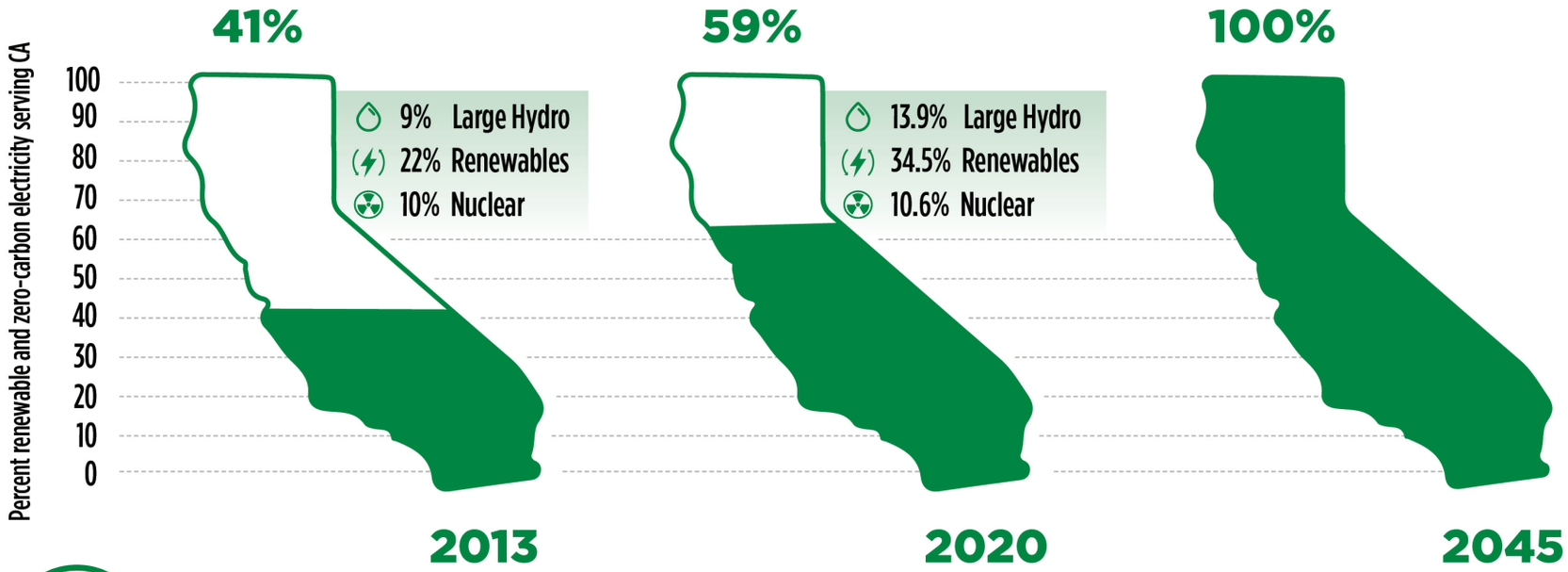
2021 CALIFORNIA CLEAN ENERGY ALMANAC

Road to 100 Percent Clean Energy for All

Progress to 100% Clean Electricity



California's Energy Governing Institutions

California Energy Commission

The California Energy Commission (CEC) is leading the state to a 100 percent clean energy future for all. It has seven core responsibilities: developing renewable energy, transforming transportation, increasing energy efficiency, investing in energy innovation, advancing state energy policy, certifying thermal power plants, and preparing for energy emergencies.

California Public Utilities Commission

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

California Independent System Operator

The California Independent System Operator (ISO) is responsible for managing the flow of electricity that serves 80 percent of California and a small portion of Nevada. The ISO also runs a real-time energy market for utilities in eight western states and conducts reliability coordinator services to most balancing authorities in the West.

California Air Resources Board

The California Air Resources Board (CARB) is the lead agency for climate change programs and oversees all air pollution control efforts in California to attain and maintain health-based air quality standards.

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CHAIR | CALIFORNIA ENERGY COMMISSION

David Hochschild

Data and analysis are the foundation of the California Energy Commission, helping inform the state's transition to carbon neutrality and a 100 percent clean energy future for all as California's energy policy and planning agency.

On behalf of the Commission's 700 scientists, engineers, lawyers and policy experts, I am proud to present the second annual California Clean Energy Almanac, a collection of key statistics and stories tracking our progress as well as the challenges on the road ahead.

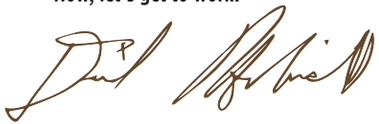
The past three years as Chair has been the most rewarding and challenging experience of my career as the world navigated a global pandemic while we continue to confront the threat posed by climate change and work to build a more sustainable, equitable future. Commission staff hasn't missed a beat, successfully transitioning to a remote-first environment while remaining more productive than ever.

Key 2021 accomplishments include:

- Adopting a $1.4 billion plan for zero-emission transportation infrastructure and manufacturing.
- Approving the 2022 Building Energy Efficiency Standards, the strongest building decarbonization policy in the United States.
- Publishing the first-ever SB 100 report and charting the state's path to 100 percent clean electricity.
- Launching the Lithium Valley Commission to advance opportunities and benefits associated with lithium recovery in the state.
- Supporting Governor Newsom's agreement with the Biden administration opening the coast to offshore wind and bringing a new industry to California.
- Investing $130 million in clean energy research and development to advance breakthrough technology solutions.
- Honoring 6 leaders making exceptional contributions in local communities through the Clean Energy Hall of Fame Awards.

We have seen how California's leadership influences world markets, helping other governments address the global crisis of climate change with exportable solutions informed by data and science. Each of these accomplishments and the information contained in the 2021 Almanac represents hope for a future-proofed California—one that is resilient, affordable and booming with the clean energy jobs of tomorrow.

Now, let's get to work.



01

ENERGY RELIABILITY

California is taking steps to safeguard the state's power grid.

Energy Reliability

Climate crisis wake-up call

The year 2020 put California's power grid to the test, as the impacts of climate change arrived with catastrophic wildfires threatening electricity infrastructure and extreme heat events combined with record demand leading to several hours of rotating outages. These severe climate impacts underscored the urgent need for sufficient green and reliable power to protect the health and safety of all Californians.

Charged by Governor Gavin Newsom, the CEC, ISO, and CPUC took action to improve reliability. But two early, extreme heat events across the West in June 2021 and increasingly severe drought conditions made it clear more needed to be done to grapple with how to cover the gap that occurs at the end of the day when renewable generation such as solar drops and demand for power rises, known as peak demand.

In 2021, extreme environmental factors challenged the grid's reliability more than ever before:

- A projected 3,500-megawatt (MW) power shortfall during extreme heat events
- A 1,000 MW drop in hydro power generation due to drought
- Transmission lines and energy imports threatened by wind and two billion acres of wildfires
- Increased energy demand during the hottest summer on record

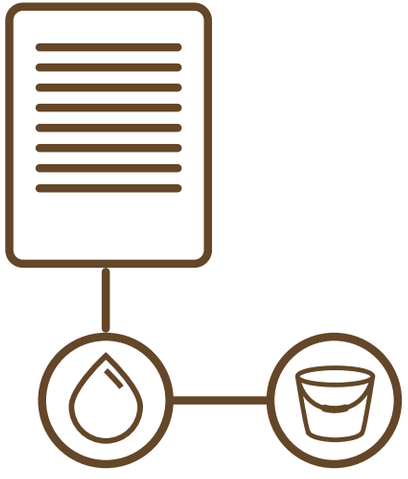
> “While we build toward a safe, affordable and reliable energy future that benefits all our communities, we’re also taking action to meet the challenges caused by climate change that are already at our doorstep.”
>
> *- Governor Newsom*

A New Plan of Action

Meeting generation and supply challenges with cooperative planning, innovation and equity

Climate change is accelerating, and California needs to speed up its pace toward 100 percent clean energy. To ensure a strong grid while this transformation takes place, California increased coordination among its energy agencies, closely monitored demand and stressors on the grid, and implemented action plans based on updated analysis.

During the summer of 2021, Governor Newsom acted through an emergency proclamation directing the CEC and California Department of Water Resources to expedite energy supply and storage projects to help safeguard the state's grid. The CEC worked with the CPUC and ISO to develop a contingency plan for a worst-case scenario energy shortfall.



Emergency Proclamation Actions

- **Coordination with adjacent balancing authorities.**
- **Expanded demand response measures and financial incentives.**
- **Consumer education campaign through the Flex Alert program.**
- **Streamlined permitting and interconnection for clean energy projects.**
- **Accelerated deployment of new energy resources such as temporary generators, with a plan to track and mitigate any associated emissions.**

By the Numbers

3,850 MW

New energy capacity added from July 2020 – August 2021

4,600 MW

Amount of offshore wind capacity that could be developed because of May 2021 agreement with federal partners, a critical clean energy source at night.

94%

The percent of electricity coming from solar, wind and other clean energy sources on April 24, 2021, a new all-time high.

02

GREENHOUSE GAS EMISSION REDUCTIONS

Electric sector leads the way.

Greenhouse Gas Emission Reductions

Greenhouse gas emissions from generating electricity continue to decline

California met its 2020 goal of reducing greenhouse gas (GHG) emissions economywide to 1990 levels four years ahead of schedule. The electric power sector leads the way. Emissions from power generation have dropped 44 percent since 2000. These gains are largely attributable to three factors:

1. California's energy efficiency standards
2. Increased use of renewable energy, primarily solar
3. Greatly reduced use of coal-fired power plants

Low-Carbon California

Turning the corner on carbon

In 2017, for the first time ever, California had most of its electricity produced from "carbon-free" sources—those that do not emit GHGs.

Next challenge: 'decarbonize' buildings

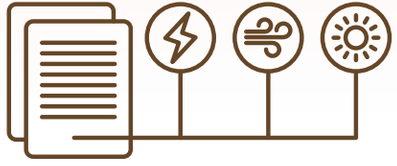
Next to transportation, the second highest source of California's GHG emissions are those linked to everyday use of buildings, mainly natural gas heating and cooking. To meet the state's 2030 and 2050 climate goals, the CEC is identifying ways to decarbonize energy use in new and existing buildings.

The end of coal is near

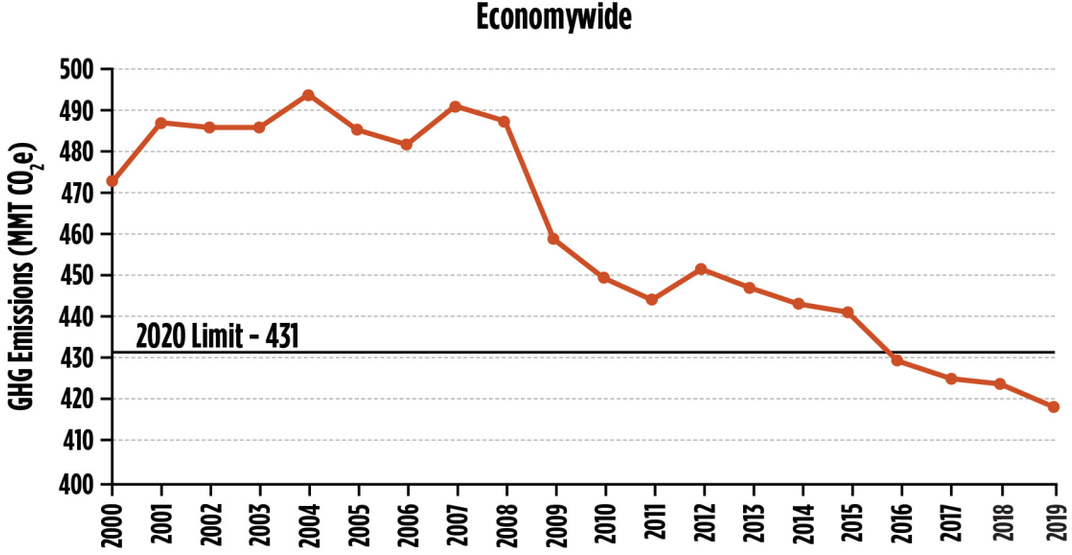
Between 2007 and 2020, coal's share of generation to meet California's electricity demand shrank from 16.6 percent to 3 percent and is expected to drop to almost zero by 2026. The state's multiple emission reduction policies, such as the Cap-and-Trade program, are accelerating the phaseout of coal-fired generation.

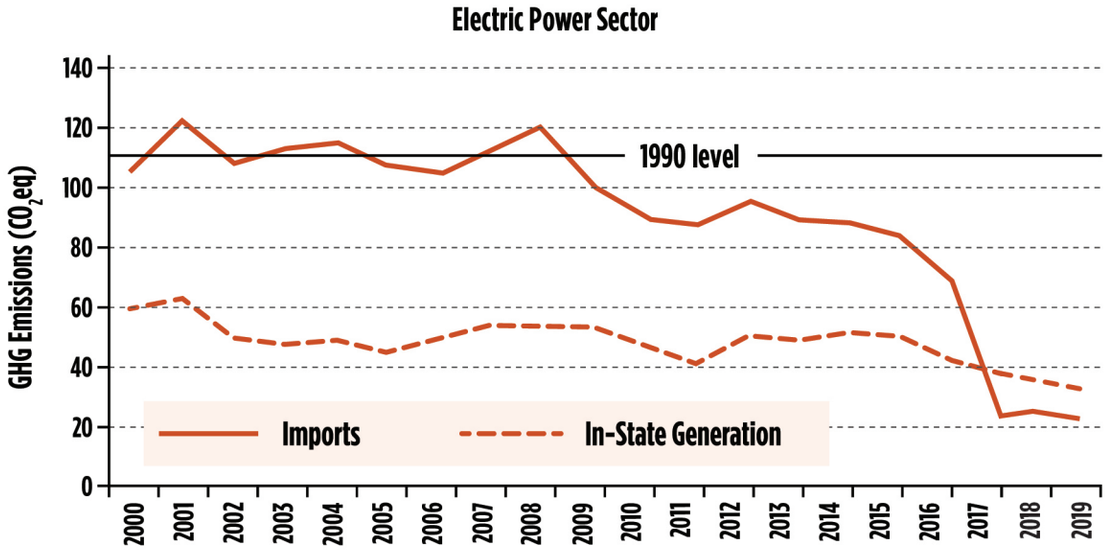
California Law

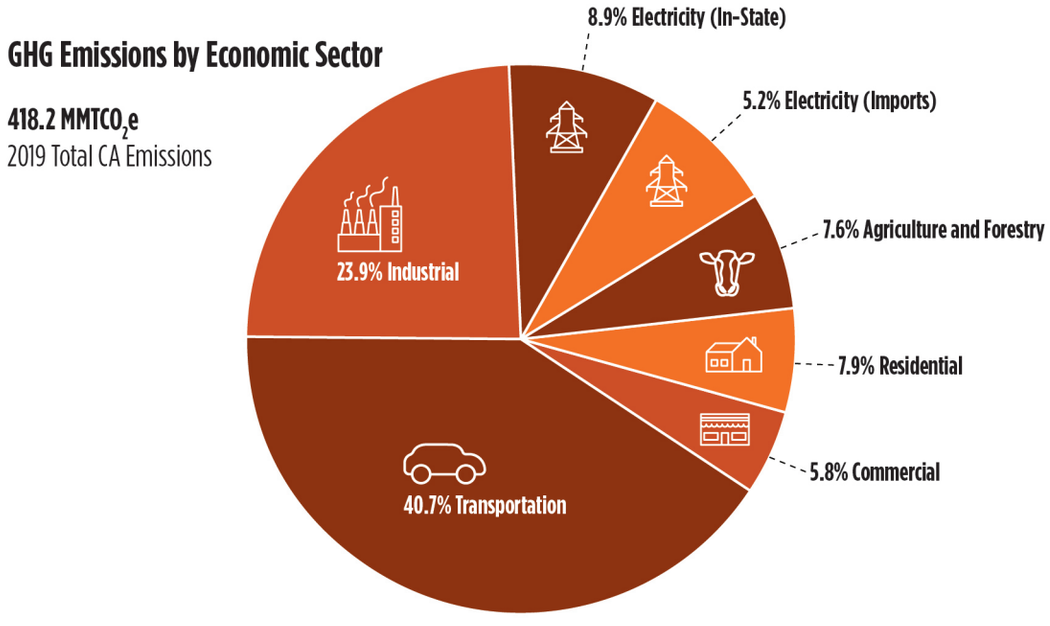
- **Assembly Bill 32 (2006):** Requires state to lower GHG emissions to 1990 levels by 2020.
- **Senate Bill 1383 (2016):** Sets a goal to cut emissions of highly potent GHGs — mainly methane and hydrofluorocarbon refrigerants — to 40 percent below 2013 levels by 2030.
- **Senate Bill 32 (2016):** Updates AB 32, raising GHG emissions reduction target to 40 percent below 1990 levels.
- **Senate Bill 100 (2018):** Increases the 2030 renewables goal from 50 percent to 60 percent and requires all retail electricity to be carbon-free by 2045.
- **Assembly Bill 3232 (2018):** Directed the CEC to develop a plan by 2021 to cut GHG emissions from buildings 40 percent below 1990 levels by 2030.
- **Senate Bill 1477 (2018):** Requires the CPUC to create a $50 million annual incentive program to decarbonize energy uses in buildings, with the CEC offering the incentives to builders of low-income homes.
- **Assembly Bill AB 525 (2021):** Requires the CEC to develop a strategic plan and set a statewide goal for offshore wind production off the California coast.



By the Numbers







Source: California Air Resources Board

03

CLEAN TRANSPORTATION

Steady investment in ever-cleaner vehicles and fuels promotes Californians' health and prosperity.

Clean Transportation

The CEC is investing $1.4 billion over the next three years to speed up the state's zero-emission vehicle (ZEV) infrastructure build-out in support of Governor Newsom's executive order phasing out the sale of new gasoline-powered passenger vehicles by 2035. The funding is focused on:

1. Infrastructure

Building a statewide network of charging outlets and hydrogen fueling stations for the growing numbers of zero-emission cars, trucks and buses.

2. Manufacturing

Supporting ZEV job creators and innovators through grants to increase in-state manufacturing of vehicles, components, charging or refueling equipment.

3. Workforce

Training and development in low-income communities, prioritizing underrepresented populations and economically disadvantaged high schools to ensure equitable participation in the clean transportation economy.

Zero-Emission Vehicles

Fast chargers

California is two-thirds of the way toward meeting its 2025 goal of having 10,000 publicly available direct current (DC) "fast" chargers that can repower an electric vehicle in about 30 minutes.

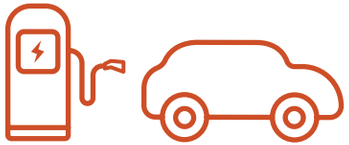
Cleaner school buses

The CEC completed its funding of $75 million to replace old school buses with all-electric ones, which will reduce students' exposure to harmful diesel exhaust. Nearly all 236 of the new buses will be going to school districts in low-income communities.

Fortifying the grid

Funding the development of technologies that allow power to flow from zero-emission vehicle batteries back to the state's power grid to help balance demand and supply.

By the Numbers

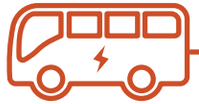


76,172

Electric vehicle charging ports in California. The state aims to reach 250,000 by 2025.

1.2 Million

The number of public or shared charging ports needed by 2030.



1 Million Sold

California surpassed 1 million zero-emission vehicles sales in Fall 2021.

04

ENERGY EQUITY

The CEC is committed to ensuring the benefits of cleaner, more efficient energy are enjoyed by all Californians, especially those in low-income and disadvantaged communities, and tribes.

Clean Energy Equity

Helping communities overcome barriers

The CEC identifies barriers to clean energy and develops strategies to overcome them with the following objectives in mind:

1. Access

Advance access to clean energy, including high-quality jobs, non-debt financial offerings and contracting opportunities to small businesses and diverse-owned businesses.

2. Investment

Increase clean energy investment, including funding of job training, technology development and demonstration projects.

3. Resilience

Strengthen communities' ability to function during power outages and enjoy reliable and affordable energy in a changing climate.

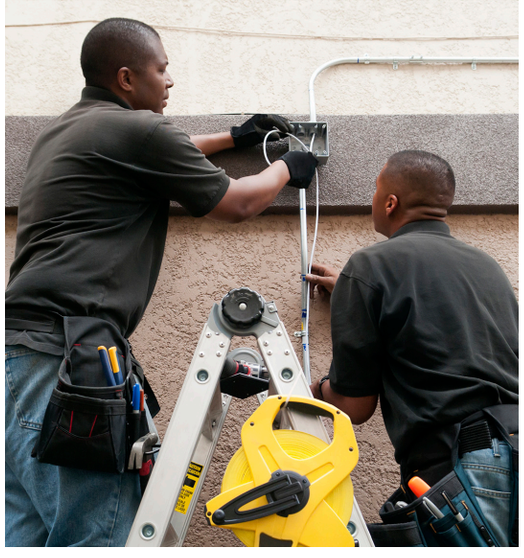
4. Engagement

Increase outreach to tribes and stakeholders to expand awareness of opportunities to participate and improve ways to benefit communities throughout California.

Diversity, Inclusion and Access

Disadvantaged Communities Advisory Group (DACAG)

Now in its fifth year, the DACAG meets to review CEC and CPUC clean energy programs and policies to ensure that disadvantaged communities, including tribal and rural communities, benefit from proposed clean energy and pollution reduction programs. Group members are either from or represent disadvantaged communities.



The CEC identified nine indicators to assess energy equity:

- Energy efficiency
- High energy bills
- Rooftop solar systems
- Zero-emission vehicles
- Abatement of health and safety issues
- Energy resilience
- Clean energy jobs
- Small business contracts
- Amount invested in innovation

By the Numbers

68%

Of CEC technology demonstration and deployment funds are invested in under-resourced communities.

51%

Of the CEC's investment in low-carbon fuels and clean vehicle technologies have gone to projects in low-income or disadvantaged communities.

By the Numbers

$23 Million

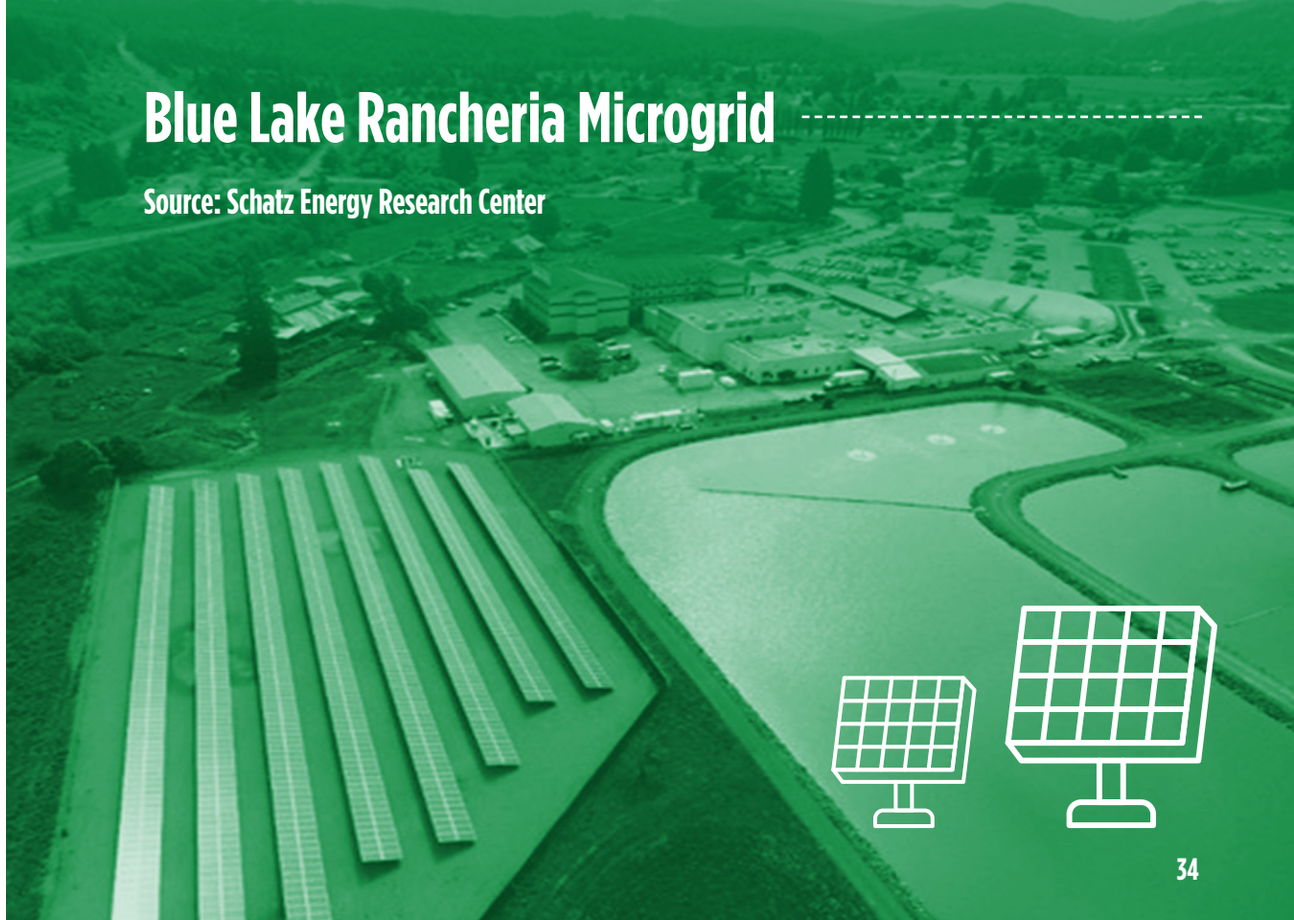
Investment the CEC has supported for tribal projects through December 31, 2020.

$996 Million

Investment in projects benefiting disadvantaged communities through December 31, 2020.

Blue Lake Rancheria Microgrid

Source: Schatz Energy Research Center



05

INVESTMENT IN CLEAN ENERGY

Continuous public investment overcomes the technical and financial hurdles of advancing clean energy.

Investment in Clean Energy

Portfolio spans all economic sectors

The CEC has put billions of dollars to work reducing GHG emissions, strengthening the economy and improving public health and the environment, particularly in disadvantaged communities. Here are three major investment programs:

1. Clean Transportation Program

A 2007 law (Assembly Bill 118, Núñez) authorized the CEC to fund projects that will "transform California's fuel and vehicle types to help attain the state's climate change policies." The funds come from motor vehicle and vessel fees.

2. Electric Program Investment Charge (EPIC)

Since 2011, EPIC has benefited Californians by funding research and development of clean technologies that make energy more affordable, reliable and environmentally sustainable. EPIC has been renewed to serve California through 2030.

3. Food Processing Plants

Established in 2018, the Food Production Investment Program helps replace high-energy-consuming equipment with very efficient market-ready technologies, accelerating adoption of state-of-the-art technologies that can substantially reduce energy costs and associated GHG emissions.

Clean Energy

Electric vehicle readiness

California has the nation's largest network of publicly accessible electric vehicle chargers, partly because of the CEC's $192.6 million investment in these installations.

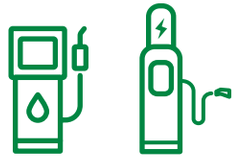
Return on investment

California's decades-long investment in energy research and technology has enabled the state to attract half the country's clean energy venture funding and create more than 530,000 clean energy jobs.

Clean Transportation Program projects since 2008 include:

- 15,153 electric vehicle chargers installed or planned
- 90 new or upgraded hydrogen stations for fuel-cell vehicles
- 54 clean medium- and heavy-duty vehicle technology demonstration projects
- 27 new or expanded manufacturing facilities

By the Numbers



$1.8 Billion

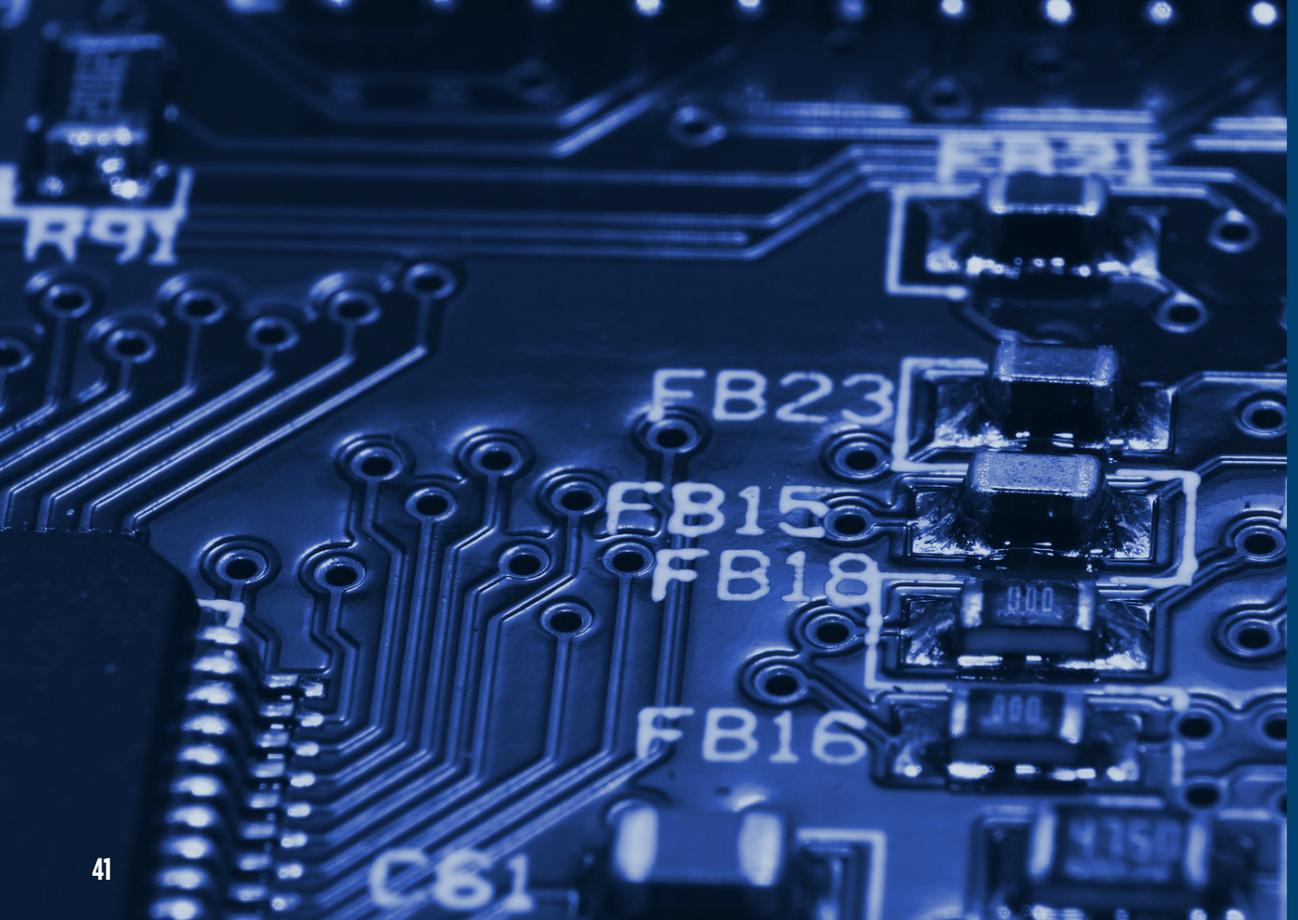
Investment in alternative vehicle fuels and technologies since 2008. More than $1 billion came from Clean Transportation Program funds, which the CEC used to leverage an additional $734 million from industry and other public agencies.

$1.3 Billion

Investment in more than 630 clean energy research and development projects.

$113 Million

Investment in clean, energy-saving technologies for the state's food processing plants. Since 2018, these funds have improved energy performance at 47 facilities by implementing 112 energy-efficient and renewable technologies across the state, reducing GHG emissions equivalent to removing 34,500 cars from the road.



06

INNOVATION

The CEC drives clean energy innovation and entrepreneurship to help meet the state's climate goals.

Innovations

Bridging the gap between laboratory and markets

The CEC's EPIC and Natural Gas Research and Development grant programs help commercialize technologies that will improve California's energy system in these ways:

1. Cleaner

With CEC grants, scientists have recently invented promising technologies to cleanly and efficiently mine an immense Southern California deposit of lithium (a key ingredient of most batteries) – enough to power the state's green economy for decades.

2. Safer

Following the fatal 2010 explosion of a gas pipeline in San Bruno, the CEC funded the creation of a database and search tool for utilities to stay abreast of the latest close-to-market technologies for monitoring the safety and performance of natural gas lines.

3. More Affordable

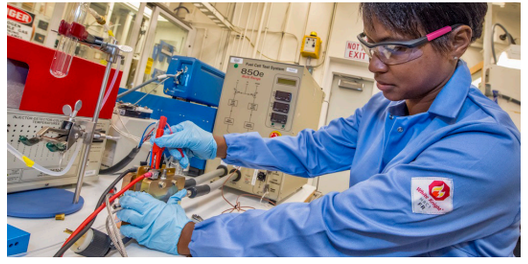
The CEC is funding the development of smart charging technologies that will make it easier for electric vehicle drivers to charge up with enough energy for their trips at the least possible cost.

4. More Resilient

EPIC-funded community "microgrids" have demonstrated the effectiveness of using locally generated renewable energy to keep hospitals, fire stations and other critical facilities operating during power outages.

Microgrids for safer communities

Microgrids act as a small electric grid that can keep essential community services running during outages on the main grid. These systems combine locally generated electricity with energy storage systems such as batteries. The CEC has funded many solar-powered microgrids to test their readiness in a wide variety of venues, from fire stations to hospitals, jails, college campuses, military bases and tribal communities.



Current areas of energy research and development include:

- Improved wildfire behavior modeling
- Mobile solar energy units for emergencies
- Smart chargers for medium- and heavy-duty electric vehicles
- Increasing life of large energy storage systems
- Portable and affordable heat pumps for renters
- Prefabricated, super-efficient building facades

Interactive climate change maps

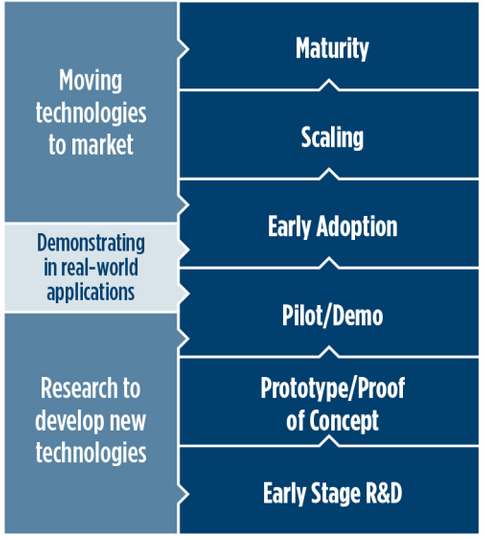
Visitors to the Cal-Adapt website can now view maps showing how global climate change is likely to affect temperatures and precipitation in any region of the state over the next 30 years. The CEC-funded site provides data, visualizations and planning tools to help communities adapt to climate change.

Public investment spurs economic activity

EPIC investment and associated activity is estimated to create 3,500 jobs each year.*

*Projected from 2014 through 2024.

Accelerating Innovation at Every Stage



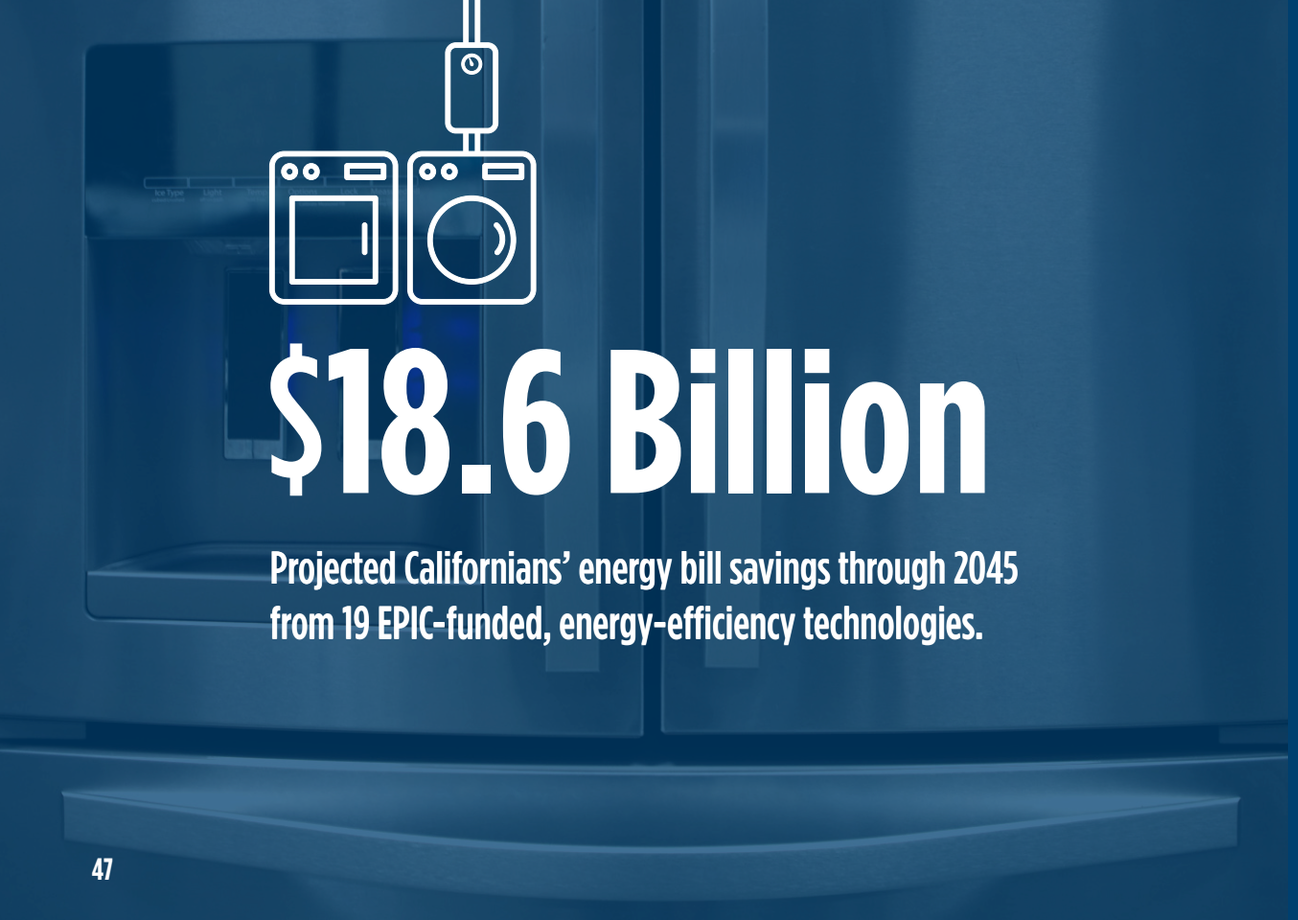
By the Numbers

$3.5 Billion

Private investment raised by businesses following EPIC support.

$160 Million

The CEC's approximate annual investment across two funding programs accelerating research and innovation across California.



$18.6 Billion

Projected Californians' energy bill savings through 2045 from 19 EPIC-funded, energy-efficiency technologies.

07

ENERGY STORAGE

California is vastly expanding energy storage systems, allowing more solar and wind power into the grid.

Energy Storage

Climate-friendly power at any hour

Because wind power is generated only when the wind blows, and solar energy is reduced on cloudy days, technologies that can store and supply extra power are becoming increasingly important. Energy storage benefits Californians in at least three ways:

1. Steady generation of clean power

Unlike solar and wind farms, energy storage systems can feed electricity to the power grid at any time.

2. Lower energy costs

When electricity demand from the grid peaks and prices rise, switching to stored power can save money.

3. Reduced climate-warming emissions

When demand peaks, grid operators can tap the cleaner stored energy instead of natural gas "peaking" plants.

Highlights

- California has the nation's largest energy storage market.
- After a decade of driving, the average electric vehicle battery has 60 percent capacity left and can be repurposed to feed the grid for another 7 to 10 years.
- California's energy agencies are exploring multiple ways residents and businesses can store energy on site for use during costly periods of peak demand on the grid.

Types of energy storage

Batteries: Rising demand for electrical vehicles and consumer electronics is expected to dramatically reduce battery prices.

Flywheels: A motor spins up the wheel with excess electricity from the grid. When power is needed, the process is reversed and the wheel's spinning runs the motor, converting kinetic energy back to electricity.

Compressed air: Pressurized air stored underground is heated and expanded to drive a generator for electricity.

Pumped storage: Electricity generated by moving water between upper and lower reservoirs helps balance swings in power load on the grid.

Thermal energy: For example, some solar farms use molten salt to store heat for generating electricity after sunset.

By the Numbers

500%

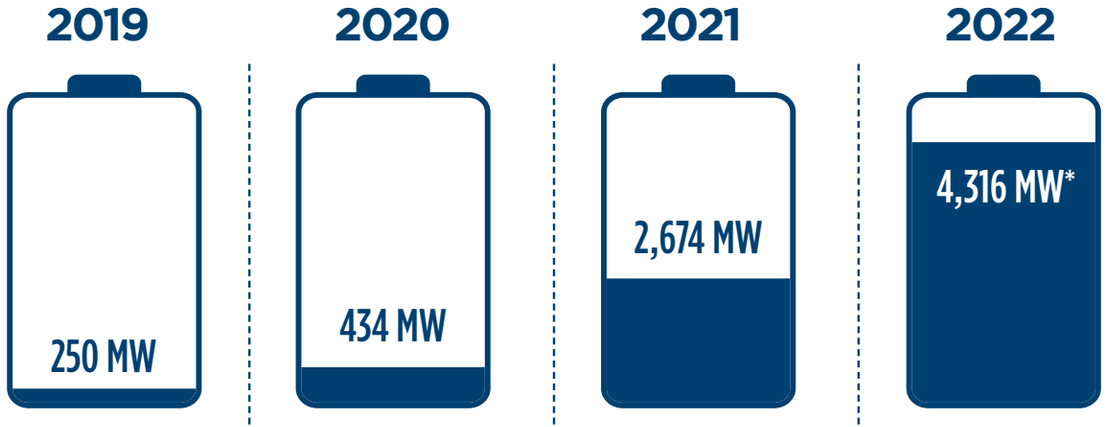
Growth of battery storage in California in 2021.

$55 Million

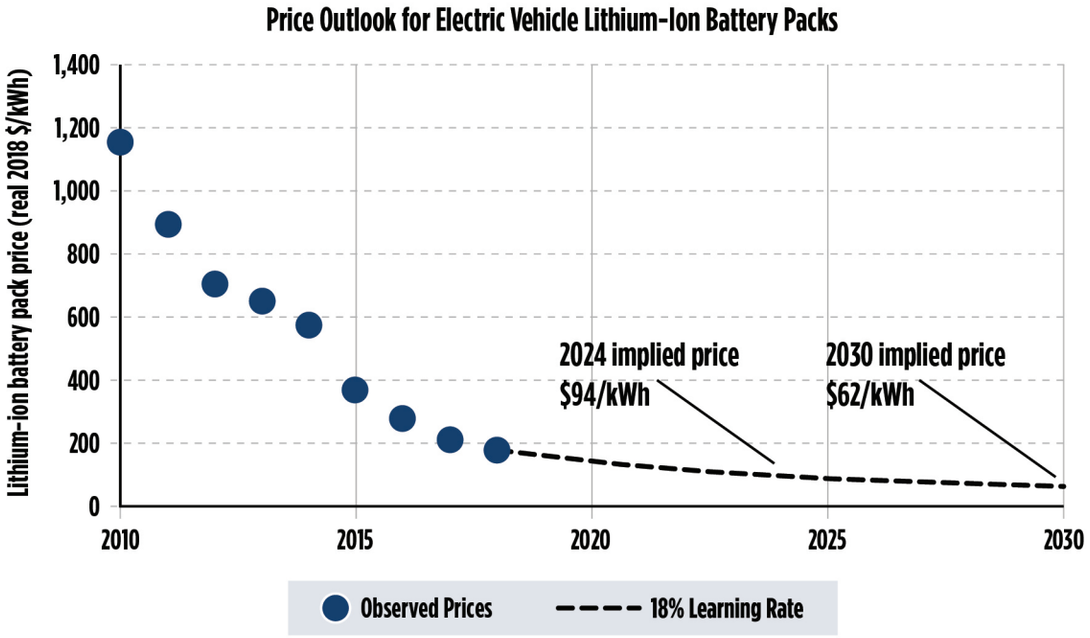
The CEC's planned investment in EPIC 4, supporting a variety of energy storage technologies enabling a more nimble and reliable grid.

Source: EPIC 4 Investment Plan

Growth in California's Battery Storage Resources



*Projected based on ISO interconnection queue


Price Outlook for Electric Vehicle Lithium-Ion Battery Packs
Lithium-ion battery pack price (real 2018 $/kWh)
1,400
1,200
1,000
800
600
400
200
0
2010
2015
2020
2025
2030
2024 implied price
$94/kWh
2030 implied price
$62/kWh
Observed Prices
18% Learning Rate

08

ENERGY EFFICIENCY

California leads the world in appliance and building energy efficiency.

Energy Efficiency

Making California more healthful, resilient and affordable

As the state's clean energy goals get more ambitious, so do the efficiency regulations, policies and programs the CEC oversees. Energy efficiency is an important contributor to the public benefits of resiliency, affordability, equity, building decarbonization, load flexibility and reliability.

Energy efficiency standards set by the CEC for appliances, newly constructed buildings, and alterations and additions to existing buildings deliver multiple benefits to residents and businesses:

1. **Lowering utility bills**
   Upgrading furnaces, air conditioners and water heaters more than 10 years old saves significant money over time.
2. **Cutting air pollution**
   Increasing energy efficiency is the most cost-effective way to reduce generation from fossil fuel-burning power plants that emit harmful smog-forming pollutants and climate-warming gases.
3. **Saving water**
   Saving energy saves water—and vice versa—because of the electricity used to capture, treat, distribute and use water.

The Built Environment

Building Energy Efficiency Standards

In summer 2021, the CEC adopted the 2022 Building Energy Efficiency Standards (Energy Code) for newly constructed buildings, additions and alterations that will produce benefits to support the state's public health, climate and clean energy goals. The CEC adopts standards every three years to cost-effectively increase the energy efficiency and lower the carbon footprint of buildings.

The 2022 update goes into effect January 1, 2023 and focuses on four key areas in newly constructed homes and businesses:

- Encouraging electric heat pump technology and use
- Establishing electric-ready requirements when natural gas is installed
- Expanding solar photovoltaic (PV) system and new battery storage standards for commercial buildings
- Strengthening ventilation standards to improve indoor air quality

Over the next 30 years, the 2022 Energy Code is estimated to provide $1.5 billion in consumer benefits and reduce 10 million metric tons of GHGs, equivalent to taking nearly 2.2 million cars off the road for a year.

Local ordinances

Local jurisdictions can adopt energy standards that are more stringent than the statewide standards. Under the 2019 Energy Code, which became effective January 1, 2020, 50 local energy ordinances have been adopted by 42 jurisdictions, of which 26 require all-electric construction.

By the Numbers

277 Billion

Water savings in gallons per year due to recent appliance standards. Equivalent to conserving the amount of water in the Hetch Hetchy Reservoir, Lake Castaic, Lake Mendocino and Ice House Reservoir.

33%

The number of Californians who live in a community with an energy code exceeding state standards.

09

RENEWABLE ENERGY

An increasing percentage of California's electricity comes from renewable sources.

Renewables

California leads the nation in use and availability of renewable energy

California has a suite of policies and programs to increase the use and availability of energy from sunlight, wind and other natural sources that are continuously replenished. Here are three major drivers:

1. Renewables Portfolio Standard

The 2002 California law and subsequent amendments require the state's electric utilities to make renewables an ever-greater percentage of their power base.

2. California Solar Initiative

Since 2006, thousands of home and business owners have earned cash-back rebates by installing solar energy systems through this suite of incentives, offered by the state energy and public utility commissions and the state's publicly owned utilities.

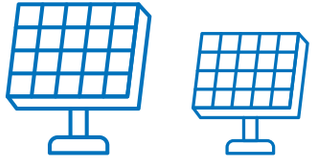
3. Community Choice Aggregators

Growing numbers of California communities have formed these local agencies to buy electricity at lower rates and from greener sources than offered by the default utility. The rise of these agencies is increasing demand for renewable energy.

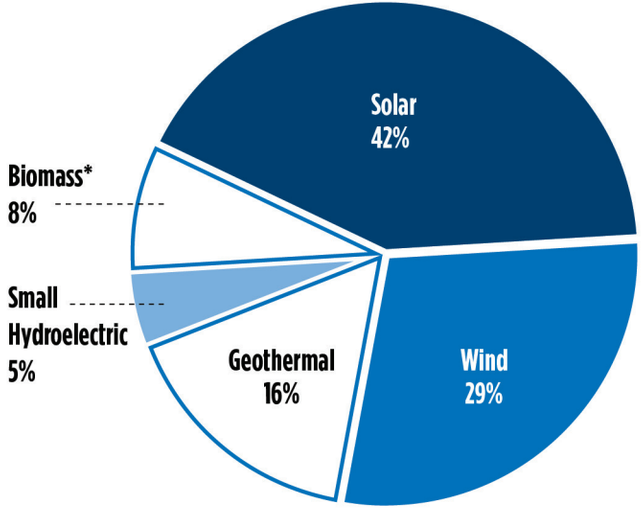
Clean Resources

Trendsetter

The city of Los Angeles approved the LA100 plan which would see the city transition to 100% clean energy by 2035 – 10 years ahead of the city's original goal.



2019 State-designated renewable energy sources include:



*Includes crop residues and landscape trimmings

By the Numbers

42%

Of California's renewable generation comes from solar, the state's No. 1 renewable energy source.

2045

When all of California's retail electricity will come from renewable or carbon-free energy sources, as required by Senate Bill 100.

$3.80 PER WATT

National median price to install a residential rooftop solar energy system in 2020, compared with nearly $12 per watt in 2000.

1.4 Million

The number of solar projects in California.

59%

Of California's electricity came from carbon-free sources in 2020.

References

For more information, visit the CEC's "Data and Reports" web page at
https://www.energy.ca.gov/data-reports

2021

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