivizing the adoption of alternative fuel vehicles, and promoting public transit ridership.

In early 2018, the California Air Resources Board (ARB) adopted regional greenhouse gas reduction targets for 2020 and 2035 as required by Senate Bill 375 (SB375). The final ARB staff report specifically states that a 25 percent emissions reduction per capita by 2035, relative to 2005 is needed in order to meet the state's climate goals, but the staff's revised proposed target has been reduced to 19 percent by 2035.[69]

FIGURE 29. TOTAL VEHICLES AND GREENHOUSE GAS EMISSIONS

CALIFORNIA, 2000–2016



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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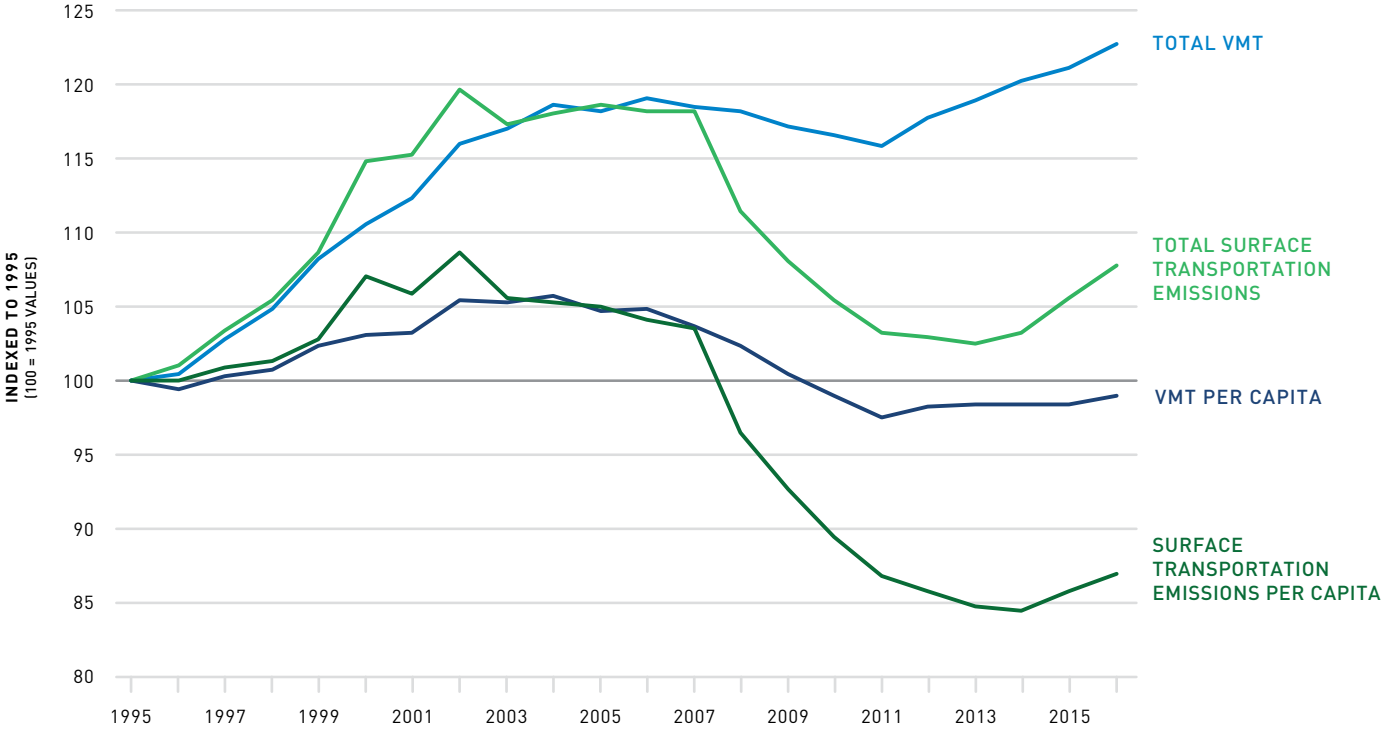
FIGURE 30. VEHICLE MILES TRAVELED AND GREENHOUSE GAS EMISSIONS FROM SURFACE TRANSPORTATION

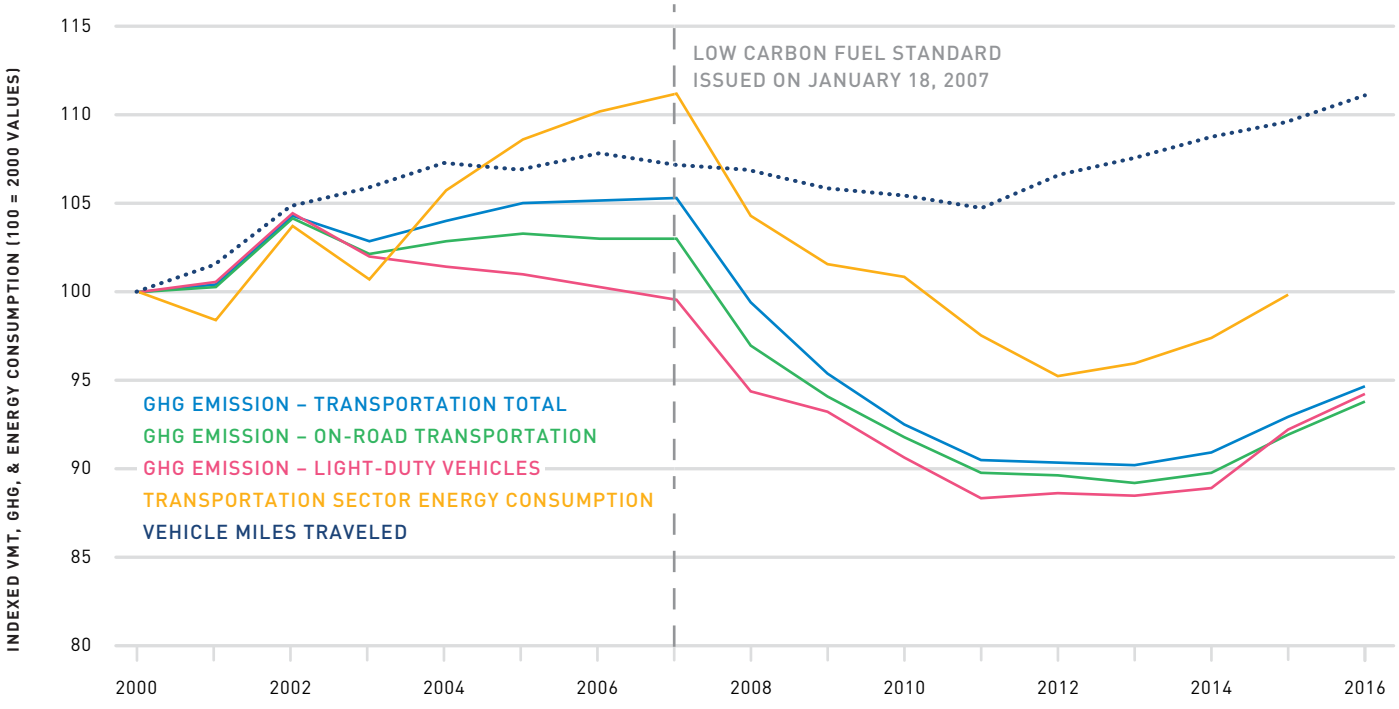
TOTAL VMT AND EMISSIONS AND PER CAPITA, CALIFORNIA, 1995–2016



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

FIGURE 31. VEHICLE MILES TRAVELED, ENERGY CONSUMPTION, AND GHG EMISSION OF TRANSPORTATION SECTOR

CALIFORNIA, 2000–2016



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Air Resources Board; U.S. Energy Information Administration, State Energy Data System; Federal Highway Administration.
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Total vehicle miles traveled (VMT) reached a record high of 340 billion VMT in 2016. Despite this, the state's fuel efficiency standards and ZEV programs have kept the transportation sector's energy consumption and GHG emission levels below what they would have otherwise been. From 2007 to 2011, energy consumption (yellow line in Figure 31) fell faster than VMT (dotted blue line in Figure 31). In 2015, energy consumption had barely returned to its 2000 level while VMT was 10 percent above the 2000 level, indicating that vehicles have become more fuel efficient. Since 2012, energy consumption has been increasing (+4.9% from 2012 to 2015) faster than VMT (+2.8% from 2012 to 2015), which could imply that people are switching to less fuel-efficient trucks & SUVs as gas prices have declined. Indeed, new light truck registrations as percentage of total new automobile registrations reached a height of 51.3 percent in 2017.[70] Comparatively, new light truck registrations accounted for just 37.9 percent of total new automobile registrations in 2013.[71]

California has outpaced the rest of the U.S. in zero-emission vehicles (ZEVs) adoption and has ambitious plans to further deploy zero-emission vehicles. Cumulatively, about half of all ZEVs sold in the U.S. were in California as of end of 2017. [72] California plus thirteen states and the District of Columbia have adopted California's stricter vehicle emissions standards, and nine of these states – along with California – also participate

TABLE 8. VEHICLE MILES TRAVELED

CALIFORNIA, 2016

VMT (MILLIONS)	VMT PER CAPITA	2015–2016 PER CAPITA CHANGE
340,114.94	8,655	0.683%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: California Department of Transportation. NEXT 10 / SF · CA · USA

TABLE 9. ALTERNATIVE FUEL AND ZERO-EMISSION VEHICLE REGISTRATIONS

CALIFORNIA

	% CHANGE 17–16	2017	2016
ELECTRIC	34.43%	181,001	134,643
PLUG-IN HYBRID	41.80%	164,286	115,858
NATURAL GAS	-9.52%	4,820	5,327
HYBRID	7.50%	1,049,853	976,623
HYDROGEN	252.67%	3301	936
TOTAL ALTERNATIVE FUEL VEHICLES	13.77%	1,403,261	1,233,387
TOTAL ZEV	**38.64%**	**348,588**	**251,437**
TOTAL VEHICLES	**1.18%**	**30,986,273**	**30,624,697**

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Zero-Emission Vehicles include electric, plug-in hybrid, and hydrogen fuel cell vehicles. Data Source: California Energy Commission.
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California's Clean Air Act Waiver in Jeopardy: Decades of Progress on Reducing Transportation Emissions at Risk

In 1970, the federal government amended the Clean Air Act to limit environmental pollutants from a range of sources, including vehicles. California, long plagued by dangerous air pollution, had been regulating vehicle emissions since the 1950s. In recognition of this history, Congress granted California the ability to apply for waivers to follow their own, stricter emissions standards and allowed other states facing air quality challenges to choose whether to follow the federal standards or those set by California. There are currently thirteen states, plus the District of Columbia following California's standards, and Colorado announced plans to join the program in June 2018. In total, these states represent more than 113 million Americans and nearly 40 percent of the nation's auto market.

In 2012, following negotiations between automakers, California and the federal government, the EPA, NHTSA and California agreed to a single national standard governing emissions and fuel-economy standards that would increase the fuel-efficiency of vehicles over time.

California and national standards that limit vehicle emissions have resulted in new passenger vehicles being approximately 99 percent cleaner than a car made in 1970. Since 2000, though vehicle miles traveled have increased, California has reduced emissions from surface transportation by 19 percent per person and 28 percent per registered vehicle, while improving air quality and public health for its millions of residents.

Despite the success of these programs, in August 2018, the Trump administration announced its intention to rollback the national standard, freezing them at 2020 levels, while attempting to revoke California's authority to regulate vehicle emissions. Eliminating California's clean vehicle standards will not only harm the state's climate goals and air quality, but will also cost consumers and discourage innovation and further technological advances in fuel economy.

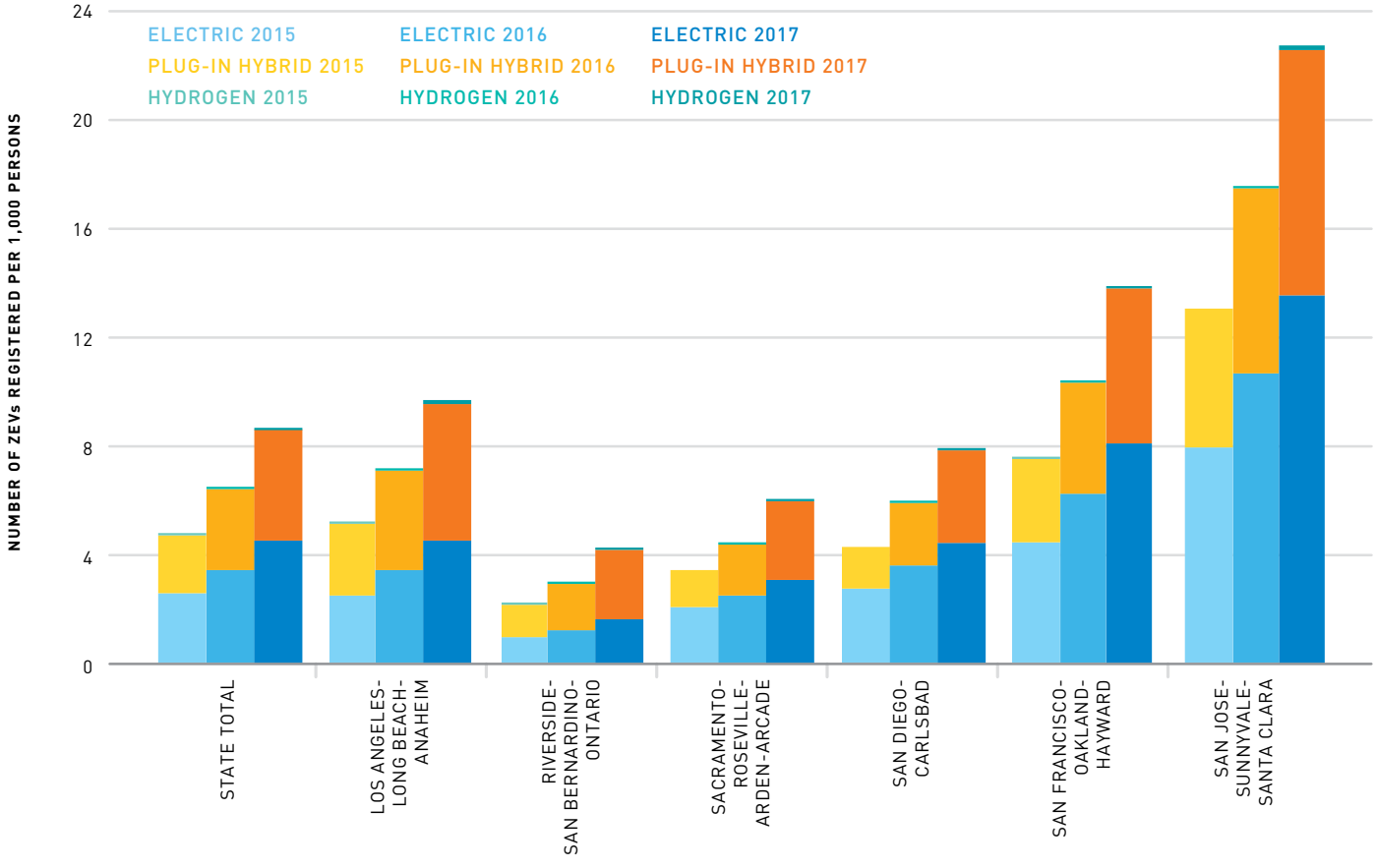
An attempt to revoke California's Clean Air Act authority is unprecedented, and will likely spark years of legal challenges. Should the administration be successful in rolling back the standards and eliminating California's program, analysts at Energy Innovation estimate that the move would cost the national economy $457 billion through 2050, while increasing transportation sector emissions 11 percent annually and gasoline consumption 20 percent annually, both by 2035.

During the last global spike in oil prices, Detroit's Big Three automakers (General Motors, Ford, and Chrysler) found themselves overinvested in inefficient vehicles that they couldn't sell, which led to a taxpayer bailout of the companies. With the global auto market trending toward more efficient and zero-emission vehicles, lowering fuel economy and emissions standards will likely make American automakers less competitive internationally.

Furthermore, suppliers to automobile manufacturers could lose $3.3 billion per annum in sales of fuel-efficient technologies between 2022 and 2025. Finally, the EPA's own research shows that by 2025, the existing vehicle standards will cut 6 billion metric tons of greenhouse gas emissions over the lifetimes of a vehicle, saving an additional $1.7 trillion in fuel costs.

FIGURE 32A. ZERO-EMISSION VEHICLES REGISTERED PER 1,000 PERSONS

SELECTED MSAs, 2015–2017



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

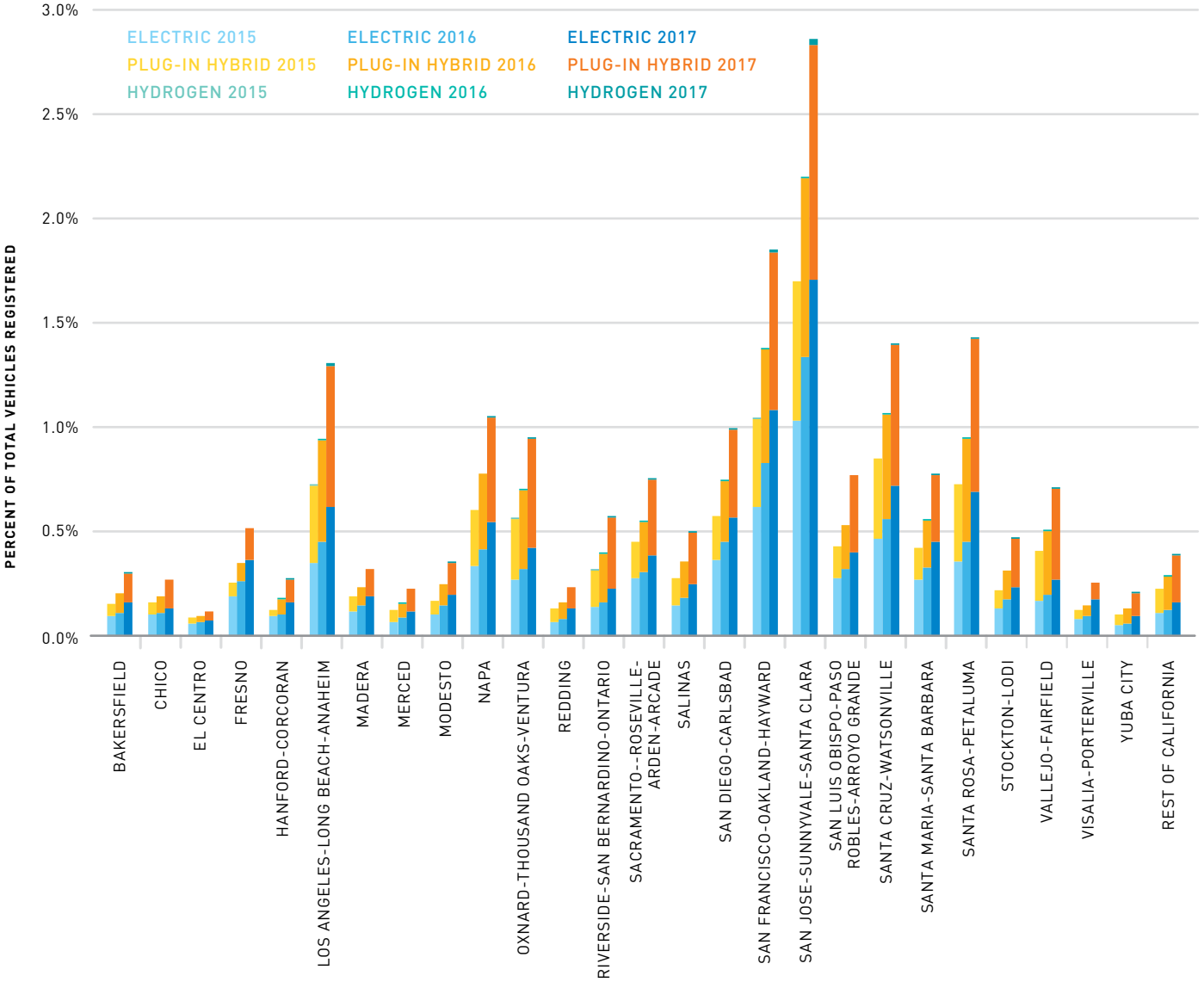
in a mandate to increase sales of ZEVs.[73] However, as of July 2018, the Trump administration is considering attempting to revoke California's Clean Air Act waiver that allows the state to set its own emissions standards.[74] Eliminating such long-standing emissions standards will not only harm the state's emission goals and air quality, but will also discourage innovation and further technological advances in fuel economy. [75]

In 2016, there were 251,437 ZEVs registered in California. The number of ZEVs registered rose to 348,588 in 2017, representing a 38.6 percent increase year over year. Alternative and zero-emission vehicle adoption taken as a whole is growing, but still makes up only 4.5 percent of the total vehicles on the road. Hybrid vehicles make up 75 percent of alternative and zero emission vehicles registered, but are seeing a slower growth rate – 7.5 percent between 2016 and 2017, compared to 9.75 percent from 2015 to 2016. Electric vehicles and plug-in hybrids are growing at a consistent rate. From 2016 to 2017, the portion of ZEVs registered out of all vehicles increased to 1.1 percent – the largest increase to date. To reach the 1.5 million goal by 2025, ZEV registrations will need to grow by 20.0 percent every year over the previous year from 2018 to 2025. Furthermore, ZEV registrations will need to increase by 27.2 percent year over year from 2026 to 2030 to reach the ambitious 5 million goal by 2030.

In California, larger metropolitan areas in general see a higher percentage of electric vehicles, likely a result of rural areas requiring longer driving distances, a preference for trucks,

FIGURE 32B. ZERO-EMISSION VEHICLES REGISTERED

CALIFORNIA MSAs, 2015–2017



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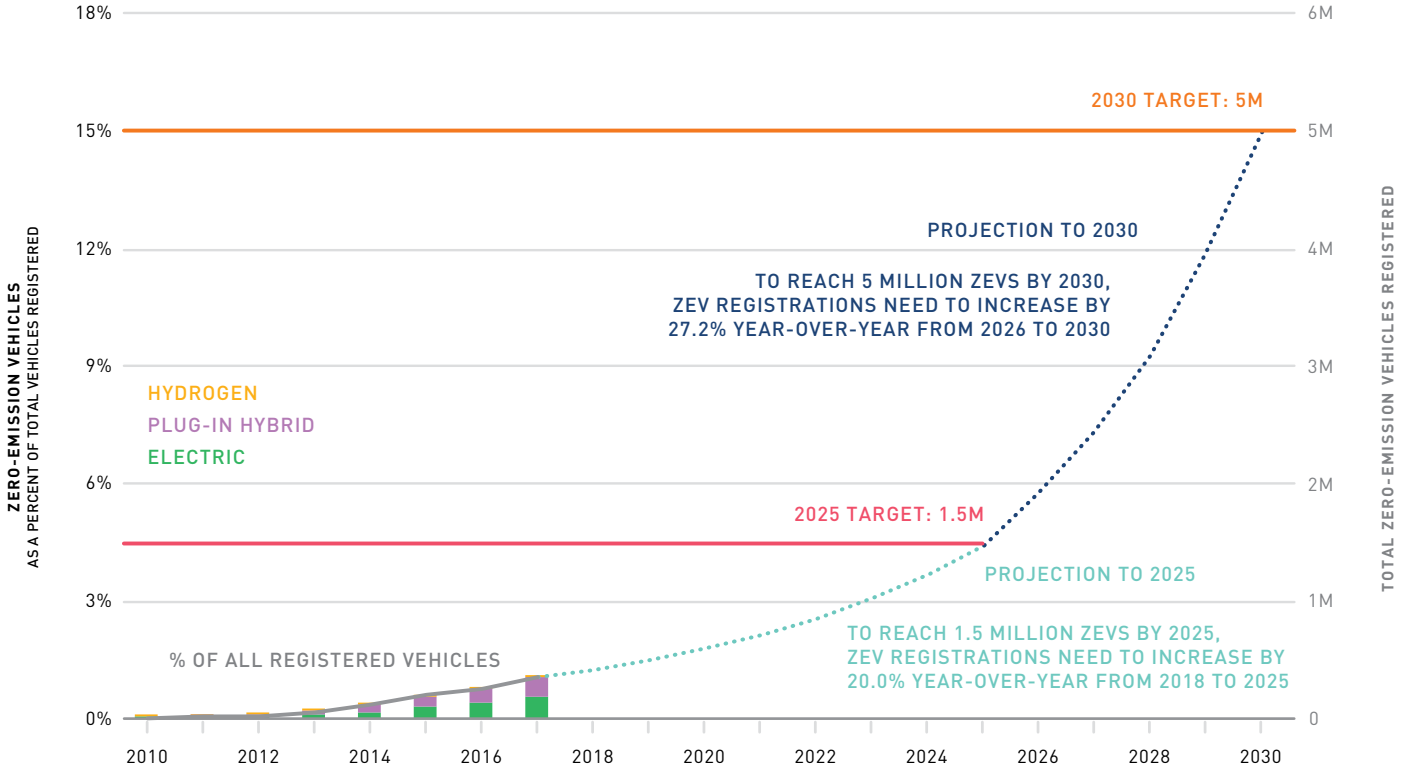
and comparatively less charging infrastructure, among other factors, such as income levels. However, less urban counties actually saw the highest jump in ZEVs registered between 2016 and 2017: Tulare (+77%), Sutter (+67%), Lake (+64%), and San Benito (+62%), and Tuolumne (+57%).

On a per capita basis, the state had 8.8 ZEVs registered per 1,000 persons in 2017. San Jose-Sunnyvale-Santa Clara metropolitan statistical area (MSA) leads the way with 23 ZEVs registered on road per 1,000 persons in 2017, a 30 percent increase over 2016. Despite the relatively high public transit usage, San Francisco-Oakland-Hayward MSA comes in second with 14 ZEVs registered per 1,000 persons in 2017.

In 2017, ZEVs accounted for 1.1 percent of all currently registered on-road vehicles in California. The presence of ZEVs varied across the state; ranging from 2.9 percent in San Jose-Sunnyvale-Santa Clara to just 0.1 percent in

FIGURE 33. TRENDS IN TOTAL ZERO-EMISSION VEHICLE REGISTRATION

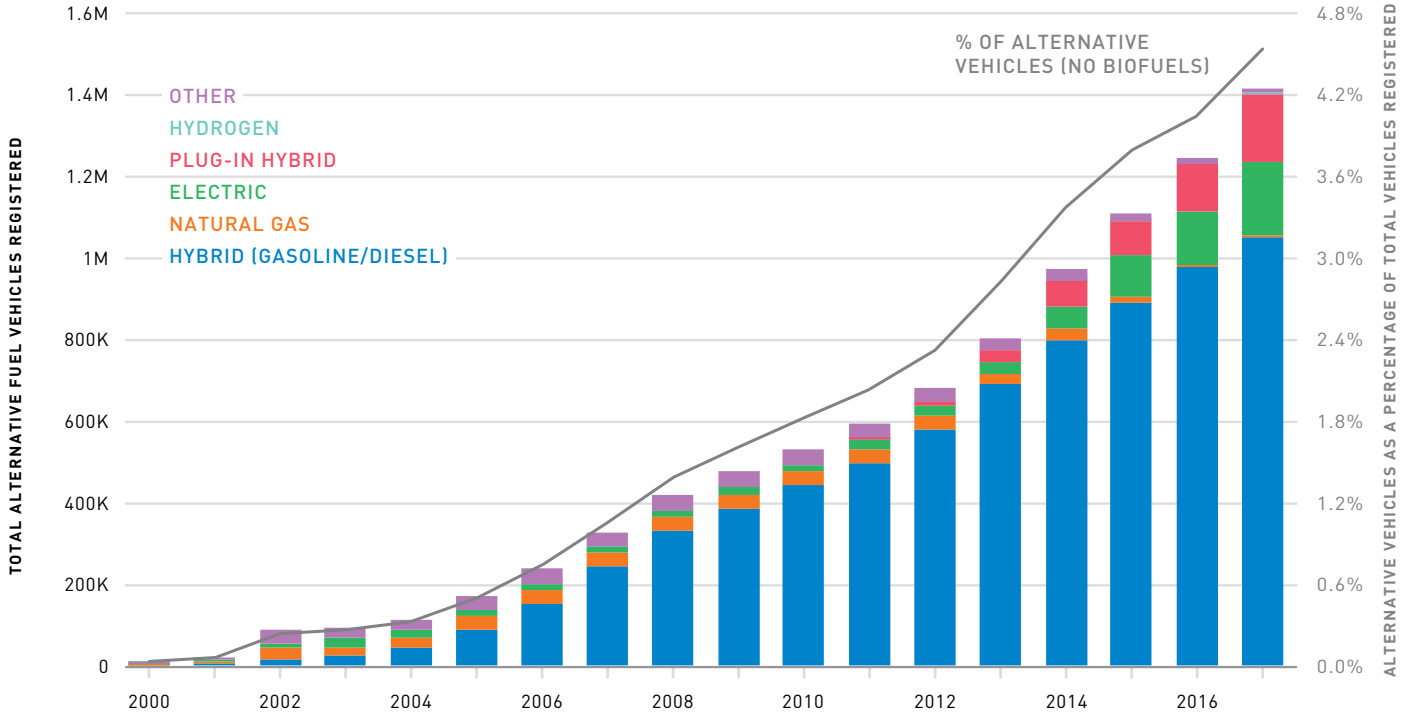
CALIFORNIA, 2010–2030



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

FIGURE 34. TRENDS IN ALTERNATIVE FUEL VEHICLE REGISTRATIONS

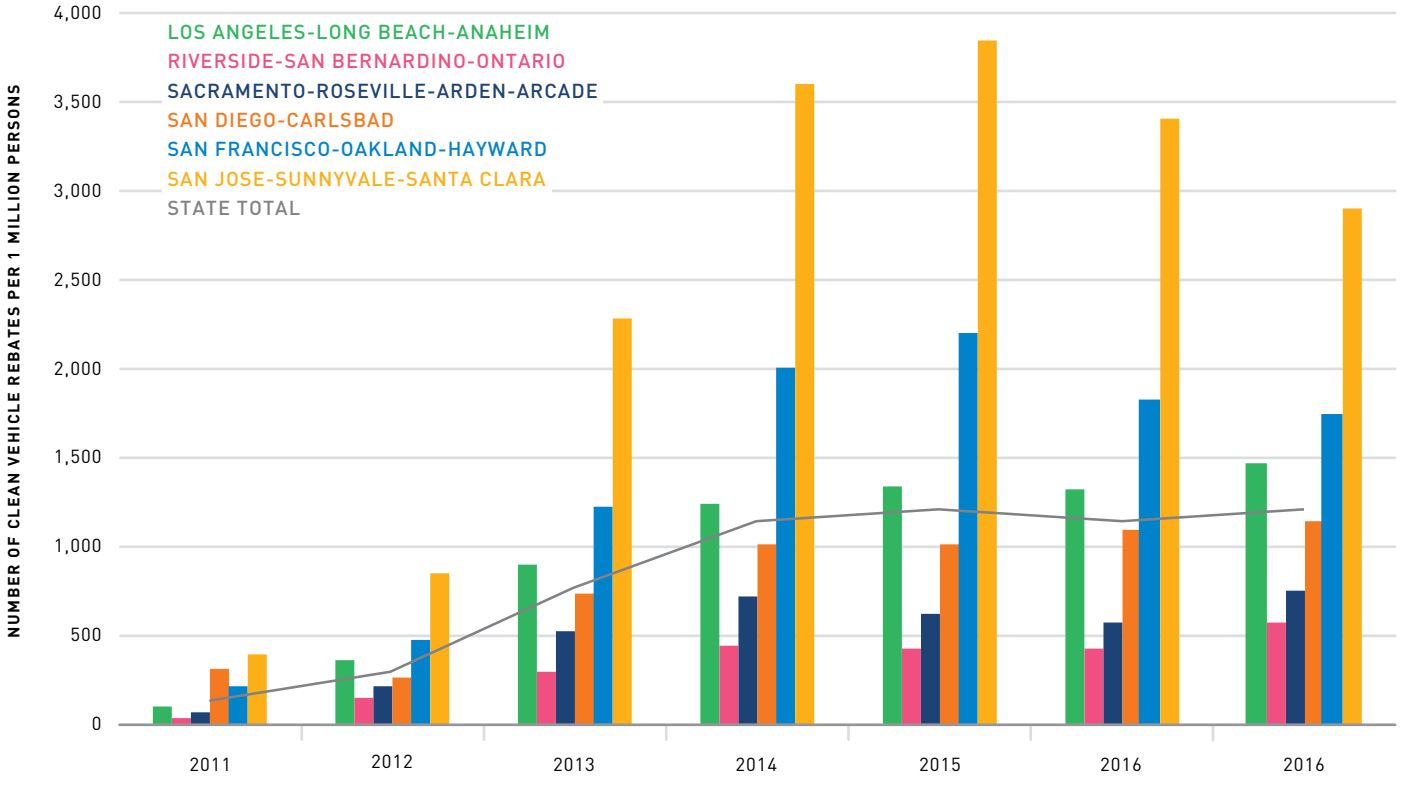
CALIFORNIA, 2000–2017



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Note: Other includes natural gas and propane. Data Source: California Energy Commission. NEXT 10 / SF · CA · USA

FIGURE 35. CLEAN VEHICLE REBATES PER 1 MILLION PERSONS

SELECTED MSAs AND CALIFORNIA, 2011–2017



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

El Centro in 2017. While the percentage is still modest, it is an increase over 2016's 0.8 percent. There is little doubt that ZEVs will become more ubiquitous in years to come, thanks to rapidly declining battery costs as well as increasing infrastructure development. In May 2018, the California Public Utilities Commission approved the state's largest investment in electrification to date – a $738 million investment in expansion of electric vehicle infrastructure and rebate programs.[76] As ZEV adoption continues to increase, which will gradually replace retiring ICEVs, ZEVs will make up a greater percent of on-road vehicles as older, internal combustion engine vehicles are retired. Between 2016 and 2017, vehicle registration in the state increased by 1.2 percent but ZEV registration in particular increased by 38.6 percent.

Clean vehicle rebates are an important tool for California to promote the adoption of cleaner vehicles. As of the end of 2017, $504.8 million in rebates had been issued across the state.[77] Cumulatively from 2010 to 2017, 71.6 percent of all rebates were issued by the Greenhouse Gas Reduction Fund (GGRF). By 2017, almost all annual rebates (99.95%) were issued by GGRF, with the remaining coming from the California Air Resources Board and the California Energy Commission.

Compared to 2016, plug-in hybrid rebates in 2017 saw a 16.1 percent increase but battery electric vehicle rebates decreased 1.3 percent. Meanwhile, the number of rebates issued on hydrogen vehicles jumped 138 percent. 2017 saw a slightly higher total rebate amount compared to 2016 statewide but the numbers actually dropped for the Bay Area, mostly because of the income cap was further lowered on November 1, 2016.[78] In 2017, San Jose-Sunnyvale-Santa Clara had the highest number of clean vehicle rebates per 1 million persons (2,903). Santa Rosa-Petaluma overtook San Francisco-Oakland-Hayward (1,744) for the number two spot for the first time with 2,043. Los Angeles-Long Beach-Anaheim finished fourth with 1,457. Overall, the state averaged 1,209 rebates per 1 million persons, up 6.5 percent compared to 2016. Finally, Central Valley MSAs such as Visalia-Porterville (+211%) and Hanford-Corcoran (+85%) had the highest jumps in rebates per capita. Of note in regard to the role of rebates is the potential benefit of preapproved rebates in driving increased sales by helping reduce the upfront cost of ZEVs. At present, only residents in San Diego County are eligible for preapproved rebates, but if the option to front load the rebate at a dealership (instead of applying for said rebate after purchasing a ZEV) could be offered more broadly, it could increase ZEV sales.[79]

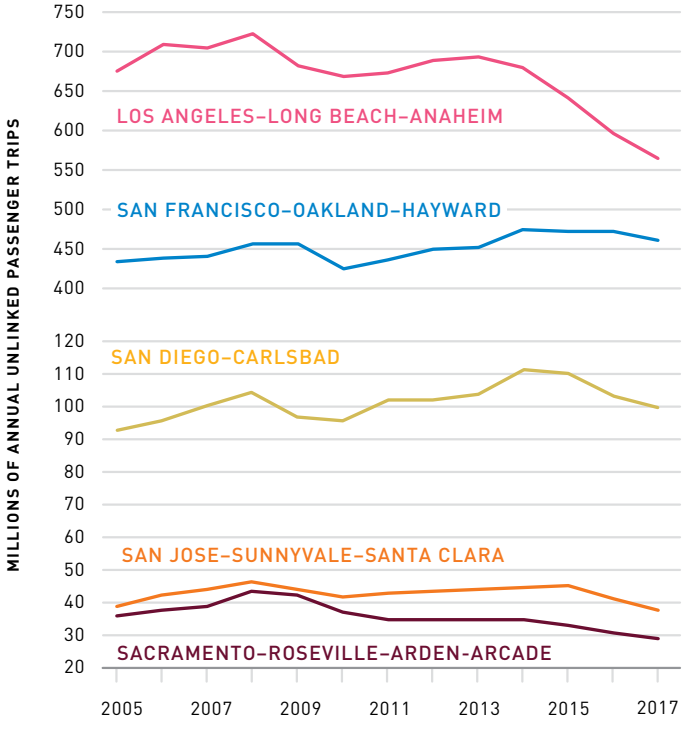
Public Transportation Indicators

Conventional internal combustion engine vehicles (ICEVs) fueled by gasoline and diesel still account for the majority (89.6%) of all on-road vehicles registered in California. However, 2017 was the first time that ICEVs made up less than 90 percent of all on-road vehicles. Increased adoption of ZEVs is only one way to help reduce GHG emissions from surface transportation. The state also relies on increased public transportation usage and active transportation to reduce GHG emissions.[80] Despite a much lower ZEV adoption level than California, New York City's very high public transit ridership helps the state as a whole achieve the lowest emissions per capita. Increasing public transportation ridership as a replacement for driving plays a vital role in reducing GHG emissions.

The recent decrease in gasoline prices have resulted in a surge in driving, which in turn has contributed to a decrease in public transportation ridership across California, as well as across

FIGURE 36. TOTAL ANNUAL UNLINKED PASSENGER TRIPS (IN MILLIONS)

TOP 5 CALIFORNIA METRO AREA BY TOTAL UNLINKED PASSENGER TRIPS, 2010–2016



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

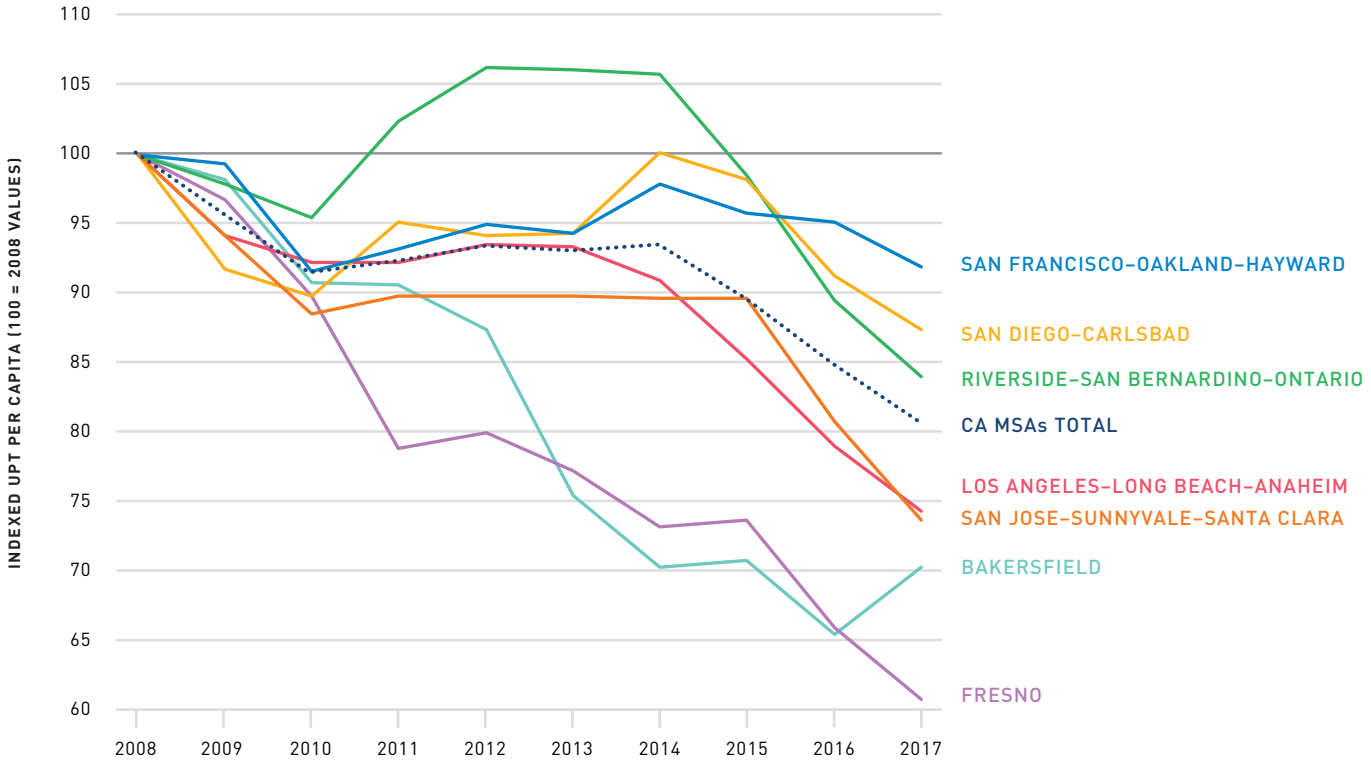
FIGURE 37. CHANGE IN TOTAL UNLINKED PASSENGER TRIPS

2016 VS. 2017, ALL MODES OF PUBLIC TRANSIT

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

FIGURE 38. UNLINKED PASSENGER TRIPS PER CAPITA

SELECTED LARGE CALIFORNIA MSAs, ALL MODES OF PUBLIC TRANSIT (BASE YEAR = 2008)



NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Data Source: National Transit Database, Department of Transportation; Madera County Transportation Commission; Department of Finance.
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the United States. However, even though gas prices actually increased in 2017, public transportation ridership continued to decline. Compared to 2016, total unlinked passenger trips (UPTs, or trips on one transit vehicle, not including connections) dropped 4.2 percent in California in 2017. Among the larger MSAs in California, Fresno saw the largest decline in UPTs with almost 40 percent from 2008 to 2017. During the same period, UPTs declined by 25 percent in Los Angeles-Long Beach-Anaheim, the largest metro area.

For the first time since 2003, the top five metro areas in terms of UPTs had less than 1.2 billion UPTs in 2017. This marks a 10.3 percent drop compared to 2007 and 13.8 percent drop compared to 2008, which had the highest UPTs to date for these five metro areas. Of these five MSAs, only San Francisco-Oakland-Hayward had higher UPTs in 2017 than in 2007. The pattern of decline is different among the remaining MSAs. UPTs in Southern California (Los Angeles-Long Beach-Anaheim and San Diego-Carlsbad) held steady until 2013 and have declined sharply since then. On the other hand, UPTs have declined gradually and continuously for Sacramento-Roseville-Arden-Arcade since the Great Recession.

The San Francisco-Oakland-Hayward MSA had the most unlinked passenger trips per capita with 98.0 trips per passenger in 2017. However, this is the first time that UPTs per capita dropped below 100 since 2011in San Francisco-Oakland-Hayward MSA. Overall, MSAs with large populations tended to have higher ridership per capita. The Hanford-Corcoran MSA, which had the fourth-highest UPTs per capita (23.7) in 2017, is the only metro where unlinked passenger trips have increased for the past three years consecutively from 2015 to 2017.

When looking at the most populous metro areas only, which accounted for more than 90 percent of all UPTs in the state, UPTs per capita in Riverside-San Bernardino-Ontario had the largest three-year drop (-20.6%). Perhaps the boom in housing prices have driven many who work in Los Angeles area to move further out into the Inland Empire, which makes taking public transit time-consuming and less feasible.[81] From 2016 to 2017, unlinked passenger trips per capita continued to decline for these large MSAs for each metro area except Bakersfield. Bakersfield is also the only large MSA where UPTs per capita held steady within the past three years.

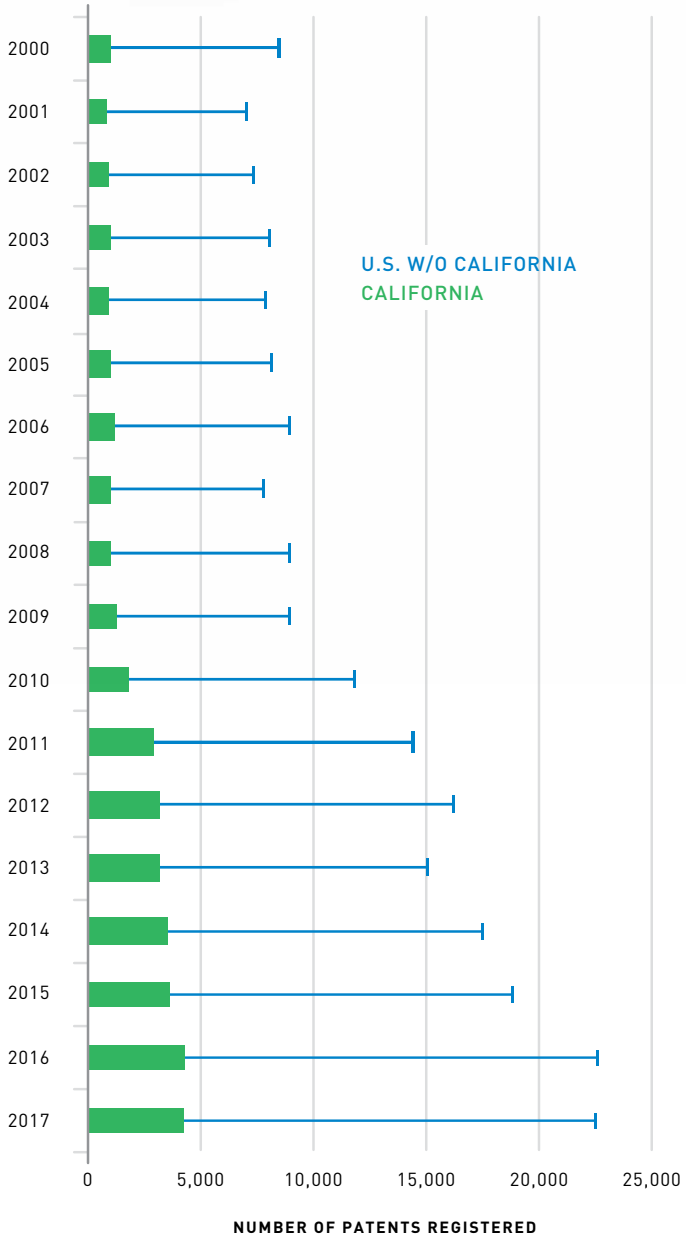
Why is it Important?

Investing in clean technology companies is important for the creation of new, innovative products and services and innovations in technology and business are critical in helping California to transition to a cleaner and more efficient economy. The public and private sectors both play important roles in clean technology investment. Financial investments in clean technology firms help to advance research, development, commercialization, and scale of new products and services. Meanwhile, patent registrations not only highlight the knowledge accumulated through previous investment in research and development activities but also reflect public and private research and development investments and clean technology sector growth potential.

While traditional venture capital investments in clean technology may be waning, other players are stepping up. From the private sector, corporations and corporate venture capitalists have the longer time horizon and mission-based investment strategies that allow them to fill in some of the gaps.[82] In addition, impact investment, an emerging field, as well as government agencies, are also playing an increasingly more significant role. The California State Teachers' Retirement System (CALSTRS), for example, has committed up to $2.5 billion to low-carbon investing recently.[83]

FIGURE 39. U.S. CLEAN TECHNOLOGY PATENT REGISTRATIONS BY RESIDENCE OF FIRST INVENTOR

CALIFORNIA VS. REST OF U.S., 2000–2017



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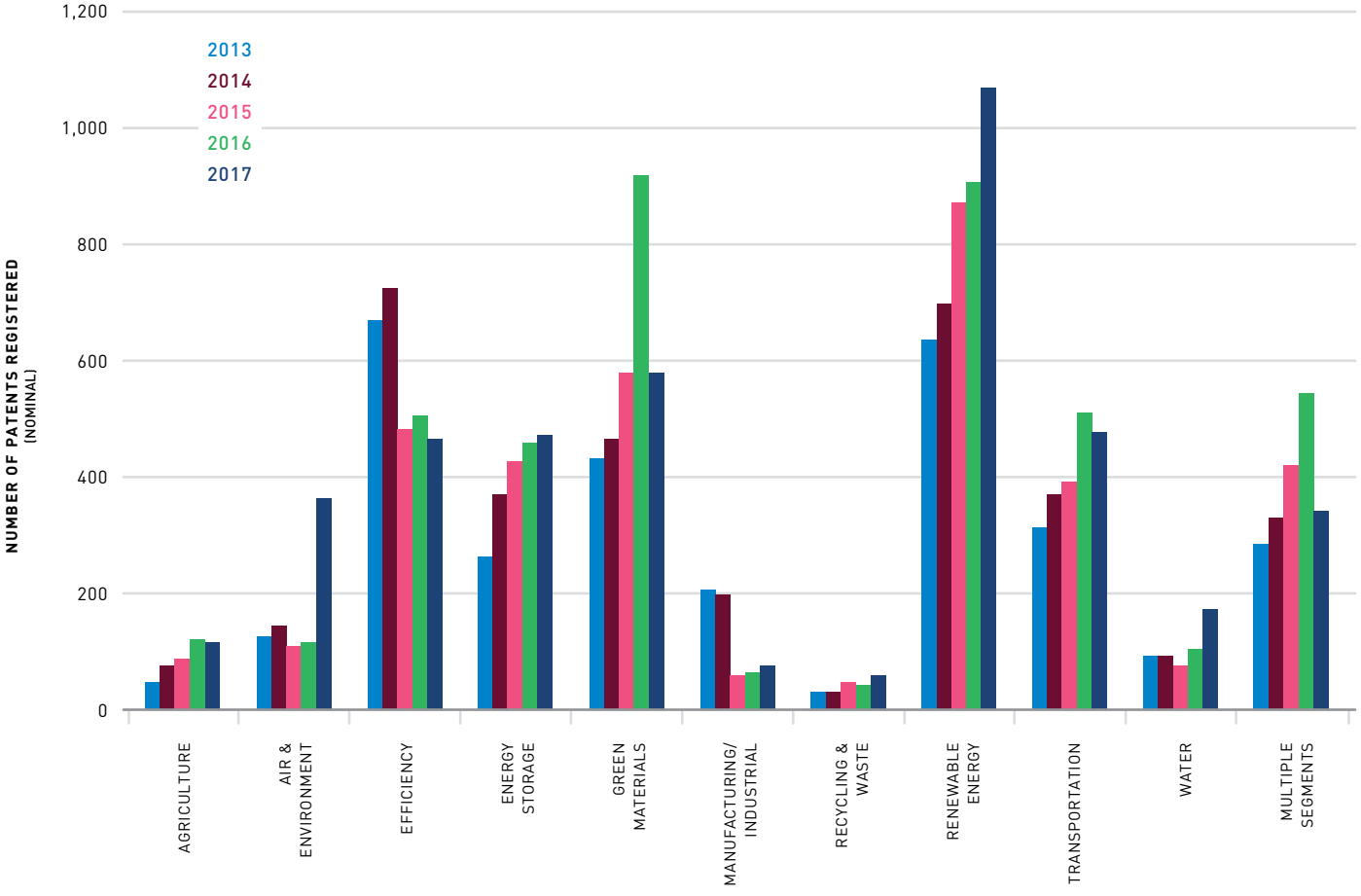
Clean Technology Patents

Compared to 2016, the number of clean technology patents registered in both California as well as the United States as a whole have flattened in 2017. Clean technology patent registrations decreased by 0.6 percent in the U.S. and 2.5 percent in California in 2017. Despite a larger percentage drop in patent registrations than the U.S., California remained the undisputed leader of clean technology patent innovations in the United States in 2017, dominating other states in all segments of clean technology patents.

Globally, the number of clean tech patents registered in 2017 was 77,376, an 11.2 percent gain over 2016's 69,553. Like California and the U.S., Japan and South Korea also recorded fewer clean tech patent registrations in 2017, compared to 2016 (-2.8% and -22.1%, respectively). Meanwhile, the European Union saw a 40.2 percent spike with EU member countries Germany, France and the United Kingdom showing significant increases in clean tech patent registrations in 2017

FIGURE 40. CALIFORNIA CLEAN TECHNOLOGY PATENT REGISTRATIONS BY SEGMENT

2013–2017



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(+31.4%, +37.3%, and +28.9%, respectively). In Brazil, India, and – to a lesser extent – China, while the absolute numbers of clean tech patents relative to other major countries were small, the number of clean tech patents registered in these countries is on the rise. Russia, however, has seen declining numbers of clean tech patents registered since 2013.

In California, 2017 results were mixed in terms of growth across the various clean technology patent segments. After experiencing a surge in 2016, Green Materials had the second largest year-over-year drop in patent registrations (-37.0%) after Multiple Segments (-37.8%). Other segments that also experienced a decline compared to 2016 include Energy Efficiency (-7.9%), Transportation (-6.6%), Agriculture (-5.0%) and Solar (-0.7%). Note that except for Energy Efficiency, which has been fairly flat in recent years, all of these segments actually posted significant gains in 2016 compared to 2015; the decreases in 2017 could simply reflect returning back to normal levels.

The number of patents registered rose in many of the traditionally smaller segments in 2017, reaching record levels. Of the smaller segments, Air & Environment saw the number of patents registered tripled in 2017. In addition, Wind (+65.0%), Recycling & Waste (+40.5%), Biofuels (+36.6%), and Other Renewable Energy (+11.7%) also recorded notable gains in 2017.

California had a total of 4,200 clean technology patents in 2017. The U.S., excluding California, had 18,347 patents, bringing the 2017 total to 22,547 for the entire U.S. With 18.6 percent of the total U.S. clean technology patents, this places California at the

TABL 10. TOTAL CLEAN TECHNOLOGY PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	4,200
2	TEXAS	1,473
3	NEW YORK	1,231
4	MICHIGAN	1,143
5	MASSACHUSETTS	948
6	ILLINOIS	825
7	OHIO	724
8	PENNSYLVANIA	717
9	FLORIDA	687
10	WASHINGTON	679

TABLE 11. GREEN MATERIALS PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	580
2	TEXAS	290
3	NEW YORK	253
4	MASSACHUSETTS	219
5	OHIO	203
6	MINNESOTA	194
7	PENNSYLVANIA	165
8	MICHIGAN	144
9	NEW JERSEY	116
10	FLORIDA	106

TABLE 12. EFFICIENCY PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	469
2	TEXAS	110
3	NEW YORK	107
4	NEW JERSEY	100
5	PENNSYLVANIA	85
6	NORTH CAROLINA	82
7	MICHIGAN	80
8	MASSACHUSETTS	77
9	ILLINOIS	71
10	WASHINGTON	68

TABLE 13. BIOFUELS PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	220
2	TEXAS	68
3	ILLINOIS	59
4	MASSACHUSETTS	53
5	PENNSYLVANIA	38
6	OHIO	34
7	IOWA	28
7	NORTH CAROLINA	28
7	WISCONSIN	28
10	INDIANA	27

TABLE 14. ENERGY STORAGE PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	472
2	MICHIGAN	191
3	NEW YORK	118
4	MASSACHUSETTS	85
5	TEXAS	81
6	CONNECTICUT	73
7	WASHINGTON	62
8	ILLINOIS	61
9	NORTH CAROLINA	46
10	FLORIDA	43

TABLE 15. SOLAR PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	421
2	NEW YORK	83
3	ARIZONA	50
4	MASSACHUSETTS	48
4	NEW MEXICO	48
6	TEXAS	44
7	COLORADO	42
8	MICHIGAN	33
9	FLORIDA	32
10	NEW JERSEY	30

TABLE 16. WIND PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	99
2	SOUTH CAROLINA	89
3	NEW YORK	61
4	TEXAS	39
5	VIRGINIA	23
6	MASSACHUSETTS	22
6	NORTH CAROLINA	22
8	PENNSYLVANIA	19
9	COLORADO	18
10	WASHINGTON	16

TABLE 18. AIR & ENVIRONMENT PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	367
2	TEXAS	175
3	NEW YORK	113
4	MICHIGAN	109
5	MASSACHUSETTS	97
6	FLORIDA	76
7	MINNESOTA	74
8	ILLINOIS	71
9	PENNSYLVANIA	67
10	NEW JERSEY	65

TABLE 19. TRANSPORTATION PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	478
2	MICHIGAN	283
3	TEXAS	164
4	ILLINOIS	146
5	WASHINGTON	135
6	NEW YORK	119
7	FLORIDA	107
8	PENNSYLVANIA	82
9	INDIANA	76
10	WISCONSIN	66

TABLE 20. MULTIPLE CATEGORIES PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	341
2	TEXAS	129
3	MASSACHUSETTS	107
4	NEW YORK	104
5	ILLINOIS	72
6	MICHIGAN	68
7	OHIO	63
8	PENNSYLVANIA	62
9	WASHINGTON	58
10	FLORIDA	49

TABLE 21. WATER PATENT RANKING

TOP RANKING STATES IN 2017

RANK	STATE	NUMBER OF PATENTS
1	CALIFORNIA	171
2	TEXAS	103
3	MICHIGAN	75
4	NEW YORK	74
5	WISCONSIN	70
6	OHIO	57
7	ILLINOIS	54
8	FLORIDA	52
9	PENNSYLVANIA	47
10	MASSACHUSETTS	44

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top for total of clean patents in 2017 followed by Texas (6.5%), New York (5.5%), Michigan (5.1%), and Massachusetts (4.2%). While California had secured the most patent registration in every segment, the remaining top-ten spots for the segments tend to fluctuate between several states.

PATENT REGISTRATION BY SEGMENT

Transportation

With 478 patents registered (17.8% of U.S. total transportation patents) in 2017, California had slightly more patents in transportation than the next two states combined – 447 transportation patents in total between Michigan and Texas.

Efficiency

479 out of 2,128 efficiency patents (22.0%) were registered in California, which was slightly less than the next 5 states combined – 484 efficiency patents in total between Texas, New York, New Jersey, Pennsylvania, and North Carolina.

Green Materials

One-seventh (580) of the 4,047 patents registered in the U.S. were in California, which is more than the next two states combined – 543 patents between Texas and New York.

Air & Environment

California saw 367 patents (17.8% of U.S. segment total) registered, which is just somewhat less than the next three states combined – 397 patents between Texas, New York, and Michigan.

Renewable Energies

Of the 4,870 renewable energy patents registered in the U.S., 1,073 (22%) were registered in California.

Biofuels

California had 220 patents registered, which is more than the next four states combined – 218 biofuels patents between Texas, Illinois, Massachusetts, and Pennsylvania.

Solar

California continues to dominate the solar patent field. With 421 patents registered, the Golden State had more solar patents than the rest of the top ten states combined: 410 solar patents total between New York, Arizona, Massachusetts, New Mexico, Texas, Colorado, Michigan, Florida, and New Jersey.

Wind

California had 99 wind patents registered, but South Carolina (with 89 patents) and New York (with 61 patents) trailed closely behind. The three states alone had almost 40 percent of all wind patents registered in the U.S. in 2017.

Clean Technology Investments

In the last few years, venture capital funding for clean technology companies has waned, following an investment boom in clean technologies between 2008 and 2011. While a similar number of investment deals were completed compared to the previous year, 2017 continued the downward trend as the average deal size shrinks.

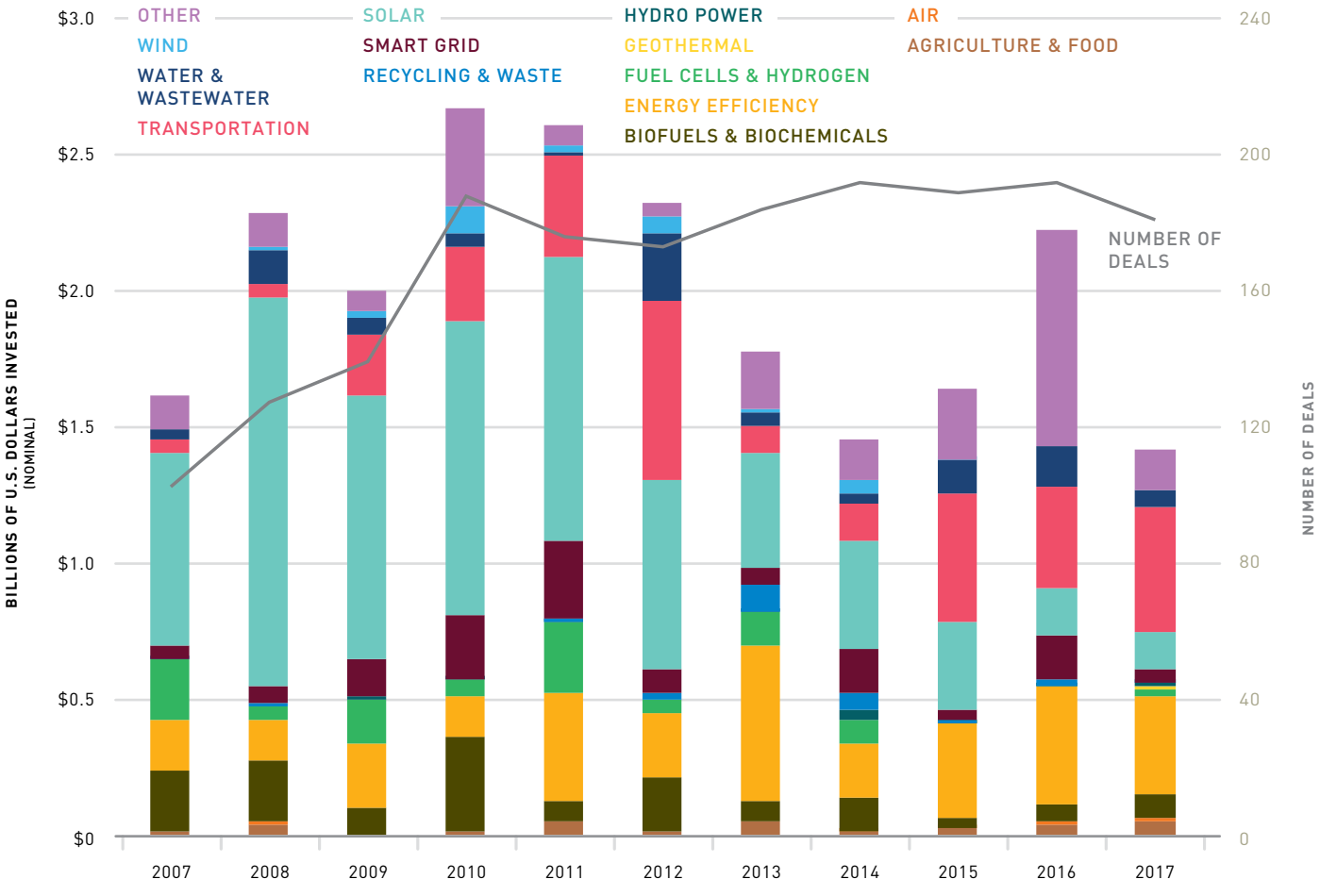
There are a number of factors that may have contributed to the decrease in venture capital (VC) funding for clean technology companies. In the late 2000s and early 2010s, clean tech VC investments boomed as a result of AB 32 being signed into law in 2006. Around the same time, shale oil and natural gas from fracking had also started to take off. The cheap and abundant natural gas that followed put a damper on clean tech investment. As clean technologies began to mature and VC firms gained a better understanding of how clean tech firms operate, investors saw that clean tech firms required a longer period of time before a return on investment. It was in this climate that VC firms started to pull back from clean tech investment, especially in the angel/early VC stages.

Despite an overall decrease in venture capital investment in California as well as the U.S., the majority of the venture capital investments in clean technology still take place in California. In 2017, some $2.5 billion were invested in the clean technology space in the U.S., of which $1.4 billion or 57.2 percent were invested in Californian companies. California's clean technology companies received more than half of all venture capital investment in the U.S. overall and in most segments except for wind, hydro power, agriculture and food, and recycling and waste in 2017.

Venture capital has been a major avenue for startup companies to secure the necessary capital to create new, innovative products and services. While other types of investors also play an important role of fostering the clean technology market, venture capitalists are unique due to their tolerance of early stage, high-risk investments and

FIGURE 41. VENTURE CAPITAL INVESTMENT IN CLEAN TECHNOLOGY BY SEGMENT

CALIFORNIA, 2006–2017



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management expertise. In recent years, however, venture capital investors have lost interest in clean technology companies in favor of companies that are able to generate returns on investments more quickly.[84] As venture capitalists exit the clean technology landscape, other entities such as impact investors and governments increasingly fill in the role. Nevertheless, venture capital investments in clean technologies are not on a complete decline – of the most active venture capital investors in clean tech in 2018, several of them, including Clean Energy Venture Group, actually invest primarily in clean tech startups.[85]

SEGMENT ANALYSIS & NOTABLE INVESTMENTS

Clean Transportation: Transportation was the largest segment of clean technology investing, with $610 million invested in the U.S., of which $459 million was invested in California. As zero-emission vehicles become increasingly popular, there has been growing demand for charging stations. ChargePoint, a developer of electric vehicle charging networks, secured $125 million from BMW I Ventures (Daimler) et al. in May 2017 after raising $58.1 million in investments in 2016.[86] Proterra, known for its zero-emission buses, secured a total of $195 million in two rounds of funding from GM Ventures (General Motors Ventures) and BMW I Ventures (Daimler) in 2017.

Energy Efficiency: Historically, investment in energy efficiency has been volatile. However, 2017 was a good year, with $356 million invested in California and $586 million invested in the U.S. View (manufacturer of smart glass[87]) alone secured $200 million in late stage venture capital funding.[88]

Biofuels & Biochemicals: Of the relatively modest $80 million secured in California, Fulcrum Bioenergy raised $50.8 million in funding from BP Ventures et al., after having secured $30 million from BP Ventures in 2016.

Mergers and Acquisitions

U.S. Mergers & Acquisitions (M&A) activities in clean technology companies totaled 124 deals in 2017, the lowest level since 2009.[89] Similarly, the total full transaction amount of all M&A transactions decreased substantially from $24 billion in 2016 to $5.3 billion in 2017 in the U.S. In California, the number of M&A deals in clean technology companies also declined in 2017 to just 20 deals, similar to the 2012 level. Similar to the U.S. trend, the California total transaction amount also decreased significantly to $837 million in 2017, similar to the 2015 level ($831 million) but far less than the 2016 level ($4.7 billion). In 2016, the Tesla acquisition of SolarCity ($2.8 billion) represented more than half of that year's M&A transaction value, an outlier compared to recent transactions over the last few years. That same year also saw both a greater number of transactions as well as higher value individual transactions than in 2017. Of the notable 2017 transactions, Texas-based ENGIE North America, a retail energy sales and services company, was acquired by Dynegy for $3.3 billion in February 2017.[90] As for California, San Diego-based EAG Laboratories, a global scientific services company that provides analytical testing and consulting solutions to end markets, was acquired by Eurofins Scientific for $780 million in November 2017.[91]

FIGURE 42. TOTAL INVESTMENT IN CLEAN TECHNOLOGY
BY SEGMENT FOR U.S. & CALIFORNIA, 2017

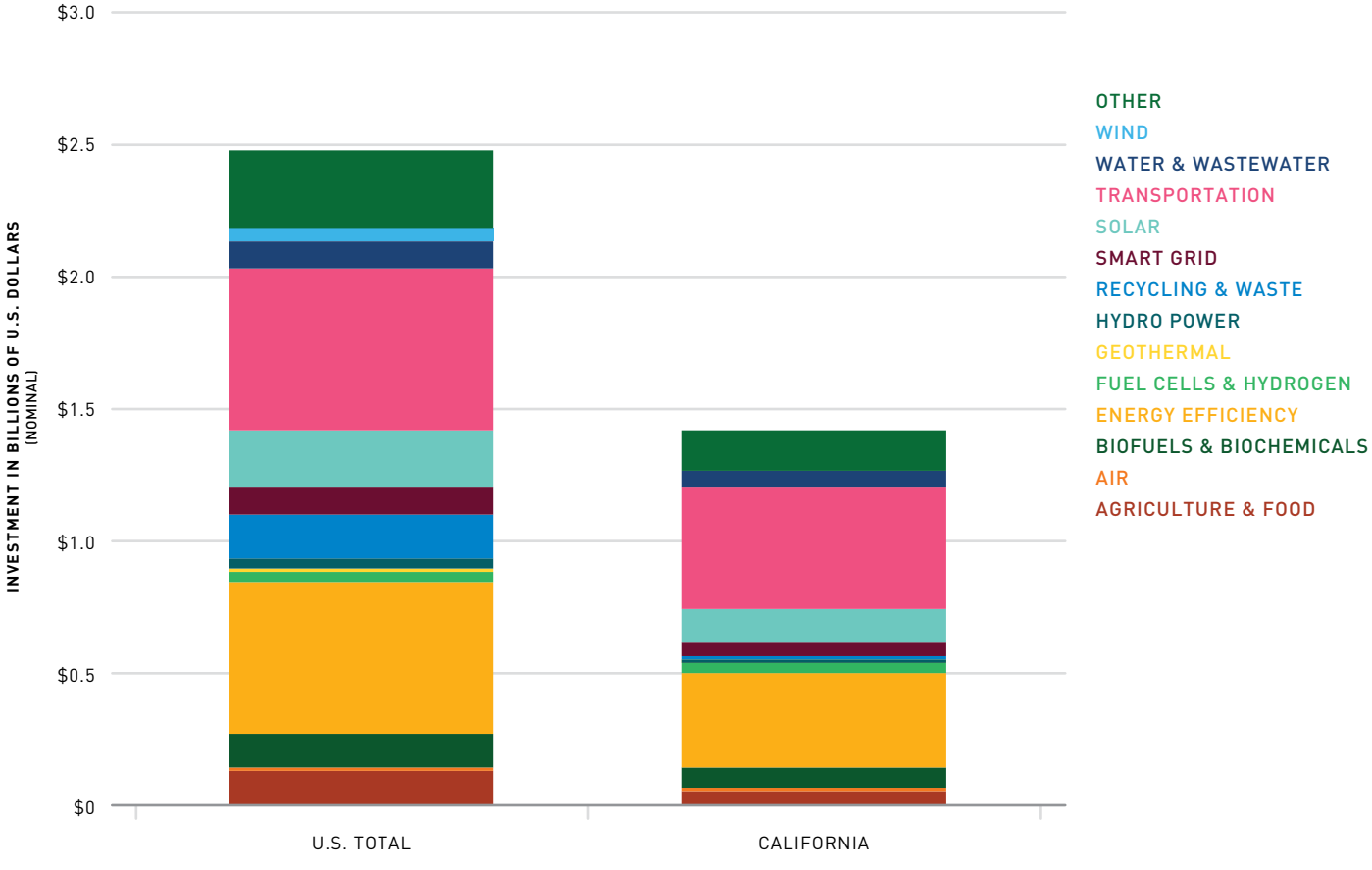

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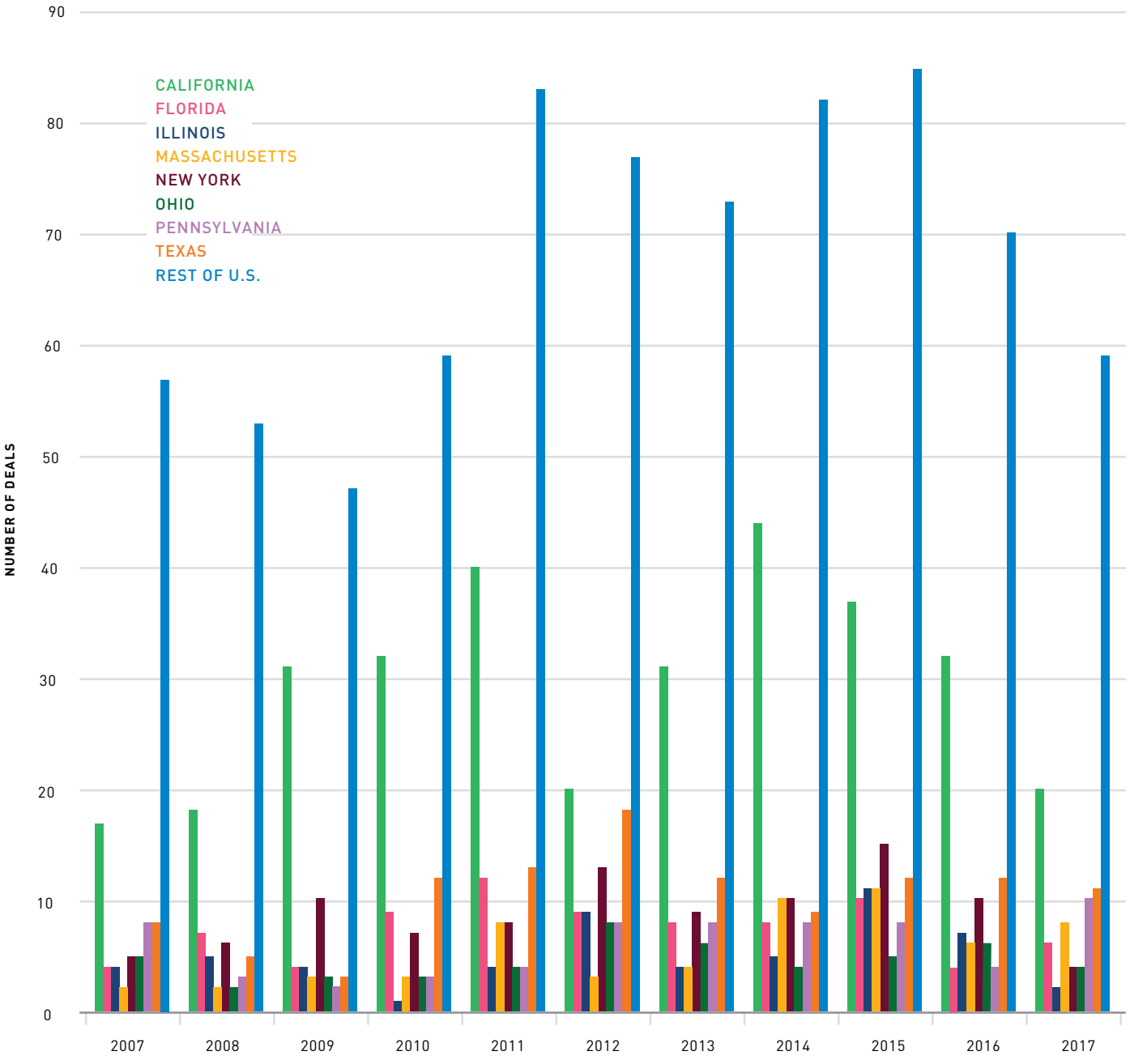
FIGURE 43. MERGERS & ACQUISITIONS OF CLEAN TECHNOLOGY COMPANIES

BY STATE OF TARGETED COMPANY, 2007–2017



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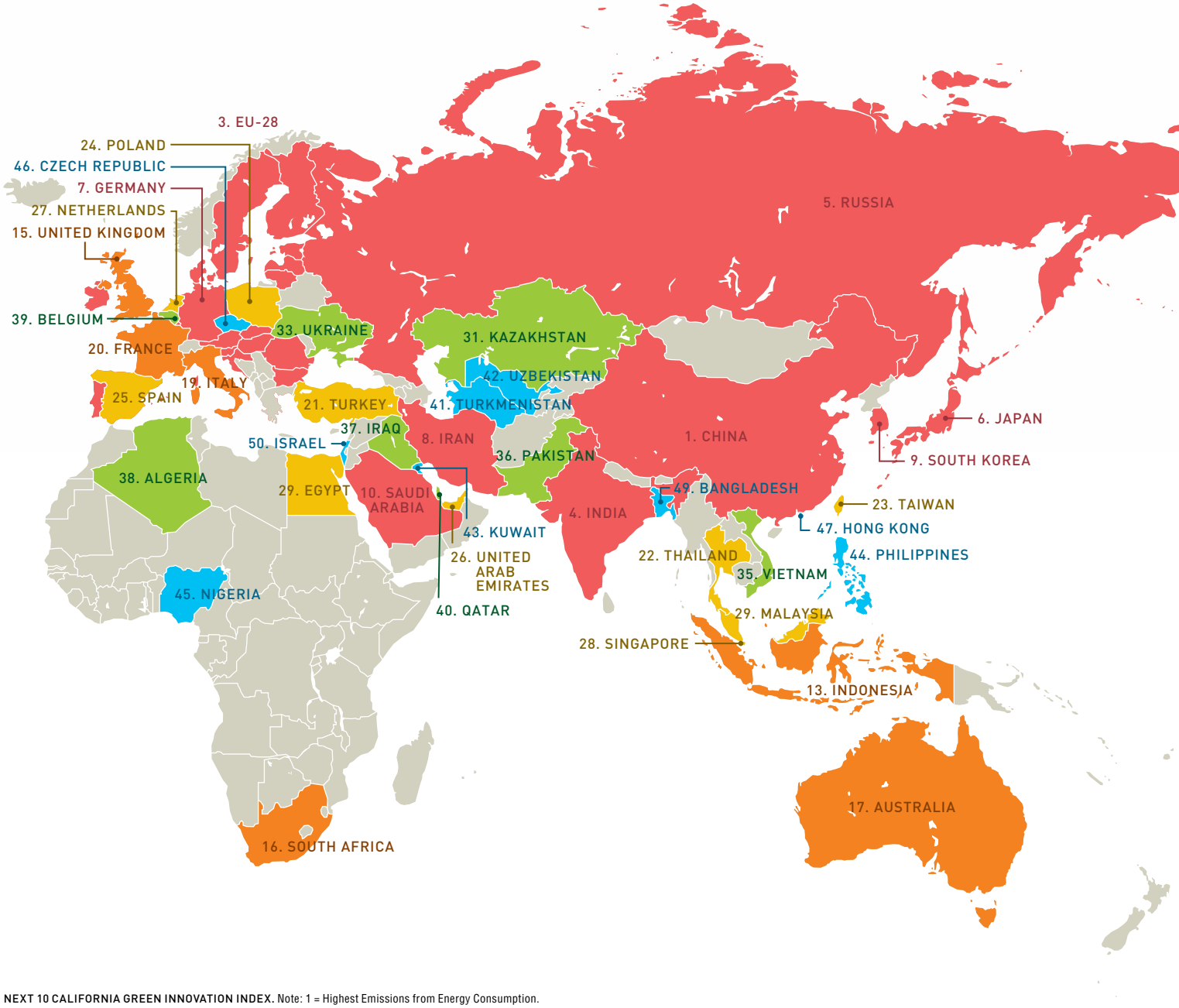
INTERNATIONAL SCORECARD

TOTAL GHG EMISSIONS FROM ENERGY CONSUMPTION RANKING

HIGHEST TOTAL EMISSIONS ($MMTCO_2e$) IN 2014



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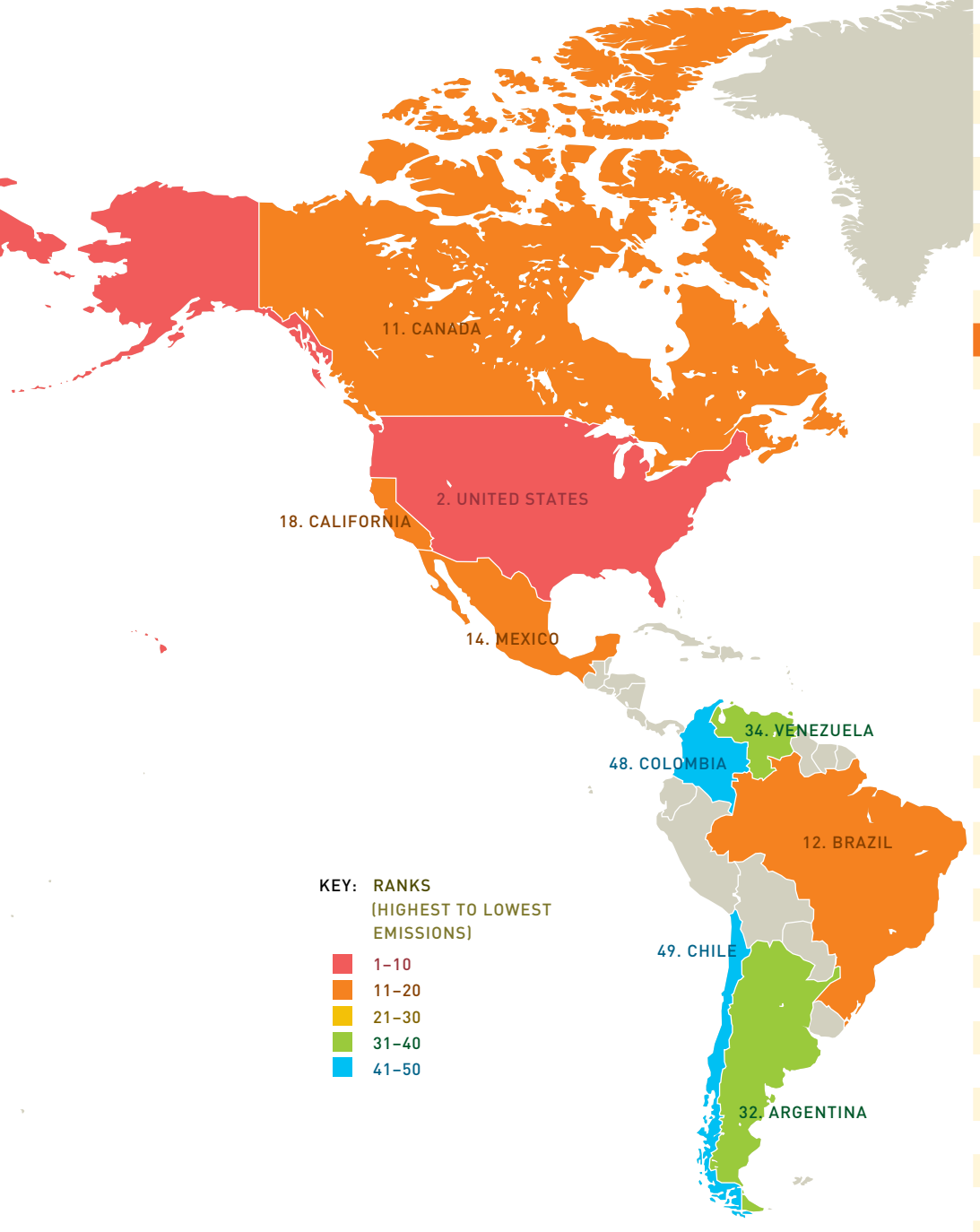
*OECD Member Countries. Analysis and data sources the same as in previous sections; rankings are out of the top 50 polluters of GHG emissions from energy consumption. NEXT 10 / SF · CA · USA



RANK	REGION	MILLION $MTCO_2e$
1	CHINA	8865.9
2	UNITED STATES*	5268.5
3	EU-28	3492.5
4	INDIA	1894.1
5	RUSSIA	1686.7
6	JAPAN*	1125.8
7	GERMANY*	742.5
8	IRAN	654.0
9	SOUTH KOREA	644.4
10	SAUDI ARABIA	605.6
11	CANADA	600.0
12	BRAZIL	540.8
13	INDONESIA	502.0
14	MEXICO*	452.9
15	UNITED KINGDOM*	429.6
16	SOUTH AFRICA	405.9
17	AUSTRALIA	371.2
18	CALIFORNIA	363.5
19	ITALY	351.1
20	FRANCE	330.8
21	TURKEY*	329.3
22	THAILAND	316.5
23	TAIWAN	295.5
24	POLAND*	281.9
25	SPAIN*	271.6
26	UNITED ARAB EMIRATES	236.7
27	NETHERLANDS	232.6
28	SINGAPORE	231.1
29	EGYPT	215.3
30	MALAYSIA	204.6
31	KAZAKHSTAN	199.3
32	ARGENTINA	189.6
33	UKRAINE	172.7
34	VENEZUELA	172.3
35	VIETNAM	157.9
36	PAKISTAN	148.9
37	IRAQ	142.4
38	ALGERIA	140.5
39	BELGIUM	135.3
40	QATAR	115.1
41	TURKMENISTAN	108.5
42	UZBEKISTAN	107.4
43	KUWAIT	102.6
44	PHILIPPINES	101.2
45	NIGERIA	97.5
46	CZECH REPUBLIC	95.1
47	HONG KONG	91.0
48	COLOMBIA	72.5
49	BANGLADESH	71.7
50	ISRAEL	70.3

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 2015 ($MMTCO_2e$)	2015 GDP PER CAPITA, 2015 US $	LOWEST CARBON INTENSITY ($MTCO_2e$/U.S.$10,000 GDP) IN 2015	LOWEST EMISSIONS PER CAPITA ($MTCO_2e$/PERSON) IN 2015	HIGHEST ENERGY PRODUCTIVITY (GDP IN 2015 USD/BTU) IN 2015
1	CHINA	$7,441	FRANCE	BANGLADESH	NIGERIA
2	UNITED STATES*	$55,425	ARGENTINA	NIGERIA	ARGENTINA
3	EU-28	$37,033	CALIFORNIA	PAKISTAN	UNITED KINGDOM*
4	INDIA	$2,394	UNITED KINGDOM*	PHILIPPINES	ISRAEL*
5	RUSSIA	$19,244	NIGERIA	INDIA	ITALY
6	JAPAN*	$47,620	BRAZIL	COLOMBIA	JAPAN*
7	GERMANY*	$49,679	ITALY	VIETNAM	CALIFORNIA
8	IRAN	$12,745	COLOMBIA	INDONESIA	VENEZUELA
9	SOUTH KOREA	$26,667	EU-28	EGYPT	GERMANY*
10	SAUDI ARABIA	$23,441	VENEZUELA	BRAZIL	FRANCE
11	CANADA	$54,930	GERMANY*	ALGERIA	EU-28
12	BRAZIL	$16,699	JAPAN*	UZBEKISTAN	BRAZIL
13	INDONESIA	$4,962	SPAIN*	MEXICO*	COLOMBIA
14	MEXICO*	$11,805	TURKEY*	IRAQ	AUSTRALIA
15	UNITED KINGDOM*	$45,151	ISRAEL*	UKRAINE	TURKEY*
16	SOUTH AFRICA	$10,240	BELGIUM*	TURKEY*	SPAIN*
17	AUSTRALIA	$65,158	AUSTRALIA	ARGENTINA	HONG KONG
18	CALIFORNIA	$63,178	NETHERLANDS*	THAILAND	NETHERLANDS*
19	ITALY	$35,193	HONG KONG	FRANCE	BELGIUM*
20	FRANCE	$43,449	UNITED STATES*	SPAIN*	UNITED STATES*
21	TURKEY*	$18,552	CANADA	VENEZUELA	PHILIPPINES
22	THAILAND	$6,299	MEXICO*	ITALY	MEXICO*
23	TAIWAN	$21,178	BANGLADESH	CHINA	INDONESIA
24	POLAND*	$15,451	PHILIPPINES	UNITED KINGDOM*	BANGLADESH
25	SPAIN*	$29,589	INDONESIA	MALAYSIA	POLAND*
26	UNITED ARAB EMIRATES	$61,113	CZECH REPUBLIC*	EU-28	CZECH REPUBLIC*
27	NETHERLANDS	$52,869	PAKISTAN	POLAND*	CANADA
28	SINGAPORE	$52,407	POLAND*	SOUTH AFRICA	EGYPT
29	EGYPT	$4,725	SOUTH KOREA	IRAN	INDIA
30	MALAYSIA	$11,773	EGYPT	ISRAEL*	SOUTH KOREA
31	KAZAKHSTAN	$15,280	MALAYSIA	JAPAN*	PAKISTAN
32	ARGENTINA	$34,559	TAIWAN	CZECH REPUBLIC*	MALAYSIA
33	UKRAINE	$5,620	RUSSIA	GERMANY*	SOUTH AFRICA
34	VENEZUELA	$30,711	IRAN	CALIFORNIA	KAZAKHSTAN
35	VIETNAM	$2,388	ALGERIA	KAZAKHSTAN	TAIWAN
36	PAKISTAN	$1,621	INDIA	RUSSIA	IRAQ
37	IRAQ	$4,964	UNITED ARAB EMIRATES	BELGIUM*	IRAN
38	ALGERIA	$5,641	UKRAINE	TAIWAN	ALGERIA
39	BELGIUM	$47,981	QATAR	SOUTH KOREA	RUSSIA
40	QATAR	$73,653	VIETNAM	HONG KONG	VIETNAM
41	TURKMENISTAN	$8,417	KAZAKHSTAN	NETHERLANDS*	SINGAPORE
42	UZBEKISTAN	$3,665	SOUTH AFRICA	AUSTRALIA	CHINA
43	KUWAIT	$42,936	THAILAND	UNITED STATES*	THAILAND
44	PHILIPPINES	$2,923	IRAQ	CANADA	UNITED ARAB EMIRATES
45	NIGERIA	$3,488	SINGAPORE	TURKMENISTAN	QATAR
46	CZECH REPUBLIC	$22,404	KUWAIT	SAUDI ARABIA	UKRAINE
47	HONG KONG	$43,228	CHINA	KUWAIT	KUWAIT
48	COLOMBIA	$9,023	SAUDI ARABIA	SINGAPORE	SAUDI ARABIA
49	BANGLADESH	$1,408	UZBEKISTAN	UNITED ARAB EMIRATES	UZBEKISTAN
50	ISRAEL	$38,668	TURKMENISTAN	QATAR	TURKMENISTAN

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. *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.

RANK	ENERGY PER CAPITA RANKING	ELECTRICITY PER CAPITA RANKING	TOTAL RENEWABLE ELECTRICITY GENERATION RANKING	SHARE OF ELECTRICITY FROM RENEWABLE RANKING
	LEAST TOTAL ENERGY CONSUMPTION PER CAPITA (BTU/PERSON) IN 2015	LEAST TOTAL ELECTRICITY CONSUMPTION PER CAPITA (kWh/PERSON) IN 2015	MOST TOTAL RENEWABLE ELECTRICITY IN 2015	HIGHEST SHARE OF RENEWABLES (RENEWABLE ELECTRICITY/TOTAL ELECTRICITY) IN 2015
1	NIGERIA	NIGERIA	EU-28	GERMANY*
2	BANGLADESH	BANGLADESH	UNITED STATES*	SPAIN*
3	PAKISTAN	PAKISTAN	CHINA	UNITED KINGDOM*
4	PHILIPPINES	PHILIPPINES	GERMANY*	ITALY
5	INDIA	INDONESIA	JAPAN*	EU-28
6	VIETNAM	INDIA	UNITED KINGDOM*	BELGIUM*
7	INDONESIA	IRAQ	INDIA	CALIFORNIA
8	COLOMBIA	COLOMBIA	BRAZIL	PHILIPPINES
9	EGYPT	ALGERIA	SPAIN*	POLAND*
10	IRAQ	VIETNAM	ITALY	NETHERLANDS*
11	ALGERIA	EGYPT	CALIFORNIA	BRAZIL
12	BRAZIL	UZBEKISTAN	CANADA	CZECH REPUBLIC*
13	MEXICO*	MEXICO*	FRANCE	AUSTRALIA
14	UZBEKISTAN	VENEZUELA	AUSTRALIA	JAPAN*
15	TURKEY*	THAILAND	POLAND*	FRANCE
16	THAILAND	BRAZIL	MEXICO*	CANADA
17	UKRAINE	IRAN	TURKEY*	UNITED STATES*
18	CHINA	TURKEY*	BELGIUM*	TURKEY*
19	ARGENTINA	ARGENTINA	NETHERLANDS*	INDIA
20	SOUTH AFRICA	TURKMENISTAN	PHILIPPINES	MEXICO*
21	VENEZUELA	UKRAINE	INDONESIA	THAILAND
22	POLAND*	POLAND*	THAILAND	INDONESIA
23	MALAYSIA	CHINA	CZECH REPUBLIC*	CHINA
24	ITALY	SOUTH AFRICA	TAIWAN	COLOMBIA
25	ISRAEL*	MALAYSIA	SOUTH AFRICA	SINGAPORE
26	SPAIN*	ITALY	RUSSIA	TAIWAN
27	UNITED KINGDOM*	UNITED KINGDOM*	ARGENTINA	SOUTH AFRICA
28	IRAN	SPAIN*	COLOMBIA	ISRAEL*
29	EU-28	KAZAKHSTAN	UKRAINE	ARGENTINA
30	KAZAKHSTAN	EU-28	EGYPT	UKRAINE
31	JAPAN*	CZECH REPUBLIC*	SINGAPORE	EGYPT
32	CZECH REPUBLIC*	HONG KONG	ISRAEL*	PAKISTAN
33	FRANCE	RUSSIA	MALAYSIA	MALAYSIA
34	GERMANY*	NETHERLANDS*	PAKISTAN	RUSSIA
35	HONG KONG	ISRAEL*	UNITED ARAB EMIRATES	BANGLADESH
36	TAIWAN	FRANCE	IRAN	UNITED ARAB EMIRATES
37	CALIFORNIA	GERMANY*	KAZAKHSTAN	HONG KONG
38	RUSSIA	CALIFORNIA	VIETNAM	KAZAKHSTAN
39	NETHERLANDS*	BELGIUM*	BANGLADESH	ALGERIA
40	BELGIUM*	JAPAN*	HONG KONG	VIETNAM
41	SOUTH KOREA	SINGAPORE	VENEZUELA	VENEZUELA
42	AUSTRALIA	SOUTH KOREA	ALGERIA	IRAN
43	UNITED STATES*	AUSTRALIA	NIGERIA	NIGERIA
44	TURKMENISTAN	TAIWAN	SAUDI ARABIA	SAUDI ARABIA
45	SAUDI ARABIA	SAUDI ARABIA	SOUTH KOREA	SOUTH KOREA
46	CANADA	UNITED STATES*	IRAQ	IRAQ
47	SINGAPORE	CANADA	QATAR	QATAR
48	KUWAIT	QATAR	TURKMENISTAN	TURKMENISTAN
49	UNITED ARAB EMIRATES	UNITED ARAB EMIRATES	UZBEKISTAN	UZBEKISTAN
50	QATAR	KUWAIT	KUWAIT	KUWAIT

Electricity Productivity

Metro areas with high gross metropolitan product (GMP) tend to have higher electricity productivity. San Francisco-Oakland-Hayward and nearby San Jose-Sunnyvale-Santa Clara, with $470.5 million and $252.5 million GMP, respectively, once again held the top two spots in electricity productivity in 2016. Los Angeles-Long Beach-Anaheim overtook San Diego-Carlsbad to finish third. Bakersfield ranked last and Merced ranked second-to-last, unchanged from the previous year, meaning that these areas' industries are more electricity-intensive than others in the state.

Solar PV Capacity Additions

Sunny Southern California metro areas had the most solar photovoltaic capacity installed in 2017. Riverside-San Bernardino-Ontario added the most solar PV capacity (in alternate current) in 2017 with 173.4 megawatt (MW) of capacity installed across all sectors combined, followed by Los Angeles-Long Beach-Anaheim with 152.2 MW installed and San Diego-Carlsbad with 135.4 MW installed. Cumulatively, Los Angeles-Long Beach-Anaheim had the highest solar PV installed with 866.1 MW as of the end of 2017, followed closely by Riverside-San Bernardino-Ontario (828.3 MW) and San Diego-Carlsbad (770.8 MW). On a per capita basis, however, the Central Valley had the most per capita solar PV capacity installed. In 2017, Madera had the most capacity installed per person (0.14 MW/person), followed by Visalia-Porterville (0.13 MW/person) and Hanford-Corcoran (0.11 MW/person).

Clean Vehicle Rebates

The income cap and increased lower-income incentives became effective on November 1, 2016 and as a result, there were a higher number of clean vehicle rebates per capita in lower-income MSAs (and less rebates in higher-income MSAs, such as the Bay Area) in 2017 compared to 2016.[92] Los Angeles-Long Beach-Anaheim maintained its top spot for clean vehicles rebates with 19,562 in 2017, an increase of 11.2 percent year over year. San Francisco-Oakland-Hayward and San Jose-Sunnyvale-Santa Clara also maintained the second and third places, respectively, but with a 3.3 percent and 14.0 percent decline, compared to 2016. On a percentage basis, smaller, inland metros saw the largest increases in 2017: Visalia-Porterville (+215%), Hanford-Corcoran (+85%), and Chico (+66%).

On a per capita basis, San Jose-Sunnyvale-Santa Clara kept the top spot with 2.9 rebates per 1,000 persons, Santa Rosa-Petaluma overtook San Francisco-Oakland-Hayward to finish second with 2.0 rebates per 1,000 persons.

Commute Time by Driving

Workers who drive alone continued to see their commute times increase across California. Those in Santa Maria-Santa Barbara had the lowest average commute time in 2016, spending just 18.3 minutes behind the wheel. Workers from Redding (19.6 minutes) and Hanford-Corcoran (20.6 minutes) also enjoyed relatively short commutes. On the other hand, those in large metro areas spent the most time driving to and from work. Workers in Riverside-San Bernardino-Ontario had the longest average commute of 31.6 minutes, which is likely due to the increased number of super commuters (those who spend more than 90 minutes commuting) to the Los Angeles-Long Beach-Anaheim metro area. Stockton-Lodi (31.0 minutes) and San Francisco-Oakland-Hayward (30.4 minutes) had the next longest average commute times.

Public Transportation

Unlinked passenger trips (UPTs) continue to decline throughout California – Hanford-Corcoran is the only MSA where UPTs per capita have increased for four consecutive years.[93] Although San Francisco-Oakland-Hayward still had by far the highest UPTs (98 per capita) in 2017, it has fallen below 100 UPTs/person for the first time since 2011. Los Angeles-Long Beach-Anaheim had the next highest UPTs per capita at 42, a 5.9 percent decrease compared to 2016. Likewise, San Diego-Carlsbad, which finished third with 30 UPTs per capita, recorded a 4.4 percent decline compared to 2016.

REGIONAL ECONOMIC & ENVIRONMENTAL INDICATORS: RANKINGS

REGION	REAL GDP	GDP PER CAPITA	POPULATION	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	HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL	HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL	HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL	HIGHEST PUBLIC TRANSPORTATION RIDERSHIP PER CAPITA
BAKERSFIELD	9	15	8	26	26	16	26	9	26	6	11	13	4	5	6	14
CHICO	21	18	20	15	4	24	3	17	4	4	22	23	14	8	13	19
EL CENTRO	24	25	21	20	14	22	14	1	14	7	25	26	26	19	26	22
FRESNO	8	14	7	14	18	18	18	7	18	7	19	9	3	3	5	10
HANFORD–CORCORAN	26	20	25	24	24	12	24	5	24	3	22	22	9	19	19	4
LOS ANGELES–LONG BEACH–ANAHEIM	1	3	1	3	13	7	13	13	13	22	3	1	5	9	2	2
MADERA	25	23	24	23	22	19	23	2	22	9	20	20	8	6	18	26
MERCED	20	26	19	25	23	14	25	4	23	16	18	21	10	19	16	25
MODESTO	15	16	11	19	20	23	20	10	20	18	11	18	23	18	23	18
NAPA	19	4	26	6	11	13	16	25	11	11	17	19	24	19	25	11
OXNARD–THOUSAND OAKS–VENTURA	7	6	9	8	7	8	9	19	7	14	8	8	20	19	12	21
REDDING	22	19	22	21	8	26	11	6	8	2	22	24	25	19	22	23
RIVERSIDE–SAN BERNARDINO–ONTARIO	5	24	3	17	9	20	8	14	9	26	6	5	6	7	1	17
SACRAMENTO–ROSEVILLE–ARDEN-ARCADE	6	9	5	12	5	25	7	22	5	17	5	6	12	13	7	8
SALINAS	13	10	15	9	12	1	10	15	12	12	13	17	21	19	20	9
SAN DIEGO–CARLSBAD	4	5	4	5	2	6	5	3	2	15	4	4	2	12	3	3
SAN FRANCISCO–OAKLAND–HAYWARD	2	2	2	1	21	4	15	26	21	24	1	2	7	2	4	1
SAN JOSE–SUNNYVALE–SANTA CLARA	3	1	6	2	10	3	21	18	10	20	2	3	13	10	8	5
SAN LUIS OBISPO–PASO ROBLES–ARROYO GRANDE	17	11	17	11	17	9	6	23	17	9	13	15	17	14	17	12
SANTA CRUZ–WATSONVILLE	18	12	18	4	3	5	1	16	3	19	7	11	22	19	24	6
SANTA MARIA–SANTA BARBARA	12	7	14	10	15	2	12	20	15	1	9	12	16	17	21	7
SANTA ROSA–PETALUMA	10	8	12	7	6	15	2	24	6	13	10	7	15	1	15	13
STOCKTON–LODI	11	17	10	18	16	11	17	12	16	25	15	10	11	11	9	15
VALLEJO–FAIRFIELD	14	13	16	13	25	10	19	21	25	23	16	14	18	16	11	20
VISALIA–PORTERVILLE	16	22	13	22	19	17	22	8	19	5	20	16	1	4	10	24
YUBA CITY	23	21	23	16	1	21	4	11	1	21	25	25	19	15	14	16

BAKERSFIELD

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	9	$35,162	35.7%
GDP PER CAPITA	15	$39,679	2.9%
POPULATION	8	886,153	31.9%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	26	2.13	4.6%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	26	12.50	39.4%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	16	2.60	6.7%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	26	16.01	-2.8%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	26	0.10	-34.4%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	26	3.07	-25.9%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	6	21.9	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	11	20	-13.0%
MOST CLEAN VEHICLE REBATES	13	296	28.1%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	4	32,891	29.0%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	5	1,944	-54.2%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	6	35,199	-25.2%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	14	6.5	7.2%

HANFORD–CORCORAN

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	26	$5,092	45.6%
GDP PER CAPITA	20	$34,005	27.5%
POPULATION	25	149,744	14.2%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	24	2.82	-25.5%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	24	76.03	36.7%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	12	2.50	15.6%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	24	9.57	95.8%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	5	0.09	-30.4%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	24	0.36	1.9%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	3	20.6	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	22	3	
MOST CLEAN VEHICLE REBATES	22	50	85.2%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	9	11,776	53.9%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	19	0	-100.0%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	19	4,767	-22.3%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	4	23.7	4.4%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Most Recent Year is 2016 for all metrics EXCEPT for Green Technology Patents and Clean Vehicle Rebates, where Most Recent Year is 2017. Real GDP: Inflation adjusted GDP where base year is 2016. Solar Capacity Installed: Unit based on alternate current in megawatts. Data Sources: Solar, California Solar Statistics; Vehicle Rebates: California Clean Vehicle Rebate Project; Patents: IPCheckups, CleanTech Patent Edge;

CHICO

RANK	2016	2001–16 %
21	$7,817	40.8%
18	$34,830	28.4%
20	224,432	9.7%
15	5.29	19.0%
14	184.01	54.0%
24	3.23	9.4%
3	3.35	6.4%
17	0.11	-17.4%
4	0.08	-15.4%
4	20.7	
RANK	2017	2016–17 %
22	3	0.0%
23	48	65.5%
14	5,788	20.5%
8	660	10.3%
13	8,968	-20.6%
19	5.6	-8.6%

EL CENTRO

RANK	2016	2001–16 %
24	$5,720	38.3%
25	$30,750	7.0%
21	186,019	29.2%
20	4.03	30.0%
17	158.49	77.9%
22	2.92	-9.6%
14	4.71	-22.1%
1	0.04	-33.8%
14	0.15	-41.2%
7	22.0	
RANK	2017	2016–17 %
25	0	N/A
26	11	37.5%
26	11	0.0%
19	0	N/A
26	0	-100.0%
22	4.3	-3.8%

FRESNO

RANK	2016	2001–16 %
8	$40,465	40.4%
15	$41,101	15.3%
7	984,537	21.8%
14	5.30	13.9%
18	142.34	49.2%
18	2.71	5.0%
18	5.04	-0.7%
7	0.10	-27.5%
18	0.19	-19.9%
7	22.0	
RANK	2017	2016–17 %
19	5	-16.7%
9	869	14.5%
3	35,120	41.6%
3	2,669	-63.5%
5	44,905	-1.8%
10	9.5	-7.9%

LOS ANGELES–LONG BEACH–ANAHEIM

RANK	2016	2001–16 %
1	$1,001,677	34.2%
3	$75,019	25.2%
1	13,352,391	7.1%
3	11.13	30.5%
3	291.27	40.5%
7	2.08	9.0%
13	4.66	-8.9%
13	0.11	-26.2%
13	0.15	5.1%
22	29.7	
RANK	2017	2016–17 %
3	890	2.4%
1	19,562	11.2%
5	28,148	-8.4%
9	252	-94.3%
2	106,669	-23.1%
2	42.0	-5.9%

MADERA

RANK	2016	2001–16 %
25	$5,150	31.9%
23	$33,246	6.8%
24	154,906	23.6%
23	3.23	-8.5%
22	94.99	154.1%
19	2.72	5.0%
23	7.58	21.5%
2	0.05	-27.3%
22	0.30	-60.7%
9	22.9	
RANK	2017	2016–17 %
20	4	100.0%
20	66	50.0%
8	15,080	57.2%
6	1,056	-83.9%
18	6,427	-5.2%
26	1.2	-1.3%

MERCED

RANK	2016	2001–16 %
20	$8,254	33.1%
26	$30,401	5.0%
19	271,500	26.7%
25	2.38	7.5%
25	69.05	23.2%
14	2.59	2.8%
25	10.20	-3.6%
4	0.09	-29.4%
23	0.35	-10.2%
16	26.4	
RANK	2017	2016–17 %
18	7	16.7%
21	58	38.1%
10	9,677	12.5%
19	0	-100.0%
16	7,084	-33.1%
25	3.1	-0.2%

Gas Consumption: California Energy Commission; Clean Vehicle Rebates: Center for Sustainable Energy, California Air Resources Board Clean Vehicle Rebates Project; Public Transit Ridership: National Transit Database, Department of Transportation. 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

MODESTO

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	15	$19,730	38.4%
GDP PER CAPITA	16	$36,438	16.6%
POPULATION	11	541,466	18.6%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	19	4.14	20.1%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	20	107.88	18.1%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	23	3.19	1.8%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	20	5.61	-5.3%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	10	0.10	-25.0%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	20	0.23	15.1%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	18	26.8	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	11	20	-23.1%
MOST CLEAN VEHICLE REBATES	18	191	-10.7%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	23	1,546	24.4%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	18	4	-98.4%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	23	3,651	-4.3%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	18	5.6	-4.7%

RIVERSIDE–SAN BERNARDINO–ONTARIO

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	5	$149,059	41.1%
GDP PER CAPITA	24	$33,243	4.8%
POPULATION	3	4,483,937	34.6%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	17	4.82	-0.5%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	16	167.49	48.9%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	20	2.73	8.1%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	8	4.17	3.7%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	14	0.11	-33.3%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	9	0.09	-24.5%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	26	31.6	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	6	108	11.3%
MOST CLEAN VEHICLE REBATES	5	2,577	36.3%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	6	24,224	0.0%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	7	831	-80.8%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	1	121,586	-2.3%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	17	5.9	-6.0%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Most Recent Year is 2016 for all metrics EXCEPT for Green Technology Patents and Clean Vehicle Rebates, where Most Recent Year is 2017. Real GDP: Inflation adjusted GDP where base year is 2016. Solar Capacity Installed: Unit based on alternate current in megawatts. Data Sources: Solar, California Solar Statistics; Vehicle Rebates: California Clean Vehicle Rebate Project; Patents: IPCheckups, CleanTech Patent Edge;

NAPA

RANK	2016	2001–16 %
19	$10,540	43.9%
4	$74,377	27.3%
26	141,711	13.0%
6	9.97	18.0%
4	288.92	63.4%
13	2.55	-1.9%
16	4.91	13.9%
25	0.14	-20.4%
11	0.12	-23.8%
11	23.0	
RANK	**2017**	**2016–17 %**
17	9	28.6%
19	118	18.0%
24	1,270	-58.1%
19	0	-100.0%
25	2,905	-10.1%
11	8.0	-4.3%

OXNARD–THOUSAND OAKS–VENTURA

RANK	2016	2001–16 %
7	$48,517	35.2%
6	$56,819	20.8%
9	853,893	11.9%
8	8.81	26.8%
5	280.18	70.9%
8	2.22	10.7%
9	4.22	-11.3%
19	0.12	-29.0%
7	0.08	-29.7%
14	25.1	
RANK	**2017**	**2016–17 %**
8	71	4.4%
8	967	17.9%
20	2,516	-32.4%
19	0	-100.0%
12	12,250	-15.2%
21	5.1	-6.3%

REDDING

RANK	2016	2001–16 %
22	$6,198	42.4%
19	$34,775	32.3%
22	178,232	7.6%
21	3.97	39.0%
13	186.90	25.1%
26	4.17	8.0%
11	4.58	-14.2%
6	0.10	-13.7%
8	0.09	41.0%
2	19.6	
RANK	**2017**	**2016–17 %**
22	3	200.0%
24	42	16.7%
25	521	-25.6%
19	0	-100.0%
22	3,943	-9.3%
23	4.2	2.6%

SACRAMENTO–ROSEVILLE–ARDEN-ARCADE

RANK	2016	2001–16 %
6	$122,218	38.3%
9	$53,788	12.0%
5	2,272,220	23.6%
12	7.31	18.6%
7	266.83	52.0%
25	3.28	-0.5%
7	4.07	-9.4%
22	0.13	-25.8%
5	0.08	-27.3%
17	26.6	
RANK	**2017**	**2016–17 %**
5	142	16.4%
6	1,725	31.5%
12	7,547	5.8%
13	69	-95.2%
7	34,785	-13.0%
8	12.6	-7.3%

SALINAS

RANK	2016	2001–16 %
13	$22,520	36.8%
10	$51,395	26.3%
15	438,175	8.3%
9	8.71	32.1%
10	214.67	42.9%
1	1.57	-7.0%
10	4.33	-3.3%
15	0.11	-18.2%
12	0.13	-5.0%
12	23.6	
RANK	**2017**	**2016–17 %**
13	17	41.7%
17	213	23.8%
21	2,093	-58.4%
19	0	-100.0%
20	4,579	-40.0%
9	10.0	-1.4%

SAN DIEGO–CARLSBAD

RANK	2016	2001–16 %
4	$215,343	35.8%
5	$65,519	17.7%
4	3,286,717	15.4%
5	10.93	15.4%
2	455.47	63.7%
6	2.08	7.6%
5	3.92	-0.7%
3	0.08	-35.0%
2	0.06	-16.5%
15	25.4	
RANK	**2017**	**2016–17 %**
4	502	-6.2%
4	3,771	5.5%
2	37,750	44.5%
12	85	-87.5%
3	97,601	-35.9%
3	30.0	-4.4%

Gas Consumption: California Energy Commission; Clean Vehicle Rebates: Center for Sustainable Energy, California Air Resources Board Clean Vehicle Rebates Project; Public Transit Ridership: National Transit Database, Department of Transportation. 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

SAN FRANCISCO–OAKLAND–HAYWARD			
METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	2	$470,529	37.3%
GDP PER CAPITA	2	$101,167	22.6%
POPULATION	2	4,651,011	11.9%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	1	14.75	24.9%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	9	236.46	35.8%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	4	2.00	-3.1%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	15	4.86	-1.3%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	26	0.14	-20.6%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	21	0.29	-3.3%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	24	30.4	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	1	1,258	-3.5%
MOST CLEAN VEHICLE REBATES	2	8,186	-3.3%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	7	20,723	42.9%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	2	2,721	383.7%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	4	63,859	-12.6%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	1	98.0	-3.3%

SANTA MARIA–SANTA BARBARA			
METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	12	$24,941	34.1%
GDP PER CAPITA	7	$55,760	20.4%
POPULATION	14	447,295	11.4%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	10	8.70	28.3%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	12	202.80	43.4%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	2	1.79	-2.6%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	12	4.62	-7.5%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	20	0.12	-30.0%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	15	0.16	-0.8%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	1	18.3	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	9	53	-10.2%
MOST CLEAN VEHICLE REBATES	12	356	17.1%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	16	3,877	658.9%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	17	10	-98.7%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	21	4,307	-31.5%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	7	15.7	-4.7%

NEXT 10 CALIFORNIA GREEN INNOVATION INDEX. Most Recent Year is 2016 for all metrics EXCEPT for Green Technology Patents and Clean Vehicle Rebates, where Most Recent Year is 2017. Real GDP: Inflation adjusted GDP where base year is 2016. Solar Capacity Installed: Unit based on alternate current in megawatts. Data Sources: Solar, California Solar Statistics; Vehicle Rebates: California Clean Vehicle Rebate Project; Patents: IPCheckups, CleanTech Patent Edge;

SAN JOSE–SUNNYVALE–SANTA CLARA

RANK	2016	2001–16 %
3	$252,487	7.1%
1	$127,568	-5.6%
6	1,979,240	13.5%
2	14.72	-2.0%
1	581.25	25.7%
3	1.99	-7.3%
21	6.68	-2.6%
18	0.11	-23.4%
10	0.11	-26.5%
20	27.7	
RANK	**2017**	**2016–17 %**
2	892	-11.0%
3	5,791	-14.0%
13	7,486	17.3%
10	203	-63.8%
8	29,929	-23.4%
5	19.1	-8.7%

SAN LUIS OBISPO–PASO ROBLES–ARROYO GRANDE

RANK	2016	2001–16 %
17	$14,272	44.6%
11	$51,250	29.7%
17	278,480	11.5%
11	8.21	23.5%
15	177.70	57.5%
9	2.29	-8.7%
6	3.95	15.0%
23	0.13	-27.4%
17	0.16	-8.2%
9	22.9	
RANK	**2017**	**2016–17 %**
13	17	13.3%
15	225	45.2%
17	3,809	319.0%
14	61	46.8%
17	7,006	-29.3%
12	7.8	-4.6%

SANTA CRUZ–WATSONVILLE

RANK	2016	2001–16 %
18	$13,581	38.0%
12	$49,286	28.2%
18	275,557	7.6%
4	11.09	65.5%
6	271.81	45.2%
5	2.02	-5.1%
1	2.42	-32.8%
16	0.11	-17.7%
3	0.07	-0.1%
19	27.1	
RANK	**2017**	**2016–17 %**
7	74	42.3%
11	377	4.1%
22	1,899	119.3%
19	0	N/A
24	3,599	-21.6%
6	18.4	-6.8%

SANTA ROSA–PETALUMA

RANK	2016	2001–16 %
10	$27,311	35.3%
8	$54,339	24.6%
12	502,604	8.6%
7	9.21	20.2%
8	257.72	53.6%
15	2.59	7.4%
2	3.31	0.9%
24	0.13	-17.5%
6	0.08	-21.0%
13	24.6	
RANK	**2017**	**2016–17 %**
10	33	-29.8%
7	1,032	42.5%
15	3,999	38.2%
1	3,744	147.0%
15	7,601	-17.3%
13	6.5	-9.8%

STOCKTON–LODI

RANK	2016	2001–16 %
11	$26,190	39.4%
17	$35,600	9.6%
10	735,677	27.3%
18	4.80	30.3%
19	134.34	53.5%
11	2.39	-2.0%
17	5.03	-21.3%
12	0.11	-29.5%
16	0.16	-28.0%
25	31.0	
RANK	**2017**	**2016–17 %**
15	15	87.5%
10	424	20.8%
11	8,764	-19.1%
11	191	-84.4%
9	24,248	-12.0%
15	6.5	-8.6%

VALLEJO–FAIRFIELD

RANK	2016	2001–16 %
14	$20,295	50.2%
13	$47,091	39.2%
16	430,972	7.9%
13	6.33	30.5%
23	79.99	18.5%
10	2.37	7.8%
19	5.07	6.2%
21	0.12	-16.1%
25	0.46	31.5%
23	30.1	
RANK	**2017**	**2016–17 %**
16	12	-29.4%
14	285	39.0%
18	3,097	372.5%
16	21	N/A
11	12,980	-8.1%
20	5.5	-6.2%

Gas Consumption: California Energy Commission; Clean Vehicle Rebates: Center for Sustainable Energy, California Air Resources Board Clean Vehicle Rebates Project; Public Transit Ridership: National Transit Database, Department of Transportation. 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

VISALIA–PORTERVILLE

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	16	$15,656	31.4%
GDP PER CAPITA	22	$33,556	4.7%
POPULATION	13	466,563	25.6%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	22	3.54	-2.0%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	21	103.41	35.6%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	17	2.70	8.5%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	22	6.78	6.2%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	8	0.10	-37.0%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	19	0.22	-14.2%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	5	20.8	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	20	4	0.0%
MOST CLEAN VEHICLE REBATES	16	214	214.7%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	1	44,077	96.4%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	4	2,228	-54.6%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	10	13,875	-17.7%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	24	3.8	-5.5%

YUBA CITY

METRIC	RANK	2016	2001–16 %
GDP (Real, in millions)	23	$5,738	42.4%
GDP PER CAPITA	21	$33,567	17.1%
POPULATION	23	170,942	21.6%
HIGHEST ELECTRICITY PRODUCTIVITY (GDP/kWh Consumed)	16	5.15	30.0%
HIGHEST NATURAL GAS PRODUCTIVITY (GDP/BTU Consumed)	11	207.05	64.4%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	21	2.86	9.9%
LOWEST ELECTRICITY CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	4	3.66	-21.1%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: RESIDENTIAL (kWh/1,000 Person)	11	0.11	-25.8%
LOWEST NATURAL GAS CONSUMPTION PER CAPITA: NON-RESIDENTIAL (kWh/1,000 Person)	1	0.06	-33.6%
SHORTEST COMMUTE TIME BY DRIVING (Minutes per day)	21	28.0	
METRIC	RANK	2017	2016–17 %
MOST GREEN TECHNOLOGY PATENTS	25	0	0.0%
MOST CLEAN VEHICLE REBATES	25	26	62.5%
HIGHEST SOLAR CAPACITY INSTALLED: COMMERCIAL (AC, KW)	19	2,875	-51.2%
HIGHEST SOLAR CAPACITY INSTALLED: INDUSTRIAL (AC, KW)	15	37	-96.7%
HIGHEST SOLAR CAPACITY INSTALLED: RESIDENTIAL (AC, KW)	14	8,592	-14.0%
HIGHEST PUBLIC TRANSPORTATION RIDERSHIP (Unlinked passenger trips per capita)	16	6.0	-10.3%

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ENDNOTES

[1] "The California Air Resources Green House Gas Inventory provides estimates of the amount of GHGs emitted to the atmosphere by human activities within California. This project utilizes the 2018 edition of the inventory. The inventory includes estimates for carbon dioxide (CO2), methane (CH4, nitrous oxide (N2O), sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs), which are often referred to as the "six Kyoto gases,"nitrogen trifluoride (NF3), hexafluoroethane (C2F6), octafluoropropane (C3F8), 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 2018 inventory may report a different emission level for an earlier year than previous inventory versions. Energy Information Administration. 'Tables 12.1 - 12.6 Carbon Dioxide Emissions from Energy Consumption: Electric Power Sector.' Monthly Energy Review. Retrieved from: https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf"

[2] By the end of fiscal year 2018-19, California will have matched the longest recovery (120 months) in modern history. http://www.ebudget.ca.gov/2018-19/pdf/Revised/BudgetSummary/Introduction.pdf

[3] "California now world's fifth-largest economy, bigger than Britain." Sacramento Bee. May 4, 2018. Retrieved from: https://www.sacbee.com/news/business/article210466514.html

[4] Last employment peaks before the 2008 Recession are state-dependent. Before the Recession, California's nonfarm employment record occurred in July 2007, whereas Texas' occurred in August 2008.

[5] Martin, P. and D. Costa (2017). Farmworker wages in California: Large gap between full-time equivalent and actual earnings. Economic Policy Institute. March 21, 2017. Accessed July 30, 2018. Retrieved from: https://www.epi.org/blog/farmworker-wages-in-california-large-gap-between-full-time-equivalent-and-actual-earnings/

[6] "China Electric Vehicle Sales on Pace to Hit This Milestone." Investor's Business Daily. Retrieved from: https://www.investors.com/news/china-electric-vehicle-sales-seen-hitting-1-million-milestone-2018/

[7] International Energy Statistics, U.S. Energy Information Administration. Retrieved from: https://www.eia.gov/beta/international/data/browser/

[8] The Climate Group's Global States and Regions Annual Disclosure can be found at: https://www.theclimategroup.org/sites/default/files/disclosure_update_2017_digital.pdf

[9] The ZEV Challenge can be found at: https://www.theclimategroup.org/news/climate-change-challenge

[10] "Portugal Joins the Under2 Coaltion" can be found at: https://www.theclimategroup.org/news/portugal-joins-under2-coalition

[11] "Three Years of the Under2 Coaltion" can be found at: https://www.theclimategroup.org/news/three-years-under2-coalition

[12] "Global Coaltion of States and Regions Surpasses Landmark 200 Jurisdictions" can be found at: https://www.theclimategroup.org/news/global-coalition-states-and-regions-surpasses-landmark-200-jurisdictions

[13] This is included emissions. 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. Excluded from the inventory are emissions from wildfires, which have had an increasingly devastating effect in California as well as the United States. Although emissions from wildfires are not included in the inventory, California recognizes the consequences of failure to address the environmental and economic impacts posed by wildfires. As such, the state has significantly increased the funding for wildfire programs appropriated from its Greenhouse Gas Reduction Fund in Fiscal Year 2017–2018.

[14] See Tables 12.1–12.6 of the current Monthly Energy Review from the Energy Information Administration. Retrieved from: https://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf

[15] California is 5th if including Washington, D.C., which ranked first.

[16] Inflation adjusted in 2016 dollars.

[17] $1,000 of economic activity is inflation-adjusted in 2015 dollars.

[18] State Carbon Dioxide Emissions by Fuel. Data for: 2015. October 2017. Energy Information Administration.

[19] California Air Resource Board revised 2014's GHG emissions slightly upward from 441.54 MMTCO2e to 441.85 $MMTCO_2e$.

[20] Facilities larger than 30 megawatt of generation capacity are considered to be large hydro and are not part of the Renewables Portfolio Standard. Those smaller than 30 MW of generation capacity are small hydro and are part of the State's RPS.

[21] Data from California Energy Commission indicates that in-state electricity generation from hydroelectric increased by approximately 50 percent in 2017 compared to 2016. See: http://www.energy.ca.gov/almanac/electricity_data/electric_generation_capacity.html

[22] Enteric fermentation, manure management, and the livestock portion of agriculture energy use.

[23] Emissions of ozone depleting substances (ODS) substitutes are expected to continue to grow as they replace ODSs banned under the Montreal Protocol. On the other hand, emissions from ODS, which are not included in the GHG inventory, have decreased significantly over time. Thus, the total emissions from ODS and ODS substitutes have still been decreasing. Information about the Montreal Protocol can be retrieved here: https://www.epa.gov/ozone-layer-protection/recent-international-developments-under-montreal-protocol

[24] Fugitive emissions are emissions of gases or vapors from pressurized equipment due to leaks and other unintended or irregular releases of gases (emissions stemming from evaporative losses).

[25] The Community Air Protection Program was established as a result of the passage of Assembly Bill 617 (Garcia, Chapter 136, Statutes of 2017) with an aim to reduce exposure in communities most impacted by air pollution.

[26] Light-duty trucks & SUVs, motorcycles, and passenger cars.

[27] California Air Resources Board (2018). Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds. March 2018. Accessed July 15, 2018. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2018_cci_annual_report.pdf

[28] Office of Environmental Health Hazard Assessment. 2017, February. Tracking and Evaluation of Benefits and Impacts of Greenhouse Gas Limits in Disadvantaged Communities: Initial Report. California Environmental Protection Agency. Retrieved from: https://oehha.ca.gov/media/downloads/environmental-justice/report/oehhaab32report020217.pdf

[29] Cushing, L. J. et al. 2016. A Preliminary Environmental Equity Assessment of California's Cap-And-Trade Program. Program for Environmental and Regional Equity, University of California. Retrieved on: http://dornsife.usc.edu/PERE/enviro-equity-CA-cap-trade

[30] Brown, R. (January 4, 2018). State Assembly Hearing. January 4, 2018. Accessed July 17, 2018. Retrieved from: http://calchannel.granicus.com/MediaPlayer.php?view_id=7&clip_id=5086

[31] The Fire Hazard Severity Zones Maps can be viewed at: http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_zones

[32] California Air Resources Board (2018). Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds. March 2018. Accessed July 15, 2018. Retrieved from: https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2018_cci_annual_report.pdf

[33] Weekly Retail Gasoline and Diesel Prices. U.S. Energy Information Administration, U.S. Department of Energy. Accessed May 30, 2018. Retrieved at: https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_a.htm

[34] This is discussed further in the Transportation and the Regional Scorecard sections.

[35] Specifically, electricity usage by the agriculture sector increased by 2,465 gigawatt-hours from 2015 to 2016, of which, usage by the DWR increased by 3,279 gigawatt-hours.

[36] California is a large state with a diverse climate. The variation in climate and typography provide state policymakers an opportunity to design smart EE policies to offer relief to those communities in hotter climates who experience a higher energy burden.

[37] The seventh fastest per capita consumption decrease year-over-year after Maine (-3.9%), Missouri (-3.8%), South Carolina (-3.5%), Washington (-3.1%), Delaware (-3.0%), and Massachusetts (-2.5%).

[38] "Nonrenewable Energy Explained." U.S. Energy Information Administration, U.S. Department of Energy. February 9, 2017. Accessed May 31, 2018. https://www.eia.gov/energyexplained/?page=nonrenewable_home

[39] Source: Electric Power Monthly, Energy Information Administration.

[40] Dlouhy, J. A. (2018). Trump Orders Action to Stem Coal, Nuclear Plant Shutdowns. Bloomberg LP. June 1, 2018. Accessed June 5, 2018. Retrieved at: https://www.bloomberg.com/news/articles/2018-06-01/trump-orders-perry-to-stem-coal-nuclear-power-plant-closures-jhw8smiv

[41] California Public Utilities Commission. "California Renewables Portfolio Standard (RPS): Current Procurement Status." Retrieved from: http://www.cpuc.ca.gov/RPS_Homepage/

[42] Data reported here are through 2016 as that is the latest year for which both in-state generation as well as import/export electricity data are available. To the extent that 2017 data are included here, the data reflect only in-state generation by fuel type for 2017.

[43] California Energy Commission (2017). "Tracking Progress – Renewable Energy Overview" December 2017. Accessed on June 5, 2018. Retrieved at: http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf

[44] While several mid-Western states such as Iowa and South Dakota have higher percentages of electricity generation from renewable source(s), 100 percent comes from wind.

[45] California Energy Commission (2017). California Energy Commission – Tracking Progress. CEC. Last updated November 2017. Available at http://www.energy.ca.gov/renewables/tracking_progress/documents/energy_storage.pdf

[46] Note that the IOUs – PG&E, SCE, and SDG&E – are required to not sign new ReMAT contracts nor accept any ReMAT applications effective December 15, 2017. More details can be viewed at the program page at: http://www.cpuc.ca.gov/feedintariff/

[47] Gerstle, B., Singh, A., Cox, C., Lee, C., and Ikle, J. (2018). Costs and Cost Savings for the RPS Program (Public Utilities Code 913.3). 2018 Padilla Report. California Public Utilities Commission. Published May 1, 2018. Accessed June 18, 2018. Available at: http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/About_Us/Organization/Divisions/Office_of_Governmental_Affairs/Legislation/2018/MASTER%202018%20PADILLA%20REPORT_FINAL.pdf

[48] Interconnected solar PV net energy metering applications in PG&E, SCE, and SDG&E. Capacity installed is measure in alternate current.

[49] Eckhouse, B. (2018). Tesla Loses Top Spot in Residential Solar to Sunrun. Bloomberg. Published March 6, 2018. Accessed June 30, 2018. Retrieved from: https://www.bloomberg.com/news/articles/2018-03-06/tesla-losing-top-spot-in-solar-to-sunrun-as-musk-shifts-gears

[50] A copy of the Rooftop Solar PV System Report detailing the Measure can be found at the California Energy Commission's website: https://efiling.energy.ca.gov/getdocument.aspx?tn=221366

[51] Next 10 and Beacon Economics (2018). Current State of the California Housing Market. Published May 2018. Available at http://next10.org/housing

[52] The Solar Foundation, Generation 180, and the Solar Energy Industries Association (2018). Brighter Future: A Study on Solar in U.S. Schools, 2nd Edition. Published November 2017. Accessed June 18, 2018. Available at: https://www.thesolarfoundation.org/solar-schools/

[53] Details on Prop 39 can be found at the California Energy Commission's website: http://www.energy.ca.gov/efficiency/proposition39/

[54] American Wind Energy Association (2018). AWEA Fourth Quarter 2017 Market Report. Accessed June 20, 2018. Available at: http://www.awea.org/4q2017

[55] Wind speed has a significant factor in determining the capacity factor for wind. California typically has one of the lowest wind speed and hence lower capacity factor than the U.S.

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[93] Unlinked passenger trips are defined as trips on one transit vehicle, not including connections (i.e., a trip with one connection would represent two unlinked passenger trips).

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.

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 2014 dollars, expressed per U.S. dollar, from the World Bank's World Development Indicators.

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.

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" (June 2017). The 1990–1999 emissions include "gross emissions" and the 2000–2015 emissions are "included emissions" only. Calculations used GDP and Population data where applicable, as described above.

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 8.1 of 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" 2002–2015, 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 on April 11, 2017. 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 operational, online, in progress, and on schedule. Years are based on the online date/contracted delivery date, though those with a status of in progress, delayed, or on schedule (i.e. not classified as online) with pre-2016 dates were labeled as 2016.

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, 2007–2016. 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, 2006–2016.

TRANSPORTATION

Emissions, Surface Transportation, VMT

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 2008–2015 are from the California Department of Transportation's Highway Performance Monitoring System's "California Public Road Data." Calculations use Population data sources where applicable.

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.

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 2016. 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.

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California Public Utilities Commission
California Solar Statistics
Center for Sustainable Energy
Cleantech Group
Database of State Incentives for Renewable Energy
Eurostat
Federal Reserve Bank of St. Louis
IHS Markit
International Council on Clean Transportation
IP Checkups
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