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California Energy Commission

COMMISSION REPORT

Draft 2019 Integrated Energy Policy Report

Gavin Newsom, Governor

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PREFACE

Senate Bill 1389 (Bowen, Chapter 568, Statutes of 2002), as amended, requires the California Energy Commission to prepare a biennial integrated energy policy report that assesses major energy trends and issues facing the state's electricity, natural gas, and transportation fuel sectors and provides policy recommendations to conserve resources; protect the environment; ensure reliable, secure, and diverse energy supplies; enhance the state's economy; and protect public health and safety (Public Resources Code § 25301[a]). The Energy Commission prepares updates to these assessments and associated policy recommendations in alternate years (Public Resources Code § 25302[d]). Preparation of the *Integrated Energy Policy Report* involves close collaboration with federal, state, and local agencies and a wide variety of stakeholders in an extensive public process to identify critical energy issues and develop strategies to address those issues.

ABSTRACT

The 2019 Integrated Energy Policy Report provides the results of the California Energy Commission's assessments of a variety of energy issues facing California. Many of these issues will require action if the state is to meet its climate, clean energy, air quality, and other environmental goals while maintaining reliability and controlling costs.

The 2019 Integrated Energy Policy Report covers a broad range of topics, including decarbonizing buildings, integrating renewables, energy efficiency, energy equity, integrating renewable energy, updates on Southern California electricity reliability, climate adaptation activities for the energy sector, natural gas assessment, transportation energy demand forecast, and the California Energy Demand Forecast.

Keywords: California Energy Commission, decarbonizing buildings, energy efficiency, energy equity, electricity demand forecast, natural gas assessment, climate adaptation and resiliency, Southern California reliability, transportation electrification, integrated resource plans, Assembly Bill 1257

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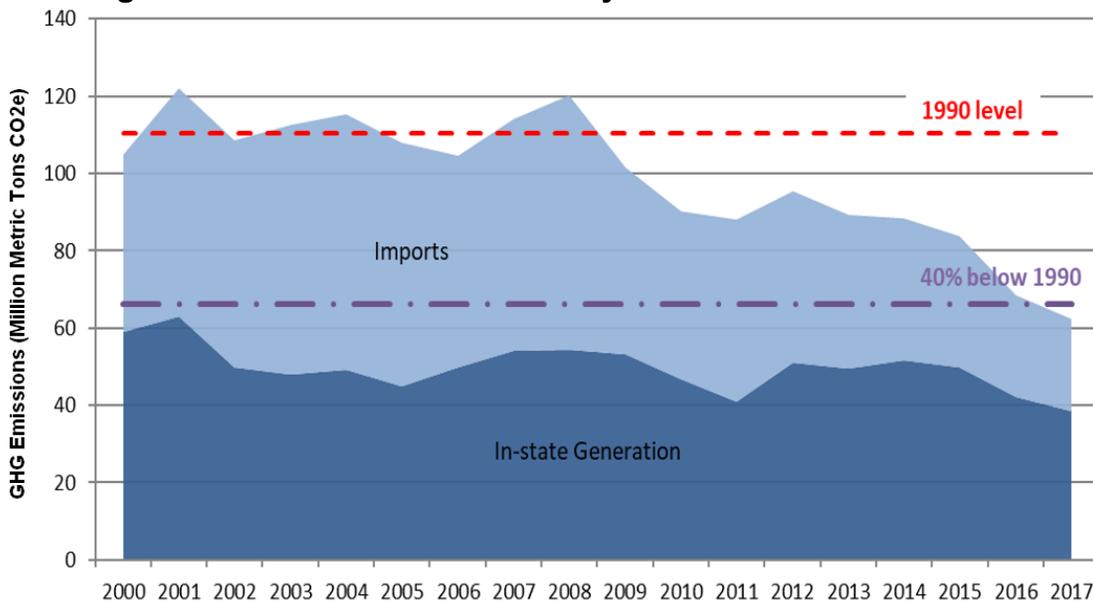
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EXECUTIVE SUMMARY

California is working to make sweeping changes in its energy system to address climate change, improve air quality, and make sure that all Californians share in the benefits of the state's clean energy future. In 2018, California furthered its national and international leadership in energy policy with the enactment of Senate Bill 100 (De León, Chapter 312, Statutes of 2018), which calls for California's electricity system to become 100 percent zero-carbon by 2045. The California Energy Commission (CEC), California Public Utilities Commission (CPUC), and the California Air Resources Board (CARB) are working together to identify pathways to deeply decarbonize the state's electricity system in response to SB 100. The aim is to leverage California's clean electricity system to decarbonize, or remove carbon from, other portions of the state's energy system.

The electricity sector led the way in California meeting its 2020 goal to reduce GHG emissions to 1990 levels, four years ahead of schedule. In 2017, GHG emissions from the electricity sector were 40 percent below 1990 levels. Although impressive, meeting the SB 100 goal of zero-carbon by 2045 requires much more work.

Figure ES-1: California's Electricity Continues to Get Cleaner



Source: CEC using data from CARB

Landmark California Initiatives to Reduce GHG Emissions

SB 100 builds on the state's goals to reduce greenhouse gases (GHGs) to 1990 levels by 2020 and reduce GHG emissions 40 percent below 1990 levels by 2030 (Assembly Bill 32, Núñez, Chapter 488, Statutes of 2006 and Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016). In 2018, Executive Order B-55-18 set a longer-term goal of statewide carbon neutrality as soon as possible and no later than 2045, with net negative GHG emissions thereafter. The targets laid out in Executive Order B-55-18 and SB 100 are consistent with international goals to reduce GHG emissions enough to avoid catastrophic climate change.

Renewable resources such as solar and wind account for about 34 percent of California's electricity use in 2018 and SB 100 requires an increase to 60 percent by 2030, making renewables one of the main driving forces in reducing the state's GHG emissions. Other factors include the sharp decline in the import of coal-fired electricity over the last decade, which is expected to drop to zero by 2025, and the beginning of a waning dependence on natural gas for electricity generation. The goal is to cut emissions from the electricity sector to zero while meeting an increasing demand and maintaining energy reliability, controlling costs, and ensuring that benefits reach all Californians.

California's Evolving Electricity System

California's electricity sector is rapidly evolving. Customers are generating their own power from rooftop solar and other distributed generation. In 2019, the state met its goal for a million solar roofs set by former Governor Arnold Schwarzenegger. Soon rooftop solar will be a mainstay on new homes as on January 1, 2020, California's building standards will require new homes to include rooftop solar. During the last decade, installed renewable capacity in the state increased from 9,313 megawatts (MW) in 2009 to 23,313 MW in 2018. The variable nature of renewable resources, which change as the sun rises or sets and as winds blow, requires shifts in how the system is managed. Flexibility with fast responsiveness is needed to accommodate morning and late-afternoon changes (termed *ramps*) in the *net load* (total load minus solar and wind generation) to prevent surplus or shortage situations on the electricity grid.

Although several tools are available to rapidly adjust supply or demand or both to meet flexibility needs, natural gas power plants provide about 75 percent of the available flexible capacity (the ability to quickly ramp energy production up or down as needed to match supply and demand). For the near term, natural gas generation will continue to play an important role in integrating renewable resources and ensuring reliability. As the electricity market grows regionally and resources such as energy storage and demand management grow to help integrate renewables, natural gas generation will decrease further.

Customers face increasing choices over their sources and suppliers of electricity. Communities are opting to make their own electric resource choices through community choice aggregation (CCA) to develop innovative ways of providing cleaner energy resources. Residential and commercial retail customers are increasingly departing from investor-owned utilities (IOUs) and moving to CCA. Large commercial and industrial customers are buying their electricity directly from renewable generators, as well as from private direct access providers when

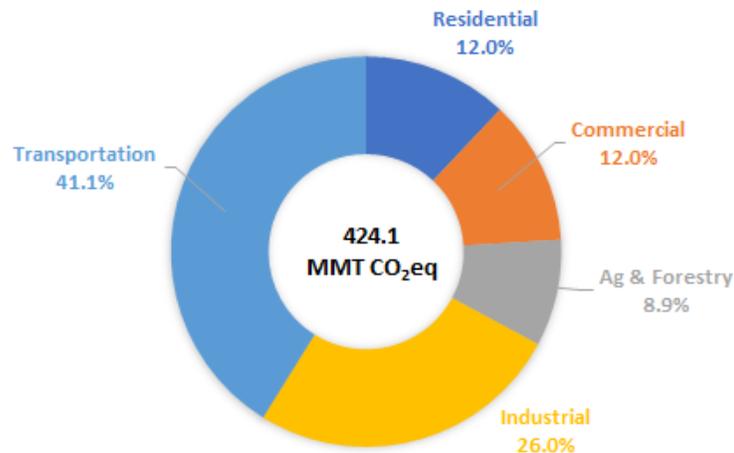
allowed. Furthermore, utilities face financial uncertainties with the looming liability associated with California's devastating wildfires, with one utility in bankruptcy. Historically, the state has used its regulatory authority over the fairly centralized electricity market to help deliver GHG reductions and achieve other environmental and policy goals. These structural changes present uncertainty as well as opportunities for achieving clean energy goals.

California's electricity system planning approach has also changed with the development of integrated resources plans (IRPs) as called for in Senate Bill 350 (De León, Chapter 547, Statutes of 2015). IRPs are long-term planning documents that outline how load-serving entities, including investor- and publicly owned utilities, community choice aggregators, and private electricity suppliers, will meet demand reliably and cost-effectively while achieving state policy goals and mandates. These plans show steady progress in achieving the state's renewable procurement requirements, including the increased Renewables Portfolio Standard of 60 percent renewables by 2030 called for in SB 100. They also meet GHG emissions reduction targets established by CARB, in consultation with the CEC and CPUC, in accordance with SB 350. A large share of the resource additions identified in the plans are from solar resources.

Buildings Are Part of the Solution

In 2017, the most recent data available, the state's building stock accounted for almost a quarter of statewide GHG emissions, including fossil fuel consumed onsite (for example, gas or propane for heating) and electricity consumption (for example, for lighting, appliances, and cooling). (See Figure ES-2.) Under Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018), the CEC must assess the feasibility of reducing GHG emissions in residential and commercial buildings 40 percent below 1990 levels by January 1, 2030. Leveraging the decarbonization of the electricity system by transitioning space and water heating in buildings toward highly efficient electric appliances, coupled with strategies to enable greater ability to shift when energy is consumed, will be key to reducing emissions from buildings. Under Senate Bill 1477 (Senate Bill 1477, Stern, Chapter 378, Statutes of 2018), the CEC and the CPUC are establishing two five-year incentive programs to enable greater penetration of these building decarbonization technologies.

ES-2: California's 2017 Greenhouse Gas Emissions by End Use



Source: CEC using data from CARB

The increased digitization of the grid presents new opportunities for flexibly integrating electrified buildings into the grid. Launching efficient technologies that can communicate with the grid can help shift the timing of energy use in buildings. At a large enough scale, such *smart* technologies can adjust electricity consumption to maximize the use of renewable generation and help manage morning and afternoon ramps without compromising comfort or function. In this way, buildings can be part of the evolving energy system and a resource that helps maintain the reliability of the electricity system.

Further, maximizing energy efficiency savings will reduce the costs of achieving the state's climate goals and open up new possibilities for meeting greater electricity demand from electrification. In late 2019, the CEC will complete the *2019 California Energy Efficiency Action Plan* that will lay out strategies for achieving deep savings through energy efficiency and reducing GHG emissions from buildings. The action plan addresses legislative requirements to update strategies that increase energy efficiency in existing buildings and, more broadly, to achieve a statewide doubling of energy efficiency savings from electricity and natural gas end uses by 2030 (Assembly Bill 758 [Skinner, Chapter 470, Statutes of 2009] and SB 350).

Transportation Electrification Is Critical

Eliminating emissions from the transportation sector is critical to the state's clean air goals—roughly 50 percent of in-state GHG emissions come from this sector when including refinery emissions from the industrial sector, along with the vast majority of criteria pollutants (such as nitrogen oxide and diesel particulate matter). Unfortunately, despite the overall reduction in statewide GHG emissions from 2013 through 2017, emissions from the transportation sector actually increased by 6 percent. A statewide shift from the use of vehicles that run on fossil fuels to those that run on electricity (referred to as "transportation electrification"), whether in the form of battery electric vehicles, plug-in hybrid electric vehicles, or fuel cell electric vehicles, is an essential component for reducing emissions. Thus, California has set ambitious goals of achieving 1.5 million zero-emission vehicles (ZEVs) by 2025 and 5 million by 2030 as established in former Governor Edmund G. Brown Jr's Executive Order B-16-2012.

California is aggressively pursuing the deployment of ZEVs through regulations and incentives administered by CARB (for example, the Advanced Clean Cars rulemaking and the Innovative Clean Transit Regulation) and incentives (such as the Clean Vehicle Rebate Project and the Low Carbon Transportation Program). The CEC's Clean Transportation Program is investing tens of millions of dollars in charging infrastructure and hydrogen refueling stations statewide. The CPUC has also directed IOUs to file applications for transportation electrification projects. Finally, the state's settlement agreement with Volkswagen for the company's violations of state and federal law in regard to emission tests will support the implementation of zero-emission transit and fleet vehicles, as well as plug-in electric vehicle recharging around the state.

These efforts have helped California become the largest ZEV market in the nation with nearly 700,000 ZEVs on the road and nearly half of the US annual sales. Plug-in electric vehicles accounted for nearly 8 percent of California's vehicle sales in 2018, compared to 2 percent nationally. However, ZEV sales are expected to accelerate worldwide in response to technological advancements and government policies. Battery pack prices have declined by upward of 85 percent from 2010 to 2018, with the potential for additional reductions through 2030. Investments in electrification, as well as autonomous and shared vehicle technologies, continue to grow dramatically. Globally, auto manufacturers may be selling upward of 15 million plug-in electric vehicles per year by 2025, given the anticipated effects of existing regulatory sales requirements.

To support California's growing ZEV population, the state will need to drastically increase the availability of refueling infrastructure. Executive Order B-48-18 set a target of 250,000 shared charging infrastructure connections, including 10,000 direct-current fast charging stations by 2025. (The same executive order also set a target of 200 hydrogen refueling stations by 2025.) Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018) subsequently required the CEC to assess the number and type of charging infrastructure necessary for California to meet its goal of 5 million ZEVs by 2030. The CEC's first charging infrastructure assessment is expected at the end of 2020. The CEC is also updating the state's Vehicle Grid Integration Roadmap, which will outline key steps in the implementation of technologies that can lower the costs for plug-in electric vehicle drivers, recharging station owners, and utility customers in general.

All Californians Must Benefit From the Clean Energy Future

California's clean energy future must create an inclusive clean energy economy in which the benefits are equitably distributed. SB 350 put California's clean energy targets into law and took steps to ensure that all Californians realize the benefits of clean energy. In response to SB 350, the CEC published the *Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities* (Barriers Study Part A) and, in 2018, CARB published the *Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents* (Barriers Study Part B). California's agencies have made significant progress toward accomplishing the recommendations in the barriers studies. For example, the CEC's Electric Program Investment Charge (EPIC) program exceeded the goal set

in Assembly Bill 523 (Reyes, Chapter 551, Statutes of 2017) for at least 25 percent of the technology demonstration and deployment funds to be allocated to projects in and benefitting low-income or disadvantaged communities. As of July 2019, the CEC's EPIC program invested about 31 percent of funds to projects in disadvantaged communities and an additional 34 percent to projects in communities that are low-income but not considered disadvantaged. (See Figure ES-3.)

Figure ES-3: EPIC Projects Located in Low-Income and Disadvantaged Communities



Source: Joint agency presentation by at the July 30, 2019, workshop on Advancing Energy Equity

Going forward, California must look for new opportunities to advance clean energy equity in disadvantaged and low-income communities, tribes, and rural communities. Areas for further work include developing attainable opportunities to finance energy upgrades, developing one-stop shops to increase access to clean technologies, advancing retrofits in low-income multifamily housing, training and dedicating staff to community outreach, and providing direct support to community based organizations.

Planning for the Future

It is critical that the state's planning efforts reflect and account for rapid changes in energy markets, such as the deployment of solar photovoltaic and energy storage technologies, migration of load from IOUs to community choice aggregators, climate change impacts on

supply and demand, and declining reliance on natural gas. The *2019 IEPR* puts forward new 10-year forecasts for electricity and natural gas use, as well as for transportation fuels. The forecasts for electricity and natural gas demand inform planning for resource procurement and transmission investments in the CPUC's Integrated Resource Planning process and the California Independent System Operator's (California ISO's) Transmission Planning Process, respectively. In addition, the CEC provides monthly peak demand forecasts in coordination with the California ISO and the CPUC for evaluating resource adequacy.

The transportation forecast aims to capture changes in consumer preferences influenced by clean vehicle policies, technology investments, and global market pressures. The findings from the transportation forecast are also inputs into the electricity and natural gas forecast. Staff continues to refine the electricity and natural gas forecast to better reflect hourly data for factors such as rooftop solar, energy efficiency, electricity storage, demand response (to reliably and quickly ramp energy load up or down in response to price signals), climate change, and electric vehicle charging. California's planning efforts continue to evolve as its historically siloed sectors such as buildings, electricity, and transportation are becoming increasingly intertwined.

Investing in technology innovation is also necessary to help the state decarbonize its energy system in ways that are clean, safe, affordable, accessible, and reliable. The CEC is conducting research that ranges from identifying pathways to achieve deep GHG reductions, to developing technological solutions such as low- and no-carbon alternatives for space heating, water heating, and cooking in buildings, to identifying solutions to better integrate electric vehicles into the grid.

In light of California's climate change policies, difficult decisions about replacing aging gas infrastructure and managing investments to maintain energy reliability are needed. In Southern California, maintaining energy reliability remains challenging, and concerns in recent years are primarily due to breakdowns in the aging natural gas infrastructure in the region. Following a massive leak at the Aliso Canyon natural gas storage facility in 2015, the state has limited the use of the facility, which has historically helped balance natural gas supply and demand. Further, multiyear outages of natural gas pipelines that serve the region greatly add to the risk of disruptions in energy reliability. The CEC, CPUC, California ISO, and the Los Angeles Department of Water and Power continue to work closely together to monitor the situation and implement solutions, with an emphasis on using preferred resources such as storage, demand response, and renewables.

Adapting to Climate Change

As California pursues its clean energy future, it must plan for and adapt to a changing environment that will affect the demands on and capabilities of the system. A warmer climate increases the need for indoor cooling, while extreme heat compromises the performance of generation, transmission, and distribution infrastructure. Reduced spring snowpack reduces hydroelectric supplies during summer months when hydropower has historically provided an important, zero-emission resource for meeting peak demand. Wildfires threaten energy sector infrastructure and, during weather associated with extreme wildfire risk, indirectly result in planned power shutoffs to protect public safety.

California's investments in research and development are one of the most important tools for reaching long-term decarbonization in a resilient and cost-effective manner. Planning for the effects of climate change in the energy sector, identifying pathways to achieve deep decarbonization of energy use, and developing innovative solutions to these complex issues must be rooted in a science-based understanding. Further, climate science must be actionable on a local level, and the state must prioritize research and actions that support climate-resilience for California's communities that are most vulnerable to climate change.

Taking Up the Challenge

California must boldly face the challenge of decarbonizing its energy system to dramatically cut GHG emissions while maintaining energy reliability, controlling costs, increasing its resiliency to climate change, and improving the equity of how clean energy benefits are realized. Addressing this challenge will require the engagement of state and local governments, industry, environmental groups, nongovernmental organizations, and Californians throughout the state. California is the fifth largest economy in the world, a state rich with renewable resources, the home of technological innovations that have spread throughout the world, and a leader in clean energy policies. California has the resources, talent, and political will to achieve its clean energy goals and be an example to others striving for a better future.

CHAPTER 1:

Electricity Sector

Introduction

California's electricity system is facing rapid and sweeping changes as California continues to lead the way in achieving greenhouse gas (GHG) reductions. In 2017, GHG emissions in the electricity sector dropped to more than 40 percent below 1990 levels, helping to ensure the state is on its way to achieving the 2030 statewide GHG reduction target set by Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016). California's Renewables Portfolio Standard (RPS) calls for 33 percent of the retail sales to be served with renewable resources by 2020. In 2018, the state achieved an estimated 34 percent.¹

The state's path to deeper GHG reductions in the electricity sector is delineated in Senate Bill 100 (De León, Chapter 312, Statutes of 2018), which calls for a 100 percent zero-carbon electricity system by 2045. SB 100 also establishes an ambitious 60 percent RPS by 2030, increased from the previous 50 percent established by Senate Bill 350 (De León, Chapter 547, Statutes of 2015). Also in 2018, Executive Order B-55-18 set a goal of statewide carbon neutrality as soon as possible (no later than 2045), with net negative GHG emissions thereafter.

Over the last decade, the electricity resource mix has changed significantly as new renewable resources have come on-line. By 2025, reliance on out-of-state coal generation will be eliminated from the state's resource mix altogether and the system is shifting to decreased reliance on fossil natural gas.

In the near to mid-term, natural gas generation plays a critical role in ensuring reliability and integrating renewable resources. Increased coordination and the evolution of markets in the western region is already helping to better integrate renewables. Carbon-free resources, such as energy storage and demand management, are also helping to integrate renewables and ensure reliability.

Changes are also underway as customers face increasing choices over their sources and suppliers of electricity. Many customers are generating their own power from rooftop solar and other distributed generation, decreasing demand on the electricity grid. Further, California is the first state to require rooftop solar on new homes under new building standards that go

¹ California Energy Commission, [Tracking Progress, Renewable Energy, December 2018](https://www.energy.ca.gov/sites/default/files/2019-05/renewable.pdf), <https://www.energy.ca.gov/sites/default/files/2019-05/renewable.pdf>.

into effect on January 1, 2020. Many communities are deciding to make their own electric resource procurement choices by forming community choice aggregators to develop innovative ways of providing cleaner energy resources. As of 2019, roughly 20 percent of customers have moved from service provided by an investor-owned utility (IOU) to service provided by a community choice aggregator. Large commercial and industrial customers are buying their electricity directly from renewable generators, as well as from private direct access providers.

In light of these changes, the regulatory framework that has ensured reliable and affordable power for California Public Utilities Commission (CPUC) jurisdictional entities representing nearly 80 percent of the electricity grid is becoming more fragmented. At the same time, one of the state's primary mechanisms for delivering GHG reductions and achieving other environmental and policy goals in the electricity sector is fragmenting as responsibility for resource procurement and resource adequacy is more disaggregated than in the past. Finally, utilities face financial uncertainties with the looming liability associated with California's devastating wildfires, with one utility in bankruptcy.

California agencies in collaborating with the California Independent System Operator (California ISO) and other California Balancing Authority Areas continue to work together to address questions about how to ensure reliability, achieve clean energy goals, and provide affordable electricity in this evolving environment. This chapter provides an overview of emerging trends in the electricity sector.

Review of Major Trends in the Electricity Sector

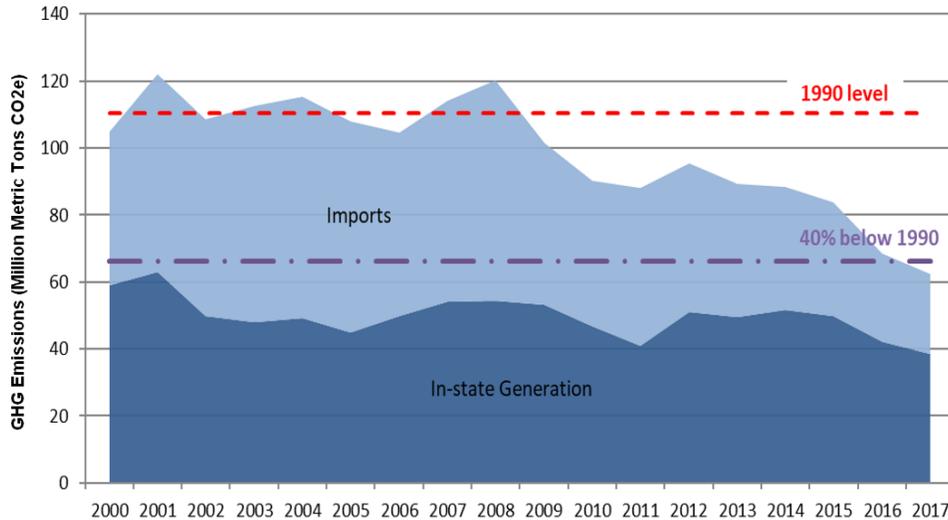
Electricity Sector Leads California's Efforts to Reduce GHG Emissions

California's electricity sector continues to make steady progress toward its energy and environmental goals and is leading California's efforts to reduce GHG emissions. GHG emissions from the electricity sector declined by 9 percent in 2017, compared with 2016, as shown in Figure 1.² In 2017, 52 percent of total electricity generation, including both in-state generation and imported power, came from zero-carbon generation sources.³ Total GHG emissions attributed to the electricity sector decreased by 6 million metric tons carbon dioxide equivalents (MMT CO₂e), from 68 MMT CO₂e in 2016 to 62 MMT CO₂e in 2017.

² CARB, 2019 Edition, [California Greenhouse Gas Emissions Inventory: 2000–2017](https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf)
https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf.

³ For the inventory, CARB includes solar, wind, large and small hydro, and nuclear as zero-GHG-emission generation sources.

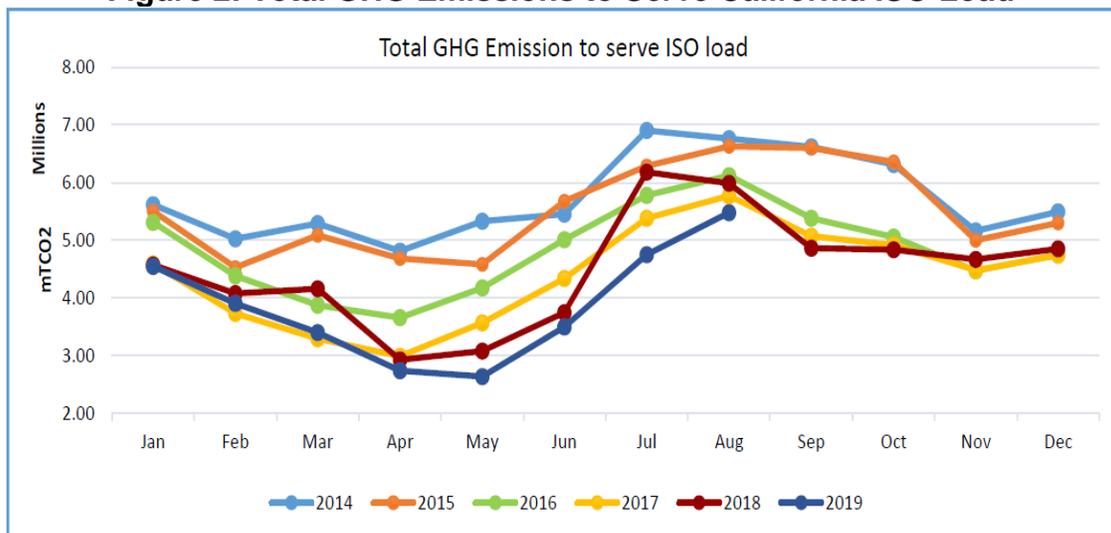
Figure 1: GHG Emissions From California's Electricity Sector Continue to Decline



Source: CEC using data from the California Air Resources Board (CARB)

More current and granular GHG emissions data is available for the portion of California load served by the California ISO. As shown in Figure 2, the overall monthly GHG emissions continue their downward trend.

Figure 2: Total GHG Emissions to Serve California ISO Load



Source: California ISO, [GHG Emission Tracking Report– August 2019](http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=44F67509-702F-41FA-82BE-37243B9996BD), <http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=44F67509-702F-41FA-82BE-37243B9996BD>

Changes in Natural Gas-Fired Electricity Generation

California is beginning a transition away from fossil natural gas as a primary fuel source for electric generation. To meet air quality, climate, and other environmental goals, natural gas generation is being replaced by resources including renewables, transmission upgrades, energy storage, energy efficiency, and demand response.

Over the last decade, the portfolio of resources in California’s electric system has significantly changed. The amount of generation from natural gas plants has decreased by roughly 22

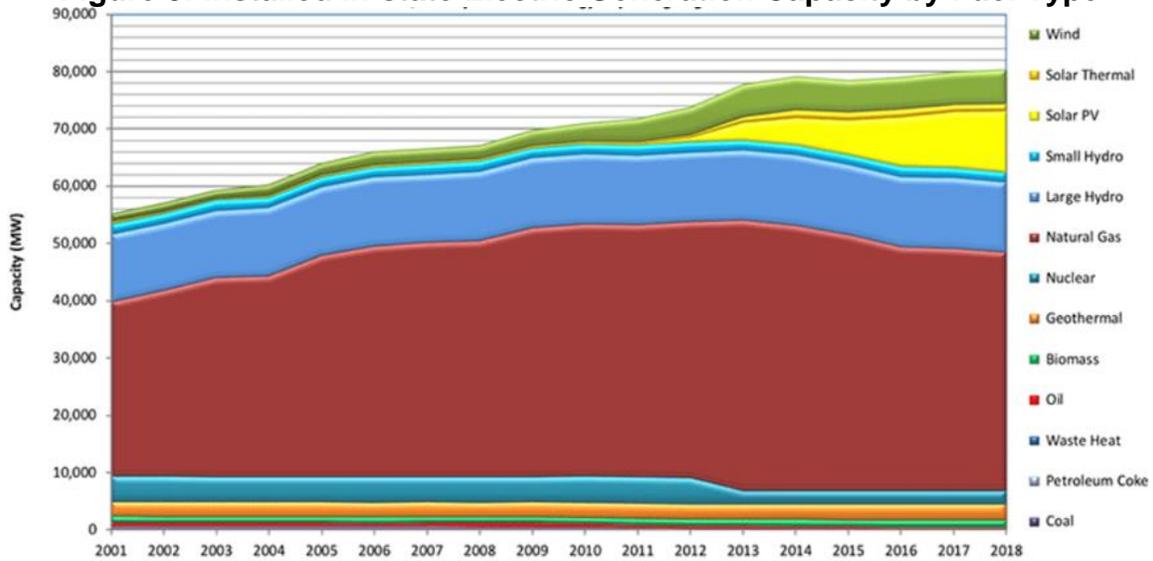
percent, from 117 gigawatt-hours (GWh) in 2009 to 91 GWh in 2018. Large amounts of renewable generation have been added to the system, primarily driven by California's Renewables Portfolio Standard (RPS) and the California Solar Initiative. Installed renewable capacity in the state increased from 9,313 megawatts (MW) in 2009 to 23,313 MW in 2018, as shown in Figure 3. Over the last decade, renewable generation, including rooftop solar PV, has also more than doubled, from GWh in 2009 to 77 GWh in 2018, as shown in Figure 4. Further changes in the state's resource mix result from reduced reliance on imported out-of-state coal resources and nuclear generation. By 2025, out-of-state coal imports will be eliminated from the resource mix and the last remaining nuclear facility in the state, Diablo Canyon Power Plant, is slated to retire.⁴

California is also retiring aging coastal natural gas plants that use ocean water for cooling (once-through cooling), with only a portion of that capacity being replaced by gas-fired generation. Between 2009 and 2018, California retired over 8,100 MW of natural gas power plants using once-through cooling. By 2020, another 5,300 MW is expected to retire, and by 2029, an additional 1,600 MW will retire.⁵ See Chapter 6 for more information.

⁴ Several of the state's publicly-owned utilities have long-term contracts with out-of-state nuclear generation from the Palo Verde Nuclear Generating Station located in Arizona that extend beyond 2030.

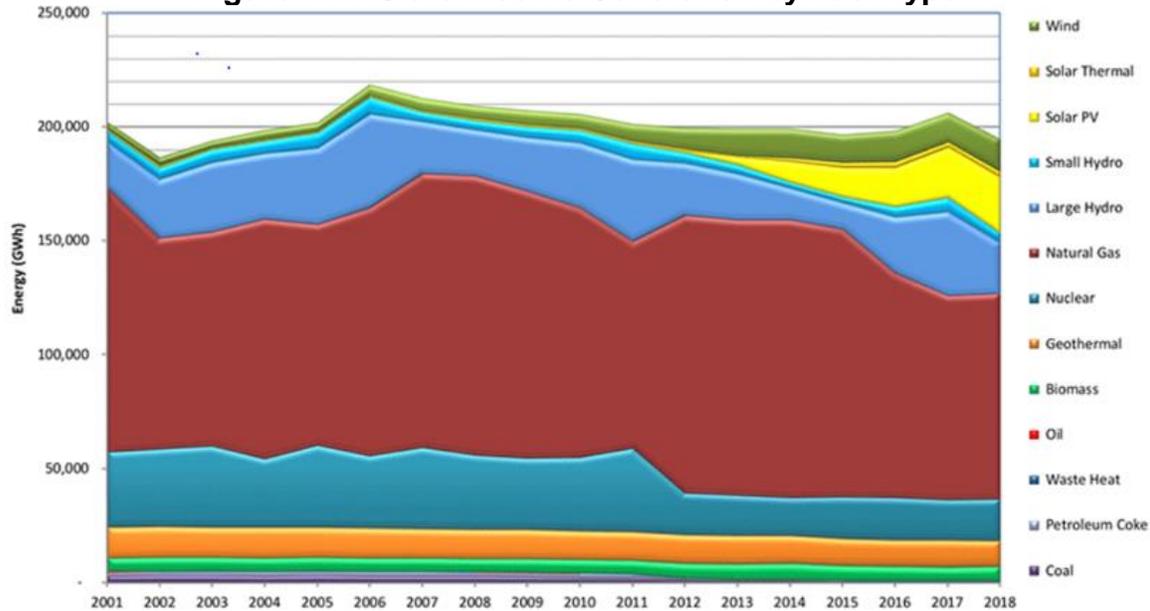
⁵ The Statewide Advisory Committee on Cooling Water Intake Structures is considering an extension of the Once-Through Cooling compliance date of Alamos units 3, 4, and 5 to December 31, 2022 due to the delay of the Mesa Loop-in transmission upgrade, [Report of the Statewide Advisory Committee on Cooling Water Intake Structures draft report](https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/saccwis/docs/sccwintprt.pdf)
https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/saccwis/docs/sccwintprt.pdf.

Figure 3: Installed In-state Electric Generation Capacity by Fuel Type



Source: CEC Quarterly Fuels and Energy Reporting

Figure 4: In-State Electric Generation by Fuel Type



Source: CEC Quarterly Fuels and Energy Reporting

Historically, natural gas power plants have had the lowest operating costs, or marginal costs, so they were the first resources called on, or dispatched, to meet electricity demand. However, the lower overall operating costs of renewable resources means that when the sun is shining

or the wind is blowing these resources are being called on instead of natural gas plants.⁶ This is leading to an overall reduction in the amount of natural gas used for electricity generation. In addition, natural gas generation has typically been the swing generation to make up for loss of hydro resources during droughts, but in 2016, renewable generation began to serve that purpose. Still, as discussed below, natural gas plants are needed to meet load during periods when renewable resources are varying or not generating and to provide grid services to ensure system and local reliability.

Currently, natural gas power plants provide about 75 percent of the flexible capacity available to meet system needs. This means that some gas plants that were designed to operate as baseload resources, primarily combined cycle power plants, are being operated more like peaking resources, running fewer hours. In recent years, peaking gas plants have been added, which run less of the time—in most cases only a few hours on the hottest days—and make up a portion of the once-through cooling plant retirements.⁷ Some natural gas plants are adding on-site energy storage to increase flexibility. Natural gas plants with low capacity factors may retire early, as they may not be economic to run if they are called on only infrequently. For the near term, natural gas generation will continue to play a key role in integrating renewable resources and ensuring reliability.

Integrating Increasing Amounts of Renewables and Storage

The integration of increasing amounts of renewable resources is changing the way the grid is operated. With the growth in intermittent renewables, system operators need additional generators with flexible capabilities to balance supply and demand.

With the addition of solar and wind generation on the system, electricity demand in the state is being served by record levels of renewables. The most recent solar peak of 11,473 MW occurred on the California ISO system on July 2, 2019. The most recent wind generation peak of 5,309 MW on the California ISO system was set on May 8, 2019. A new overall renewable generation penetration peak for the California ISO system was recorded on May 15, 2019, with 80 percent of instantaneous load served by all renewables.⁸ As solar penetration continues to increase on the customer side of the meter and on the grid, the net load⁹ shows steep

6 For example, in the California ISO market, resources with the lowest marginal costs are called on first to meet load, which is also referred to as economic dispatch. Solar has essentially zero marginal costs while wind has very low marginal costs when compared with natural gas generation.

7 For example, the Carlsbad Energy Center is a 500 MW peaker plant that replaced the 946 MW Encina combined-cycle power plant.

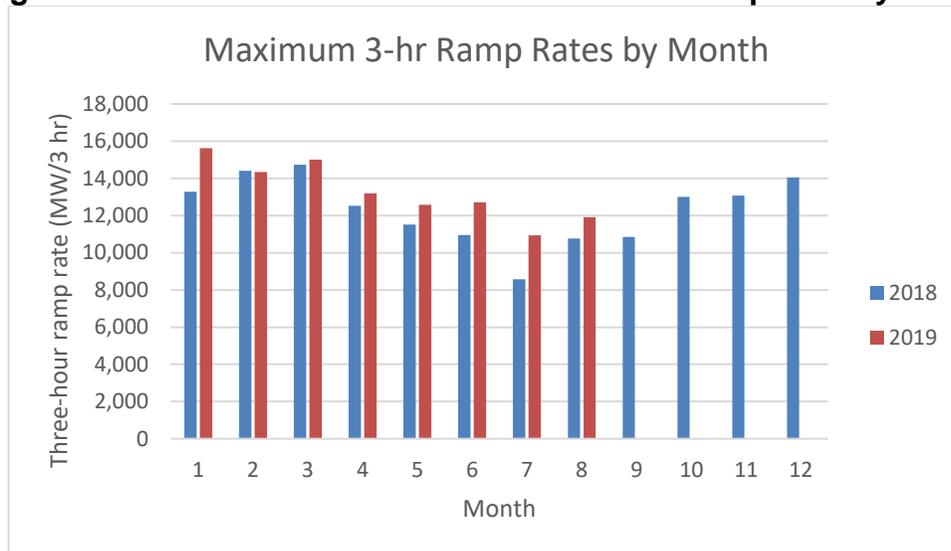
8 Letter from Steve Berberich (President and Chief Executive Officer of California ISO) to ISO Board of Governors. *CEO Report*. July 17, 2019. [Memorandum to ISO Board of Governors from Steve Berberich, president and CEO](http://www.caiso.com/Documents/CEOReport-Jul2019.pdf) <http://www.caiso.com/Documents/CEOReport-Jul2019.pdf>.

9 *Net load* is the amount of energy that must be provided net of wind and solar generation.

afternoon ramps as demand remains high or increases, while solar generation subsides as the sun sets. These ramps, managed by the California ISO and other balancing authorities, are becoming even steeper, as shown in Figure 5. These three-hour ramp rates far exceed predictions by the California ISO several years ago, when the maximum ramp rate on a typical spring day in 2020 was predicted to be 13,000 MW in three hours.¹⁰ In January 2019, the three-hour ramp was almost 16,000 MW.

Similarly, the minimum net load is lower than predicted, as shown in Figure 6. Several years ago, the California ISO predicted that the net load would not reach a minimum of 12,000 MW until 2020 for the worst case of a typical spring day when load is low and renewable generation (primarily wind and solar) is high. However, the California ISO reaches well below that level on spring days, as well as nearly every month of the year. Although the California ISO has identified reliability concerns with minimum loads below 12,000 MW, the California ISO grid has remained stable, even though loads have consistently dropped below this level and were as low as 5,439 MW in May 2019.

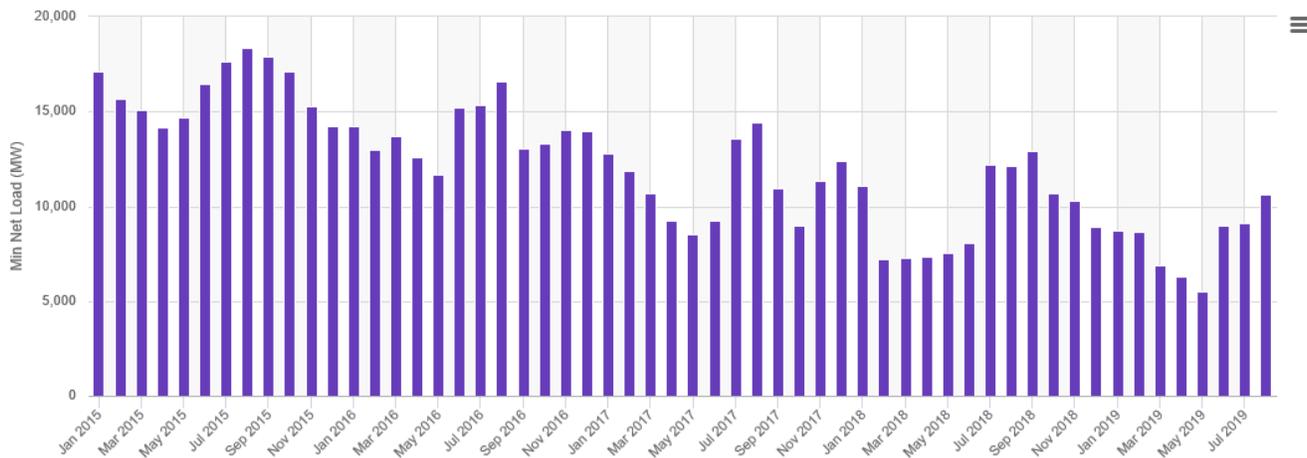
Figure 5: California ISO Maximum Three-Hour Ramp Rate by Month



Source: Based on data obtained from the California ISO, available at [Link to past Monthly Renewables Performance Reports on the California ISO website](http://www.caiso.com/market/Pages/Reports/Bulletins/RenewablesReporting.aspx#MonthlyRenewables) <http://www.caiso.com/market/Pages/Reports/Bulletins/RenewablesReporting.aspx#MonthlyRenewables>.

¹⁰ California ISO. *Fast Facts: What the Duck Curve Tells Us About Managing a Green Grid*. 2016. [Fact sheet on the "duck curve" by the California ISO](http://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf#search=what%20the%20duck%20curve%20tells%20us) http://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf#search=what%20the%20duck%20curve%20tells%20us.

Figure 6: California ISO Monthly Minimum Net Load (January 2015–August 2019)



Source: California ISO, Monthly Renewables Performance Report for August 2019 on California ISO's website
<http://www.caiso.com/Documents/MonthlyRenewablesPerformanceReport-Jul2019.html>.

The *2018 IEPR Update*¹¹ further described the challenges and opportunities associated with the need to increase the flexibility in the electricity system to integrate more renewable energy. Progress is being made in developing performance standards for inverter-connected solar and wind power plants that will help improve reliability and increase services to the grid. There is an increasing need for energy storage that can absorb excess energy and reinject it into the grid when needed, and California is seeing an emerging trend toward hybrid resources, such as solar-plus-storage projects.

The California ISO is receiving an increasing number of inquiries from generation developers interested in pairing energy storage with either existing or proposed generation (conventional or renewable). As of July 3, 2019, the California ISO's Generator Interconnection Queue included 35,341 MW of hybrid resources seeking interconnection, or a little more than 40 percent of the total requested. Based on the number of interconnection requests and strong interest by developers and stakeholders, the California ISO anticipates the installed capacity of hybrid resources will grow significantly in coming years.¹²

In response to this trend, the California ISO launched a new stakeholder process to address issues associated with market participation of hybrid resources. The initiative will explore how

11 CEC staff. 2018. *2018 Integrated Energy Policy Report Update, Volume II*. CEC. Publication Number: 100-2018-001-V2-CMF. (p. 197) [Link to 2018 IEPR Update on the CEC's website](https://www2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf) <https://www2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf>.

12 California ISO. *Hybrid Resources Issue Paper*. July 18, 2019. [Copy of California ISO's Hybrid Resources Issue Paper](http://www.caiso.com/Documents/IssuePaper-HybridResources.pdf) <http://www.caiso.com/Documents/IssuePaper-HybridResources.pdf>.

such hybrid generation resources can be registered and configured to operate within the California ISO markets. Hybrid resource configurations are expected to raise new operational and forecasting challenges, which this initiative will assess. In the meantime, the California ISO will allow existing solar facilities to co-locate new storage with an expedited Material Modification Assessment Process so the additional storage does not need to resubmit into the California ISO interconnection queue.¹³

Addressing Short-Term Resource Adequacy Concerns

The California ISO submitted a system resource adequacy and operational analysis¹⁴ for 2021–2022 as part of the comments it filed in the CPUC integrated resource plan proceeding. (See Chapter 10 for more information on integrated resource plans). The analysis identified capacity shortfalls starting in 2020 and challenges meeting summer evening peak load. The state is facing these short-term resource adequacy gaps, the California ISO explained, because the peak demand it serves has shifted from the afternoon to the early evening (within hour ending at 5:00 p.m. [17 Pacific Standard Time] [PST] in 2020 and 2021, and 6:00 p.m. [18 PST] in 2022), which is when solar production is significantly reduced or not available.¹⁵

The California ISO resource adequacy analysis shows a 500 MW system resource adequacy deficiency in 2020, which increases to 2,300 MW and 2,200 MW in 2021 and 2022, respectively.¹⁶ The analysis also shows operational deficiencies reaching maximums of 2,300 MW, 4,400 MW, and 4,700 MW in 2020, 2021, and 2022, as shown in Figure 7, 8, and 9, respectively.¹⁷ In Figure 7, the 2020 analysis shows an operational gap starting at 6:00 p.m. Pacific Daylight Time (PDT) (in hour ending in 17 PST) and in the two hours immediately after.¹⁸ Figure 8 shows that in 2021, the reliability gap expands to four hours, from 6:00 p.m. through 9:59 p.m. PDT (hour ending 17 through 20 PST).¹⁹ Figure 9 shows that in 2022, the

13 California ISO. See [Attachment A](http://www.caiso.com/Documents/Oct2-2019-Comments-ReliabilityProcurementProposedDecision-IRP-R16-02-007.pdf), <http://www.caiso.com/Documents/Oct2-2019-Comments-ReliabilityProcurementProposedDecision-IRP-R16-02-007.pdf>.

14 The California ISO's complementary operational analysis reflects the capability of the projected resource adequacy fleet to serve load after the gross peak hour based on operational performance rather than static capacity values. The California ISO's energy-based analysis focuses on hours 4:00 p.m. to 9:00 p.m. PDT.

15 [California ISO briefing on post 2020 operational outlook](http://www.caiso.com/Documents/Briefing-Post-2020-GridOperationalOutlook-Presentation-Sep2019.pdf), September 18, 2019, Board of Governors Meeting General Session, p. 4, <http://www.caiso.com/Documents/Briefing-Post-2020-GridOperationalOutlook-Presentation-Sep2019.pdf>.

16 [Reply Comments of the California ISO](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M311/K582/311582922.PDF), August 12, 2019, CPUC Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements, p. 2, <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M311/K582/311582922.PDF>.

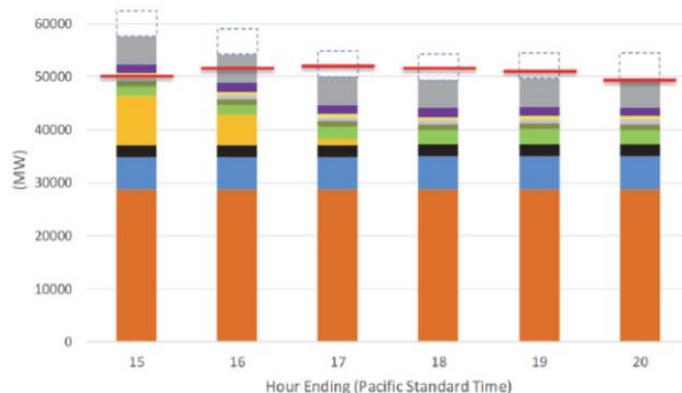
17 *Ibid.*, p. 2.

18 *Ibid.*, p. 11.

19 *Ibid.*

reliability gap continues from 6:00 p.m. through 9:59 p.m. PDT (to cover hours ending in 17 through 20 PST), but the peak hour shifts from 6:00 p.m. to 7:00 p.m. PDT (hour ending in 18 PST).²⁰

Figure 7: 2020 Projected Energy Production From Resource Adequacy Fleet

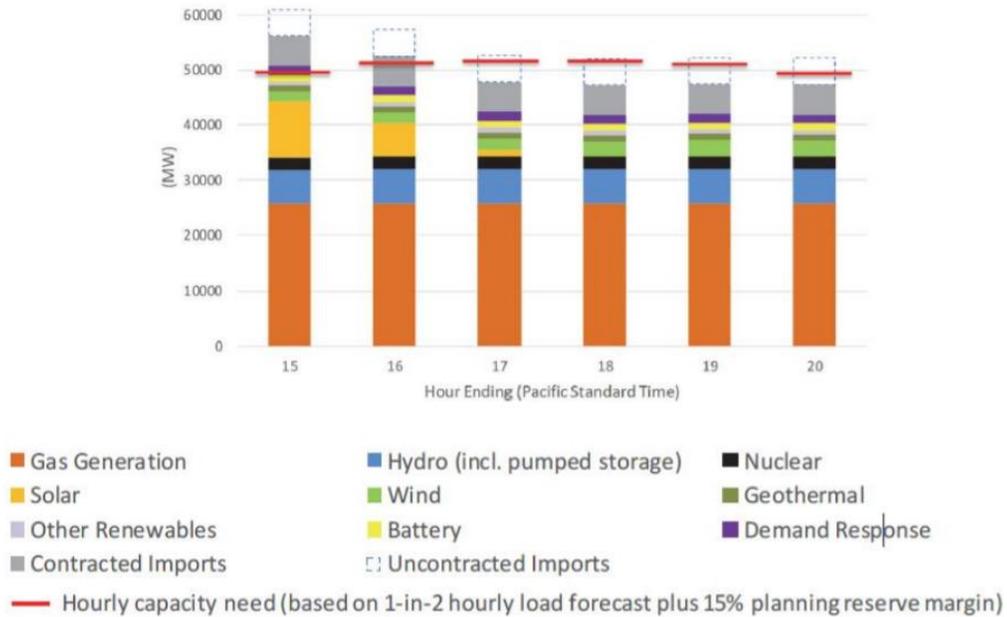


- Gas Generation
- Solar
- Other Renewables
- Contracted Imports
- Hydro (incl. pumped storage)
- Wind
- Battery
- Uncontracted Imports
- Nuclear
- Geothermal
- Demand Response
- Hourly capacity need (based on 1-in-2 hourly load forecast plus 15% planning reserve margin)

Source: California ISO

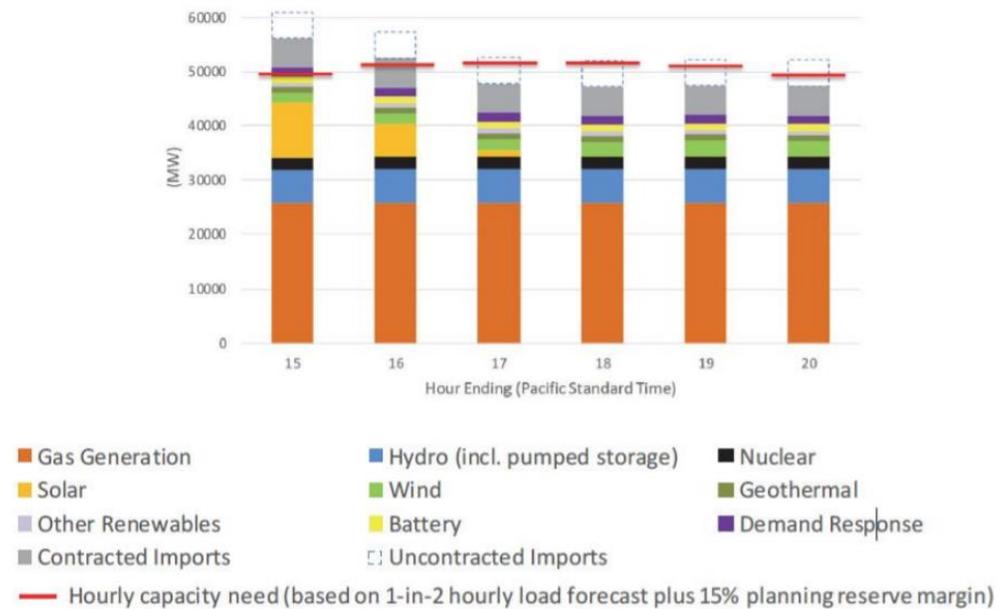
²⁰ Ibid.

Figure 8: 2021 Projected Energy Production from Resource Adequacy Fleet



Source: California ISO

Figure 9: 2022 Projected Energy Production from Resource Adequacy Fleet



Source: California ISO

The California ISO explained that there are several challenges to addressing these short-term resource adequacy concerns, including energy capacity decreasing due to net retirement of 4,000 MW of OTC natural gas-fired plants, increasing load, thermal resource retirements and

increasing renewable integration needs outside of California along with potential changes in hydro resource conditions in California and the West.²¹

As part of the CPUC integrated resource plan proceeding, the CPUC has issued a decision to address the electricity system resource adequacy shortages beginning in 2021.²² Specifically, the decision recommends that the State Water Resources Control Board extend the OTC compliance deadlines for natural gas-fired plants required to retire by December 31, 2020.²³ In addition, the decision requires incremental procurement of system-level resource adequacy capacity of 3,300 MW by all load-serving entities (LSEs) serving load within the California ISO balancing authority area.²⁴

Western States Coordination and Collaboration

Increased regional coordination is important to supporting policies, objectives, and efficient and reliable operations of the changing energy system. Coordination offers potential to significantly increase the ability to efficiently integrate additional renewable energy and to develop and import renewable generation in regions with attributes that match or complement California's season and daily operational needs.

The Western EIM is a real-time wholesale energy trading market that enables participants anywhere in the West to optimally buy and sell energy when needed. It has proven successful in producing cost savings, reducing renewables curtailment, and reducing GHG emissions. The existing Western EIM has nine member entities (including the California ISO).²⁵ Eleven additional entities plan to join by 2022.²⁶ The Bonneville Power Administration (BPA) has signed an implementation agreement which positions it to join the Western EIM in 2022.²⁷

21 [California ISO briefing on post 2020 operational outlook](http://www.caiso.com/Documents/Briefing-Post-2020-GridOperationalOutlook-Presentation-Sep2019.pdf), September 18, 2019, Board of Governors Meeting General Session, p. 7, <http://www.caiso.com/Documents/Briefing-Post-2020-GridOperationalOutlook-Presentation-Sep2019.pdf>.

22 [CPUC Decision Requiring Electric System Reliability for 2021-2023, R. 16-02-007, released November 7, 2019](http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=318169119) <http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=318169119>.

23 *Ibid.*, p. 2, pp. 16–24.

24 *Ibid.*, p. 3, pp. 28–33.

25 The entities and their dates of entry include the following: PacifiCorp (2014), NV Energy (2015), Arizona Public Service (2016), Puget Sound Energy (2016), Portland General Electric (2017), Idaho Power (2018), Powerex (2018), and the Balancing Authority of Northern California/Sacramento Municipal Utility District (2019).

26 Entities and their planned dates of entry include Seattle City Light (2020), Salt River Project (2020), Los Angeles Department of Water and Power (2021), Northwestern Energy (2021), Turlock Irrigation District (2021), Public Service Company of New Mexico (2021), Balancing Authority of Northern California Phase 2 [Modesto Irrigation District, City of Redding, and City of Roseville] (2021), Western Area Power Administration–Sierra Nevada Region (2021), Avista Utilities (2022), Tucson Electric Power (2022), and Tacoma Power (2022).

27 BPA is a nonprofit federal power marketer that markets wholesale electrical power from 31 federal hydroelectric projects in the Northwest, one nonfederal nuclear plant, and several small nonfederal power plants. Joining the Western EIM is part of BPA's overall grid modernization

Assuming all these entities join as noted, in 2022 the balancing authorities participating in the Western EIM will account for more than 77 percent of the load in the Western Electricity Coordinating Council.

There is also growing interest in extending the day-ahead market to include Western EIM entities. To that end, the California ISO launched its Extended Day-Ahead Market Initiative on October 10, 2019, with an issue paper.²⁸ The paper outlines the major topics to be addressed in the Extended Day-Ahead Market Initiative, including transmission provisions, distribution of congestion rents, resource sufficiency evaluations, ancillary services, and accounting for GHG costs. The aim is to enable current and future Western EIM entities to participate in a day-ahead market using a framework similar to the existing Western EIM real-time market, rather than requiring full integration into the California ISO balancing area.

As participation in the Western EIM increases and as opportunities for expanding the market services offered to participants are considered, Western EIM governance issues are being addressed in various forums. The CEC is engaged with several regional entities that have roles related to reliability, transmission planning, market development, and other issues of interest to states and provinces in the West.

Also, the California ISO is taking on a new role in the western United States as the reliability coordinator (RC) in its control area and it has extended these services to other western balancing authorities.²⁹ After more than a year of planning and stakeholder input, the new service, RC West, launched operations on July 1, 2019, providing reliability coordinator services for balancing authorities and transmission for most of California, and one entity in Mexico, Centro Nacional de Control de Energía. In early November 2019, following additional certifications by North American Electric Reliability Corporation and Western Electricity Coordinating Council, the California ISO anticipates that RC West will become the reliability coordinator for another 23 entities in the Western Interconnection, overseeing 87 percent of the load in the western United States.³⁰

program that positions BPA and its customers to benefit from new technology and emerging market opportunities. [BPA Grid Modernization Program website](https://www.bpa.gov/Projects/Initiatives/Grid-Modernization/Pages/Grid-Modernization.aspx) <https://www.bpa.gov/Projects/Initiatives/Grid-Modernization/Pages/Grid-Modernization.aspx>.

²⁸ [Link to Extended Day-Ahead Market Initiative information on the California ISO's Web page](http://www.caiso.com/informed/Pages/StakeholderProcesses/ExtendedDay-AheadMarket.aspx) <http://www.caiso.com/informed/Pages/StakeholderProcesses/ExtendedDay-AheadMarket.aspx>.

²⁹ A reliability coordinator (RC) has the highest level of authority and responsibility for the reliable operation of the power grid, and has a wide-area view of the bulk electricity system. It is required to comply with federal and regional grid standards, and can authorize measures to prevent or mitigate system emergencies in day-ahead or real-time operations. The RC also provides leadership in system restorations following major events.

³⁰ [Information on the California ISO's role as reliability coordinator](http://www.caiso.com/informed/Pages/RCWest/Default.aspx) <http://www.caiso.com/informed/Pages/RCWest/Default.aspx>.

As the Western EIM expands, the California ISO continues to work with participants, as well as adjacent balancing authorities and transmission operators to establish critical telemetry and operating procedures that minimize, or preclude, the impacts of Western EIM operations on adjacent, affected systems. This visibility into both Western EIM participant systems and adjacent, affected systems delivers significant economic and operational benefits.

Decarbonizing the State's Electricity Sector

Senate Bill 100 Sets the Framework to Decarbonize the Electricity Sector

SB 100 establishes 2045 targets for renewable and zero-carbon energy procurement equal to 100 percent of retail sales to end users and 100 percent of electricity procured to serve state agencies. It also requires all state agencies to incorporate these targets into their relevant planning, including in the CEC's Integrated Energy Policy Report (IEPR) process. The bill also increases the state's RPS to 60 percent of retail sales by December 31, 2030, and raises interim procurement requirements by amounts consistent with this increase. SB 100 requires the CPUC, CEC, and CARB to use programs authorized under existing statutes to achieve this policy.

SB 100 requires a joint report prepared by the CEC, CARB, and CPUC, in consultation with the state's balancing authorities, to the Legislature by January 1, 2021, and every four years thereafter.³¹ The report will address the implementation of the policy including a review focused on technologies, forecasts, existing transmission, maintaining safety, environmental pollution, affordability, and system and local reliability. The report will include an evaluation of the potential benefits and impacts on the system, any anticipated financial costs and benefits to utilities including customer rate impacts and benefits, barriers to achieving the policy, and alternative scenarios to achieve the policy and their associated costs and benefits.

On September 5, 2019, the CEC, CARB, and CPUC publicly kicked off a collaborative effort to implement SB 100 with a workshop that included participation from the Governor's Office, the Secretary of Natural Resources, and leadership from each of the agencies. At the workshop, policy leaders stressed that the benefits of California's clean energy future must reach low-income and disadvantaged communities. To help engage a wide variety of perspectives on the

³¹ A balancing authority is responsible for continuously balancing supply and demand for electricity within its areas and between other balancing authorities and for maintaining adequate reserves to ensure reliable operation. They including the California Independent System Operator, the Balancing Authority of Northern California, the Los Angeles Department of Water and Power, the Imperial Irrigation District, the Turlock Irrigation District, and several others who connect to California.

scope of the joint agency report, the collaborative effort held a series of three workshops held in Northern California, Central California, and Southern California.³²

Research is Needed to Support California’s Transition to Clean Energy in a Changing Climate

California’s clean energy future and environmental goals can only be fully realized by remaining at the forefront of clean energy research. Making the leap to a clean, modern energy system supporting continued growth in the world’s fifth-largest economy demands a sustained, directed, equitable, and vigorous public-interest research investment program. With SB100 as a north star, the CEC is investing in ideas and approaches to unlock the promise of the clean-energy, low-carbon future for all Californians.

Achieving and sustaining this future requires thoughtful, vigorous, benefit-focused investment through CEC programs like the Electric Program Investment Charge (EPIC). EPIC invests over \$130 million annually to unleash innovation and drive refinement in areas like energy efficiency, energy generation, storage, grid resiliency, renewable integration, electrified transportation, and to bring breakthroughs from the lab to the market. EPIC offers researchers and entrepreneurs something the market often cannot: sustained, reliable, and sufficient funding to do their work, minimizing risks that can derail progress or delay market adoption all with strong oversight.

Climate Science Requires Focus on All Sectors, Including Electricity

California met its goal of reducing statewide GHG emissions to 1990 levels in 2016—four years ahead of schedule.³³ The 2017 Climate Change Scoping Plan³⁴ laid out a cost-effective and achievable path to meet the state’s goal to further reduce statewide GHG emissions to 40 percent below 1990 levels by 2030. In 2017, GHG emissions in the electricity sector alone dropped more than 40 percent below the 1990 level;³⁵ however, there is still work to do in all sectors to meet the statewide 2030 target.

32 [For additional information and to participate in the Senate Bill 100 proceeding](https://www.energy.ca.gov/sb100), see <https://www.energy.ca.gov/sb100>.

33 In 2016, statewide GHG emissions were 429 MMT CO₂e, 2 MMT CO₂e below the 2020 GHG limit of 431 MMT CO₂e. GHG emissions have continued to decline since 2016. In 2017, statewide GHG emissions were 424 MMT CO₂e, 7 MMT CO₂e below the 2020 limit. CARB, 2019 Edition, [California Greenhouse Gas Emissions Inventory: 2000–2017](#) (pp. 1-2), https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf.

34 See CARB. 2017. [California’s 2017 Climate Change Scoping Plan](#), https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

35 CARB, [California Greenhouse Gas 2000-2017 Emissions Trends and Indicators Report, 2019 Edition](#) <https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fww2.arb.ca.gov%2Fghg-inventory->

The state also faces the challenge of meeting mid-century targets to achieve the state's climate change goals. As discussed above, SB 100 established a 100 percent zero-carbon electricity goal by 2045. Furthermore, state policy calls for economywide GHG emissions reductions of 80 percent below 1990 levels by 2050³⁶ and carbon neutrality by 2045, with net negative emissions thereafter.³⁷ These aggressive goals are consistent with the Paris Agreement—which calls for limiting global warming to well below 2 degrees Celsius and pursuing efforts to limit warming to 1.5 degrees.³⁸

Effectively integrating 100 percent zero-carbon electricity and achieving carbon neutrality in the state by 2045 will require rigorous analysis of various scenarios and pathways as well as coordinated planning across multiple state agencies, local governments, utilities, and community choice aggregators. This planning must also include developing strategies to increase the resiliency of California's electricity system to the effects of climate change (see Chapter 5). Although California is ahead of schedule in meeting its 33 percent renewable energy target by 2020 and on track to achieve 60 percent renewable energy by 2030, completely decarbonizing the electricity sector to meet climate change objectives will dramatically change the state's electric system and focused attention is needed to maintain reliability.

Initial Considerations for Near-Zero Carbon Electricity

On September 24, 2019, the CEC hosted an IEPR workshop on Near-Zero Carbon Electricity. The workshop's objective was to explore existing decarbonization scenarios and pathways and to highlight some practical considerations that could help inform policy makers working to achieve 2045 and 2050 clean energy and carbon neutral goals. The IEPR workshop, while complementary, is separate from the ongoing workshops being held to inform the SB 100 proceeding.

The workshop began with a brief overview of the CARB Climate Scoping Plan. The Scoping Plan describes the approach California will take to reduce GHG emissions to achieve its goals. Dr. Maureen Hand, an air resources engineer at CARB, noted that CARB's "thinking about how to approach climate challenge is evolving" and "the concept of carbon neutrality is gaining

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36 Executive Order S-03-55.

37 Executive Order B-55-18.

38 IPCC, [Special Report Global Warming of 1.5°C](https://www.ipcc.ch/sr15/), <https://www.ipcc.ch/sr15/>.

importance.”³⁹ The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 Degrees Celsius, released in 2018, finds that to limit global warming to 1.5 degrees Celsius, GHG emissions must be reduced and carbon must be removed from the atmosphere.⁴⁰ Consistent with these findings, the executive order on carbon neutrality introduces the concept of balancing carbon emissions and carbon sequestration within the state.⁴¹

The workshop then moved on to a discussion of two key studies containing in-depth analyses of decarbonization pathways. Dr. Zack Subin, a senior consultant at Energy+ Environment Economics (E3), and Melanie Kenderdine, a principal at Energy Futures Initiative (EFI), presented high-level synopses of their studies on decarbonization scenarios in California. Each study looked at various scenarios and developed multiple pathways based on distinct inputs. These studies provide multiple viewpoints, pathways, and potential strategies to decarbonize California’s energy system. While there are still many unknowns, these studies provide insight into some of the challenges the state may face as it moves to decarbonize the energy sector.

E3’s 2018 study *Deep Decarbonization in a High Renewables Future* analyzed a reference scenario, SB 350 scenario, and 10 mitigation scenarios to assess GHG emissions reductions required to meet the state’s 2030 and 2050 goals.⁴² As shown in Figure 10, the E3 study found that all of the mitigation scenarios including the high electrification scenario meet the state’s GHG emissions reduction goals.⁴³ The study focuses on the high electrification scenario, which E3 found to be relatively lower-cost and lower-risk compared to other mitigation scenarios.⁴⁴ This scenario uses a combination of existing technologies and includes high levels of energy efficiency and conservation, renewable electricity, and electrification of buildings and transportation.⁴⁵

39 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 31, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0>.

40 IPCC, [Special Report Global Warming of 1.5°C](https://www.ipcc.ch/sr15/), <https://www.ipcc.ch/sr15/>.

41 See Executive Order B-55-18.

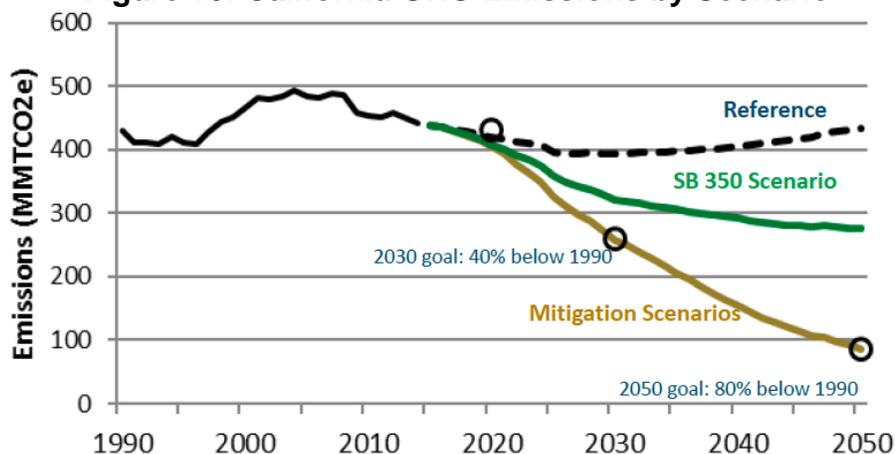
42 Energy+ Environment Economics (E3), *Deep Decarbonization in a High Renewables Future*, June 2018, pp. 28-29 https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf.

43 Ibid.

44 Ibid., p.2.

45 Ibid., pp. 2-3.

Figure 10: California GHG Emissions by Scenario



Source: E3, 2019

When summarizing this study at the workshop, Dr. Subin stated that “electrification is the lynchpin for decarbonizing the energy system.”⁴⁶ As shown in Figure 11, the E3 study indicates that in 2050, under the high electrification scenario, all of the emissions from buildings and light-duty vehicles are nearly eliminated.⁴⁷ Dr. Subin explained that this is accomplished by reaching 100 percent sales of electric building appliances and electric light-duty vehicles by about 2035 to 2040.⁴⁸ He also noted that “this leaves room for emission reductions in the most challenging sectors, such as industry, off-road transportation, waste, and agriculture.”⁴⁹ According to the E3 study, biofuels should be targeted toward high-value uses that are difficult to electrify or substitute, supplemented by electrolytic fuels or carbon capture and

46 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 48, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0>.

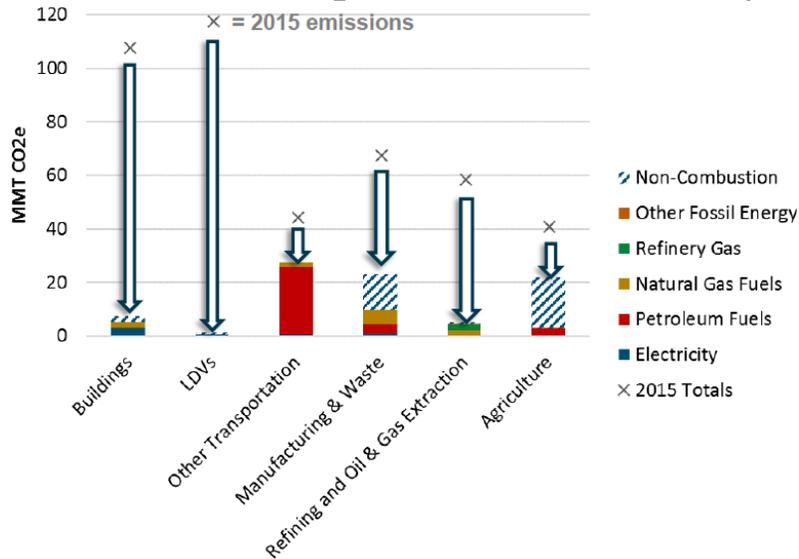
47 [E3 Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266), The Role of Electricity in Decarbonizing CA’s Energy System, p.5, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266>.

48 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 45, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7rIa5xm1E%3D&reserved=0>. The E3 study did not evaluate scenarios to achieve carbon neutrality by 2045, which will require accelerating these measures further or identifying additional measures.

49 [E3 Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266), The Role of Electricity in Decarbonizing CA’s Energy System, p.5, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266>.

sequestration or both (for example, aviation, trucking, industrial heating, and backup thermal electricity generation).⁵⁰

Figure 11: California 2050 GHGs High Electrification Scenario (86 MMT CO₂e)



Source: E3, 2019

E3’s high electrification scenario relies on current strategies to decarbonize electricity (for example, wind, solar, flexible loads, and storage).⁵¹ However, Dr. Subin explained that simply scaling up these strategies would not, by themselves, ensure the state fully achieves zero-emission electricity by 2050.⁵² In fact, the E3 study found that only 90 to 95 percent decarbonized electricity is achievable by scaling up current approaches.⁵³

According to E3, completely decarbonizing electricity will require an additional option to provide firm capacity and long-duration energy storage.⁵⁴ Dr. Subin noted “that could be one of any number of options, including using biomethane or hydrogen in gas turbines, it could be

50 Ibid., p. 11.

51 Ibid., p. 11.

52 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7r1a5xm1E%3D&reserved=0), p. 48, <https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7r1a5xm1E%3D&reserved=0>.

53 [E3 Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266), The Role of Electricity in Decarbonizing CA’s Energy System, p.5, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266>.

54 Ibid.

nuclear or CCS, or it could be advanced duration ... multiday storage.”⁵⁵ The E3 study concluded that until any of these additional options are available, maintaining sufficient firm capacity is critical.⁵⁶ Dr. Subin stated that this likely means “keeping most of the existing gas generation fleet around in California.”⁵⁷ Lastly, the E3 study notes that because electrification is consumer-facing, California must prioritize affordable, reliable electricity.

The workshop also delved into EFI’s 2019 study *Optionality, Flexibility, and Innovation, Pathways for Deep Decarbonization*.⁵⁸ The EFI study uses a portfolio approach to present a wide range of options to achieve deep decarbonization in California. In particular, the study identifies GHG emissions reduction potential and sector-specific pathways for meeting the state’s 2030 and 2050 targets.

The EFI and E3 studies use different inputs. Melanie Kenderdine, the report’s project director, explained that EFI used a 2016 baseline for GHG emissions reductions rather than the California 1990 baseline to account for changes in the technology space since 1990.⁵⁹ Ms. Kenderdine also noted that although total GHG emissions in 2016 are almost the same as in 1990, the emissions within each sector are different.⁶⁰

The EFI study examines emissions reductions of 40 percent below 2016 levels by 2030 and 80 percent below 2016 levels by 2050 on a per sector basis (assuming each sector must reduce by 40 percent and 80 percent below 2016 emission levels). Figure 12 shows EFI’s approach for

55 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 49, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0>.

56 [E3 Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266), *The Role of Electricity in Decarbonizing CA’s Energy System*, p.5, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229820&DocumentContentId=61266>.

57 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 49, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0>.

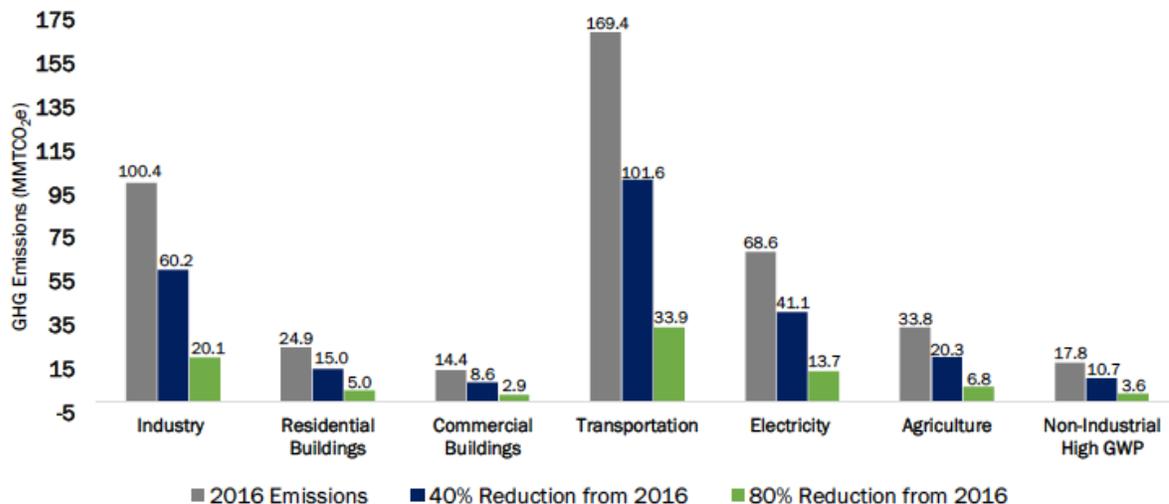
58 Energy Futures Initiative (EFI), May 2019, [Optionality, Flexibility, and Innovation, Pathways for Deep Decarbonization in California](https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf), https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf.

59 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 74, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7rIa5xm1E%3D&reserved=0>.

60 Ibid.

determining emissions reductions needed to meet the economywide targets by sector.⁶¹ According to EFI, in the electricity sector alone, 55 MMT CO_{2e} reductions are needed to meet the 2050 target.⁶²

Figure 12: Study Approach: 2030 and 2050 Emission Reduction Targets by Sector From 2016 Baseline (MMT CO_{2e})



Source: Energy Futures Initiative, 2019. Compiled using data from CARB, 2018.

The EFI study also looked at the different types of technologies needed to achieve the GHG emissions reductions for each sector. Figure 13 shows estimated emissions reduction potential for each pathway by sector based on an attempt to meet the state’s target of 40 percent emissions reduction from the 1990 (or 2016 as assessed by EFI) levels by 2030.⁶³ EFI’s scenarios envision that in the electricity sector, the largest emissions reduction by 2030 comes from natural gas combined cycle with carbon sequestration (NGCC).⁶⁴ The EFI study indicates

61 EFI, May 2019, [Optional, Flexibility, and Innovation, Pathways for Deep Decarbonization in California](https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf), https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf.

62 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwvGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 78, <https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwvGQTD2PPV7rIa5xm1E%3D&reserved=0>.

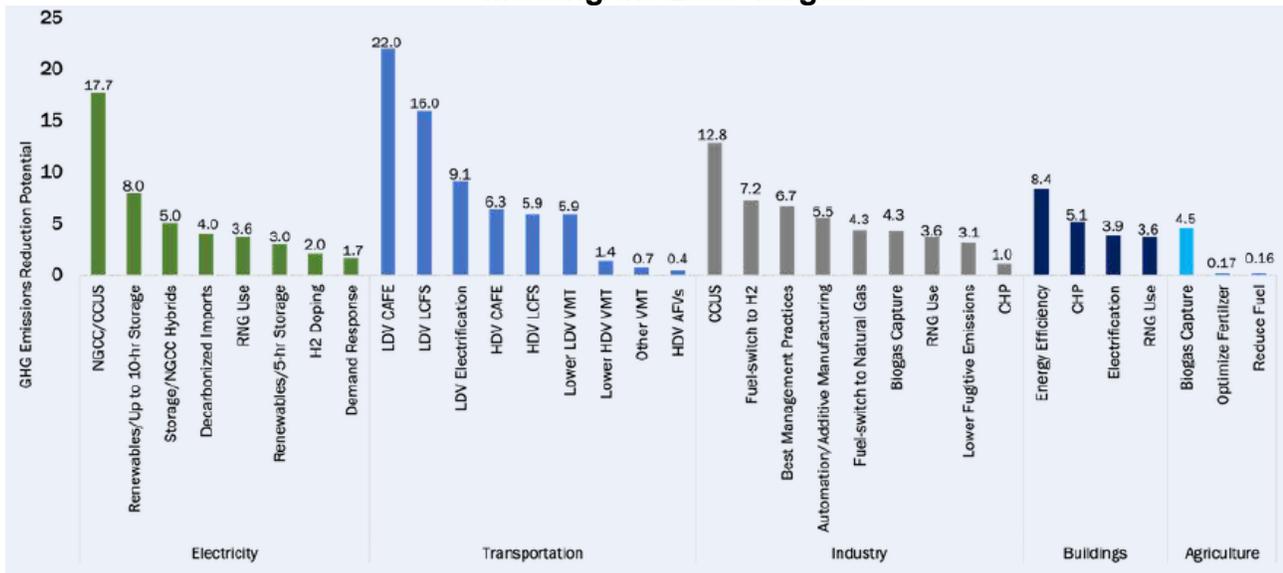
63 EFI, May 2019, [Optional, Flexibility, and Innovation, Pathways for Deep Decarbonization in California](https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf), https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf.

64 Ibid.

[Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwvGQTD2PPV7rIa5xm1E%3D&reserved=0), p. 82, <https://gcc01.safelinks.protection.outlook.com?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwvGQTD2PPV7rIa5xm1E%3D&reserved=0>

that the state could achieve 17.7 MMT in reductions from NGCC (nearly 50 percent of in-state generation comes from natural gas powered plants) and about 8 MMT could come from renewables with up to 10 hours of energy storage.⁶⁵ These two top pathways, Ms. Kenderdine explained, could help achieve the reductions in the electricity sector that EFI found are needed by 2030.⁶⁶

Figure 13: Identified Emissions Reduction Potential of Sector-Specific Pathways for Meeting the 2030 Targets



Source: Energy Futures Initiative

However, EFI does not believe that storage for 10 days stretches with no wind will be available by 2030.⁶⁷ At the workshop, Ms. Kenderdine explained that natural gas fuel is needed to run the system reliably with a lot of wind and solar on the electric system.⁶⁸ Further, she noted

cumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7r1a5xm1E%3D&reserved=0.

65 Energy Futures Initiative (EFI), May 2019, *Optionality, Flexibility, and Innovation, Pathways for Deep Decarbonization in California*, https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf.

66 *Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity*, p. 82, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DcumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uvwGQTD2PPV7r1a5xm1E%3D&reserved=0>. The E3 study did not evaluate scenarios to achieve carbon neutrality by 2045, which will require accelerating these measures further or identifying additional measures.

67 *Ibid.*, pp. 79, 85.

68 *Ibid.*, p. 86.

that hydrogen made from renewables could substitute natural gas and serve as the fuel needed to run the system.⁶⁹ Yet it is unclear whether existing infrastructure can be used for hydrogen in time to meet the 2030 and 2050 targets.⁷⁰

The EFI and E3 scenarios and pathways provide useful data points for decision makers to consider as the state transitions to a 100 percent clean energy standard and works toward a carbon neutral economy. No matter which strategies are selected to achieve the 2030 and 2050 GHG emissions reduction goals, there are some practical considerations for policymakers to keep in mind (for example, the multiple days in a row of low or no wind and solar to meet demand).

At the September 24 workshop, Ms. Debra Lew, an energy consultant to the Western Interconnection Regional Advisory Body, illuminated some of these considerations. She stated that “100 percent clean energy is possible with today’s technology ... but it might be very expensive,” if not implemented in a smart way with costs in mind.⁷¹ Ms. Lew highlighted three challenges to grid reliability as the amount of intermittent resources increases: system stability, system balancing, and resource adequacy. Concerning system balancing, she noted the importance of controlling both sides of the supply/demand balance and suggested that this may be addressed with controllable or price-sensitive signals on both sides of the supply and demand balance.⁷² For instance, Ms. Lew explained, time-of-use rates could replace the need for a four-hour battery, and coincident peak demand charges could replace the need for more system peakers.⁷³

However, Ms. Lew noted that time-of-use prices alone are not enough to balance supply and demand; chasing time-of-use rates can make system balancing worse by causing large step changes.⁷⁴ She suggested that dispatching demand can smooth this problem and noted that we must start thinking of demand response, not as a generator, but more as demand that is price elastic.⁷⁵ This would mean that demand would be determined by who is willing to pay at a moment in time.⁷⁶ Ms. Lew explained that if there is significant amount of price-elastic

69 Ibid.

70 Ibid.

71 Ibid., p. 61.

72 Ibid., p. 63.

73 Ibid.

74 Ibid., p. 64.

75 Ibid., p. 65.

76 Ibid., p. 66.

demand and we electrify inherently flexible sectors, such as transportation and building heating, the loss of load concept goes away (hours or days for which generation is insufficient to meet demand).⁷⁷ In response to CEC Commissioner McAllister's questions on how and who can implement demand responding to price, Ms. Lew explained "we most expose more loads to more price volatility."⁷⁸ One way would be to develop more plug-and-play infrastructure through code and standards such that aggregators can use control protocols to communicate with loads like electric water heaters and other appliances.⁷⁹

Regarding system stability, Ms. Lew discussed the challenge caused by high penetration of inverter-based resources (such as solar and wind) in the electric system.⁸⁰ Inverters read the system voltage and frequency and inject current appropriately.⁸¹ All inverters on the grid are grid-following inverters and they require system strength to operate reliably and stably.⁸² Ms. Lew explained that if 100 percent of electricity comes from inverters it would not work because the grid-following inverters would not have a voltage or frequency reference signal to read.⁸³ To help address this challenge, Ms. Lew noted, states must begin exploring options available, including fine-tuning and coordinating controller settings, installing synchronous condensers to provide grid strength, building more transmission to alleviate weak grid issues, and developing or requiring grid forming inverter technologies.⁸⁴

Changes Related to Electric Service Providers

Adding to the complexity of planning for and implementing the changes needed in California's electricity system are shifts and uncertainty in the business models for electric service

77 Ibid.

78 Ibid., pp. 101-102.

79 Ibid., p. 103.

80 Ibid., pp. 66-67.

81 [Debra Lew Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-07), Maintaining Reliability in a Near-Zero carbon Grid, <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-07>.

82 Ibid.

83 [Transcript of September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7r1a5xm1E%3D&reserved=0), p. 67, <https://gcc01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fefiling.energy.ca.gov%2FGetDocument.aspx%3Ftn%3D230529%26DocumentContentId%3D62099&data=01%7C01%7C%7Ca5a959d59e7743960a3208d763ce2326%7Cac3a124413f44ef68d1bbaa27148194e%7C0&sdata=veAVcyBq05aqBtCd37GO%2FR2uwwGQTD2PPV7r1a5xm1E%3D&reserved=0>.

84 Ibid., pp. 69-69

[Debra Lew Presentation for September 24, 2019, IEPR Lead Commissioner Workshop on Near-Zero Carbon Electricity](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-07), Maintaining Reliability in a Near-Zero carbon Grid, <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-07>.

providers. Traditionally, electric service providers have been the primary mechanism for implementing state energy policies.

IOU Financial Uncertainty and Fire Liability

Facing up to \$30 billion in liability associated with the deadly fires in the northern portions of the state in the last few years, Pacific Gas and Electric Company (PG&E) filed voluntary petitions under Chapter 11 of the U.S. Bankruptcy Code on January 29, 2019. PG&E was able to secure financing to ensure that during the bankruptcy process it would be able to deliver safe and reliable electricity and natural gas to its customers. The Bankruptcy Court provided PG&E with the authority to continue existing customer programs, including energy efficiency and other programs that support adoption of clean energy. In response to the Chapter 11 filing, Governor Gavin Newsom issued the following statement:

“PG&E today filed for reorganization in federal bankruptcy court. That was PG&E’s choice, but it does not change my focus, which remains protecting the best interests of the people of California. My administration will continue working to ensure that Californians have access to safe, reliable, and affordable service, that victims and employees are treated fairly, and that California continues to make forward progress on our climate change goals.”⁸⁵

In June 2019, the judge overseeing the bankruptcy proceeding ruled that the bankruptcy court, not the Federal Energy Regulatory Commission (FERC), has final jurisdiction over whether the utility can cancel and amend up to \$42 billion in power purchase agreements, including for renewable projects to meet the state RPS requirements. This ruling raises concerns over what action the court will ultimately take on the RPS contracts and how that might affect the state’s progress in meeting RPS goals and reducing GHG emissions.

Fires in Southern California similarly pose large potential liability for Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E). In response to the PG&E bankruptcy filing, the credit of all utilities was downgraded. However, financial conditions have improved somewhat with the IOUs showing profits during the second quarter of this year.⁸⁶ Energy companies credited Governor Newsom and state lawmakers for creating a new wildfire liability insurance

⁸⁵ [Governor Newsom statement on PG&E bankruptcy filing](https://www.gov.ca.gov/2019/01/29/pge-bankruptcy-filing/) https://www.gov.ca.gov/2019/01/29/pge-bankruptcy-filing/.

⁸⁶ For example on July 31, 2019, Moody’s Investor Services upgraded SDG&E from a negative outlook to a positive outlook based on improved fire safety programs and AB 1054 establishing a new utility wildfire insurance fund. [SDG&E media statement on Moody’s upgrading SDG&E’s financial outlook](https://sdgenews.com/article/sdge-media-statement-moodys-upgrading-sdges-financial-outlook) https://sdgenews.com/article/sdge-media-statement-moodys-upgrading-sdges-financial-outlook.

fund for utilities earlier this summer, saying it will ease the risk of fires that undermine their financial stability.⁸⁷

In response to instability in the energy sector and PG&E's decision to file for bankruptcy, Governor Newsom created a strike force in February 2019 to coordinate the state's efforts relating to the safety, reliability, and affordability of energy and achieving the state's climate commitments.⁸⁸ In October 2019, widespread public safety power shutoffs in response to wildfire risk further amplified the need to address fire risks. (For more information, see Chapter 5 on Climate Adaptation.) Millions of Californians lost power for days at a time. Governor Newsom stated that, "Far too many households and businesses were without power for seven days straight. This cannot – and will not – be the new normal."⁸⁹

Emergence of Community Choice Aggregators and the Evolving Role of IOUs

The movement toward community choice aggregators, along with growth in customer-installed resources (primarily rooftop solar photovoltaic [PV]), has transformed what was once a vertically integrated industry to one in which responsibility for resource procurement and resource adequacy is fragmented among a diverse set of entities. Community choice aggregators are formed by local jurisdictions or through joint powers authorities to purchase power for their customers. Their governing bodies are composed mostly of city and county officials representing districts within the community choice aggregator and have staffs that are usually separate from municipality or county staff.

When a community choice aggregator is established, IOU customers in the service area are automatically enrolled in the community choice aggregator and must opt out of the community choice aggregator if they choose to remain with the IOU. The community choice aggregator is responsible for procuring power, while the IOU is responsible for distribution, metering, billing and collection, and customer service. In 2019, community choice aggregators are expected to account for more than 20 percent of total load in the IOUs' service territories and they are expected to grow over the next few years.⁹⁰ In fact, 26 local jurisdictions have filed statements

87 California Current, August 5, 2019.

88 Governor Newsom's Strike Force. *Wildfires and Climate Change: California's Energy Future*. April 12, 2019. [Wildfires and Climate Change: California's Energy Future report](https://www.gov.ca.gov/wp-content/uploads/2019/04/Wildfires-and-Climate-Change-California's-Energy-Future.pdf) <https://www.gov.ca.gov/wp-content/uploads/2019/04/Wildfires-and-Climate-Change-California's-Energy-Future.pdf>.

89 [Governor Newsom Outlines State Efforts to Fight Wildfires, Protect Vulnerable Californians and Ensure that Going Forward, All Californians have Save, Affordable, Reliable and Clean Power](https://www.gov.ca.gov/2019/11/01/governor-newsom-outlines-state-efforts-to-fight-wildfires-protect-vulnerable-californians-and-ensure-that-going-forward-all-californians-have-safe-affordable-reliable-and-clean-power/), November 1, 2019, <https://www.gov.ca.gov/2019/11/01/governor-newsom-outlines-state-efforts-to-fight-wildfires-protect-vulnerable-californians-and-ensure-that-going-forward-all-californians-have-safe-affordable-reliable-and-clean-power/>.

90 In 2019 community choice aggregators are expected to account for 36 percent of load in Pacific Gas and Electric (PG&E) service territory and 12.4 percent for Southern California Edison (SCE). San Diego Gas & Electric (SDG&E) has less than 1 percent of load met by community

of intent or implementation plans or both with the CPUC to establish a community choice aggregator.

The rapid emergence of community choice aggregators over the last few years prompted the CPUC to undertake a comprehensive assessment of the impacts of community choice aggregators and increased customer choice. In particular, the CPUC assessed how this trend affects California's ability to achieve policy objectives related to affordability, decarbonization, and reliability. Community choice aggregators are an exciting new model that brings benefits to customers in different ways than IOUs.⁹¹ Addressing global warming requires all hands on deck and it is important that all power providers are working together collaboratively and strategically to ensure the state meets its climate-related goals.

Recommendations

Both the 2017 IEPR and the 2018 IEPR Update focused extensively on the challenges and opportunities associated with increasing the flexibility and resilience of the electricity system. These IEPRs included a wide range of recommendations to meet these challenges while also maintaining a reliable, sustainable electricity sector that will support continuing decarbonization of the transportation and building sectors. Recommendations included improvements needed in rate design, forecasting, demand response, energy storage, expansion of western electricity markets and regional coordination, and research and development for transportation electrification, smart inverters, and electric vehicle chargers.

While progress has been made in many of these areas, California must continue developing the tools needed to ensure a reliable grid as load is added and the state brings more variable renewable resources on-line. The following are recommendations to further advance California's electric system:

- **Develop a plan that identifies the appropriate amount and mix of resources and technologies to ensure reliability in the near- to mid-term while facilitating the longer term transition to a zero-carbon electricity system called for in Senate Bill 100.** The California Energy Commission (CEC) should continue to work with the California Public Utilities Commission (CPUC), the California Air Resources Board, and the California Independent System Operator (California ISO) to develop an orderly plan for deploying new clean technologies to ensure a reliable zero-carbon grid in 2045. The plan for the near- to mid-term should account for plant

choice aggregators. However, the City of San Diego developed a business plan for forming a community choice aggregator that would encompass 30 percent of SDG&E's load and could begin service in 2021.

⁹¹ [Information about community choice aggregation on the California Community Choice Association website](https://cal-cca.org/cca-impact/) https://cal-cca.org/cca-impact/.

retirements, identify critical, strategically located gas generation needed for reliability where deferring retirements may be appropriate, and ensure that new and emerging technologies are employed to fill the role of these plants. This will allow for the retirement of natural gas generation and provide a reliable and resilient grid in the long-term.

- **Continue to support research to better forecast load and renewable generation.** The CEC should continue to support research that improves forecasting capabilities that allow grid operators to predict more accurately the amount of generation that will be needed to meet the net load and support more frequent bidding of solar generators into short-term markets.
- **Accelerate research, development, and use of smart inverters.** The CEC, CPUC, and the California ISO should accelerate research, development, and deployment of smart inverters with advanced capabilities for inverter-based resources to enhance power quality, decrease grid disturbances, and participate in ancillary service markets.⁹²

⁹² "Ancillary services" refer to the functions that help grid operators maintain a reliable electricity system. Ancillary service maintain the proper flow and direction of electricity, address imbalances between supply and demand, and help the system recover after a power system event.

CHAPTER 2:

Building Decarbonization and Energy Efficiency

Introduction

Expanding on California's decades-long leadership on climate change, the state is working to double the energy efficiency of, and decrease the greenhouse gas (GHG) emissions from, existing buildings. The transformation of buildings from carbon emitters to a clean distributed energy resource will require support of stakeholders, regular and sustained state guidance, creative incentive programs, market transformation, and new technologies. It will also require the balance of other state goals and challenges, such as increasing energy equity, reducing costs, and managing increased levels of energy demand with clean electricity sources.

The California Energy Commission (CEC) is developing the California 2019 Energy Efficiency Action Plan (2019 Action Plan) that will serve as the state's policy map for improving, increasing, and targeting energy efficiency. The CEC released the draft 2019 Action Plan⁹³ for public comment in August 2019 and will consider it for adoption by the end of 2019. The 2019 Action Plan is built around three goals:

- Achieving a doubling of energy efficiency savings by 2030.
- Reducing the barriers to energy efficiency in low-income, disadvantaged, and rural communities, as well as reducing the metrics developed to track progress.
- Reducing GHG emissions from the built environment.

The CEC gathered public input on the 2019 Action Plan through five workshops from April to May 2019.⁹⁴ The proposed 2019 Action Plan includes background and recommendations on energy programs and efficiency targets. It also addresses financing mechanisms, resiliency, multifamily building energy efficiency, building decarbonization, industrial and agricultural energy efficiency, use of energy data to better design and target efficiency, demand response measures, and barriers and opportunities to expand low-income and rural residents' access to energy efficiency and renewable energy.

The CEC's Energy Research and Development Division is assessing pathways to decarbonizing the energy system. The division funded a study by E3, to evaluate deep decarbonization

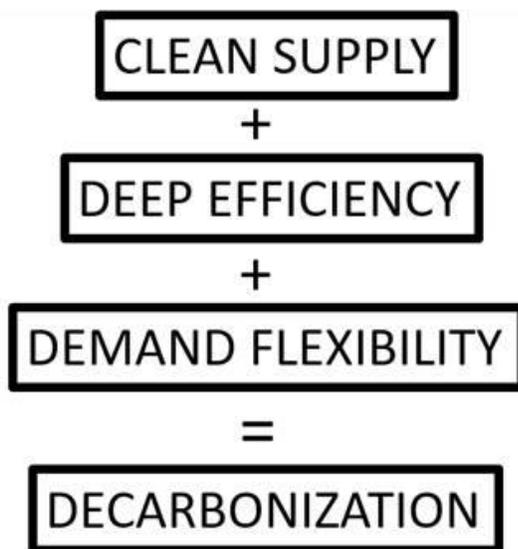
93 [2019 California Energy Efficiency Action Plan- draft staff report](https://efiling.energy.ca.gov/getdocument.aspx?tn=229496) <https://efiling.energy.ca.gov/getdocument.aspx?tn=229496>.

94 The CEC held workshops in San Francisco, Redding, Fresno, Los Angeles, and San Diego. [Link to information on workshops under the 2019 IEPR proceeding on the CEC's website](https://ww2.energy.ca.gov/2019_energypolicy/documents/) https://ww2.energy.ca.gov/2019_energypolicy/documents/.

scenarios in California for the 2030 and 2050 timeframes.⁹⁵ All scenarios for meeting California’s decarbonization targets show reduced natural gas demand at the distribution level, negative impacts on gas system reliability as throughputs decline, and increased gas rates for remaining customers.

Another recent study by Gridworks urges the state to develop a gas system transition plan that will “minimize and stabilize” rate increases.⁹⁶ Three key, complementary elements are required for the long-term achievement of California’s emissions reduction goals (see Figure 14): clean energy supply resources (see Chapters 1 and 9), energy efficiency improvements in buildings and appliances (both gas and electric), and flexibility in electric demand.

Figure 14: Achieving Optimal Decarbonization



Source: CEC

Decreasing the State’s Reliance on Fossil Fuels in Buildings

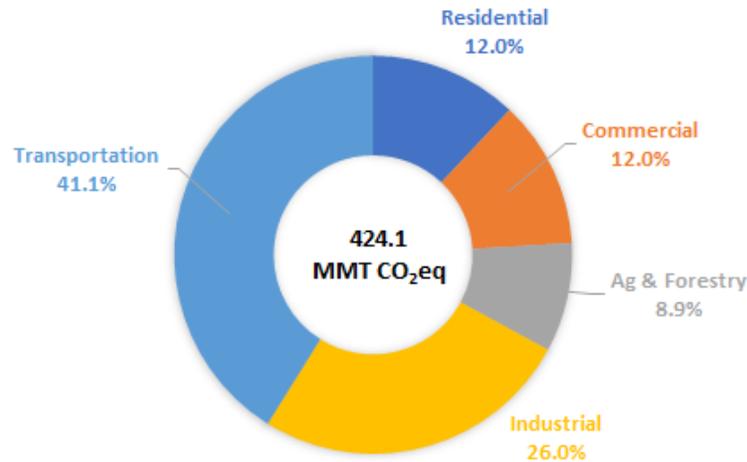
California’s existing buildings (represented by residential and commercial sectors in Figure 15) account for nearly a quarter of the state’s GHG emissions. This includes emissions from both fossil fuel consumed onsite (gas or propane for heating) and that embedded in electricity (lighting, appliances, and cooling).

95 Energy and Environmental Economics (E3) produced the study, [Deep Decarbonization in a High Renewables Future](https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf) https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf.

96 Gridworks. [California’s Gas System in Transition](https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf), https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.

The 2009 Residential Appliance Saturation Survey (RASS) estimated 93 percent of natural gas combusted in statewide households results from these three end uses: water heating at 49 percent, space heating at 37 percent, and cooking at 7 percent.⁹⁷

Figure 15: California's 2017 GHG Emissions by End Use



Source: CEC using data from CARB GHG Inventory

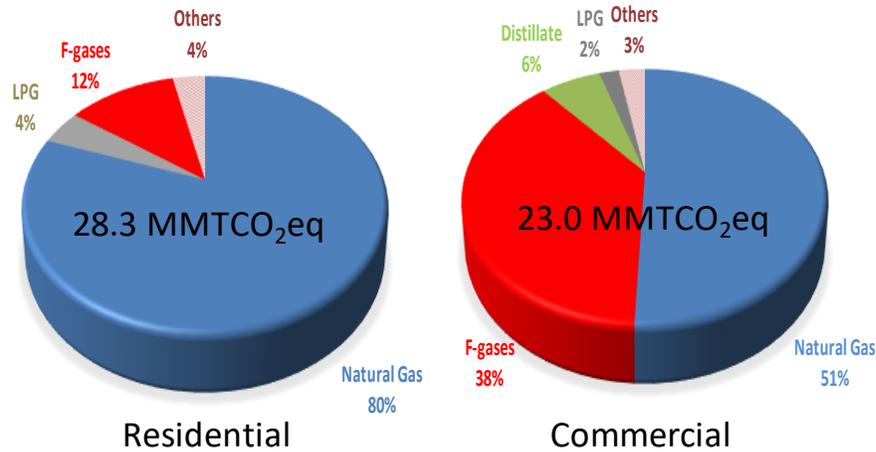
In 2009, natural gas provided onsite heating for 90 percent of the state's buildings. The remaining 10 percent of buildings had heat provided primarily by propane gas.⁹⁸ Figure 16 shows the percentage of GHG fuels consumed in residential and commercial settings. Natural gas is the main source of direct GHG emissions from residential and commercial building sectors at 80 and 51 percent respectively. Indoor GHG emissions from gas heating include carbon dioxide, nitrous dioxide, and escaped methane through combustion.

To reduce GHG emissions in buildings, options include making gas-powered products more efficient, electrifying end uses previously served by natural gas, and switching to low-GHG fuel sources, such as renewable natural gas (RNG).

97 CEC. [2009 California Residential Appliance Saturation Survey \(RASS\)](#). Figure ES-6: Statewide Natural Gas Energy Consumption, 354 therms per household. The CEC RASS is conducting a 2019 RASS with results expected in March 2020. <https://ww2.energy.ca.gov/appliances/rass/>.

98 CEC. 2009. [California Residential Appliance Saturation Survey \(RASS\)](#). 2010. Table ES-4: Saturation by Dwelling Type.

Figure 16: Direct GHG Emissions From the Residential and Commercial Sectors



Source: CEC staff using data from the California Air Resources Board (CARB) Note: Fluorinated gases, or *F-gases*, are man-made gases that have some of the highest global warming potential values. There are four types: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF₆), and nitrogen trifluoride (NF₃). *LPG* represents liquefied petroleum gases.

Recent research estimates⁹⁹ that overall methane emissions from leaks and unburned methane in California homes is equivalent to about 0.5 percent of total consumption in the residential sector.¹⁰⁰ Methane released into the atmosphere is 25 times more potent than the same quantity of carbon dioxide, making prevention of escaped methane emissions critical to combating climate change.¹⁰¹ To make sure that methane is captured in reporting, analysis, and solution sets, CARB is including methane leaks from homes in its California GHG inventory.¹⁰²

In addition to methane emissions in homes and businesses, emissions estimates show that most methane emissions occur during source extraction and processing of natural gas. For example, a recent study by the Environmental Defense Fund estimates methane leaks for the natural gas system, nationwide, from well production through distribution, to be 13 million

99 Sweeney, Meredith, Daniel Ersoy, Kristine Wiley, Erin Case, Eric Stubee, and Marc L. Fischer. Gas Technology Institute. 2019. *Assessment of Fugitive Emissions from the Natural Gas System—Commercial Buildings*. California Energy Commission. Publication Number: CEC-500-2017-033.

100 Fischer, M. L., W. R. Chan, W. Delp, S. Jeoin, V. Rapp, Z. Zhu. 2018. "An Estimate of Natural Gas Methane Emissions From California Homes." *Environmental Science & Technology*. 52, 10205-10213.

101 IPCC, AR4 Climate Change 2007: Synthesis Report, [Link to AR4 Climate Change 2007: Synthesis Report on the IPCC's website](https://www.ipcc.ch/report/ar4/syr/)

102 The global warming potential (GWP) of methane (CH₄) gas is 21. Methane is much more potent than carbon dioxide (CO₂) gas by comparison. Carbon dioxide is the gas reference for all GHG's and has a GWP score of 1. All GHG's are indexed to CO₂ using a CO₂ equivalent (CO₂e), unless otherwise noted.

metric tons carbon dioxide equivalents (MMT CO₂e).¹⁰³ Since California imports about 90 percent¹⁰⁴ of its natural gas, it is important to quantify the associated out-of-state emissions. In addition to source extraction sites, the natural gas supply chain relies on an extensive distribution pipeline system, throughout which leaks can occur. Overall, the emissions estimates from the delivery system are less than those for source emissions. Recent studies attribute 5 percent of total U.S. pipeline leakage to the western region (which includes California and 11 other states).¹⁰⁵ The rate is comparatively low because the western region has newer or upgraded piping in comparison to other regions.

Injection of RNG—produced from biomass—into the pipeline can lower net system GHG emissions relative to an all-fossil natural gas supply. However, multiple sectors are already competing for the limited supply of RNG, including heavy-duty transportation and aviation.¹⁰⁶ Synthetic natural gas, which is produced using carbon dioxide and hydrogen from sustainable sources is another option but seems to be costly.¹⁰⁷ Clean hydrogen could also be blended with natural gas, but there are limitations with regard to the amount that could be safely injected into pipelines.¹⁰⁸ All these options should be considered when looking at potential decarbonization of the natural gas system. Regardless of source, methane leakage must be addressed given its direct climate impact. Methane leakage from the oil and gas sectors, left uncontrolled, also poses serious public health risks.¹⁰⁹ The processes of fracturing and flaring methane gas results in the release of harmful particulate matter into the atmosphere. Long-term exposure to concentrated particulate matter has negative public health impacts.¹¹⁰

As indicated above, reducing GHG emissions in California buildings will require a combination of clean energy supplies, deep energy efficiency improvements in buildings and appliances,

103 Aerial Surveys of Elevated Hydrocarbon Emissions from Oil and Gas Production Sites. 2016. Environmental Defense Fund (EDF). Lyon, David, Alvarez, Ramon, Zavala-Araiza, Daniel, Brandt, Adam, Jackson, Robert and Hamburg, Steven.

104 CEC. [California Energy Demand 2014-2024 Final Forecast](https://ww2.energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-SF-V1.pdf) <https://ww2.energy.ca.gov/2013publications/CEC-200-2013-004/CEC-200-2013-004-SF-V1.pdf>.

105 2015. [Direct Measurements Show Decreasing Methane Emissions from Natural Gas Local Distribution Systems in the United States](https://pubs.acs.org/doi/abs/10.1021/es505116p) <https://pubs.acs.org/doi/abs/10.1021/es505116p>. (See National Emission Inventory section.)

106 Synthetic natural gas, which is produced using carbon dioxide and hydrogen from sustainable sources is another option but seems to be costly (Mahone et al., 2018, Aas et al., 2019). Clean hydrogen could also be blended with natural gas, but there are limitations with regard to the amount that could be safely injected (Aas et al., 2019). All these options should be considered when looking at potential decarbonization of the natural gas system.

107 CEC, [Natural Gas Distribution in California's Low-Carbon Future](#) (October 2019). CEC-500-2019-055-D

108 CEC, [Natural Gas Distribution in California's Low-Carbon Future](#) (October 2019). CEC-500-2019-055-D

109 [World Health Organization, Ambient Air Pollution: Health Impacts](#)

110 Office of Air Quality Planning and Standards, US EPA. [Assessing Human Health and Ozone Impacts from US Oil and Natural Gas Sector Emissions in 2025](#)

and electric demand flexibility. The use of fossil natural gas in California’s buildings presents a challenge. On the one hand, California’s transition toward low-emissions energy systems begins with a status quo of thorough penetration of gas service and end uses across the state’s diverse stock of buildings, variable climates, and vast array of locations. On the other hand, over the longer term, the state must wean itself from fossil natural gas. That is, customers across the state must have reliable, affordable access to non-fossil options for all their energy needs.

San Diego Gas and Electric (SDG&E) commented: “The CEC must design and implement technology neutral programs to achieve building decarbonization and customer’s needs and preferences must be represented. This ‘customer choice’ approach will lead to cost-effective programs for building decarbonization. ... There are other paths to building decarbonization, which includes pairing renewable natural gas with more efficient gas end use devices, and SDG&E encourages the CEC employ a technology neutral approach when deciding how to reduce emissions in buildings.”¹¹¹

Southern California Gas (SoCalGas) suggested, “If the goal is to make significant strides to combat climate change, a multifaceted approach that considers all pathways to lower the carbon intensity of residential and commercial buildings is best, especially if there are more cost-effective and less disruptive ways to achieve the same goal.”¹¹²

During the April 22, 2019, joint agency workshop on Building Decarbonization, SoCalGas further commented, “Commercial buildings that need reliable energy for critical equipment (such as hospitals) may choose to invest in highly efficient combined heat and power systems that are independent of the electric grid to support their needs. Allowing for such flexibility should be considered.”¹¹³

Investing in energy efficient natural-gas equipment in dual-fuel buildings offers an opportunity to achieve energy savings and carbon reduction in the near and medium terms. Indeed, the Energy Efficiency Action Plan focuses on improving both electric and gas efficiency as part of the Senate Bill 350 (De León, Chapter 547, Statutes of 2015) energy efficiency doubling target. However, it is not clear that the state’s 2045 GHG reduction goals are consistent with maintaining the current size and scale of its gas distribution systems. Leakage and indoor air quality will remain nettlesome issues. And none of the gas advocates have made a clear case for a realistic long-term pathway in which most or all retail customers will have a choice of

111 [Comments of SDG&E](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228288&DocumentContentId=59466), Docket Number 19-IEPR-06, TN 228288, p. 4, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228288&DocumentContentId=59466>.

112 SoCalGas comments on Building Decarbonization Workshop, [CEC docket 19-IEPR-06, TN #227834](#)

113 Ibid.

safe, carbon-free gas for use in buildings. Indeed, California’s second-largest gas distribution utility supports efforts to limit new connections to the natural gas system.¹¹⁴

To facilitate the enterprise of decarbonizing California’s buildings, the Legislature passed Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018) and Senate Bill 1477 (Stern, Chapter 378, Statutes of 2018). AB 3232 directs the CEC to assess how to reduce GHG emissions from buildings 40 percent below 1990 levels by 2030. The CEC will develop the building decarbonization assessment in a public process and will transmit the final report to the Legislature by January 1, 2021.

SB 1477 requires the CPUC, in consultation with the CEC, to create two incentive programs—Building Initiative for Low-Emissions Development (BUILD) and Technology and Equipment for Clean Heating (TECH). These two programs will use \$50 million of gas corporation cap-and-trade revenues annually for four years to promote the installation of low-emission and near-zero-emission space and water heating technologies in new and existing homes. The programs will promote clean emission technology and work to shift the market by coordinating with manufacturers, distributors, and contractors. In addition, SB 1477 addresses energy equity challenges by reserving a minimum 30 percent of total program funding for new housing in low-income and disadvantaged communities. The CPUC issued a building decarbonization order instituting rulemaking (OIR) proceeding in January 2019 (R.19-01-011).¹¹⁵ A final decision on the SB 1477 programs is expected in early 2020 with implementation to begin in late 2020.

Load Flexibility for Renewables Integration

Steep upward and downward ramps in load—in the morning and particularly in the afternoon and evening—present a daily challenge to electric system operators as discussed in Chapter 1. Flexibility on the load side can help mitigate these ramps and facilitate the use of renewable energy when it is available and, conversely, avoid using electricity when it has a relatively high carbon content, thus reducing overall GHG emissions.¹¹⁶ Optimizing demand flexibility can help pave the way for using higher levels of renewable resources and the eventual transition to a zero-carbon electricity grid. With the right automation, grid-level signals can allow devices to

114 [Inside Climate News article “Following Berkeley’s Natural Gas Ban, More California Cities Look to All-Electric Future”](https://insidclimateneeds.org/news/23072019/berkeley-natural-gas-ban-california-cities-incentive-all-electric-building-construction-future)
<https://insidclimateneeds.org/news/23072019/berkeley-natural-gas-ban-california-cities-incentive-all-electric-building-construction-future>.

115 CPUC opened the order instituting rulemaking regarding building decarbonization in November 2018, R.19-01-011

116 “Renewable integration” involves balancing electricity generation to load while maintaining voltage and frequency within prescribed limits to ensure reliability and provide reserves for unexpected events. Intermittent renewable resources that increase minute to minute and have hourly variability require more ancillary services and ramping capabilities.

minimize the associated impact on the distribution grid while maintaining or improving the ability to meet customer needs throughout the day.

Heat pumps for water and space heating are one example of an enabling technology for load flexibility. Making small adjustments in space-conditioning schedules and using heat pump hot water heaters as thermal batteries can help match the timing of electricity demand to the generation of renewable energy, as well as reduce the severity of the late afternoon demand ramp as solar output rapidly decreases.¹¹⁷

The greater the number of controllable heat pump systems in the built environment, the greater their aggregate potential to help integrate renewable resources and enhance grid reliability. Many other electric loads, including lighting, pumps and compressors, electric vehicles, and a wide array of appliances can provide analogous flexibility services routinely and cost-effectively.

Rapid electrification poses significant challenges to California's electricity distribution infrastructure. Natural gas has been the preferred energy resource for most heating end-uses, and electric distribution systems were not necessarily designed to meet those heating loads. Increased building decarbonization via electrification will require upgrading parts of the existing distribution system to handle the increased load. Transportation electrification will have a similar effect—a rapidly growing electrical load that will need to be accounted for in present-day upgrades and future distribution plans.

Onsite solar photovoltaic (PV) systems are now a mainstream reality for planning electricity supply and demand. Historical one-way (utility-scale generation being delivered to the consumer) grid design must adapt to include increasing amounts of generation being pushed from behind-the-meter onto the distribution system. Onsite panel sizing, grid interconnections, improved capacity factors and tolerances for “downstream” power transformers are important elements of load shift scenarios.

Today's grid continues to rely on natural gas power plants, especially to meet reliability requirements, peak hour demand, and for voltage and frequency regulation. New approaches to distribution system management can ensure that the increased decarbonization of transportation and buildings does not increase demand from natural gas power plants (particularly from less efficient peaker plants¹¹⁸) in such a way as to cause near-term increases

117 “Ramping” refers to the ability of generation resources to change output in larger amounts over a 10-minute to three-hour time frame to respond to larger changes in wind and solar output. For example, solar resources will shut down more or less at sunset, requiring that other generation is brought on-line quickly or “ramped up.” Generators must be able to “ramp down” as solar resources begin production after sunrise each day.

118 “Peaker plants” are typically simple-cycle generating stations that a utility uses to produce extra electricity during periods of high, or peak demand.

in emissions. Specifically, smarter and more grid-interactive buildings can help to meet these integration challenges while allowing existing heating equipment to be used for the associated full-rated life before upgrading.

The CEC and CPUC held a joint agency workshop August 27, 2019, on Energy Efficiency and Building Decarbonization. The workshop covered issues including the feasibility of decarbonizing buildings, load flexibility, energy efficiency, and fuel substitution options. After the workshop, multiple stakeholders submitted comments regarding cost-effective building decarbonization strategies and ideas about mixed fuel approaches that could reduce emissions. For instance, the Agriculture Energy Consumers Association (AECA), representing industrial sector customers, commented that full-electrification of industrial processing is not feasible in the short term.¹¹⁹ Instead, AECA supports exploring sustainable methods that reduce fossil fuel use (such as energy efficiency, solar thermal, and carbon capture). The American Public Gas Association (APGA) is supportive of overall GHG reductions and policies that advance cleaner fuels such as RNG.¹²⁰

Other stakeholders support policy action on decarbonization that focuses on a planned transition toward all-electric buildings to eliminate building-driven emissions. Redwood Energy, a multifamily housing design firm with experience in zero-carbon buildings, submitted comments requesting the CEC adopt an all-electric building code.¹²¹ Gridworks, a nonprofit organization studying decarbonization solutions, agrees the state should adopt an all-electric building code for new residential and commercial buildings. Gridworks¹²² recommends a strategic statewide transition away from the gas network within a public, long-term regulatory planning process that would include integrally the transition of the gas service workforce.

The CEC has reviewed all stakeholder comments¹²³ from the August 27 workshop and is considering all recommendations. In general, the CEC seeks information and diverse policy options that cost-effectively decarbonize buildings. Speaking at the workshop, Commissioner J. Andrew McAllister stated, “We need to think about load flexibility. I’m convinced that the least-

119 [Agricultural Energy Consumers Association written comments](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229753&DocumentContentId=61189) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229753&DocumentContentId=61189. TN# 229753. Submitted September 17, 2019.

120 [American Public Gas Association written comments](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229710&DocumentContentId=61136) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229710&DocumentContentId=61136. TN# 229710. Submitted September 10, 2019.

121 [Redwood Energy written comments](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229746&DocumentContentId=61180) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229746&DocumentContentId=61180. TN# 229746. Submitted September 17, 2019.

122 See Grid work’s 2019 report, [California’s Gas System in Transition](https://gridworks.org/initiatives/cagas-system-transition/), for their full list of policy recommendations. https://gridworks.org/initiatives/cagas-system-transition/.

123 [Public comments received for the August 27, 2019, joint agency workshop on Energy Efficiency and Building Decarbonization](https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-08-27_workshop/2019-08-27_comments.php) https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-08-27_workshop/2019-08-27_comments.php.

cost pathway is making our buildings all they can be—that they follow supply in a way that’s nimble”.¹²⁴

Load Management Standards

The past decade has seen remarkable advancements and transformations in both supply of and demand for electricity in California. Increased wind and particularly solar resources sharpen the challenge of balancing electric supply and demand in real time throughout each day, and across the seasons. These changes bring an urgent need for increased flexibility in demand-side resources to meet cleaner but decreasingly flexible supply resources.

California has long recognized the importance of using load management strategies to regulate real-time electric demand. As far back as 1976, the Warren-Alquist Act emphasized load management alongside energy efficiency requirements. Taken together, these tools ensure conservation of energy is first in the selection of resources to meet energy demand. Today’s opportunities dwarf those original aspirations, which mostly addressed emergency load shedding. Both the 2017 IEPR and 2018 IEPR Update articulated the importance of demand response, not only for economically managing onsite loads, but also for using other distributed energy resources to provide grid-stabilizing services.

The CPUC-directed and sponsored 2025 California Demand Response Potential Study (DR Potential Study)¹²⁵ found a largely untapped, cost-effective potential for thousands of megawatts (MW) of demand response to provide high value to California’s electricity system. Demand response can respond to system conditions by shifting load away from high-cost, high-GHG emission resources to lower-cost, low-GHG emissions resources when renewables are highly available and potentially in danger of curtailment. Demand response has traditionally been a utility- or customer-dispatched process, where customers receive the benefits of bill management, incentives, or credits.

In the past few years, attempts to expand the market for third-party demand response and integrate those resources into California ISO markets have been spearheaded through the CPUC’s Demand Response Auction Mechanism (DRAM). While utility demand response programs have always counted as resource adequacy, the DRAM provides an auction mechanism to procure resource adequacy from third-party demand response providers in

¹²⁴ [August 27, 2019 joint agency workshop on Energy Efficiency and Building Decarbonization recording](https://ww2.energy.ca.gov/php/yt_player.php?vidNo=J1pcss2twCc&title=Joint%20Agency%20Workshop%20on%20Energy%20Efficiency%20and%20Building%20Decarbonization&desc=California%20Energy%20Commission%20staff%20present%20the%20draft%202019%20California%20Energy%20Efficiency%20Action%20Plan,%20including%20updated%20strategies%20to%20increase%20energy%20efficiency%20in%20existing%20buildings%20and%20updated%20targets%20for%20doubling%20energy%20efficiency%20savings%20by%202030.)
https://ww2.energy.ca.gov/php/yt_player.php?vidNo=J1pcss2twCc&title=Joint%20Agency%20Workshop%20on%20Energy%20Efficiency%20and%20Building%20Decarbonization&desc=California%20Energy%20Commission%20staff%20present%20the%20draft%202019%20California%20Energy%20Efficiency%20Action%20Plan,%20including%20updated%20strategies%20to%20increase%20energy%20efficiency%20in%20existing%20buildings%20and%20updated%20targets%20for%20doubling%20energy%20efficiency%20savings%20by%202030.

¹²⁵ LBNL. [2025 California Demand Response Potential Study- Charting California's Demand Response Future](https://drrc.lbl.gov/publications/2025-california-demand-response)
[https://drrc.lbl.gov/publications/2025-california-demand-response.](https://drrc.lbl.gov/publications/2025-california-demand-response)

competition with the utility programs. DRAM providers earn capacity revenues through resource adequacy contracts with the utilities and energy revenues through direct participation in California ISO markets. The CPUC, IOUs, and California ISO have made concerted efforts to implement DRAM as a pilot. In its evaluation of the DRAM pilot,¹²⁶ the CPUC “found mixed results” and made recommendations to change the design of DRAM to improve the performance and reliability of DRAM resources. Subsequently, the CPUC redesigned DRAM and authorized the continuation of DRAM for four years, with the results to be evaluated for a permanent determination.

The 2017 IEPR and 2018 IEPR Update found that demand response in California is underperforming in terms of quantity of demand response megawatts in IOU portfolios and participating in California ISO markets. However, significant gains have been made to improve the quality of demand response through new CPUC rules and enforcement procedures prohibiting fossil back-up generation resources from participating in demand response, new click-through platforms to enable customer authorization of third-party demand response provider access to customer data, and integration of demand response into the California ISO market to make the resource more visible to grid operators. Demand response, particularly in combination with other distributed energy resources, could go well beyond DRAM in providing auxiliary services at the bulk-power and distribution levels. Demand response could provide services and earn revenues at multiple levels of the system, making demand response more economically viable in the short run and scalable in the longer term.

The DR Potential Study identifies the potential for expansion of demand response by an order of magnitude. New approaches are needed, coupled with increased focus and priority. The two most recent IEPRs have called for the CEC to use its load management standards authority to contribute to that outcome. The Warren-Alquist Act directs that the CEC:

“Adopt standards by regulation for a program of electrical load management for each utility service area ... to encourage load shifting through cost-effective rate structures, energy storage, and automation, among other things. ... Any expense or any capital investment required of a utility by the standards shall be an allowable expense or an allowable item in the utility rate base and shall be treated by the Public Utilities Commission as such in a rate proceeding.”

In 2008,¹²⁷ the state designated energy efficiency and demand response as the top strategies in the state’s loading order, giving demand-side resources the highest priority in meeting the

126 “Energy Division’s Evaluation of Demand Response Auction Mechanism,” Final Report, January 4, 2019.

127 See the [California Long Term Energy Efficiency Strategic Plan](#), also known as Strategic Plan. The CPUC first adopted the Strategic Plan in 2008; it was updated in 2011. <https://www.cpuc.ca.gov/general.aspx?id=4125>.

state's electricity needs.¹²⁸ More recently, both the 2017 IEPR and 2018 IEPR Update articulated the importance of demand response, not only to achieve onsite bill management objectives, but also to support system-wide stability in the electrical grid.

Given the ubiquity of interval meters and internet-connected end uses, the opportunities for demand flexibility today dwarf the state's original aspirations. The DR Potential Study found that nearly 20 years after the California electricity crisis—which sent peak prices soaring, and bankrupted the second largest electric utility in the state—significant potential for peak-shaving and load-shifting demand response still exists untapped. This means that thousands of megawatts of cost-effective capacity (shed), and far more megawatt hours of energy (shift) are left on the table, rather than providing high value to California's electricity system.

Recent state legislation¹²⁹ has directed the CEC to investigate load management as a tool for reducing GHG emissions by shifting electric demand to take advantage of abundant renewables. The CEC has initiated a rulemaking to identify and institute approaches that would enable statewide expansion of flexible technologies and practices.¹³⁰ In doing so, the CEC will seek the input of the CPUC, California ISO, and stakeholders to chart the most constructive path possible. The process will seek to identify the primary barriers to the practice of demand response and investment in flexible demand technologies, and to develop specific recommendations for reducing or removing those barriers.

Finally, and most recently, a new law (Senate Bill 49 [Skinner, Chapter 697, Statutes of 2019]) gives the CEC expanded authority to include demand flexibility in its Title 20 appliance regulations. This work will complement Load Management Standards efforts by eventually ensuring an even larger base of grid-responsive technologies across the state.

Building Decarbonization Technology and Research

Energy research, development, and demonstration (RD&D) that supports and advances technologies is vital to achieving California's energy and climate goals. First and foremost are the decades of energy efficiency research that encompass hundreds of projects in support of building and appliance energy efficiency technologies and practices. Deep energy efficiency is the primary carbon reduction strategy for California's buildings, minimizing long-term energy consumption right from the start. Ongoing research on advanced building shells, for example, will help ensure that new structures across the state require only modest amounts of energy

128 Loading Order policy, California Public Utility Code § 454.5(b) (9) (C).

129 2018 in AB 3232 (Friedman, 2018), Public Resources Code, Section 25403(a) (4).

130 Load Management Rulemaking, Docket 19-OIR-01.

for mechanical heating and cooling. An appropriate mantra for the construction industry is “Take care of the building shell.”

The CEC conducts applied technical and economic research on low- and no-carbon alternatives for space heating, water heating, and cooking in buildings. The CEC is also researching innovative approaches for reducing the carbon intensity of space-conditioning in buildings. Examples include:

- Analysis of heating, ventilation, and air-conditioning (HVAC) supporting technologies and integration into a single system. Technologies analyzed included a variable-capacity compressor and variable-speed blower, automated demand response, intelligent dual-fuel heating, and zonal controls. The project includes testing a single-family residential heat pump¹³¹ conditioning system optimized for California climates.¹³²
- Evaluation of operational performance issues and market barriers of heat pump technology.¹³³ This work will assess barriers to further adoption of heat pumps across markets.
- Review of cost-effective and integrated demand-side retrofits in multifamily buildings.¹³⁴ Example measures include smart thermostats, plug-load controls, and central system heat pump water heating. The project will focus on solutions to maximize building decarbonization in retrofit markets.

To identify opportunities to reduce energy intensity or improve efficiency in industrial settings while still maintaining the ability to meet customer desires, the CEC is researching fuel substitution and energy efficiency in commercial food service research that includes determining energy savings, cooking times, and other parameters of interest to food service operators. As a whole, these commercial food service studies demonstrate the potential for reducing energy consumption through innovative precommercial appliance and control technologies.¹³⁵

131 “Heat pumps” are devices transferring heat energy between two sources through a refrigerant cycle. Heat pump technologies in buildings are increasingly used for water heating and space heating purposes.

132 Grant EPC-14-021, Development and Testing of the Next Generation Residential Space Conditioning System for California, [Information on next generation residential space conditioning system project on the CEC's website](http://innovation.energy.ca.gov/SearchResultProject.aspx?p=30005&tk=636963103836691770)
<http://innovation.energy.ca.gov/SearchResultProject.aspx?p=30005&tk=636963103836691770>.

133 Work Authorization NAV-15-007, Heat Pump Technology Performance and Barriers and Recommendations for EPIC Research, Development, and Demonstration Activities.

134 Grant EPC-15-053. Customer-Centric Approach to Scaling Integrated Demand Side Management Retrofits. [Information on customer-centric approach to scaling IDSM retrofits project on the CEC's website](http://innovation.energy.ca.gov/SearchResultProject.aspx?p=30924&tk=636963114547718447)
<http://innovation.energy.ca.gov/SearchResultProject.aspx?p=30924&tk=636963114547718447>.

135 EPC-15-027.

At the August 27, 2019, joint agency workshop, the CEC heard stakeholder comments on fuel options and energy efficiency issues. The range of comments on efficient technologies was smaller in comparison to building decarbonization, and some points overlap with emission reducing goals. The Western Propane Gas Association supports propane as a low cost, and cleaner fuel options for building technology.¹³⁶ The California Hydrogen Business Council (CHBC) supports technology-neutral approaches to building decarbonization, and not one-size fits all models.¹³⁷ CHBC points to hydrogen assets that can provide zero-carbon onsite energy.

Building Energy Efficiency Standards and Decarbonization

When packaged with deep energy efficiency measures, building electrification presents the next most cost-effective path to decarbonization after the direct greening of sources of electricity.¹³⁸ Electrification directly leverages the state’s renewable sources of generation,¹³⁹ is immediately achievable with current building science and technology and has become a popular path for local jurisdictions seeking to adopt energy-efficient reach codes¹⁴⁰—building requirements that are stricter than the state’s Building Energy Efficiency Standards (CCR, Title 24)—that support their local climate plans.

As discussed above, space heating and water heating remain two of the largest drivers of energy use in buildings, and natural gas is the dominant source for both. The 2019 Building Energy Efficiency Standards included changes to ensure the standards do not prevent electrifying these heating loads in small residential buildings. Future code updates will aim to enable similarly highly efficient, low-carbon pathways for newly constructed commercial and large multifamily buildings.

Single-Family Residential

The 2019 Building Energy Efficiency Standards (BEES) took two steps to enable decarbonization of new homes:

136 [Western Propane Gas Association written comments](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229780&DocumentContentId=61222) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229780&DocumentContentId=61222. TN# 229780. Submitted September 18, 2019.

137 [California Hydrogen Business Council written comments](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229840&DocumentContentId=61288) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229840&DocumentContentId=61288. TN# 229840. Submitted September 24, 2019.

138 [Decarbonization of Heating Energy Use in California Buildings](https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf) https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf. 2018. Synapse Energy Economics, Inc. Introduction. p. 7.

139 [Copy of Residential Building Electrification in California report on E3's website](https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf) https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf.

140 As of September 2019, Berkeley and Menlo Park had passed local ordinances banning the expansion of natural gas service to all new construction. Another eight jurisdictions are considering reach code standards that would facilitate all-electric or electric-preferred new construction. Visit the [Building Decarbonization Coalition](https://www.buildingdecarbonizationcoalition.org/) website for updates and local government efforts.

- Added language that allows electric options for new homes.¹⁴¹ These options make all-electric building designs simpler and avoid gas-piping installation costs altogether.
- Established an all-electric prescriptive compliance path for homes.¹⁴² Recent advancements in heat pump technology along with improvements in wall and attic performance made this change possible.

Both of these changes take effect January 1, 2020.

Multifamily Residential

In the 2022 BEES update, the CEC plans to address energy efficiency in multifamily buildings. This update will address some barriers to building decarbonization—including mixed-use buildings that share central systems—ensuring that all-electric emissions reduction pathways are available to all types of multifamily construction.

The practice of placing per-unit heating equipment in the conditioned space of the dwelling poses a challenge in heating-dominant areas. If the heat pump is using conditioned air as a source of heat, it can end up drawing heat out of the same area the occupant is trying to keep warm. By improving modeling of centralized systems that use heat pump technology, the BEES can promote designs that bypass this potential issue. These designs enable markets to realize the energy efficiency potential, design flexibility benefits, and GHG reductions that heat pump systems offer.

Nonresidential

Commercial buildings have more varied designs than homes, and electric equivalents to commercial gas equipment are not available for some applications. Enabling an electric decarbonization pathway will require establishment of an all-electric baseline, starting with the most common commercial building types. Heat pumps are a technically feasible and cost-effective alternative for many space-heating and water-heating loads in commercial buildings.

The 2019 BEES consolidated demand response requirements into a single section, allowing advanced demand coordination and holistic building efficiency measures as part of a communicating energy grid. Grid interactivity represents an enormous opportunity to reduce the costs of integrating renewables and achieving California’s climate goals, and will be a focus of the 2022 BEES. The next step is to define an ideal set of behaviors (that is, automated

141 See CCR Title 24, Part 6, Section 150.0, Water Heating.

142 The “prescriptive compliance path” in the California Energy Code is the default baseline design defined in the code. The alternative is the optional “performance compliance path” which requires modeling the proposed project and showing it just as or more energy-efficient as the prescriptive path.

control functions) for commercial buildings and identify the communication infrastructure needed to enable interactions with the grid.

California Utility Decarbonization Efforts and Programs

Integrated resource plans (IRPs) are instrumental electricity planning tools for utilities and load-serving entities. IRPs include information on a utility's anticipated energy demand and efforts to decarbonize its resource mix. IRPs also help regulators monitor compliance with the state's Renewables Portfolio Standard (RPS). The CEC reviews final IRPs for publicly owned utilities (POUs) to ensure they meet state mandates. However, POUs are free to establish goals that exceed state requirements. (For more detailed information on POU IRPs, see Chapter 10 and Appendix D.)

Smart grid policy and planning is key in optimizing energy efficiency as a resource and lowering emissions overall. At the August 27, 2019, joint agency workshop on Energy Efficiency and Building Decarbonization, Commissioner J. Andrew McAllister discussed the concept of real time energy management that ensures supply and demand resources are matched up. "We need from energy efficiency the headroom to put all this new electrification on the grid. ... It has to be done in a way ... that's smart."¹⁴³ The CPUC expects to consider proposed plans on aggregated demand side resources in the next IRP cycle in 2020.

Sacramento Municipal Utility District

Even with the growth of solar PV, energy efficiency improvements, and increased use of demand response, Sacramento Municipal Utility District (SMUD) expects energy usage to continue to grow between 2019 and 2030.¹⁴⁴ This growth in energy usage is due to expected demand increases from electric vehicles and all-electric homes and buildings.

SMUD's 2018–2022 IRP focuses on achieving decarbonization through electrification strategies in Sacramento, while meeting customer affordability and reliability objectives. SMUD also has a net-zero-GHG emissions goal by 2040. This goal is more aggressive than its previous goal to reduce emissions 90 percent below 1990 levels by 2050.¹⁴⁵ To achieve these reductions in the Sacramento region, SMUD's analysis shows that it will be necessary to scale up the pace of

¹⁴³ [August 27, 2019 joint agency workshop on Energy Efficiency and Building Decarbonization recording](https://ww2.energy.ca.gov/php/yt_player.php?vidNo=J1pcss2twCc&title=Joint%20Agency%20Workshop%20on%20Energy%20Efficiency%20and%20Building%20Decarbonization&desc=California%20Energy%20Commission%20staff%20present%20the%20draft%202019%20California%20Energy%20Efficiency%20Action%20Plan,%20including%20updated%20strategies%20to%20increase%20energy%20efficiency%20in%20existing%20buildings%20and%20updated%20targets%20for%20doubling%20energy%20efficiency%20savings%20by%202030.)
https://ww2.energy.ca.gov/php/yt_player.php?vidNo=J1pcss2twCc&title=Joint%20Agency%20Workshop%20on%20Energy%20Efficiency%20and%20Building%20Decarbonization&desc=California%20Energy%20Commission%20staff%20present%20the%20draft%202019%20California%20Energy%20Efficiency%20Action%20Plan,%20including%20updated%20strategies%20to%20increase%20energy%20efficiency%20in%20existing%20buildings%20and%20updated%20targets%20for%20doubling%20energy%20efficiency%20savings%20by%202030.

¹⁴⁴ SMUD. *Resource Planning Report: IRP Filing Report for Submission to the CEC*. April 2019. [Link to download SMUD's Resource Planning Report filed on the CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227887&DocumentContentId=59276) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=227887&DocumentContentId=59276>.

¹⁴⁵ This goal is more ambitious than the state goal of reducing GHG emissions to 80 percent below 1990 levels by 2050.

electrification of buildings and transportation. SMUD also plans to leverage improvements in energy efficiency, demand response, and renewable energy as it supports continued electrification.¹⁴⁶

Table 1: Summary of SMUD Building Electrification Programs

SMUD Program	Description
Construction of all-electric new homes	Provides incentives to builders and their design teams for development of all-electric homes.
All-Electric Smart Homes	Provides incentives to homebuilders to include electric heat pump water heaters, heat pump climate controls, and induction cooktops into new homes. (Provides \$5,000 for each single-family home and \$1,750 for each multifamily unit that declines to install natural gas infrastructure.)
SolarShares SM	Offers commercial and residential customers a community solar product giving customers many of the same benefits as behind-the-meter generation.
Equipment efficiency	Provides rebates or SMUD financing or both for qualifying efficiency and electrification improvements to homes building envelopes and equipment.
Home Performance Program	Participating contractors evaluate performance of the whole house and recommend comprehensive improvements. Program packages include both energy efficiency and electrification.
Low-Income Energy Retrofits	Completes energy retrofits for qualifying low-income households through four offerings: Weatherization, Energy Saver Deep Retrofit, Energy Saver House Bundle, and Energy Saver Apartment Bundle.

Source: SMUD 2018–2022 IRP, [Link to download SMUD's Resource Planning Report filed on the CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227887&DocumentContentId=59276)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=227887&DocumentContentId=59276>

SMUD Building Electrification Plans

In addition, SMUD has a goal to electrify 80 percent of existing homes and 100 percent of low-income homes in Sacramento by 2040 and is developing a program to encourage electrification of homes for low-income customers. SMUD and national homebuilder D.R. Horton teamed up in October 2018 to build “all-electric communities” of more than 100 homes in Sacramento that will be priced for first-time homebuyers.

SMUD also plans to shift program delivery to maximize benefits for the underserved, and it wants to start now, learning along the way and developing a model for success for others to follow.

¹⁴⁶ SMUD also has programs supporting distributed generation adoption, community solar, voluntary green pricing, and energy efficiency.

SMUD's electrification efforts focus mainly on the residential sector, which accounts for most of the gas consumption for space and water heating in the Sacramento region. SMUD's analysis shows that achieving its GHG reduction goals will require more than 85 percent of existing residential and 75 percent of commercial space and water heating equipment to be converted from gas to electricity. This level of electrification assumes that future state Building Energy Efficiency Standards will mandate the majority of new home construction be all-electric by 2030.

Of the large utilities, SMUD is the most focused on building electrification and includes an analysis of how many existing buildings will need to convert from gas to electric space and water heating. Targets such as these are the first step toward reaching decarbonization goals from the residential and commercial sectors and should be established for the other electric utilities to help the state to reach its GHG reduction goals.

Los Angeles Department of Water and Power

Since 2007, Los Angeles Department of Water and Power's (LADWP's) energy efficiency programs have reduced consumption by roughly 3,275 GWh per year.¹⁴⁷ The energy efficiency potential study concluded that LADWP could cost-effectively achieve another 15 percent energy efficiency from 2017 through 2027, in addition to the previously committed 15 percent from 2010 through 2020. If LADWP keeps the same pace through 2030, it would meet the state's goal to double energy efficiency.¹⁴⁸

LADWP's IRP¹⁴⁹ identifies four key initiatives to achieve its resource goals: GHG reduction, transportation electrification, dispatchable resources, and system reliability. LADWP will examine strategies to reduce GHG emissions and expects that a portfolio approach of coal replacement, RPS, energy efficiency, local solar, energy storage, and transportation electrification will reduce GHG emissions an estimated 78 percent below 1990 levels over the next 20 years.

LADWP is accelerating transportation electrification, stating that it is the most effective component for reducing overall GHG emissions. LADWP plans to use transportation electrification as a strategy to absorb over-generation of renewables. To accomplish this strategy, it plans to offer incentives for charging when solar is abundant.

147 Los Angeles Department of Water & Power, *2017 Power Integrated Resource Plan*, August 2018. [Link to download LADWP's 2017 IRP filed on CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291) https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291.

148 CEC's Web page on Clean Energy and Pollution Reduction Act – SB 350, <https://www.energy.ca.gov/rules-and-regulations/energy-suppliers-reporting/clean-energy-and-pollution-reduction-act-sb-350>.

149 Los Angeles Department of Water & Power, *2017 Power Integrated Resource Plan*, August 2018. [Link to download LADWP's 2017 IRP filed on CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291) https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291.

Table 2: Summary of LADWP Building Decarbonization Programs

LADWP Program	Description
Low-Income Economic Development	Provides grants to low-income housing developers. Projects must achieve 15 percent greater energy savings than codes.
LADWP Facilities Program	Improves energy efficiency throughout LADWP's facilities with energy efficiency upgrades in HVAC and lighting.
Solar Incentive Program	Offered increased monetary benefits for customers living in areas of low solar penetrations.
Solar Rooftops Program	Provides priority enrollment for customers living in areas of low solar penetrations.

Source: LADWP 2017 IRP, [Link to download LADWP's 2017 IRP filed on CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=227897&DocumentContentId=59291>

Pacific Gas and Electric Company

Roughly 14 percent of Pacific Gas and Electric Company's (PG&E's) residential customers and 15 percent of commercial customers are in disadvantaged communities. Of these, 72 percent of residential and 62 percent of commercial customers are in the Central Valley, despite the fact that Central Valley customers represent only one-fifth of all residential customers in the PG&E electric service territory.¹⁵⁰ PG&E has proposed a pilot program in the San Joaquin Valley to expand access to affordable and cleaner energy options in disadvantaged communities. One pilot would allow eligible customers to obtain new electric or gas appliances at no cost and receive all feasible energy efficiency measures for the home. San Joaquin Valley disadvantaged customers in the pilot communities who have electric service will also be eligible for increased savings through community solar.

PG&E's service area has more behind-the-meter solar PV interconnected than any other utility in the United States. PG&E supports customer adoption of solar and other distributed generation technologies by implementing distributed generation-specific tariffs and incentive programs, working to improve and streamline interconnection processes, and providing customers distributed generation-related educational and customer service resources.

PG&E is implementing California's programs to develop energy storage resources in the state in order to integrate renewable resources, provide output in periods of peak demand, and reduce GHG emissions. PG&E is accelerating implementation of energy storage in its grid through owning and operating storage resources, procuring storage through third-party

¹⁵⁰ PG&E. *Integrated Resource Plan, 2018*. Prepared for the California Public Utilities Commission. August 1, 2018. [Copy of PG&E's 2018 IRP filed with the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M229/K725/229725998.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M229/K725/229725998.PDF>.

contracts, testing innovative storage solutions through pilot projects, and enabling customer adoption of energy storage.

Southern California Edison

Southern California Edison's (SCE's) IRP¹⁵¹ identifies the residential and commercial sector as a viable opportunity for GHG emission reductions via electrification of space and water heating. Sufficient lead time is needed to supplant GHG-emitting vehicles and space and water heaters with clean energy-powered technologies.

SCE's 2030 statewide estimations center on 7 million electric vehicles by 2030¹⁵² and nearly one-third of space and water heaters switched over to electric power from natural gas. SCE states that programs that educate customers about building technologies, such as electric heat pumps for space and water heating, produce the greatest GHG benefits. Education paired with incentives work better at overcoming economic barriers to adoptions on building decarbonization measures.

Of the state population living in disadvantaged communities, 47 percent are in SCE's service area. Roughly 40 percent of SCE's residential households are in disadvantaged communities or have subsidized rates or both.

San Diego Gas & Electric Company

About 5 percent of San Diego Gas & Electric Company's (SDG&E's) customers are in disadvantaged communities.¹⁵³ SDG&E offers incentives for solar installations, as well as community solar options for customers in disadvantaged communities. (See Table 3.)

151 Combs, Janet S. and Karlstad, Cathy A. *Integrated Resource Plan of Southern California Edison Company (U 228-E)*. Rulemaking 16-02-007. August 1, 2018. [Copy of SCE's IRP filed with the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M230/K379/230379549.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M230/K379/230379549.PDF>.

152 Of the 7 million EVs, roughly 2.5 million would be in SCE's service territory.

153 Smith, Aimee M. *2018 Individual Integrated Resource Plan of San Diego Gas & Electric Company (U 902 E)*. Rulemaking 16-02-007. August 1, 2018. [Copy of SDG&E's IRP filed with the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M230/K585/230585448.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M230/K585/230585448.PDF>.

Table 3: Summary of IOU Building Decarbonization Programs

Program	Description
Distributed Energy Storage Investments and Programs (Assembly Bill 2868 [Gatto, Chapter 681, Statutes of 2016]) (PG&E)	PG&E has proposed an energy storage program that provides incentives for low-income/disadvantaged community customers to electrify water heating and shift the associated load to off-peak hours. If approved, the program would launch in 2020 and enroll 6,600 customers, who will benefit from energy bill savings and reduced onsite emission from propane-based water heating.
Home Energy Efficiency Rebates (SCE)	Rebates to offset purchase of energy-efficient products, including hybrid electric heat pump water heater.
Disadvantaged Communities - Single-family Affordable Solar Homes (DAC-SASH) (SCE and SDG&E)	Modeled after SASH program, provides upfront financing incentives toward the installation of solar generation system on homes of low-income customers.
Community Solar Green Tariff (SCE and SDG&E)	Allows primarily low-income customers in disadvantaged communities to benefit from the development of solar generation projects in their own or nearby disadvantaged communities.
Green Tariff Shared Renewables (SDG&E)	Community solar program that includes a carve-out of 10 MW to be procured from projects sized between 0.5 and 1 MW within disadvantaged communities.

Source: PG&E, SCE, and SDG&E IRPs

Similar to LADWP, investor-owned utilities (IOUs) are focused on transportation electrification. This strategy is important for the state to reduce its GHG emissions. Increasing the energy efficiency of buildings and appliances is also a key strategy to reducing GHG emissions from buildings.

Quantifying and setting targets for building decarbonization is a first step toward meeting carbon reduction goals. Utilities can contribute by assessing the potential for GHG reductions from existing buildings in their service territories and targeting buildings for cost-effective retrofits.

Role of the Traditional Energy Efficiency Portfolios

As decarbonization moves to the center of California’s energy policy, the role and composition of the traditional gas and electric energy efficiency portfolios is changing. Going forward, traditional programs will need to focus more directly on two areas: first, ensuring low-income residents perceive the full range of benefits of the low-carbon energy economy; second, to expand dramatically their investment in market transformation efforts around low-carbon technologies, whether within electric or gas end-uses or in support of fuel substitution. In the IOU realm, given recently tightened cost-effectiveness requirements and reduced efficiency program goals, overall spending on the IOU energy efficiency portfolios may decline going forward. At the same time, potential exists to incorporate aggregated energy efficiency and load flexibility into utility energy procurement or resource adequacy markets or both. One area of effort going forward—whether by California’s publicly owned utilities, IOUS, or community choice aggregators—is to continue to develop tools and programs that enable facile aggregation, procurement, and forecasting of these demand-side resources.

Recommendations

The California Energy Commission (CEC) has proposed strategies and policy recommendations as part of the draft California 2019 Energy Efficiency Action Plan. The overarching objectives of the recommendations are to meet the doubling of energy efficiency savings by 2030, remove barriers to energy efficiency faced by low-income and disadvantaged communities, and reduce GHG emissions from new and existing buildings.

Today, the pressing needs for energy efficiency and building decarbonization efforts are alternative financing mechanisms, new and improved tools, and new program structures. The portfolio of programs overseen by the California Public Utilities Commission (CPUC) cannot be the only solution to California's energy efficiency goals. Private markets and other nonratepayer sources of funding need to be tapped through innovative programs designs and collaborative efforts. These new designs must be crafted with an inclusive equity framework that works for the people within a local community, including tribal governments and rural, low-income, or disadvantaged communities.

Codes and standards development will continue to be a significant pathway for change and improvement but cannot be the sole mechanism to achieve the state's energy goals, especially as federal standards progress slows. New metrics, improved standards compliance, and expanded data access are essential for success.

Key actions to take include:

- A one-stop shop for energy efficiency and building decarbonization programs that can leverage funds outside of the utility portfolio and cover all sectors—residential, commercial, agriculture, and industrial. By combining taxpayer and ratepayer funds from health, energy, air quality, and utility entities, customers can receive deeper energy retrofits.
- Open programs that offer comprehensive solutions with demand flexibility, demand response, electric vehicle, solar photovoltaic, and storage, in addition to traditional energy efficiency measures. Significant work is needed to breakdown the silos separating funding for this, ensuring that funds are available on a rolling basis, and made easily available to low-income and disadvantaged communities.
- Expand pay-for-performance and on-bill repayment programs so customers can more easily finance energy efficiency upgrades.
- Adopt monetary values for the co-benefits of energy efficiency and building decarbonization, including indoor air quality, improved working conditions, and improved comfort.
- Develop demand flexibility standards. Research the business case for demand flexible appliances and the infrastructure needed at the building level for success.
- Develop geographically aggregated datasets of energy consumption to assist utilities, researchers, program administrators, local governments, tribes, and state agencies to more accurately target areas where energy efficiency and building decarbonization is most cost-effective, would reduce local transmission and distribution strain, and would benefit environmental justice communities.

- For investor-owned utilities (IOUs), work with the CPUC integrated resources planning process to develop the ability to incorporate aggregations of energy efficiency and demand response programs into long-term planning and procurement. For publicly owned utilities (POUs), develop methods to integrate aggregations of energy efficiency and demand response projects into integrated resource plans (IRPs). The CEC should work with POUs to establish minimum thresholds of cost-effective energy efficiency and demand response that must be included in IRPs.

The diversity of activities, approaches, jurisdictions, and authorities required for building decarbonization requires involvement of the widest array of actors. Key stakeholders in this realm include the CEC, CPUC, the California Air Resources Board, the California Independent System Operator, the California Legislature, the California Governor's Office, local governments, tribal governments, building officials, the California Department of Community Services and Development, the California Department of Public Health, the California Alternative Energy and Advanced Transportation Financing Authority, IOUs, POUs, community choice aggregators, building contractors, original equipment manufacturers and their distributors and retailers, architects and designers, energy professionals, nongovernmental organizations, program administrators, and more.

A complete list of the recommended actions to achieve the state's energy efficiency goals, including lead and partner entities, is available in the final 2019 California Energy Efficiency Action Plan.

CHAPTER 3:

Clean Transportation

Introduction

The state's efforts against global climate change have begun to show progress, and in 2017, California continued to exceed its goal of reducing greenhouse gas (GHG) emissions to 1990 levels, three years ahead of schedule. However, despite the state's *overall* reduction in GHG emissions, emissions from the transportation sector have increased by roughly 6 percent from 2013 (the lowest point since 2000) through 2017 (the most recently available data).¹⁵⁴ The transportation sector (including vehicles, oil extraction, and oil refining) is also the largest source of GHG emissions in California, accounting for roughly 50 percent of in-state emissions.¹⁵⁵ In addition to being California's largest emitter of GHGs, the transportation sector is also a major emitter of criteria pollutants, with mobile sources responsible for nearly 80 percent of nitrogen oxide emissions and 90 percent of diesel particulate matter emissions statewide.¹⁵⁶

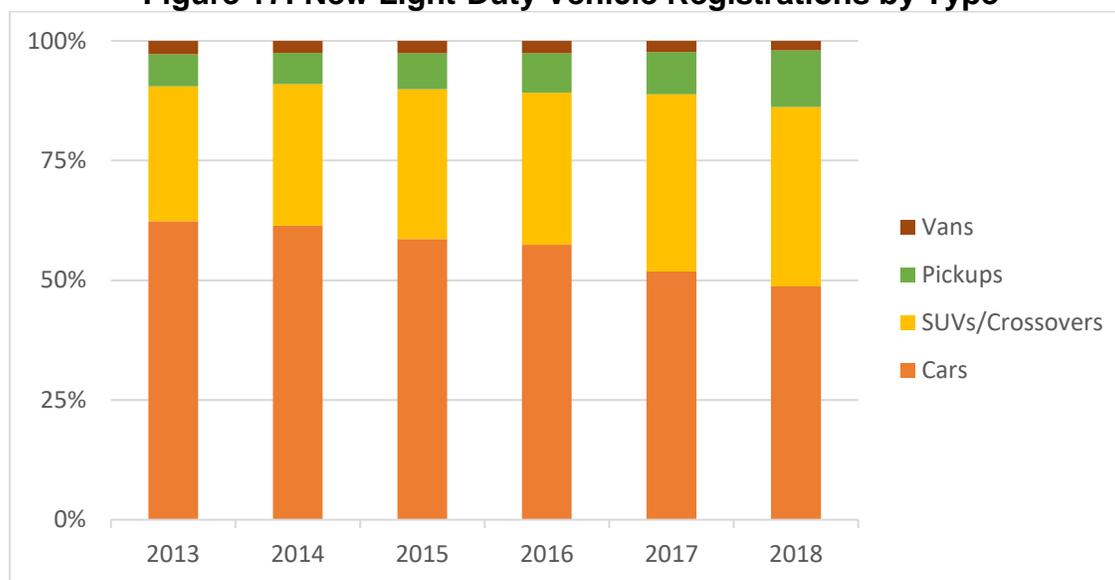
One key reason for the rise in transportation GHG emissions is that California consumers are purchasing larger passenger vehicles, such as light trucks and sport utility vehicles, which emit more GHGs per mile than smaller vehicles. The respective shares of these vehicle sales are shown in Figure 17.

154 California Air Resources Board (CARB). 2019. [California Greenhouse Gas Emissions for 2000 to 2017](https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf)
https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf.

155 CARB. July 11, 2018. [California Greenhouse Gas Emission Inventory](https://www.arb.ca.gov/cc/inventory/data/data.htm) <https://www.arb.ca.gov/cc/inventory/data/data.htm>.

156 CARB. May 2016. *Mobile Source Strategy*. [Link to Mobile Source Strategy on CARB's website](https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrsrc.pdf)
<https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrsrc.pdf>.

Figure 17: New Light-Duty Vehicle Registrations by Type



Source: CEC

California’s Long-Standing Leadership in Clean Transportation

To understand the expected role of zero-emission vehicles (ZEVs) in California’s evolving transportation sector, it is important to consider the goals and milestones that California has set for itself, the regulations and requirements that guide state progress, and the incentives and other programs that support such progress.

The California Air Resources Board (CARB) has developed a set of regulations to control emissions from passenger vehicles, collectively known as the Advanced Clean Cars Program. These standards regulate per vehicle emissions of soot and smog-causing pollutants as well as GHG emissions. The vehicle standards are footprint-based, so that bigger vehicles are permitted to emit more GHGs per mile. The Advanced Clean Cars package also includes a technology-forcing mandate for ZEVs.

For the first time in the 40-plus year history of California’s vehicle standards, the Trump Administration is revoking the waiver for the state’s vehicle GHG standards and its ZEV mandate. California and 22 other states have filed suit to defend the standards, and several major automakers have already expressed their intention to comply with California’s standards. Climate change is real and must be addressed, and many Californians are still breathing some of the nation’s dirtiest air. So, California must continue to make progress in reducing emissions from the transportation sector. With these objectives in mind, California has set aggressive goals and milestones for itself.

Clean Transportation Goals and Milestones

Table 4 summarizes California’s major policy goals and milestones for reducing GHG emissions, reducing criteria pollutant emissions, and increasing the deployment of ZEVs within the state.

California leads the nation in ZEV deployment, with nearly 630,000 ZEVs sold as of August 2019, roughly half the national total.¹⁵⁷

Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) amended the Global Warming Solutions Act of 2006 to extend the emission targets of Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006). The amendment set a statewide GHG emission limit for 2030 equivalent to 40 percent below emissions levels in 1990. AB 32 and SB 32 directed CARB to develop *California's 2017 Climate Change Scoping Plan*, published by CARB in November 2017.¹⁵⁸ Subsequently, Executive Order B-16-2012, issued by former Governor Edmund G. Brown Jr., set an objective of reducing transportation sector emissions to 80 percent below 1990 levels by 2050.

In addition to the need for GHG emission reductions, California also faces tremendous challenges in meeting federal air quality standards. CARB reports that 12 million Californians live in communities that exceed the ozone and particulate matter standards set by the United States Environmental Protection Agency (U.S. EPA), and that the South Coast and San Joaquin Valley are the only two areas in the nation in extreme nonattainment for the federal ozone standard.¹⁵⁹ A recent report from the American Lung Association states that Los Angeles remains the city with the worst ozone pollution, as it has for 19 years of the 20-year history of the report. The Fresno-Madera-Hanford region returned to the most polluted slot for year-round particle pollution, while Bakersfield maintains its rank as the city with the worst short-term particle pollution.¹⁶⁰

157 Veloz. August 6, 2019. [July 2019 dashboard of PEV sales from Veloz's website](https://www.veloz.org/wp-content/uploads/2019/08/7_july_2019_Dashboard_PEV_Sales_veloz.pdf) https://www.veloz.org/wp-content/uploads/2019/08/7_july_2019_Dashboard_PEV_Sales_veloz.pdf.

158 CARB. November 2017. [California's 2017 Climate Change Scoping Plan](https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf) https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

159 CARB. March 7, 2017. [Revised Proposed 2016 State Strategy for the State Implementation Plan](https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf) <https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf>.

160 The American Lung Association 'State of the Air 2019' Finds Pollution Levels Rising in Many Areas. Available at [Overview of American Lung Association's 2019 State of the Air report on the American Lung Association's website](https://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2019-full.pdf) <https://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2019-full.pdf>.

Table 4: GHG, Fuel, and Air Quality Goals and Milestones

Policy Origin	Objectives	Goals and Milestones
Assembly Bill 32	GHG Reduction	Reduce GHG emissions to 1990 levels by 2020
Senate Bill 32	GHG Reduction	Reduce GHG emissions to 40 percent below 1990 levels by 2030
Executive Order B-55-18	GHG Reduction	Achieve carbon neutrality by 2045
Senate Bill 100	GHG Reduction	Requires 100 percent of retail sales of electricity to end-use customers to come from 100 percent zero-carbon resources by 2045
Clean Air Act; California State Implementation Plans	Air Quality	80 percent reduction in oxides of nitrogen (NO _x) by 2031
Executive Order B-16-2012	GHG Reduction, Increase Zero-Emission Vehicles and Infrastructure	Reduce GHG emissions from the transportation sector to 80 percent below 1990 levels by 2050 Infrastructure to accommodate 1 million electric vehicles by 2020 1.5 million electric vehicles by 2025
Senate Bill 350	GHG Reduction, Increase Zero-Emission Vehicles and Infrastructure	Requires publicly owned utilities (POUs) with electricity demands exceeding 700 gigawatt-hours to develop integrated resource plans (IRPs) by January 2019. Requires investor-owned utilities (IOUs) to file applications for investments to support transportation electrification. Established the Disadvantaged Communities Advisory Group to review and provide guidance on clean energy and pollution reduction programs to the California Energy Commission (CEC) and the CPUC.
Assembly Bill 1493	GHG Reduction	Reduce GHG emissions from new cars and trucks by to 22 percent below 2002 levels by 2012 and 30 percent below 2002 levels by 2016
Senate Bill 1275	Increase Zero-Emission Vehicles	1 million zero-emission vehicles by 2023
Executive Order B-48-18	Increase Zero-Emission Vehicles and Infrastructure	5 million zero-emission vehicles by 2030 250,000 electric vehicle chargers, including 10,000 direct current fast chargers, and 200 hydrogen refueling stations by 2025
Executive Order B-32-15 on Sustainable Freight	Air Quality, GHG Reduction, Petroleum Reduction	Required an action plan to include targets. The resulting targets included improving system efficiency per GHG emission by 25 percent by 2030, as well as 100,000 vehicles and equipment capable of zero emission operation by 2030

Source: CEC

The adoption of ZEVs is a key element of addressing the state's GHG emission reduction targets and air quality improvement requirements. The Governor's Interagency Working Group on ZEVs developed the *ZEV Action Plan*, issued in 2013 and subsequently updated in 2016 and

2018, to identify actions that support the state’s ZEV goals.¹⁶¹ In addition, the Governor’s Office of Planning and Research released the *Electric Vehicle Charging Station Permitting Guidebook* in 2019.¹⁶² This guidebook will hasten the transition to PEVs by simplifying the launch of EV charging stations in addition to exploring best practices and a ZEV readiness scorecard.

California has set goals for the deployment of ZEVs for 2023, 2025, and 2030. Senate Bill 1275 (De León, Chapter 530, Statutes of 2014) established the Charge Ahead California Initiative to place 1 million ZEVs and near-ZEVs in service by January 1, 2023. Executive Order B-16-2012 set a goal of 1.5 million ZEVs by 2025. Finally, Executive Order B-48-18 set a target of 5 million ZEVs by 2030.

As part of Executive Order B-32-15, the California Sustainable Freight Action Plan was released in 2016 and identifies state policies, programs, and investments to achieve subsequent targets. The executive order directs the CEC and other state agencies to work on corridor-level freight pilot projects within the state’s primary trade corridors that integrate advanced technologies, alternative fuels, freight and fuel infrastructure, and local economic development opportunities.

Senate Bill 350 (De León, Chapter 547, Statutes of 2015) called for the formation of the Disadvantaged Communities Advisory Group (DACAG) to review and provide guidance on CEC and CPUC clean energy programs, and to determine whether those programs are effective and useful in disadvantaged communities. Ensuring the DACAG’s participation in ZEV-related activities is a key element of ensuring that the state’s ZEV programs benefit all Californians. In Spring 2019, the DACAG specifically advised the CEC to focus its Clean Transportation Program investments on zero-emission fuels.

Accelerating the Deployment of ZEVs and the Infrastructure Required to Fuel Them

Rules, Regulations, and Requirements

To meet its numerous GHG emissions reduction and clean air targets, California relies on a mixture of rules, regulations, requirements, and incentives to shape the acceleration of ZEVs.

¹⁶¹ [ZEV Action Plan and updates](http://www.business.ca.gov/ZEV-Action-Plan) <http://www.business.ca.gov/ZEV-Action-Plan>.

¹⁶² Governor’s Office of Business and Economic Development. 2019. [Electric Vehicles Charging Station Permitting Guidebook](http://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf) <http://businessportal.ca.gov/wp-content/uploads/2019/07/GoBIZ-EVCharging-Guidebook.pdf>.

CARB's Advanced Clean Cars rulemaking consists of a suite of regulations for reducing emissions from the state's light-duty fleet.¹⁶³ CARB is working on the update to the ZEV Regulation for the Advanced Clean Cars 2 program, which will look at regulations beyond 2025 and help ensure zero- and near-zero-emission technology options continue to be commercially available.

The Innovative Clean Transit Regulation developed by CARB requires the state's transit agencies to transition buses to zero-emission technologies by 2040.¹⁶⁴ Under the regulation, California transit agencies will submit rollout plans demonstrating feasibility. These plans are due in 2020 for large transit agencies and in 2023 for small agencies.

CARB also administers the Low Carbon Fuel Standard (LCFS), requiring fuel providers to reduce the carbon intensity of transportation fuel by 20 percent by 2030. In 2018, CARB adopted amendments to the LCFS that added a special crediting provision for ZEV infrastructure including direct current (DC) fast charging and hydrogen refueling stations. Beyond the normal credits generated from the dispensed fuel, these special provisions allow an entity to generate infrastructure credits based on the capacity of the charger or station.

In 2014, the CPUC adopted Decision 14-12-079 to allow greater utility investment in electric vehicle charging infrastructure. The CPUC directed IOUs¹⁶⁵ to file applications for programs and investments that authorized nearly \$1 billion in IOU transportation electrification spending through 2023.¹⁶⁶ Table 5 summarizes the transportation electrification programs for the three largest utilities subject to the CPUC's oversight.

163 More information about the [Advanced Clean Cars](https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program) rulemaking is available at <https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program>.

164 More information about the [Innovative Clean Transit](https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit) regulation is available at <https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit>.

165 The CPUC regulates six IOUs: Pacific Gas and Electric (PG&E), Southern California Edison (SCE), San Diego Gas & Electric (SDG&E), Liberty Utilities, PacifiCorp, and Bear Valley Electric Service.

166 CPUC Decision 18-01-024. [Link to Decision 18-01-024 on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M204/K670/204670548.PDF)
<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M204/K670/204670548.PDF>.

CPUC Decision 18-05-040. [Link to Decision 18-05-040 on the CPUC's website](https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442457637)
<https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442457637>.

CPUC Decision 18-09-034. [Link to Decision 18-09-034 on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M231/K030/231030113.PDF)
<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M231/K030/231030113.PDF>.

Table 5: CPUC-Jurisdictional Transportation Electrification Programs

Utility, Sector, and Program Budget, Size and Scope	
Pacific Gas & Electric	
Light-Duty	EV Charge Network (\$130M) 7,500 level 2 electric vehicle supply equipment (L2 EVSE), Fast Charge Program (\$22.39M) 234 direct-current fast chargers (DCFCs), Home EV Charger Information Resource Project (\$500k) upgrade EV website, EV Schools (\$5.76M) 88-132 L2 EVSE at 22 sites, EV Parks (\$5.54M) 40 L2 EVSE & 3 DCFC at 15 sites
Medium-Duty Heavy-Duty	FleetReady Program (\$236.3M) electrify 700 sites and 6,500 MD/HD EVs, Medium/Heavy-Duty Fleet Customer Demonstration (\$3.35M) make-ready & EVSE for 1 fleet, Electric School Bus Renewables Integration (\$2.2M) make-ready equipment for 2-5 school buses
Off-Road	Idle Reduction Technology (\$1.7M) demonstrate idle-reduction technologies for truck stops or transport refrigeration units (TRUs)
San Diego Gas & Electric	
Light-Duty	Power Your Drive (\$45M) 3,500 L2 EVSE, Electrify Local Highways (\$4M) 80 L2 EVSE & 8 DCFCs at park and rides, Dealership Incentives (\$1.79M) dealership training, Schools Pilot (\$18.7M) 184 L2 EVSE & 12 DCFC at 30 sites, Parks Pilot (\$9.9M) 120 L2 EVSE & 20 DCFC at 10 sites.
Medium-Duty Heavy-Duty	Fleet Delivery Services (\$3.69M) up to 90 MD EVs, Green Shuttle (\$3.15M) L2 EVSE and/or DCFCs with solar/storage, Medium-duty and Heavy-duty Electric Vehicle Charging Infrastructure Program (\$150.56M) 3,100 class 2-8 EVs, forklifts, and TRUs, Vehicle-to-Grid Pilot (\$1.73M) utilize 10 school buses for V2G operations
Off-Road/ Ports	Port Electrification (\$2.4M) 30 EVSEs for medium-duty/heavy-duty vehicles and forklifts
Airports	Airport Ground Support Equipment (\$2.84M) EVSE retrofitting and assess fleet charging behavior
Southern California Edison	
Light-Duty	Charge Ready Pilot (\$66M) 2,500 L1/L2 EVSE, Residential Make-Ready Rebate (\$3.99M) up to 5,000 L2 EVSE rebates, Urban DCFC Clusters (\$3.98M) up to 50 DCFCs, Charge Ready and Market Education Program (\$760.1M) rebates for 48,000 EVSEs, Schools (\$19.77M) 250 L1/L2 EVSE at 40 sites, Parks & Beaches (\$9.89M) 120 L2 EVSE, 10 DCFC, 15 mobile EVSE at 27 sites
Medium-Duty Heavy-Duty	Medium/Heavy-Duty Make-Ready (\$342.6M) 870 sites with 8,490 medium-duty/heavy-duty EVs, Electric Transit Bus Make-Ready (\$3.97M) bus depot make-ready equipment
Off-Road/ Ports	Port of Long Beach Rubber Tire Gantry Crane (\$3.03M) make-ready equipment for nine cranes, Port of Long Beach Terminal Yard Tractor (\$450k) 24 EVSE for yard tractors

Source: CPUC

POU Transportation Electrification

As discussed in Chapter 10, POUs are required to submit integrated resource plans (IRPs) to the CEC. In addition to meeting GHG targets and RPS procurement requirements, POU IRPs

must address procurement of transportation electrification.¹⁶⁷ The IRPs describe incentives and rate programs for charging installation, principally for light-duty vehicles requiring residential, workplace, commercial and public charging.

Within their IRPs, some POU specifically referenced their current or anticipated incentives for charging infrastructure. Anaheim, for instance, proposes a \$500 rebate for private-use chargers, a \$5,000 rebate for public chargers, and a \$10,000 rebate for Level 2 chargers at schools or affordable housing locations, or for public DC fast chargers. Several POU are featuring transportation electrification in their IRPs. Plans of the two largest POU—Los Angeles Department of Water and Power (LADWP) and Sacramento Municipal Utility District (SMUD)—are discussed below.

LADWP Transportation Electrification

LADWP's IRP recognizes the benefits of transportation electrification in reducing overall GHG and criteria pollutants in the Greater Los Angeles Area, increasing electric vehicle sales, and absorbing potential overgeneration from renewable resources. As a result, LADWP's preferred portfolio incorporates high electrification, including doubling the electric vehicles (EVs) it would serve from 290,000 to 580,000 in 2030.¹⁶⁸ In addition to vehicle electrification, other transportation electrification opportunities are available, including power for cargo ships at the Port of Los Angeles and electrified cargo transport and mass transit, among others.

LADWP updated its electric transportation program to include installing 10,000 city and private commercial chargers for public, workplace, and city-owned vehicles, as well as supporting residential and commercial EV charging. Other transportation electrification efforts include:

- Electrifying the Los Angeles Metro bus fleet by installing charging infrastructure for depot (overnight) charging and en route charging.
- Purchasing 112 zero-emission electric buses for the Los Angeles Department of Transportation while converting 100 percent of buses to electricity by 2030.
- Electrifying equipment to reduce emissions from ships, trucks, harbor craft, and cargo-handling equipment for the San Pedro Bay Ports, which could increase load at the port to 900 GWh by 2030.

¹⁶⁷ The POU IRPs must also address energy storage, retail rates, reliability, net load, disadvantaged communities, and transmission and distribution systems. Specific discussions of these issues are presented in the staff review papers for each POU. [Link to docket log for 18-IRP-01 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=18-IRP-01) <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=18-IRP-01>.

¹⁶⁸ The energy use in 2030 for transportation electrification in the base case is 1,172 GWh, which increases to 2,344 GWh in the high electrification scenario.

- Purchasing 20 electric buses to replace 14 diesel buses and add 6 buses to the Los Angeles World Airport fleet.

LADWP also participates in the electrification working group with Southern California Public Power Authority and the California Electric Transportation Coalition to address opportunities and challenges of a new, electrified transportation system and to identify trends, business models, and strategies for rolling out charging infrastructure.

SMUD Transportation Electrification

Transportation electrification is part of SMUD’s overall strategy of increased electrification in its service territory. SMUD promotes the adoption of EVs through purchase incentives, investments in charging infrastructure, and consumer education. As of 2018, there were about 9,400 light-duty EVs in Sacramento County. SMUD estimates that the Sacramento region will need more than 200,000 light duty EVs by 2030 and roughly 1 million by 2050 to meet the state’s GHG emission goals.

Specific EV-related incentives that SMUD offers include cash incentives for EV buyers, residential Level 2¹⁶⁹ charger incentives, and incentives for EV chargers at workplaces and multifamily residential housing. SMUD also offers EV owners an EV time-of-day rate that is designed to encourage EV charging after midnight. SMUD has looked at the grid impacts of increased EV charging and is investigating smart charging solutions in addition to strengthening its distribution system to address potential effects.¹⁷⁰

SMUD is also participating in research projects related to medium- and heavy-duty EVs to prepare for the expected increase in EV adoption in that segment of the market. School bus fleets, refuse trucks, and shuttle buses are expected to be the first fleets to electrify in the medium- and heavy-duty EV sector.

Incentives

As part of meeting the state’s targets, the state also administers or supports funding for the implementation of ZEVs and ZEV infrastructure through multiple programs and activities. Key sources of funding are listed below.

- Clean Transportation Program: Administered by the CEC, the Clean Transportation Program (formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program) provides funding for projects that help the state meet its GHG

169 Level 2 chargers use 208/240 volts, up to 19.2 kW (80 amps), whereas Level 1 chargers use 110/120 volts, 1.4 to 1.9 kW (12 to 16 amps). For reference, 1,000 kW is roughly enough electricity for the instantaneous demand of 750 homes at once.

170 “Smart charging” in the intelligent charging of EVs where charging can be shifted based on grid loads and in accordance with the vehicle owner’s needs.

reduction and clean air goals. Despite numerous technological, policy, and market developments favoring the development and deployment of ZEVs and ZEV infrastructure, statutory guidance for the Clean Transportation Program has not been significantly updated since the program's first investment plan in 2009. For the 2019–2020 Investment Plan Update, the CEC has sought to emphasize ZEVs and ZEV infrastructure within the program's \$95.2 million in available funding.¹⁷¹

- School Bus Replacement Program: Senate Bill 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017) allocated \$75 million to the CEC to replace the oldest school districts in California, with a special priority on disadvantaged communities and those with a majority of students eligible for free or reduced-price meals. The CEC received applications listing more than 1,600 buses for replacement, and exhausted available funds by providing 233 electric school buses to 64 awardees throughout the state. All of these buses will have vehicle-to-grid capabilities built in, with the prospective of providing energy storage, back-up power in an emergency, and load management services.
- Air Quality Improvement Program/Low Carbon Transportation Program: For the 2019–2020 fiscal year, CARB allocated \$447 million in GHG Reduction Funds to the Low Carbon Transportation Program. An additional \$48 million was allocated under the Air Quality Improvement Program, for a total of \$495 million within a combined CARB funding plan. Specifically, the Low Carbon Transportation Program budget includes \$200 million available for light-duty ZEV Clean Vehicle Rebate Project, \$65 million for transportation equity projects, and \$182 million for heavy-duty and off-road equipment.¹⁷²
- Electrify America: Electrify America resulted from a settlement with Volkswagen for its violation of federal and state law by using illegal devices to defeat emission tests beginning with its model year 2009 vehicles. California will receive about \$423 million from a national Environmental Mitigation Trust to fund projects that will fully alleviate the lifetime emissions caused by the illegal devices. In May 2018, CARB approved a beneficiary mitigation plan outlining how settlement funding will be spent.¹⁷³ Volkswagen will also invest \$800 million in ZEV-related projects in the state, (including

171 CEC. September 2019. [2019-2020 Investment Plan Update for the Clean Transportation Program - Second Lead Commissioner Report](#). Publication Number CEC-600-2018-005-LCF-REV2. Available at <https://efiling.energy.ca.gov/getdocument.aspx?tn=229582>.

172 CARB. June 2019. [Link to presentation on Fiscal Year 2019–2020 Funding Plan for Clean Transportation Incentives from the CARB website](#) https://ww2.arb.ca.gov/sites/default/files/2019-06/061319_fundingplanwkshp_presentation.pdf.

173 CARB. June 2018. "Beneficiary Mitigation Plan for the Volkswagen Environmental Mitigation Trust." [Link to information on the Volkswagen Environmental Mitigation Trust on the CARB website](#) <https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california>.

deployment of charging infrastructure, transit buses, freight projects, and drayage trucks) and must offer and sell additional BEV models in California between 2019 and 2025.

- Transit and Intercity Rail Capital Program (TIRCP): Administered by Caltrans, the TIRCP provides competitive grants for capital improvement projects that will modernize the state's transit, rail, and ferry systems. In the program's 2015–2018 awards, these projects have included funding for nearly 300 new ZEV buses for transit districts across the state. Funding for the buses came from a mixture of GHG Reduction Funds and the Road Repair and Accountability Act of 2017 (Senate Bill 1 [Beall, Chapter 5, Statutes of 2017]).¹⁷⁴

Status of the ZEV Market

On May 2, 2019, the CEC convened an IEPR workshop to discuss the latest status of the ZEV market, including presentations from Bloomberg New Energy Finance (BloombergNEF), the International Council on Clean Transportation (ICCT), Navigant Consulting, and the U.S. Energy Information Administration (U.S. EIA).¹⁷⁵ These researchers discussed how targets to reduce GHG emissions and air pollution affect the automotive industry's advancement of vehicle powertrain and charging technologies, the possible impacts on the energy system, the outlook for new consumer products using ZEV technologies, and emerging mobility options.

ZEVs on the Global Stage

Globally in 2018, BEV and PHEV sales reached more than 2 million, with the market in China comprising more than 50 percent of demand.¹⁷⁶ Globally, 10 automakers produced nearly 1.5 million PEVs in 2018. Seven companies supplied batteries for the 1.5 million PEVs.¹⁷⁷

The United States has the third largest PEV market in the world, behind China and Europe; in 2018 Americans purchased roughly 350,000 PEVs, representing more than 2 percent of the nation's overall light-duty vehicle sales (shown in Figure 18). Californians purchased more than half of all U.S. EV sales, accounting for nearly 9 percent of the state's new cars.¹⁷⁸ PEV

174 More information about the [Transit and Intercity Rail Capital Program](https://calsta.ca.gov/subject-areas/transit-intercity-rail-capital-prog) is available at <https://calsta.ca.gov/subject-areas/transit-intercity-rail-capital-prog>.

175 [Link to notice, presentations, and documents for the May 2, 2019, workshop on the Status of the ZEV Market](https://ww2.energy.ca.gov/2019_energypolicy/documents/#05022019-am) https://ww2.energy.ca.gov/2019_energypolicy/documents/#05022019-am.

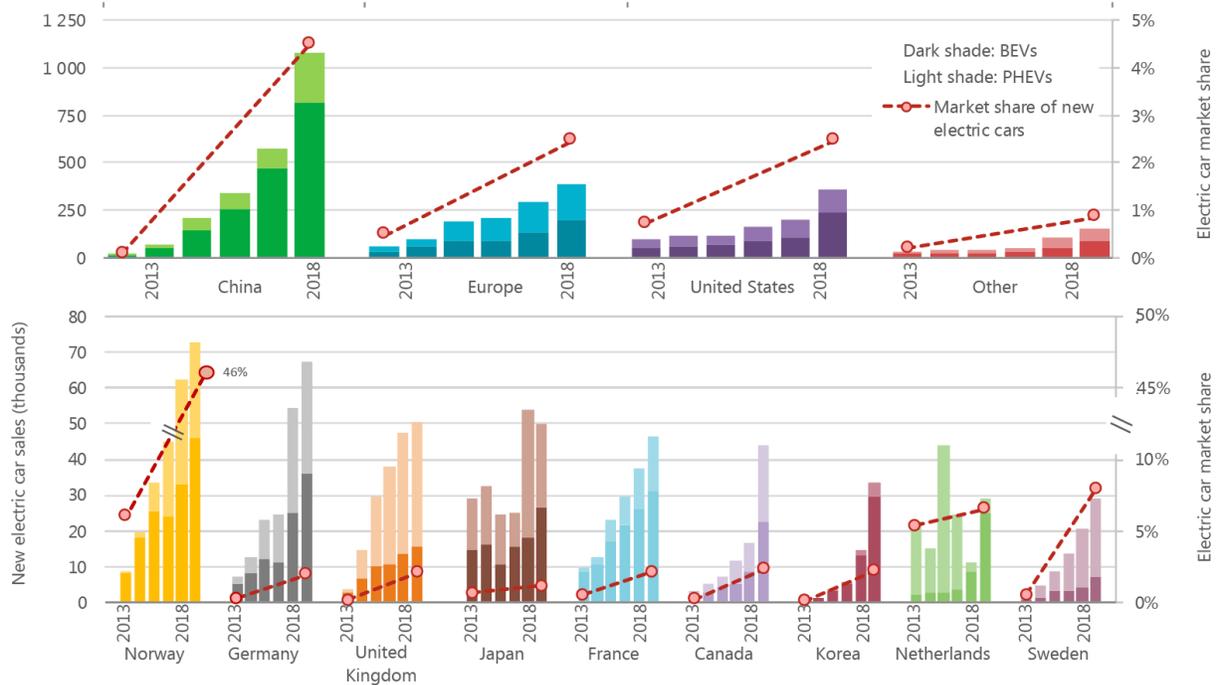
176 Nicholas, Michael. *Global Light Duty Electric Vehicle Trends, Costs of Battery Technologies, Consumer Prices, and Implications for Policy*. International Council on Clean Transportation. May 2, 2019, Workshop on the Status of the Zero-Emission Vehicle Market.

177 Ibid.

178 California New Car Dealers Association, "California Green Vehicle Report," February 2019. [Link to California Green Vehicle Report on the California New Car Dealers Association website](https://www.cncda.org/wp-content/uploads/Cal-Alt-Powertrain-Report-1Q-19-Release.pdf) <https://www.cncda.org/wp-content/uploads/Cal-Alt-Powertrain-Report-1Q-19-Release.pdf>.

demand originating from the 10 states that adopted California’s ZEV regulations accounts for 63 percent of demand nationwide.¹⁷⁹

Figure 18: Global Markets for Plug-In Electric Vehicles (2013–2018)



Source: International Energy Agency, Global EV Outlook 2019, [Link to Global EV Outlook 2019](https://www.iea.org/publications/reports/globalevoutlook2019/)
<https://www.iea.org/publications/reports/globalevoutlook2019/>.

To illustrate the scale of electrification efforts needed in the near term, Navigant and BloombergNEF estimate that global PEV sales are growing toward 25 million to 30 million per year by 2030, reaching cumulative sales of 150 million by the same year. Achieving carbon neutrality in alignment with the goals of the Paris Agreement¹⁸⁰ would likely require deployments well in excess of 200 million ZEVs over the next decade.¹⁸¹

Veloz, “CA Electric Car Sales Broke Year-over-year Increases Every Month in 2018,” January 11, 2019. [Link to news release about electric car sales on Veloz’ website](https://www.veloz.org/wp-content/uploads/2019/01/Veloz-2018-Sales-Year-in-review-Release-FINAL.pdf) <https://www.veloz.org/wp-content/uploads/2019/01/Veloz-2018-Sales-Year-in-review-Release-FINAL.pdf>.

179 Chawan, Ajay. *Perspective: Future of Transportation Electrification*. Navigant Consulting. May 2, 2019 Workshop on the Status of the Zero-Emission Vehicle Market.

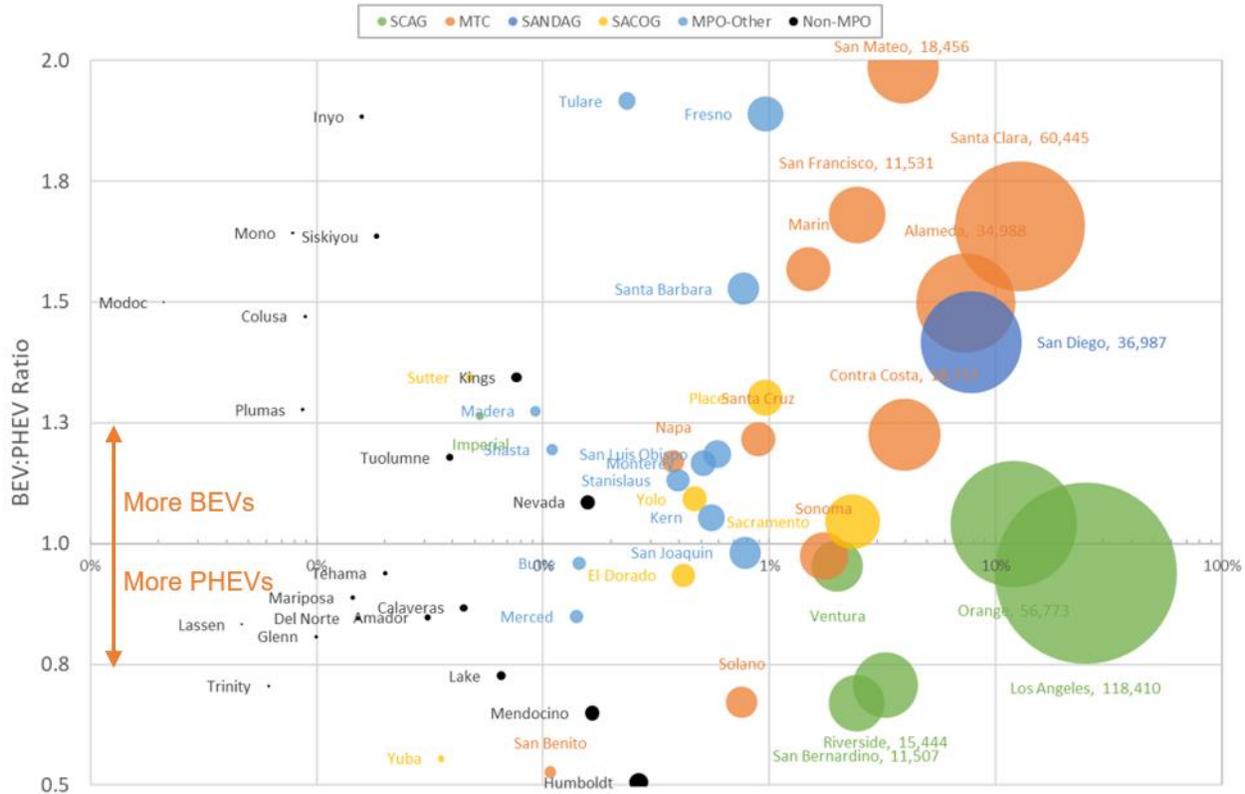
180 The [Paris Agreement](http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf) set a target of no more than 2 degrees Celsius warming, with a goal of 1.5 degrees, to avoid catastrophic climate change. <http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>.

181 This level of ZEV deployment aligns with the International Energy Agency’s Below 2 Degrees Scenario, which corresponds to a warming of 1.75°C, which is within the range of the ambition of the Paris Agreement. Per Executive Order B-55-18, California is “pursuing efforts to keep warming below 1.5°C.” International Energy Agency. [Global Electric Vehicle Outlook 2017](https://webstore.iea.org/global-ev-outlook-2017), <https://webstore.iea.org/global-ev-outlook-2017>.

ZEVs Within California

According to the Department of Motor Vehicles, there were roughly a half million light-duty ZEVs registered in California at the end of 2018. BEVs slightly outnumber PHEVs, with 51 percent and 48 percent of deployment, respectively, and with FCEVs comprising 1 percent of the market. PEVs purchased in the four largest metropolitan planning organization regions account for 62 percent of the PEVs in the state.¹⁸² County-level powertrain preferences vary (Figure 19), with the largest southern coastal market purchases for BEVs and PHEVs at roughly equal rates, while drivers in southern inland counties prefer PHEVs, and Bay Area drivers generally prefer BEVs. The largest markets for FCEVs are Los Angeles (1,914 total registrations) and Orange County (1,243 total registrations).

Figure 19: Powertrain Preferences and Share of PEV Market, by County



Source: CEC analysis of Department of Motor Vehicles data. Registrations are as of December 31, 2018.

182 These regions include areas covered by the Southern California Association of Governments (SCAG), Metropolitan Transportation Commission (MTC) of the Bay Area, San Diego Association of Governments (SANDAG), and Sacramento Council of Governments (SACOG).

Heavy-duty vehicles are electrifying more slowly than passenger vehicles. Of the more than 2 million vehicles with weight limits greater than 6,000 pounds (Class 2 through Class 8) registered in California as of December 2018, nearly 1,500 were BEVs. Of these BEVs, roughly 60 percent were Class 6, and roughly 25 percent were Class 4, both considered “medium-duty.” As of the end of 2018, there were no registered Class 2 BEVs nor any Class 3 through Class 8 PHEVs or FCEVs. However, nearly all conventional truck manufacturers have announced plans for commercialization of zero-emission trucks by 2021. Furthermore, new manufacturers specializing in zero-emission trucks and buses are entering the market. The total ownership cost for zero-emission buses, when accounting for reduced fuel and maintenance costs, is lower than for compressed natural gas (CNG) and diesel buses. When accounting for societal benefits and cost of individual ownership, the CEC’s School Bus Replacement Program found electric buses to have a cost-effectiveness score of 1.28, compared to a score of 0.73 for CNG, and 0.71 for diesel.¹⁸³ According to CARB, cost parity for electrified trucks (not including infrastructure) is projected to be comparable to diesel within five years, resulting in increased demand and supply for such configurations.¹⁸⁴ However, ZEV infrastructure investments will be needed to enable the broader adoption of these vehicles. For more detail on projected demand for medium- and heavy-duty vehicles, see Chapter 8 on the Transportation Energy Demand Forecast.

Supply Trends in ZEV Industry

The future growth of all ZEV classes in California will be increasingly influenced by the global market. Perhaps the most important factor will be the automotive battery supply chain. In the CEC’s May 2019 workshop, BloombergNEF reported that since 2010, the price of automotive lithium-ion battery packs has declined 85 percent to a 2018-weighted average of \$176 per kilowatt-hour (kWh). Individual automakers’ purchase contracts vary by chemistry and production volume within a range of \$125/kWh to \$400/kWh.¹⁸⁵ This estimate is consistent with an ICCT review of a bottom-up engineering cost analysis, automaker statements, and other prominent projections.¹⁸⁶

183 The cost-effectiveness score consists of societal benefits and the total cost of ownership (TCOE), an industry standard for measuring lifetime cost of a project over 20 years. If the quotient is 1 or greater, the project is cost-effective. If the quotient is less than one, the project is not cost-effective. [CEC School Bus Replacement Program](https://www.energy.ca.gov/sites/default/files/2019-05/Cost-Effectiveness.pdf) <https://www.energy.ca.gov/sites/default/files/2019-05/Cost-Effectiveness.pdf>.

184 Jaw, Kathy, Joshua Cunningham, and Tony Brazil. CARB. The Need for EV Charging Infrastructure Assessments to Inform Policies, March 11, 2019, IEPR Workshop on Assessing Charging Infrastructure Needs in California. [Link to presentation "The Need for EV Charging Infrastructure Assessments to Inform Policies" filed on the CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227307&DocumentContentId=58166) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=227307&DocumentContentId=58166>.

185 Goldie-Scot, Logan. ["Battery Storage Costs and Implications for the Electrification of Transportation."](#) BloombergNEF. May 2, 2019, Workshop on the Status of the Zero-Emission Vehicle Market.

186 ICCT, 2019. Update on Electric Vehicle Costs in the United States Through 2030.

By 2030, the price of a battery pack may range between \$50 and \$100 per kWh. Major factors that could reduce costs include continued advancement in cathode and anode design, improvements in cell energy density from solid-state electrolytes, higher package efficiency, economies of scale, and manufacturer learning and subsequent process improvements.¹⁸⁷ Price volatility of the component metals used within batteries is unlikely to increase costs greatly. For example, BloombergNEF estimates that doubling the commodity cost of nickel (the metal that would most greatly change pack cost) would only increase the cost of a nickel-manganese-cobalt (NMC 811) cathode-based battery pack by about 6 percent.¹⁸⁸

Transportation electrification with BEVs is expected to expand across vehicle classes commensurate with cost reductions compared to conventional internal combustion engines and PHEVs, principally driven by battery pack cost reductions. The main factors affecting cost-competitiveness among the different powertrain types include vehicle class (for example, car, light truck, sport utility vehicle), range (affecting the size of the pack), and the incremental costs for combustion engine vehicles to comply with increasing fuel efficiency requirements across international markets. Notably, in contrast to BEVs, PHEVs are unlikely to see a similar cost reduction, given that PHEVs have smaller battery packs that represent a lower share of overall cost, and PHEVs must be engineered to support components for electric and internal combustion powertrains.¹⁸⁹

To further illustrate the modular and flexible design of battery systems, Navigant highlighted Audi's globally standardized battery pack architecture that can accommodate many cell supplier designs and form factors, as well as Ford's \$500 million investment to develop trucks based on Rivian's low-profile battery and powertrain platform.¹⁹⁰

The four researchers at the May 2019 workshop unanimously agreed that BEV growth would likely outpace PHEV growth. BloombergNEF noted that 248 of the 384 PEV models that will be

187 Presentations from [Logan Goldie-Scot](#) and [Mike Nicholas](#) at the May 2, 2019, workshop on the Status of the Zero-Emission Vehicle Market. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228033&DocumentContentId=59317> and <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228037&DocumentContentId=59318>.

188 NMC 811 battery packs are commonly used in Chevrolet, BMW, and Nissan electric vehicles. Goldie-Scot, Logan. "[Battery Storage Costs and Implications for the Electrification of Transportation.](#)" BloombergNEF. May 2, 2019 Workshop on the Status of the Zero-Emission Vehicle Market.

189 Presentations from [Logan Goldie-Scot](#) and [Mike Nicholas](#) at the May 2, 2019, workshop on the Status of the Zero-Emission Vehicle Market. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228033&DocumentContentId=59317> and <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228037&DocumentContentId=59318>.

190 Chawan, Ajay. "[Perspective: Future of Transportation Electrification.](#)" Navigant Consulting. May 2, 2019, workshop on the Status of the Zero-Emission Vehicle Market.

available globally by early 2020 will be BEVs.¹⁹¹ Both ICCT and BloombergNEF analyses estimate that BEVs will reach purchase cost parity with internal combustion engine vehicles in equivalent classes during the mid-2020s, and one to two years sooner if considering the total cost of ownership parity.¹⁹² However, while PHEVs may not achieve initial cost parity with internal combustion engine vehicles in the near future, they may provide utility for drivers who do not have home charging.¹⁹³ By the end of 2022, PHEVs may constitute about half of the 81 PEV models that are expected in the United States.¹⁹⁴ Globally, by 2025, with several hundred models available, auto manufacturers are anticipated to sell 15 million PEVs annually, given the anticipated effects of existing regulatory sales requirements. However, as discussed in the next section, complementary policies to address charging infrastructure needs and enable broader driver acceptance may be necessary to secure the benefits of global economies of scale and continued growth for the California market.¹⁹⁵

Effects of Automation and Shared Mobility

The confluence of vehicle electrification, driving automation, and connected (capable of remote communication) or shared mobility (which includes ride-hailing, taxis, and car sharing) has the potential to lead to dramatically decreased or increased emissions from the transportation sector. McKinsey & Company analyzed the \$220.6 billion invested since 2010 in nearly 1,200 global startup companies operating in 10 mobility technology areas. Overall, U.S. investors have spent the largest amount, and U.S. companies have received \$84.5 billion, the most investment of any country.¹⁹⁶ Importantly for emissions reductions, the electric vehicle, charging, and battery sectors garnered 15 percent of cumulative investment (\$33 billion). The rate of annual investment in electric vehicles and charging in the 2014–2019 period notably increased to \$3 billion per year, a fivefold increase over the 2010–2013 period. Electrification investments rival the \$29.9 billion invested in automated vehicle and advanced driver

191 [Transcript of the May, 2, 2019, Workshop on the Market for ZEVs](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228404&DocumentContentId=59603)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=228404&DocumentContentId=59603>.

192 Presentations from [Logan Goldie-Scott](#) and [Mike Nicholas](#) at the May 2, 2019, workshop on the Status of the Zero-Emission Vehicle Market. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228033&DocumentContentId=59317> and <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228037&DocumentContentId=59318>.

193 ICCT, 2019. Update on electric vehicle costs in the United States through 2030.

194 [Link to Electric Vehicle Market Status paper by M.J. Bradley & Associates LLC](#)
<https://www.mjbradley.com/sites/default/files/ElectricVehicleMarketStatus05072019.pdf>.

195 Nicholas, Michael. "[Global Light-Duty Electric Vehicle Trends, Costs of Battery Technologies, Consumer Prices, and Implications for Policy.](#)" International Council on Clean Transportation. May 2, 2019, workshop on the Status of the Zero-Emission Vehicle Market. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228037&DocumentContentId=59318>.

196 McKinsey & Company. 2019. "Start Me Up: Where Mobility Investments are Going." [Memorandum from Noel Crisostomo with the CEC to the Docket Unit of the CEC regarding adding information to the 19-IEPR-04 docket](#)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=228310&DocumentContentId=59494>.

assistance systems. While electrification investments are a relatively small part of the mobility sector, electrification has generated more than 14,000 patents, nearly half of the total.

As the leading market for ZEVs within the United States, it is feasible and imperative for California to promote innovative approaches in mobility to minimize transportation emissions. For example, in its 2018 Annual Energy Outlook, the U.S. Energy Information Administration (U.S. EIA) provides scenarios and costs related to the introduction of autonomous vehicles (AVs) into the transportation sector. The U.S. EIA estimates the costs of nonspeed-limited Level 4 and Level 5 AVs¹⁹⁷ to decline by half between 2025 and 2050 (to about \$80,000) as LIDAR¹⁹⁸ technology improves. The U.S. EIA also projects that the ride-hailing providers would begin purchasing full-speed Level 4 AVs in 2025 and in the mid-2030s will pivot to prefer Level 5 AVs. Overall, the U.S. EIA estimated that between 2040 and 2050, AVs would increase from 5 percent to 50 percent of sales for ride-hailing fleets.¹⁹⁹

For comparison, BloombergNEF's 2019 EV Outlook estimates that shared mobility will serve 20 percent of total passenger travel by 2040, and that 80 percent of the shared mobility fleet will be PEVs because of superior operational costs. Strikingly, when compared to its 2018 EV Outlook, BloombergNEF's 2019 EV Outlook found that 51 million fewer passenger PEVs will be sold globally in 2040 due in part to a "less optimistic view on car sales and a more aggressive view on the growth of shared mobility."²⁰⁰ Separately, the U.S. EIA estimates that AVs could reduce energy consumption of the U.S. light-duty vehicle fleet by 60 percent or increase it by 200 percent.²⁰¹ In general, uncertainty in how AV trends will affect vehicle fuel efficiency, vehicle miles traveled, and energy use has raised the need to minimize emissions of AVs as a key policy priority for California's energy and transportation planning agencies.²⁰² Aligned with

197 Per the U.S. Department of Transportation, "Automated Driving Systems 2.0, A Vision For Safety," Level 4 automation is "high automation" where the vehicle is capable of performing all driving functions under *certain* conditions and the driver may have the option to control the vehicle. Level 5 automated vehicles can perform all driving functions under *all* conditions. [Automated Driving Systems 2.0 document from the National Highway Traffic Safety Administration's website](https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.

198 "LIDAR" stands for Light Detection and Ranging and is a key technology allowing vehicles to sense the position of other objects.

199 Chase, Nicholas. U.S. Energy Information Administration. "Zero-Emission Vehicles and Automated Vehicles: Uncertainty and Energy Implications." May 2, 2019 workshop on the Status of the Zero-Emission Vehicle Market. [Presentation by U.S. EIA at the May 2, 2019, workshop on the ZEV market](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59320) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59320>.

200 BloombergNEF Electric Vehicle Outlook 2019. [Memorandum from Noel Crisostomo with the CEC to the Docket Unit of the CEC regarding adding information to the 19-IEPR-04 docket](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59493) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59493>.

201 Chase, Nicholas. U.S. Energy Information Administration. "Zero-Emission Vehicles and Automated Vehicles: Uncertainty and Energy Implications." May 2, 2019 workshop on the Status of the Zero-Emission Vehicle Market. [Presentation by U.S. EIA at the May 2, 2019, workshop on the ZEV market](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59320) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=228035&DocumentContentId=59320>.

202 Governor's Office of Planning and Research. "California Automated Vehicle Principles for Healthy and Sustainable Communities." [Automated Vehicle Principles for Healthy and Sustainable Communities information on the Governor's Office of Planning and Research website](http://opr.ca.gov/docs/20181115-California_Automated_Vehicle_Principles_for_Healthy_and_Sustainable_Communities.pdf) http://opr.ca.gov/docs/20181115-California_Automated_Vehicle_Principles_for_Healthy_and_Sustainable_Communities.pdf.

its second Advanced Clean Cars Program and consistent with a requirement to reduce emissions from transportation network companies (Senate Bill 1014, Skinner, Chapter 369, Statutes of 2018), CARB is developing a Clean Miles Standard with the intent of encouraging ZEVs to reduce vehicle miles traveled via pooling, active transport, and transit, and to account for AVs.²⁰³

Charging Infrastructure Analyses for Widespread Deployment

For California to meet its goals to reduce transportation emissions, it is critical to address a key constraint to the sustained long-term growth of ZEVs by accelerating the widespread deployment of charging infrastructure.

In March 2018, the CEC published a projection of the charging infrastructure needed to ease the adoption of 1.5 million ZEVs by 2025. In collaboration with the National Renewable Energy Laboratory (NREL), the CEC developed a modeling framework that quantifies the types of charging infrastructure needed to ensure that light-duty PEV drivers can meet their personal mobility needs.²⁰⁴ The CEC's resulting "Electric Vehicle Infrastructure Projections" (EVI-Pro) tool estimated the needed types of chargers by county for each year up to 2025. By 2025, these include 121,000 chargers at multiunit dwellings, 99,000–133,000 Level 2 chargers at destinations, and 9,000–25,000 DC fast chargers in public locations.²⁰⁵

Later in 2018, the Legislature passed Assembly Bill 2127 (Ting, Chapter 365, Statutes of 2018). The statute directs the CEC to complete biennial assessments of charging infrastructure needed to meet the state's 2030 goals for GHG emissions reductions and the deployment of 5 million ZEVs, as well as achieve ambient air quality standards. The assessment will expand upon the EVI-Pro tool as part of analyzing charging infrastructure, make-ready electrical equipment, supporting hardware and software, and other programs. The assessment will focus on the adoption of PEVs in on-road, off-road, port, and airport applications. The statute requires gathering data and feedback from the CPUC, CARB, utilities, transportation and transit agencies, charging infrastructure companies, environmental groups, automobile manufacturers, and others.

203 Jaw, Kathy, Joshua Cunningham, and Tony Brazil. California Air Resources Board. "The Need for EV Charging Infrastructure Assessments to Inform Policies, March 11 IEPR Workshop on Assessing Charging Infrastructure Needs in California." [Presentation by CARB at the March 11, 2019, workshop on EV Charging Infrastructure Assessment \(AB 2127\)](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227307&DocumentContentId=58166) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=227307&DocumentContentId=58166>.

204 Bedir, Abdulkadir, Noel Crisostomo, Jennifer Allen, Eric Wood, and Clément Rames. 2018. *California Plug-In Electric Vehicle Infrastructure Projections: 2017-2025*. CEC. Publication Number: CEC-600-2018-001. [Revised California Plug-in Electric Vehicle Projections: 2017–2025 staff report](https://efiling.energy.ca.gov/GetDocument.aspx?tn=224521&DocumentContentId=55071) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=224521&DocumentContentId=55071>.

205 CEC EV Infrastructure Projection Tool (EVI-Pro) [Link to online CEC EV Infrastructure Projection Tool](http://maps.nrel.gov/cec) <http://maps.nrel.gov/cec>.

The CEC presented on the initial scoping of these analyses in IEPR workshops on March 11, 2019,²⁰⁶ and May 2, 2019,²⁰⁷ as well as a Demand Analysis Working Group meeting on June 14, 2019.²⁰⁸ In these presentations, the CEC described a framework for the factors driving adoption of electric transportation technologies and associated charging infrastructure. Representatives from CARB, the CPUC, the South Coast Air Quality Management District, the San Joaquin Air Pollution Control District, and leading electric transportation researchers at NREL and Lawrence Berkeley National Laboratory (LBNL) and the University of California at Davis (UCD) also presented at the workshops.

AB 2127 reinforces the need for consistent charging accounting. Various data collection and reporting initiatives and regulatory and incentive programs at CARB,²⁰⁹ the CPUC,²¹⁰ and the CEC highlight opportunities to harmonize data and definitions to ensure that stakeholders have accurate and up-to-date information on the availability of charging infrastructure and the adequacy of the charging network as a whole.

Without the ability to track charging installations accurately, capacity and cost may be misrepresented, and opportunities to advance the charging infrastructure may be missed. To further ensure that charging infrastructure assessments reflect timely and accurate information, the CEC may explore developing data collection regulations to collect information on the number, type, and usage of deployed charging equipment.

Per the March 2019 workshop, the lack of standardization for varied thresholds of charging, or *different components of charging*,²¹¹ poses a barrier to advancing the EVSE assessment. For instance, the 2018 results from EVI-Pro did not fully analyze the different scenarios that will modify charging needs and opportunities, such as changes to the amount of electricity discharged from the EVSEs (due to utility signals) or changes in end user behavior.

206 [Link to main webpage for documents from the March, 11, 2019, workshop on the EV Charging Infrastructure Assessment \(AB 2127\)](https://ww2.energy.ca.gov/2019_energypolicy/documents/#03112019) https://ww2.energy.ca.gov/2019_energypolicy/documents/#03112019.

207 [Link to main webpage for documents from the May 2, 2019, workshop on EV Charging Infrastructure Assessment \(AB 2127\)](https://ww2.energy.ca.gov/2019_energypolicy/documents/#05022019-pm) https://ww2.energy.ca.gov/2019_energypolicy/documents/#05022019-pm.

208 Materials from June 14, 2019, Demand Analysis Working Group meeting. [Link to documents from the June 14, 2019, meeting of the Demand Analysis Working Group](http://dawg.energy.ca.gov/meetings/transportation-electric-vehicle-forecast) <http://dawg.energy.ca.gov/meetings/transportation-electric-vehicle-forecast>.

209 [Information on CARB's draft proposed regulation order on EVSE standards](https://ww2.arb.ca.gov/our-work/programs/electric-vehicle-charging-stations-open-access-senate-bill-454) <https://ww2.arb.ca.gov/our-work/programs/electric-vehicle-charging-stations-open-access-senate-bill-454>.

210 [Link to documents from the CPUC's May 9, 2019 meeting on Metrics & Methodologies to Evaluate Transportation Electrification Programs](https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442461242) <https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442461242>.

211 Such as in increasing order: "connectors," "EVSE" or "chargers," "charging infrastructure," and "stations," as defined in the CEC's presentation at the March, 11, 2019 IEPR staff workshop on EV Charging Infrastructure Assessment (AB 2127). [Presentation by CEC at March 11, 2019, workshop on EV Charging Infrastructure Assessment \(AB 2127\)](https://efiling.energy.ca.gov/GetDocument.aspx?tn=227308&DocumentContentId=58167) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=227308&DocumentContentId=58167>. pps. 25–29.

Based on initial AB 2127 outreach and feedback, the CEC has identified major factors affecting the needs for charging, the extent of make-ready electric infrastructure, and the design of equipment, including:

- Regulatory mandates on mobile source emissions, which induce the creation of supplies of zero-emission and electric vehicles and equipment.
- Research and development of charging technology, especially for power capability in excess of 350 kW that can serve medium- and heavy-duty vehicles.
- Regional and local conditions guiding the development and implementation of electric transportation plans.
- Funding for charging infrastructure from private markets, public funds, and utility ratepayer funds.
- Driver adoption and behaviors related to vehicles and charging.

In turn, these factors could be influenced in several ways by the charging infrastructure assessment results, and that the frequency of updates occurring at least biennially would promote the tracking of how charging infrastructure needs evolve with the market.

Throughout the IEPR process, stakeholders have expressed a desire to see the CEC's charging infrastructure assessments address the following:

- Improving the consistency of accounting for charging installations and use.
- Implementing improvements recommended in the 2018 EVI-Pro staff report.
- Expanding infrastructure projections for light-duty commercial vehicles.
- Expanding infrastructure projections for medium- and heavy-duty vehicles.
- Quantifying the value of public EV charging infrastructure.²¹²
- Identifying the needs of transportation network companies' fleet vehicles and autonomous vehicles.
- Analyzing the demand for make-ready equipment using utilities' maps.
- Assessing the costs of individual charging equipment hardware components.
- Implementing charging equipment software communication protocols.
- Dispersing charging geographically in consideration of travel needs, emissions targets, and grid planning.
- Coordinating implementation of state policies and investments to ensure ratepayer funds are being fully leveraged and used efficiently.

²¹² Forthcoming report from National Renewable Energy Laboratory for the CEC.

- Addressing the need for specialized expertise to permit and install infrastructure within local markets throughout California.
- Building upon previous and forthcoming infrastructure analysis.

The statute requires the CEC to update the assessment at least every two years, with the first charging infrastructure assessment by December 2020.

The initial scoping and outreach of AB 2127 have occurred within the 2019 IEPR proceeding. In that time, stakeholders have emphasized how drastically electric transportation options and technologies will change through 2030. This continuous evolution illustrates the importance of pacing the charging infrastructure assessments such that they can inform ongoing planning by state and regional agencies as well as industry and nongovernmental stakeholders. Because the requirements of AB 2127 do not end with adoption of the 2019 IEPR, the CEC has opened a separate docket (19-AB-2127) with which to conduct and collect future AB 2127 analysis and feedback.²¹³

Updating the Vehicle Grid Integration Roadmap

Vehicle-Grid Integration (VGI) represents the ability of plug-in electric vehicles to provide services to the grid. This can be done in a number of ways, including strategic charging (to prioritize cleaner or lower cost electricity) or bidirectional charging (to provide electricity back to the grid, to buildings, or to other vehicles). When implemented, these approaches can improve the economics of plug-in electric vehicles and charging infrastructure while simultaneously supporting a cleaner, more reliable, more cost-efficient electrical grid.

The California ISO, in coordination with the Governor's Office, the CEC, and the CPUC, developed the original VGI Roadmap in 2014.²¹⁴ The 2017 IEPR recommended that the CEC “work with the California ISO and the CPUC to update the VGI Roadmap reflecting the needs to use open standards, to return the value of grid integration to stakeholders, and to commercialize prior investments in research and maintain leadership in advanced technology development.”²¹⁵

213 Please visit [Link to CEC's online electronic comment system](https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-AB-2127) (https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-AB-2127) to submit an electronic comment. Enter your contact information and a comment title describing the subject of your comment(s). Email comments may also be submitted; include the docket number 19-AB-2127 in the subject line and send to docket@energy.ca.gov.

214 *California Vehicle Grid Integration Roadmap: Enabling Vehicle-Based Grid Services*. 2014. [Vehicle-Grid Integration Roadmap on the California ISO's website](https://www.caiso.com/Documents/Vehicle-GridIntegrationRoadmap.pdf) <https://www.caiso.com/Documents/Vehicle-GridIntegrationRoadmap.pdf>.

215 See Chapter 4: Accelerating the Use of Distributed energy Resources on the California Grid and Appendix H regarding the Vehicle-Grid Integration Roadmap in the *2017 Integrated Energy Policy Report*. [Link to 2017 IEPR report and dockets on the CEC's website](https://www2.energy.ca.gov/2017_energy/policy/) https://www2.energy.ca.gov/2017_energy/policy/.

A goal of the updated VGI Roadmap is to provide policy direction that ensures charging infrastructure deployments benefit drivers and ratepayers, in addition to accelerating transportation electrification and carbon neutrality. The agencies expect to release a Draft VGI Roadmap for public review in fall 2019 and hold a public workshop to solicit input. The CEC anticipates publishing the final updated VGI Roadmap in early 2020.

Automaker Perspective on VGI

The automotive industry continues to support the commercialization of VGI technologies. In comments to the CEC, for instance, American Honda Motor encouraged looking beyond demonstration and pilot projects. Instead, Honda encouraged a focus on policy changes, such as:

- Interconnection of stationary and onboard inverters.
- Regulatory determinations of value that can compensate drivers, site hosts, utilities, and aggregators.
- Modifications to demand response and net metering programs to fully realize the value of V2G.

Source: Jessalyn Ishigo. August 6, 2019. [Link to Honda's V2G Comments to the CEC](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229242&DocumentContentId=60649)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=229242&DocumentContentId=60649>.

Through 2018, staff from the CEC worked with staff from the California ISO, CPUC, and CARB to develop an approach, framework, and topics to cover in an update to the VGI Roadmap. On September 6, 2018, to kick off the roadmap update, the joint agencies held a public webinar that presented the proposed approach and a draft list of 14 VGI roadmap goals and 39 problems/issues that impede achieving those goals.²¹⁶

Building upon the three tracks from the original 2014 VGI Roadmap, staff from the CEC organized the draft goals and problems/issues for the roadmap update into four tracks, including a new one focused on customers:

- 1) **Policy and Planning:** Identify policy and planning interactions, barriers, and gaps to achieve widespread managed charging deployment.

California Vehicle Grid Integration Roadmap: Enabling Vehicle-Based Grid Services. 2014. [Vehicle-Grid Integration Roadmap on the California ISO's website](https://www.caiso.com/Documents/Vehicle-GridIntegrationRoadmap.pdf) <https://www.caiso.com/Documents/Vehicle-GridIntegrationRoadmap.pdf>.

²¹⁶ The September 6, 2018, kickoff webinar material and recording of the webinar are available online. [Link to workshop documents and notices for the California Vehicle-Grid Integration Roadmap Update on the CEC's website](https://ww2.energy.ca.gov/transportation/vehicle-grid-integration/documents/index.html) <https://ww2.energy.ca.gov/transportation/vehicle-grid-integration/documents/index.html>.

- 2) **Economic Potential:** Identify the costs (equipment, operational, and process) and benefits of managed and bidirectional charging versus unmanaged charging at the scale of millions of PEVs. Identifying these costs/benefits will promote business model creation to spur investment.
- 3) **Technology Needs:** Identify VGI technologies for all vehicle classes to expedite the actions described in the “Policy and Planning” and “Economic Potential” tracks. Delineate key areas of commercialization versus new research.
- 4) **Customer Experience:** Expand the feasibility of VGI for end users, especially low-income residents and residents in disadvantaged communities, to participate in managed charging. Ensure VGI efforts emphasize access to all Californians.

On October 29 and 30, 2018, the CEC hosted a two-day VGI Roadmap workshop that included a VGI technology showcase. At the technology showcase, 12 automotive and electric vehicle supply equipment manufacturers and a large university campus demonstrated some of the advanced vehicles, charging equipment, and tools for optimizing charging available in the market today. Following the technology showcase, the CEC held four panel sessions corresponding to the roadmap tracks that included presentations and discussions from automakers, electric vehicle service providers, national laboratories, utilities, and environmental and ratepayer advocates.²¹⁷ As part of the workshop, the joint agencies presented a revised list of goals and problems/issues and solicited public comment on potential actions to address them. The joint agencies considered the public input in preparation of the draft roadmap update, which is being coordinated with the development of the Distributed Energy Resources Research Roadmap and other VGI developments in California and globally.

²¹⁷ The October 29 and 30, 2018 VGI Roadmap workshop materials and recording are available online. [Link to workshop documents and notices for the California Vehicle-Grid Integration Roadmap Update on the CEC's website](https://ww2.energy.ca.gov/transportation/vehicle-grid-integration/documents/index.html) <https://ww2.energy.ca.gov/transportation/vehicle-grid-integration/documents/index.html>.

VGI in School Buses

Under the new School Bus Replacement Program created by Senate Bill 110 (2017), the CEC targeted electric school buses as distributed energy resources, and challenged bus manufacturers to include bidirectional charging. As a result, in July 2019, the CEC awarded funds for more than 200 electric buses with V2G capabilities (as well as funds for charging infrastructure and training).

Source: CEC, *Energy Commission Awards Nearly \$70 Million to Replace Polluting Diesel School Buses With All-Electric School Buses Throughout California*, July 15, 2019.
<https://www.energy.ca.gov/news/2019-07/energy-commission-awards-nearly-70-million-replace-polluting-diesel-school-buses>

In parallel to the VGI roadmap update, the CPUC launched two working groups to examine the costs and benefits of VGI and address vehicle-to-grid (V2G) interconnection. The first working group will identify and enable stakeholders to capture the value of smart charging and V2G to help scale electric vehicles as distributed energy resources (DERs). Specifically, the working group is expected to identify which use cases can provide value in the immediate future to serve as demand response or storage that can be “captured” as grid capacity. The CPUC is interested in understanding how the value of VGI compares to other resources and what policies are necessary to support implementation of the technology. The working group is anticipated to complete its analysis by early 2020.²¹⁸ A second working group will identify existing standards to fulfill the necessary safety requirements for interconnecting an AC inverter inside a PEV. A final report is anticipated to inform the DRIVE and Rule 21 proceedings by early 2020.²¹⁹

Recommendations

- **The California Energy Commission (CEC) should continue supporting research and development opportunities and cost reduction strategies to enable bi-directional charging and minimize the grid impact of medium and heavy-duty plug-in electric vehicles (PEVs).** Vehicle-to-grid and vehicle-to-building technologies can reduce the ownership cost of PEVs and reduce the infrastructure upgrades required to support medium- and heavy-duty vehicle electrification. Certain use cases, such as school buses, have duty cycles that particularly match the business case for such

²¹⁸ [Information, materials, and meeting schedule for the Vehicle Grid Integration Working Group on Gridworks' website](https://gridworks.org/initiatives/vehicle-grid-integrationwg/)
<https://gridworks.org/initiatives/vehicle-grid-integrationwg/>.

²¹⁹ Joint Administrative Law Judges’ Ruling Establishing Subgroup and Schedule to Develop Proposal on Mobile Inverter Technical Requirements for Rule 21 and Noticing Workshop, R.17-07-007 and R.18-12-006, August 23, 2019. [Link to CPUC ruling regarding Rulemaking 17-07-007 and Rulemaking 18-12-006 on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M311/K582/311582954.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M311/K582/311582954.PDF>.

strategies. Conducting pilot demonstrations of these use cases can accelerate commercialization and promote PEVs as distributed energy resources (DER) that can provide grid services. In addition, integrated DER such as solar and energy storage can reduce the peak demand on the grid and provide onsite, zero carbon, and reliable generation to support vehicle electrification while minimizing the cost to upgrade the distribution grid and expediting the deployment of charging infrastructure.

- **The CEC and collaborating state agencies should continue to identify and eliminate technical and policy barriers to implementing vehicle-to-grid (VGI) capable infrastructure.** Through various VGI Roadmap Working and Sub-Working Groups, the CEC will collaborate with private and adjacent public agencies to ensure the effectiveness of the VGI rollout. As part of this effort, agencies will present their contributions to the working group and develop a strategic VGI valuation method.
- **Consider additional funding for the CEC's School Bus Replacement Program.** The CEC's School Bus Replacement Program provided \$75 million for schools to replace older diesel-powered buses with new electric buses, and was supported by additional funding from the CEC's Clean Transportation Program to install charging infrastructure for those buses. School districts applied for grant funds to replace over 1,600 diesel school buses, but the program only had sufficient funding for 233 zero-emission buses and charging infrastructure. Given the harmful impacts to children from exposure to toxic diesel exhaust, the state should prioritize replacing older diesel school buses with clean new electric buses, particularly in disadvantaged communities.
- **To assess fully the availability and gaps of plug-in electric vehicle charging infrastructure, the CEC should pursue additional data collection authority under its Title 20 regulatory authority.**

CHAPTER 4:

Advancing Energy Equity

“We must map out longer-term strategies ... for California’s energy future, to ensure that the cost of climate change doesn’t fall on those least able to afford it,” Governor Newsom stated in his State of the State Address on February 12, 2019.²²⁰ California’s low-income and disadvantaged communities are the most likely to disproportionately suffer the impacts of climate change. For this reason, the state must continue to strategically direct its investments to address climate change in these communities.

Energy equity is a critical component of the state’s strategy for achieving its ambitious climate change and clean energy goals. Addressing barriers to and investing in clean energy and clean transportation for low-income and disadvantaged communities is not only fundamental to help the state protect the most vulnerable communities from climate change, but is also necessary to help low-income Californians achieve energy bill savings and benefit from clean energy market opportunities such as workforce development. California remains deeply committed to continuing to advance energy equity to ensure that low-income and disadvantaged communities, as well as tribal and rural communities, reap the benefits of a transformed clean energy future.

SB 350 Requires California to Focus on Energy Equity

Senate Bill 350 (De León, Chapter 547, Statutes of 2015) established ambitious energy goals, including doubling energy efficiency and increasing renewable electricity, to support California’s target of reducing greenhouse gas (GHG) emissions to 40 percent below 1990 levels by 2030. SB 350 also requires that the state take steps to focus on equity to ensure that all Californians, including those in the most vulnerable communities, realize the benefits of a transformed clean energy economy.

SB 350 directed the California Energy Commission (CEC) to study barriers for low income-customers, including those in disadvantaged communities, to energy efficiency and weatherization investments, and renewable energy generation and to contracting opportunities for local small businesses in disadvantaged communities. In addition, SB 350 directed the California Air Resources Board (CARB) to publish a study on barriers for low-income customers, including those in disadvantaged communities, to zero-emission and near-zero

²²⁰ [Governor Newsom’s February 12, 2019, State of the State address](https://www.gov.ca.gov/2019/02/12/state-of-the-state-address/) https://www.gov.ca.gov/2019/02/12/state-of-the-state-address/.

emission transportation options. SB 350 also requires that the CEC and CARB develop recommendations on how to address these barriers.

As directed by SB 350, in December 2016, the CEC published the *Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities* (Barriers Study Part A). The study identifies 12 recommendations to increase access to address barriers to clean energy.²²¹ CARB published the *Low -Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents* (Barriers Study Part B) in February 2018.²²² The study identifies barriers that limit access to clean transportation for low-income customers and disadvantaged communities and identifies six priority recommendations.

SB 350 Recommendations and Implementation Accomplishments

California state agencies have been working together to implement the recommendations in the Barriers Studies. Table 6 contains a summary of the 12 recommendations in the Barriers Study Part A to address the barriers to low-income access to clean energy, as well as the lead and supporting agencies implementing the recommendations. Table 7 contains a summary of the recommendations from CARB’s Barriers Study Part B.

Table 6: Barriers Study Part A Recommendations and Lead and Supporting Agencies

	Recommendation	Lead and Supporting Agencies
1	Establish a multiagency task force to promote coordination across state-administered programs.	Lead: Governor’s Office Supporting: CEC, California Public Utilities Commission (CPUC), CARB, Department of Community Services & Development (CSD), California Department of Housing and Community Development, and State Water Resource Control Board
2	Enable the economic advantages of community solar to low-income and disadvantaged populations.	Lead: CPUC Supporting: CSD
3	Strategize and track progress of workforce, community, and clean energy goals.	Lead: California Labor and Workforce Agency, California Workforce Development Board (CWDB)
4	Develop new financing pilot programs to encourage investment for low-income	Lead: California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA)

²²¹ CEC, *Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities*. [Link to workshop information, notices, and documents regarding SB 350 Barriers Study on the CEC’s website](https://ww2.energy.ca.gov/sb350/barriers_report/) https://ww2.energy.ca.gov/sb350/barriers_report/.

²²² CARB, *Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents*, [Link to CARB Barriers Report on the CARB website](https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document) https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document.

	Recommendation	Lead and Supporting Agencies
	customers, including disadvantaged communities.	Supporting: CEC, CPUC
5	Establish common metrics and encourage data sharing across agencies and programs.	Lead: CEC Supporting: CPUC, CARB, CSD, California Department of Housing and Community Development, California Department of Public Health (CDPH)
6	Expand opportunities for low-income and disadvantaged communities to use photovoltaic and solar thermal technologies.	Lead: CPUC, CSD
7	Enhance affordable housing tax credits for housing rehabilitation projects to include energy efficiency and renewable energy upgrades.	Lead: California Tax Credit Allocation Committee Supporting: CEC, CPUC, California Department of Housing and Community Development, CAEATFA
8	Establish regional outreach and technical assistance, outreach, and funding one-stop shop pilots.	Lead: CPUC, CEC, CARB
9	Investigate the need for heightened consumer protection for low-income customers and small businesses in disadvantaged communities seeking access to clean energy.	Lead: Governor's Office Supporting: CPUC, CEC
10	Direct funding to collaborate with community-based organizations for community-centric delivery of clean energy programs.	Lead: CPUC, CEC, CARB Supporting: Strategic Growth Council (SGC), CSD, Department of General Services (DGS), Governor's Office of Business and Economic Development (Go-Biz), community-based organizations
11	Direct research, development, demonstration, and market facilitation programs to include targeted benefits for low-income customers and disadvantaged communities.	Lead: CEC Supporting: CPUC
12	Conduct an in-depth, data-driven study for increasing contracting opportunities for small businesses located in low-income and disadvantaged communities.	Lead: Governor's Office of Business and Economic Development (Go-Biz) Supporting: DGS, SGC, CPUC, CEC

Sources: [Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities](#) and the CEC's [Barriers Study Recommendations Report out on SB 350 Implementation Progress](#), July 2019. TN 229108. <https://efiling.energy.ca.gov/getdocument.aspx?tn=214830> and <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229108&DocumentContentId=60513>

Table 7: Barriers Study Part B Recommendations and Lead and Supporting Agencies

	Recommendation	Lead and Supporting Agencies
1	Expand assessments of low-income resident clean transportation and mobility needs to ensure feedback is incorporated in transportation planning and for guiding investments.	Lead: California Department of Transportation (Caltrans), CARB, California Transportation Commission (CTC) Supporting: Local transportation authorities, metropolitan planning organizations (MPOs), councils of government (COGs), transit agencies, CEC, CPUC, SGC, CDPH
2	Develop an outreach plan targeting low-income residents across California to increase residents' awareness of clean transportation and mobility options.	Lead: CARB, CEC, CPUC, SGC Supporting: CDPH, CTC, Caltrans, Department of Motor Vehicles, Go-Biz, air districts, investor-owned utilities, publicly owned utilities
3	Develop regional one-stop shops to increase consumer awareness and technical assistance.	Lead: CARB, CEC, SGC Supporting: CPUC, CSD, California Natural Resources Agency, California Department of Housing and Community Development, California Department of Water Resources
4	Develop guiding principles for grant and incentive solicitations to increase access to programs and maximize low-income resident participation.	Lead: CARB, CEC, CPUC, SGC Supporting: CTC, Caltrans, California Department of General Services, CDPH
5	Maximize economic opportunities and benefits for low-income residents from investments in clean transportation and mobility options by expanding workforce training and development.	Lead: California Labor and Workforce Development Agency, CWDB, CARB Supporting: CEC, CPUC, CSD, CDPH, California Employment Development Department
6	Expand funding and financing for clean transportation and mobility projects, including infrastructure, to meet the accessibility needs of low-income and disadvantaged communities.	Lead: CARB, CEC, CPUC, CTC, Caltrans Supporting: SGC, air districts

Source: CARB, Barriers Study Part B, [CARB Barriers Report on the CARB website](https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document) <https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document>

On July 30, 2019, the CEC, CPUC, and CARB held a joint agency workshop on Advancing Energy Equity to review progress towards implementing the recommendations in the Barriers Studies and to explore next steps and key actions to advance energy equity throughout California. At the workshop, state agencies discussed the actions they have already taken and the actions they plan to complete to fulfill the recommendations of the Barriers Studies. Appendix E provides a summary of the implementation status of each recommendation in the Barriers Studies.

As demonstrated in Appendix E, California’s state agencies have made significant progress towards accomplishing the recommendations in the Barriers Studies. The programs created to implement the recommendations are making a real contribution and benefiting low-income Californians and those living in disadvantaged communities. Moreover, these programs have laid a solid foundation upon which California can construct an equitable energy future. The following list highlights some of the completed and ongoing actions that are removing barriers to clean energy and clean transportation:

- The CPUC created the following:
 - The Community Solar Green Tariff (CSGT) program allows low-income customers in disadvantaged communities to benefit from the development of solar generation

projects located in or near their communities, resulting in a 20 percent discount on their overall bill.

- The Disadvantaged Communities- Single-Family Affordable Solar Homes (DAC-SASH) program provides up-front incentives for installation of solar for low-income resident-owners of single-family homes in disadvantaged communities.
- The Disadvantaged Communities- Green Tariff (DAC-GT) program allows income-eligible residential customers in disadvantaged communities to subscribe to receive electricity generated from a solar facility in California and receive a 20 percent discount on their overall bill.
- In conjunction with the Contractors State License Board and the Department of Business Oversight, a taskforce was formed to 1) provide relief for customers harmed by solar companies' unfair business and lending practices and 2) develop policy solutions to improve consumer protections for solar customers, particularly those in disadvantaged communities.
- The CPUC and CEC jointly established the Disadvantaged Communities Advisory Group (DACAG) in 2018. DACAG reviews and provides advice on the effectiveness and usefulness of clean energy and pollution reduction programs in disadvantaged communities.²²³ The DACAG presented their first annual report, covering 2018 activities, to the CPUC and CEC in 2019.
- In February 2019, the CPUC adopted an Environmental and Social Justice (ESJ) Action Plan.²²⁴ The ESJ Action Plan acknowledges that the CPUC has a responsibility to serve Californians in a way that helps address inequities. The ESJ Action Plan is a commitment to advancing decisions and programs that strive to provide everyone across the state with consumer protections and other benefits. The ESJ Action Plan represents the CPUC's vision but does not bind the CPUC legally to any specific outcomes or process.
- The CEC accomplished the following:
 - In 2018, the CEC published its Energy Equity Indicators report, which identified a series of metrics designed to help identify opportunities for advancing the progress clean energy access, investment, and resilience in California's low-income and disadvantaged communities.²²⁵

223 [Information on the Disadvantaged Communities Advisory Group](https://ww2.energy.ca.gov/sb350/DCAG/) <https://ww2.energy.ca.gov/sb350/DCAG/>.

224 [CPUC Environmental and Social Justice Action Plan](https://www.cpuc.ca.gov/CPUCNewsDetail.aspx?id=6442461331) <https://www.cpuc.ca.gov/CPUCNewsDetail.aspx?id=6442461331>.

225 [Link to information on Energy Equity Indicators on the CEC's website](https://ww2.energy.ca.gov/sb350/barriers_report/equity-indicators.html) https://ww2.energy.ca.gov/sb350/barriers_report/equity-indicators.html.

- As of July 2019, the Electric Program Investment Charge (EPIC) program, the majority of which is administered by the CEC, invested approximately 31 percent of its technology demonstration and deployment funds to 104 project sites located in disadvantaged communities and an additional 34 percent to 74 project sites that are low-income only.²²⁶
- The CEC will implement new scoring criteria in upcoming technology demonstration and deployment solicitations to ensure that projects located in disadvantaged and low-income areas are providing direct benefits to the community.
- As noted above, the CEC and CPUC jointly established the DACAG in 2018 to review and provide advice on the effectiveness and usefulness of clean energy and pollution reduction programs in disadvantaged communities.
- CSD created the following programs:
 - The Community Solar Pilot Program aims to make the benefits of solar energy more available to eligible low-income households, lower residents' energy bills and provide co-benefits to communities, including economic and workforce development. The Low-Income Weatherization Program provides low-income households with solar photovoltaic systems and energy efficiency upgrades at no cost to residents.
- CAEATFA has implemented the following programs:
 - The Residential Energy Efficiency Loan Assistance Program is a pilot program designed to help homeowners and renters access lower cost financing for energy efficiency projects by reducing risk to participating lenders. The program has seven active lenders and more than \$20 million available in loan loss reserve funds to help participating lenders mitigate energy efficiency loan risk. The program is leveraging nearly \$7 million in private capital, with 52 percent of borrowers located in low-moderate income census tracts.
 - The Small Business Financing (SBF) pilot program aims to help small businesses access better financing terms for energy efficient retrofits.
 - The Affordable Multifamily Energy Efficiency Financing pilot program is designed to leverage and complement existing efforts to finance affordable multifamily energy efficiency retrofits and to encourage growth in private-market energy efficiency lending.
- CARB has developed the following activities:

²²⁶ [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN# 229108, p. 16.

- An outreach plan and roadmap that identifies strategies for effectively coordinating, streamlining, and delivering tailored clean transportation outreach.
- Regional one-stop shop project for low-income customers that increases awareness of transportation rebates and incentive programs, and provides reliable information about available technologies and clean transportation options. The initial pilot focuses on the development of a streamlined, single application for low-income consumers to apply and qualify for CARB’s low-carbon transportation equity programs, such as Clean Cars 4 All, the Clean Vehicle Rebate Project, financing assistance programs, and clean mobility options for disadvantaged communities.
- Continued funding of transformative, low-carbon transportation projects to support the transformation of California’s fleet—supporting clean vehicle ownership, clean mobility, streamlined access to funding and financing opportunities, increasing community education, and exposure to clean technologies.
- A new Sustainable Transportation Equity project, which uses a community-based approach to identify and address the unique mobility needs of a given community, will fund a variety of clean transportation activities within disadvantaged communities. Additionally, the Clean Mobility Options Voucher Pilot project will provide funding for clean mobility projects, such as carshare, bikeshare and other ride sharing opportunities in low-income and disadvantaged communities.
- Dedicated funding for community-based organizations to increase outreach and awareness of Low Carbon Transportation Investments, support community transportation needs assessments, and build capacity for clean transportation projects in low-income and disadvantaged communities.
- GO-Biz funded the following:
 - The Small Business Technical Assistance Expansion Program supports small business services, such as free or low-cost one-on-one consulting and low-cost training. The program’s funding is focused on services to underserved business groups, including women, people of color, veterans and low-wealth, rural, and disaster impacted communities.
 - The Capital Infusion Program supports one-on-one business consulting provided by the Small Business Development Network to assist small businesses in accessing capital.
 - The Technical Assistance Program (TAP) supports other federal small business technical assistance centers.

Stakeholder Proposed Recommendations for Actions and Strategies Moving Forward

As California continues to chart a path to meet its climate, air pollution, and clean energy goals, it must also identify next steps and key actions needed to improve and increase access to clean energy and clean transportation. As noted in Appendix E, some recommendations have not been fully implemented and state agencies continue to work on identifying opportunities to implement them. At the July 30, 2019, joint agency workshop on Advancing Energy Equity, Vice Chair Jenea Scott asked “How do we keep moving? How do we get on to

the next steps and what some of those key actions should be?”²²⁷ Panelists and participants at the workshop discussed additional actions that could be taken now and in the future to fulfill the recommendations that have not been completely met and that are necessary to continue advancing energy equity within the state. The panelists presented recommendations in the following areas:

- Financing
- One-stop shop implementation
- Low-income multifamily housing retrofits
 - Focus on deed-restricted properties
- Providing direct support to community-based organizations and having dedicated staff for community outreach

Financing to Create Equity

Access to capital and credit for financing energy efficiency upgrades was identified as a barrier in the Barriers Study Part A. With competing demands on household income and limited ability to qualify for credit, traditional debt-based financing is not a useful financing mechanism for low-income households. Two of the recommendations in the Barriers Study Part A addressed financing mechanisms for providing energy efficiency upgrades for low-income residents (Recommendations 4 and 7). At the July 30, 2019, joint agency workshop on Advancing Energy Equity, Dr. Holmes Hummel with Clean Energy Works identified that financing building efficiency upgrades by way of utility tariffed on-bill investments has been a very cost-effective financing method that has been available for years in several states (such as Hawaii, Kansas, Kentucky, Arkansas, North Carolina, New Hampshire, and Tennessee).²²⁸ Tariffed on-bill financing works when a utility offers inclusive financing for cost-effective energy upgrades by establishing an opt-in tariff that authorizes the utility to recover its cost with a charge on the bill that is significantly less than the estimated savings. The investment capital is assigned to the meter, so if a participating customer moves, their obligation to pay ends, and the terms of the tariff apply to the successor customer at that site.

²²⁷ [Transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/getdocument.aspx?tn=229742) https://efiling.energy.ca.gov/getdocument.aspx?tn=229742, p. 11.

²²⁸ [Link to presentation by Clean Energy Works at the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229096&DocumentContentId=60501) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229096&DocumentContentId=60501, p. 1.

[Link to transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229742&DocumentContentId=61170) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229742&DocumentContentId=61170, p. 125.

Utility tariffed on-bill financing does not require a consumer loan, lien, or debt. It can be used by utility customers of all income levels, whether they are renters or property owners. Utilities and electric cooperatives, such as the New Hampshire Electric Cooperative, Roanoke Electric, and the Mountain Association for Community Economic Development, that have implemented tariffed on-bill financing have reported an order-of-magnitude increase in the pace of capital deployment.²²⁹ When compared to traditional debt-based loans, tariffed on-bill financing has been able to achieve higher customer uptake rates and greater energy savings, while experiencing a much lower repayment default rate.²³⁰

One-Stop-Shop Creation

The Barriers Study Part A recommended the creation of multiple regional one-stop shops to “provide technical assistance, targeted outreach, and funding services to enable owners and tenants of low-income housing across California to implement energy efficiency, clean energy, zero-emission and near-zero emission transportation infrastructure, and water-efficient upgrades in their buildings”(Recommendation 8).²³¹ During the July 30, 2019, workshop, Ted Lamm, a research fellow at the University of California, Berkeley Center for Law, Energy, and the Environment, presented two case studies that highlight the potential benefits of one-stop shops for energy efficiency incentives. Both case studies showed how complicated it is to consolidate, coordinate, and align existing state and local energy efficiency incentives.²³² However, if done, it could result in greater replicability of successful, energy-efficient, and affordable housing rehabilitation projects.²³³

Mr. Lamm noted that a one-stop-shop will not solve all issues that arise when implementing energy efficiency measures, but “it would help the responsible agencies coordinate and align their incentives on the energy and tax sides. And it would give them [the agencies] a forum to

229 [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229100, pp. 43-59.

230 Ibid., p. 129.

231 CEC, *Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities*. [Link to workshop information, notices, and documents regarding SB 350 Barriers Study on the CEC's website](https://ww2.energy.ca.gov/sb350/barriers_report/) https://ww2.energy.ca.gov/sb350/barriers_report/. p. 9.

232 [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229153.

233 [Transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/getdocument.aspx?tn=229742) <https://efiling.energy.ca.gov/getdocument.aspx?tn=229742>, pp. 116-122.

address these conflicts, particularly timeline conflicts, in a systematic fashion. At the same time, it would also facilitate a simpler single point of access for customers."²³⁴

An ongoing effort to support under resourced communities' climate change preparations is being guided by the Strategic Growth Council. In 2018, Senate Bill 1072 (Leyva, Chapter 377, Statutes of 2018) created the Regional Climate Collaborative Program which would be administered by the Strategic Growth Council. The program would assist under resourced communities with accessing statewide public and other grant funds. Selected collaboratives will provide capacity building services to help build community-driven leadership, knowledge, skills, experience, and resources to identify and access public funding for climate change mitigation and adaption projects within the under resourced community.

Jessica Buendia of the Strategic Growth Council highlighted an important point during the July 30 workshop—for programs to be successful, strong community support for the programs is needed.²³⁵

Low-Income Multifamily Housing Retrofits

As identified in the Low Income, High Efficiency report discussed by Ted Lamm at the July 30 workshop, meeting statewide energy efficiency targets is very challenging in the low-income multifamily residential sector. The report details:

“Unlike single-family, owner-occupied homes, these buildings are subject to split incentives between owners who might pay for an efficiency retrofit and tenants who would reap the savings based on reduced energy consumption in their units. Low-income property owners also typically face reduced access to capital to fund a project, increased restrictions on their ability to finance one, and older construction that requires significant renovation in other areas.”²³⁶

One of the case studies described by Mr. Lamm at the workshop illustrated the benefit of the concept of a one-stop shop. The case study described a deed-restricted property in San Diego. The City of San Diego owned the land and leased it to MG Properties Group, which owned the housing structures. The long-term ground lease from the city required that 20 percent of the housing units be for low-income residents. Because the property had a deed restriction, it qualified the rehabilitation project for a Fannie Mae Green Rewards Loan, which provides lower

234 [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229742, p. 120-121.

235 [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229742, p. 198.

236 [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229099, p. 1.

interest loans and other financial benefits.²³⁷ The project was able to align the new ground lease term and financing event, which helped integrate utility and state incentives with federal tax benefits and favorable loan terms, generating significant energy efficiency increases.

Some specific solutions illustrated by the case study include:

- Subsidizing low-cost or free whole-property energy audits for owners that cannot afford the upfront costs to maximize access to state programs and to prepare owners to take advantage of opportunities that arise at refinancing.
- Allowing participants to use incentive funds to directly pay for retrofits as they are contracted and completed. This removes upfront cost barriers for owners and properties that do not have funds available from cash flow or refinancing events.
- Encouraging conversion of market-rate housing to deed-restricted, inclusive mixed-income properties to increase access to energy efficiency retrofit incentives and create new inventories of affordable housing for low-income households.²³⁸

Provide Direct Support to Community-Based Organizations and Have Dedicated Staff for Community Outreach

Several participants at the July 30, 2019, workshop attributed the success of many of the energy efficiency programs and pilots to the involvement of trusted and established community-based organizations. Self-Help Enterprises, a nonprofit organization located in the San Joaquin Valley with over 50 years' experience in providing project assistance to low-income families to build and sustain healthy homes and communities, was involved in the San Joaquin Valley disadvantaged communities pilots (created by Assembly Bill 2672, Perea, Chapter 616, Statutes of 2014).²³⁹ The pilots seek to bring affordable energy options to residents of disadvantaged communities in the San Joaquin Valley. To inform the community of the pilots and the energy improvement opportunities, Self-Help Enterprises helped conduct over 100 community meetings and workshops and engaged with roughly 1,000 residents.²⁴⁰ Significant community engagement and outreach is needed to make projects and programs successful.

²³⁷ Ibid., p. 121.

²³⁸ [Link to Docket 19-IEPR-05 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05), <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-05>, TN 229099, p. 23.

²³⁹ [Link to San Joaquin Valley Affordable Energy Proceeding on the CPUC's website](https://www.cpuc.ca.gov/SanJoaquin/) <https://www.cpuc.ca.gov/SanJoaquin/>.

²⁴⁰ [Transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/getdocument.aspx?tn=229742) <https://efiling.energy.ca.gov/getdocument.aspx?tn=229742>, p. 104.

Community-based organizations know the communities they serve and community members know the organizations. At the workshop, Jessica Buendia with the Strategic Growth Council emphasized that the messenger can really make a difference in the success of a program or project, and that when a community-based organization's expertise is used, the organization should be appropriately compensated, as are other technical experts.²⁴¹

Emerging Energy Equity Issues

Participants at the July 30, 2019, joint agency workshop also illuminated issues that state agencies that should consider as they pursue making clean energy equitable for all Californians. These issues are summarized below.

Energy Storage

At the workshop, Srinidhi Sampath with the California Housing Partnership said she has heard from property owners that energy storage may help them better manage the new time-of-use electricity rates being rolled out by utilities throughout the state. She also mentioned that many affordable senior housing properties—in reaction to utilities implementing public safety power shutoff plans (because of catastrophic wildfire risk)—are looking for ways to be energy resilient because of their electricity needs for medical equipment and medication storage.²⁴² CEC Vice Chair Scott added that she heard that people are purchasing diesel generators for use in the event of power loss, which contradicts the state's goals of reducing GHG emissions and air pollution. Both raised the potential for energy storage as a potential feasible resource in lieu of diesel generators.²⁴³

Jin Noh with the California Energy Storage Alliance agreed that there is "potential for different source technologies to address longer durations of energy need to service critical load" and said "it's helpful to really understand ... what the duration need is so that developers of all different types of storage technologies have information ... [about] how they can best provide this resiliency."²⁴⁴

Mr. Noh also identified that there could be synergies with solar programs and storage systems. For example, with the CPUC's recently launched Solar on Multifamily Affordable Housing program (SOMAH), adding energy storage to improve the energy resiliency for a development

241 Ibid., p. 201.

242 Ibid., p. 163-164.

243 Ibid., p. 170-171.

244 Ibid., p. 165-166.

could result in higher incentives for housing developers to include both and “unlock this market.”²⁴⁵

To help the state develop this market and realize its potential, the CPUC recently approved the following changes to its Self-Generation Incentive Program (SGIP):²⁴⁶

- Expanding eligibility and increasing levels for battery projects in low-income and disadvantaged communities to increase participation.
- Establishing a new \$100 million equity resiliency incentive program and budget set-aside for battery storage for medical baseline/critical needs customers and low-income customers in tier 2 and Tier 3 high-fire-threat districts,²⁴⁷ critical services facilities serving those districts, and customers in those districts that participate in two low-income solar generation programs.
- Establishing a \$10 million budget for SGIP storage incentives to support pilot projects in 11 San Joaquin Valley disadvantaged communities (Allensworth, Alpaugh, Cantua Creek, Ducor, Fairmead, Lanare, Le Grand, La Vina, Seville, West Goshen, and California City).²⁴⁸
- Establishing a new equity heat pump water heater incentive set-aside of \$4 million for low-income customers and communities.

The agencies may want to explore how to encourage additional energy storage investments in areas subject to weather-related public safety power shutoffs.

Beyond the CalEnviroScreen Definition of Disadvantaged Community

During the workshop, Sarah Stawasz with the Bear River Band of Rohnerville Rancheria, raised the concern that many state programs use the CalEnviroScreen definition of disadvantaged

²⁴⁵ Ibid., p. 167-168.

²⁴⁶ The CPUC's Self-Generation Incentive Program provides incentives to support existing, new, and emerging distributed energy resources. SGIP provides rebates for qualifying distributed energy systems installed on the customer's side of the utility meter. Qualifying technologies include wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems. CPUC Decision 17-10-004 created the SGIP Equity Budget, which will be implemented beginning with Step 3. This Equity Budget will be allocated 25% of SGIP funds already allocated for energy storage projects, and will provide incentives for customer-sited energy storage in disadvantaged communities and low-income communities in California.

²⁴⁷ The CPUC adopted three fire-threat tiers for the state. Tier 1 are areas with zero to moderate wildfire risk. Tier 2 are areas with elevated wildfire risk, and Tier 3 are areas with extreme wildfire risk. [Decision Adopting a Work Plan for the Development of Fire Map 2 17-01-009](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M172/K762/172762082.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M172/K762/172762082.PDF>.

²⁴⁸ For more information about the CPUC's San Joaquin Valley Disadvantaged Communities Pilot Projects, see [CPUC Decision 18-12-015](https://www.cpuc.ca.gov/SanJoaquin/). <https://www.cpuc.ca.gov/SanJoaquin/>.

community;²⁴⁹ however, for many rural tribal communities which “may not meet the CalEnviroScreen definition of environmentally disadvantaged ... the definition needs to include economically disadvantaged, including tribal, rural, and low-income communities.²⁵⁰ She added a more “inclusive definition of disadvantaged community that helps increase funding eligibility could have a great impact” for increasing the independence and resiliency of rural communities. Others present agreed with the concern. As Stan Greschner, chair of the Disadvantaged Communities Advisory Group stated, “We can coalesce around just ensuring all of these hard-to-reach communities are incorporated ... [into the definition of disadvantaged community].”²⁵¹ The agencies may want to explore working with CalEPA to refine the CalEnviroScreen tool, especially in its reflection of tribal communities, while ensuring that the SB 350 barriers work is broadly inclusive of the diversity of California’s low-income and vulnerable communities. Alternatively, the agencies could consider designating tribal communities as eligible for disadvantaged community budgets or programs in addition to those designated by CalEnviroScreen.

Create Incentive Programs That Allow for Participation From Those Within Rural Areas

During the workshop, Brian Adkins with the Bishop Paiute Tribe explained that some utility energy programs, such as the CPUC’s Disadvantaged Communities Single-Family Solar Homes program (DAC-SASH) (see Recommendation 6 above), required participants to be a customer of Pacific Gas and Electric (PG&E), Southern California Edison (SCE), or San Diego Gas & Electric (SDG&E) (which are all CPUC-regulated electricity utilities). On some tribal lands and in other rural parts of the state, electricity service from a regulated utility is not available. In addition, Mr. Adkins stated that some federal programs require information about the past 12 months of electricity use, which is not available in areas or homes without existing electrical service.²⁵² These homes tend to rely on heating fuels such as fuel oil, propane, and wood, which can come with higher costs and may result in poor indoor air quality and higher GHG emissions. In California, these areas may also be more prone to wildfires and electrical blackouts initiated to prevent wildfires.

249 The California Environmental Protection Agency (CalEPA) is responsible for identifying disadvantaged communities for purposes of the Cap-and-Trade funding program. CalEPA designated as disadvantaged communities the 25% highest scoring census tracts using results of the California Communities Environmental Health Screening Tool (CalEnviroScreen).

250 [Transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/getdocument.aspx?tn=229742) https://efiling.energy.ca.gov/getdocument.aspx?tn=229742, p. 160.

251 Ibid., p. 161.

252 Ibid., pp. 180–181.

Incentive programs created specifically for currently unserved buildings could benefit rural parts of the state.

Strengthening Partnerships With Tribes and Providing Access to Funding Opportunities

The CEC's Tribal Program facilitates effective government-to-government cooperation, collaboration, and communication with California Native American tribes.²⁵³ The cornerstone of the Program is the CEC's Tribal Consultation Policy, which reflects the CEC's commitment to obtaining tribal input on the development of CEC regulations, rules, policies, plans, and activities that might affect tribes. Pursuant to the policy, the CEC sponsored the July 2019 California Sustaining Tribal Resources Conference in Bishop, California, hosted a May 2019 workshop in Sacramento, California focused on CEC funding opportunities and improving tribal access to state funds. In addition, the CEC, the Pechanga Band of Luiseño Indians, the Governor's Office of the Tribal Advisor, and the CPUC held a California Tribal Energy Summit in November 2018. The goal of the summit was to initiate or advance dialogue between California Native American tribes and the state's energy agencies on advancing climate change and energy goals.²⁵⁴ Through such events, the CEC and other state agencies are developing a better understanding of the importance of expanding tribal access to state programs that support clean energy strategies for generation, resiliency, and climate adaptation. It is important that the CEC and state agencies continue to prioritize communication and partnership with tribes to devise effective ways to increase tribal participation on state decision-making and tribal access to state funding and technical assistance.

Scaling-Up From Pilot Projects to Statewide

Several of the state's energy-related programs and pilot projects were discussed during the workshop. Dr. Holmes Hummel explained that Clean Energy Works has focused on advancing tariffed on-bill financing because it is trying to address the questions posed by former CEC Chair Robert B. Weisenmiller: "how do we make [programs] go ten times faster, ten times larger? Who can tell me about ideas that will change the rate of progress by an order of magnitude?"²⁵⁵ On a similar note, CPUC Commissioner Martha Guzman-Aceves asked the workshop panelists: "Should we at the CPUC choose ... our top 5 percent communities? Should we use the energy indicators to determine where we should geographically focus? Should we get around the silo funding? Should we have some ... pot of funding ... instead of [each

253 [Link to information on the CEC's Tribal Program](https://www.energy.ca.gov/programs-and-topics/programs/tribal-program) https://www.energy.ca.gov/programs-and-topics/programs/tribal-program.

254 [Link to the CEC staff report on the energy summit](https://ww2.energy.ca.gov/2019publications/CEC-700-2019-001/CEC-700-2019-001.pdf) https://ww2.energy.ca.gov/2019publications/CEC-700-2019-001/CEC-700-2019-001.pdf.

255 Ibid., pp. 123–124.

program having different geographic or population focus] ... Are we going about this all wrong, or can we keep those silos and have the geographic focus?"²⁵⁶ Although not an emerging issue, agencies need to continue to explore and seek ways on how to scale-up from limited programs and pilots to statewide adoption, deployment, and implementation of programs and projects to achieve the state's clean energy goals.

The state agencies involved in implementing the recommendations in the Barriers Study have made significant progress carrying out the programs that are helping advance energy equity. To more effectively reach all of California's disadvantaged and low-income communities, tribes, and rural communities, the agencies must continue to work together and forge synergies between various energy programs. Moving forward, California must look for new opportunities to create more energy resilient communities and identify the next key actions the state should pursue to remove barriers vulnerable communities face to access investments in clean energy and clean transportation.

Specific to tribes, the state should develop regional data sets and tools that reflect and address the unique features of tribal communities. Some of the state's energy planning tools, like CalEnviroScreen do not appropriately recognize tribes. This effort could also include a statewide assessment of tribal energy needs and a gap analysis. The July 30, 2019, IEPR workshop laid the foundation for exploring areas of further work such as developing attainable opportunities to finance energy upgrades, creating one-stop shops to increase access to clean technologies, advancing retrofits and energy storage in low-income multifamily housing, training and dedicating staff to community outreach, and providing direct support to community based organizations.

²⁵⁶ Ibid., p. 204.

CHAPTER 5:

Climate Change Adaptation

Introduction

A warming climate poses risks to every part of California—from its urban centers to its rural areas, both coastal and inland. Sea-level rise threatens a populous coastline of more than 1,000 miles. Declining snowpack and drought impact households and an economy dependent on reliable water supplies. Increasingly damaging wildfires endanger people and property across the state. More frequent and intense extreme heat is a hazard to human health and exacerbates local air quality.

California’s energy sector is vulnerable to climate change in many ways. A warmer climate increases demand for indoor cooling, while extreme heat can compromise the performance and accelerate the degradation of generation, transmission, and distribution infrastructure. Reduced spring snowpack reduces hydroelectric supplies during summer months when hydropower has historically provided an important, nonfossil resource for meeting peak demand.

In recent decades, examples of weather-related damages to California’s electricity sector are numerous and severe. The July 2018 Southern California heat wave resulted in one of Los Angeles Department of Water and Power’s (LADWP’s) highest-ever demand peaks, as well as power outages that affected more than 80,000 customers. Some service restorations required more than 48 hours due to the sheer number—more than 700—of local outages and the logistics of restoring underground equipment.²⁵⁷ The July 2006 California heat wave lasted nearly two weeks and was estimated by Pacific Gas and Electric Company (PG&E) to incur damages of \$150 million to \$300 million in infrastructure repair costs and increases in the cost of peak electricity.²⁵⁸ Another example is costs associated with loss of hydroelectric power during the recent drought. From October 2011 through September 2015, these losses totaled more than \$2 billion in California.²⁵⁹

Adaptation in the energy sector is essential to supporting a healthy economy in California, as climate change has the potential to threaten the financial health of the state’s economy unless

257 LADWP (2018). *July 2018 Heat Storm Outage Event Summary*. [Link to news release about heat related power outage in July 2018 on LADWP’s website](https://www.ladwpnews.com/weekend-of-july-6-2018-heat-storm-related-power-outages-and-response/) <https://www.ladwpnews.com/weekend-of-july-6-2018-heat-storm-related-power-outages-and-response/>.

258 PG&E (2016). *Climate Change Vulnerability Assessment and Resilience Strategy* (November 2016).

259 Gleick, Peter. 2017. *Impacts of California’s Five-Year (2012–2016) Drought on Hydroelectricity Generation*. ISBN: 978-1-893790-79-7.

proper planning and action are taken. California’s rapidly evolving energy sector presents opportunities to build a climate-safe energy infrastructure as the state progresses toward its 2030 and 2045 climate goals. Energy sector innovation holds the promise of strengthening community preparedness, supporting resilient recovery efforts, and promoting more stable financial markets—which depend on sound credit ratings of investor-owned utilities (IOUs) and community choice aggregators—while maintaining a reliable electric grid. Meeting this promise will require developing scientifically informed, flexible, and adaptive strategies to increase energy sector resilience to multiple stressors from climate change, with particular attention to vulnerable populations. Successful implementation will rely on cross-sectoral collaboration, community engagement, and help from local jurisdictions with implementing innovative technologies to align with statewide goals.²⁶⁰

This chapter discusses recent advances in climate adaptation policy, scientific developments relevant to climate adaptation for California’s energy sector, and updates on innovative technologies. Drawing on community perspectives shared at an August 8, 2019, Integrated Energy Policy Report (IEPR) workshop on Climate Adaptation in California’s Energy Sector, the chapter highlights opportunities for strengthening community-level resilience through community-driven planning, sustained engagement of communities, and implementation of energy sector innovations to promote community resilience in disadvantaged or vulnerable communities.

Policy and Guidance in Support of a Resilient California

As Governor Gavin Newsom observes, recognizing and adapting to climate change are “not an ideological endeavor... [rather, it] is a very practical one for California.”²⁶¹ Accordingly, California explicitly prioritizes integrated consideration of adaptation and greenhouse gas (GHG) emissions reductions as a cornerstone of its climate policy.²⁶²

260 Public comment submitted by Center for Climate Protection to Docket no. 19-IEPR-10. [Link to Create an Energy Resilience Planning Handbook for Local Governments on the CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229513&DocumentContentId=60924) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229513&DocumentContentId=60924>.

See discussion in part 1 of August 8, 2019, IEPR workshop. [Link to Workshop Transcript](https://efiling.energy.ca.gov/getdocument.aspx?tn=229831). <https://efiling.energy.ca.gov/getdocument.aspx?tn=229831>.

261 California Governor Gavin Newsom. Press Conference April 12, 2019. [Link to video of Governor Newsom's press conference on April 12, 2019](https://www.youtube.com/watch?v=WxRrAGe3s_8) https://www.youtube.com/watch?v=WxRrAGe3s_8. (Stated around minute 17:50).

262 CEC staff. 2018. 2018 Integrated Energy Policy Report Update, Volume II. CEC. Publication Number: 100-2018-001-V2-CMF. (p. 197) [Link to 2018 IEPR Update on the CEC's website](https://ww2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf) <https://ww2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf>.

ICARP Technical Advisory Council Charter. Vision and principles approved September 2017. [Link to information and meetings for the ICARP Technical Advisory Council](http://opr.ca.gov/planning/icarp/tac/) <http://opr.ca.gov/planning/icarp/tac/>.

An evolving range of policy initiatives designed to strengthen the state’s climate resilience complements California’s leadership on reducing GHG emissions. Adapting to climate change is already an important part of community planning in California. The state’s General Planning Guidelines, which guide local jurisdictions in developing long-term visions for future growth, recognize that land-use and community planning are central to climate adaptation and resilience. Local governments in California consider climate change in the safety element of their general planning (Senate Bill 379 [Jackson, Chapter 608, Statutes of 2015]). California also recognizes that land-use decisions can compound environmental justice risks. With that in mind, the state requires general planning processes to identify objectives and policies to avoid compounding health risks in disadvantaged communities, to encourage stakeholder engagement in public decision-making processes, and to prioritize improvements and programs that address the needs of disadvantaged communities (Senate Bill 1000 [Leyva, Chapter 587, Statutes of 2016]).

Through the Safeguarding California Plan: 2018 Assessment (Safeguarding California), the state has continued to refine its roadmap for a resilient California based on an evolving body of research on climate risk and resilience options, as well as lessons learned from case studies.²⁶³ A collaborative effort of more than 20 state agencies, Safeguarding California describes adaptation risk and strategies for agriculture; biodiversity and habitat; climate justice; emergency management; energy; forests; land-use and community development; oceans and coasts; parks, recreation, and California culture; public health; transportation; and water. Assembly Bill 1482 (Gordon, Chapter 603, Statutes of 2015) directs the California Natural Resources Agency to update the plan every three years.

Senate Bill 246 (Wieckowski, Chapter 606, Statutes of 2015) established California’s Integrated Climate Adaptation and Resiliency Program (ICARP) to develop holistic strategies that support coordination of climate activities at the state, local, and regional levels. The ICARP engages state and local government, nonprofit and private sector practitioners, scientists, and community leaders to coordinate activities through its Technical Advisory Council. In 2017, the Technical Advisory Council adopted a vision for adaptation in California and principles to guide implementation of strategies to achieve the vision. (See sidebars.)

Climate Change Research Plan for California (2015). Climate Action Team. CalEPA. February 2015. [Link to Climate Change Research Plan for California report](https://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf) https://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf.

²⁶³ California Natural Resources Agency (2018). *Safeguarding California Plan: 2018 Update*. [Link to Safeguarding California Plan: 2018 Update report](http://resources.ca.gov/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf) <http://resources.ca.gov/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>.

Vision for Adaptation in California

"All Californians thrive in the face of a changing climate. Leading with innovation, California meets the challenge of climate change by taking bold actions to protect our economy, our quality of life, and all people. The state's most vulnerable communities are prioritized in these actions. Working across all levels of government, the state is prepared for both gradual changes and extreme events. Climate change adaptation and mitigation is standard practice in government and business throughout the state. California meets these goals with urgency, while achieving the following long-term outcomes:

- **All people & communities** respond to changing average conditions, shocks, and stressors in a manner that minimizes risks to public health, safety, and economic disruption and maximizes equity and protection of the most vulnerable.
- **Natural systems** adjust and maintain functioning ecosystems in the face of change.
- **Infrastructure and built systems** withstand changing conditions and shocks, including changes in climate, while continuing to provide essential services."

ICARP Technical Advisory Council Charter. Vision and principles approved September 2017.

[Link to information and documents on the ICARP Technical Advisory Council](#)

Principles to Guide Adaptation in California

1. Prioritize **integrated** climate action
2. Prioritize **equity, community resilience, and protection of the most vulnerable**
3. Prioritize **natural and green infrastructure**
4. Avoid **maladaptation** by making decisions that do not exacerbate risks or exposure and do not transfer the challenge to another group, location, or sector
5. Emphasize **science-based** planning, policy, and investment
6. Employ **adaptive** and **flexible** governance that uses collaborative partnership
7. Take **immediate actions** to reduce climate change risks

ICARP Technical Advisory Council Charter. Vision and principles approved September 2017.

[Link to information on the ICARP Technical Advisory Council](#)

<http://opr.ca.gov/planning/icarp/tac/>.

Recognizing Vulnerability and Integrating Equity

In July 2018, ICARP released a resource guide on Defining Vulnerable Communities in the Context of Climate Adaptation.²⁶⁴ This guide includes a definition of climate vulnerability as adopted by its Technical Advisory Council and describes existing statewide tools and process guides that can help identify communities particularly vulnerable to climate change. Resources provided in the guide can help local planners identify communities vulnerable to climate impacts in a manner consistent with Senate Bill 379 and can help identify environmental justice communities, as required by Senate Bill 1000.

California's Office of Emergency Services is updating the state's adaptation planning guide, which provides guidance to support community-level climate adaptation planning and implementation. The updated guide will integrate climate equity and climate justice as guiding principles to be considered in all phases of adaptation planning and provide best practices for outreach to affected communities, with the goal of safeguarding California's frontline communities.

New Policy Developments Related to Climate Resilience

In June 2019, Governor Newsom took action to move California toward a safer, more affordable, and more reliable energy future, signing a trio of wildfire safety and accountability bills. Assembly Bill 110 (Ting, Chapter 80, Statutes of 2019), Assembly Bill 111 (Committee on Budget, Chapter 81, Statutes of 2019), and Assembly Bill 1054 (Holden, Chapter 79, Statutes of 2019) all contribute to overall improvement of wildfire safety and utility oversight. They provide resources to implement catastrophic wildfire legislation (AB 110); help establish the California Energy Infrastructure Safety Act and the necessary governmental structure for the associated implementation (AB 111); and help create additional safety oversight for utility infrastructure, recast cost recovery from wildfire damages, and authorize the Wildfire Fund to address future-related wildfire liabilities (AB 1054).

Similarly, Senate Bill 901 (Dodd, Chapter 626, Statutes of 2018), the Governor's Executive Order on Wildfire Safety (N-05-19), and the CPUC's adoption of new policies and procedures to support its risk-informed decision-making have established a new utility safety framework. These actions have already affected how IOUs' Risk Assessment and Mitigation Phase (RAMP) reports are reviewed.²⁶⁵

²⁶⁴ Governor's Office of Planning and Research. July 2018. [Defining Vulnerable Communities in the Context of Climate Adaptation resource guide](http://opr.ca.gov/docs/20180723-Vulnerable_Communities.pdf) http://opr.ca.gov/docs/20180723-Vulnerable_Communities.pdf.

²⁶⁵ For example: Kurtovich, M., W. Al-Mukdad, J. Rahman, J. Battis. California Public Utilities Commission. May 24, 2019. *A Regulatory Review of Southern California Edison's Risk Assessment Mitigation Phase Report for the Test Case 2021 General Rate Case*, Investigation 18-11-006.

Responding to the need to move swiftly to implement strategies that limit utilities wildfire-related risks, Senate Bill 901 also required electric utilities to prepare and submit wildfire mitigation plans to the CPUC. These plans complement their RAMP filings and describe IOUs' plans to prevent, combat, and respond to catastrophic wildfires affecting their service territories.

Governor Newsom Convenes Expert Team on Wildfire, Climate Change, and Energy

Recognizing the urgency, complexity, and importance of ensuring the stability of California's energy sector, Governor Newsom convened a team composed of bankruptcy lawyers and financial experts from the energy sector to explore these issues. The resulting report²⁶⁶—drawn up in 60 days and expanded on in a June 2019 update—outlines steps the state must take to reduce the number and severity of wildfires, including the wildfire mitigation and resiliency efforts proposed by the Governor.²⁶⁷ It also reiterates the state's commitment to clean energy. The report outlines actions to hold the state's utilities accountable and identifies potential changes to stabilize the financial status of California's utilities. These actions help meet the energy needs of customers and the economy by allocating responsibility for wildfire costs, strengthening utility market regulation, and proposing systemic reforms and safety commitments.

In response to unprecedented, widespread public safety power shutoffs that left millions of Californians without electricity for extended periods in late October 2019, Governor Newsom called "for fundamental change to PG&E" and "laid out a path forward to ensure the overly broad application of public safety power shutoffs will never happen again."²⁶⁸ To ensure prompt action, the Governor delineated how parties involved with PG&E's bankruptcy must take steps to "ensure safety investments and fundamental transformations ... before the next fire season." Governor Newsom also appointed an Energy Czar to "help the state game out every option and be prepared to intervene" in the transformation of PG&E.

266 "Wildfire and Climate Change: California's Energy Future. A Report from Governor Newsom's Strike Force." Governor Newsom's Strike Force, April 2019. [Link to Wildfires and Climate Change: California's Energy Future report](https://www.gov.ca.gov/wp-content/uploads/2019/04/Wildfires-and-Climate-Change-California's-Energy-Future.pdf) <https://www.gov.ca.gov/wp-content/uploads/2019/04/Wildfires-and-Climate-Change-California's-Energy-Future.pdf>.

267 [Proclamation of State of Emergency by Gavin Newsom regarding wildfires](https://www.gov.ca.gov/wp-content/uploads/2019/03/3.22.19-Wildfire-State-of-Emergency.pdf) <https://www.gov.ca.gov/wp-content/uploads/2019/03/3.22.19-Wildfire-State-of-Emergency.pdf>.

268 "Governor Newsom Outlines State Efforts to Fight Wildfires, Protect Vulnerable Californians and Ensure That Going Forward, All Californians Have Safe, Affordable, Reliable and Clean Power." Office of the Governor, November 1, 2019. [Link to press release](https://www.gov.ca.gov/2019/11/01/governor-newsom-outlines-state-efforts-to-fight-wildfires-protect-vulnerable-californians-and-ensure-that-going-forward-all-californians-have-safe-affordable-reliable-and-clean-power/). <https://www.gov.ca.gov/2019/11/01/governor-newsom-outlines-state-efforts-to-fight-wildfires-protect-vulnerable-californians-and-ensure-that-going-forward-all-californians-have-safe-affordable-reliable-and-clean-power/>.

Insuring Wildfire-Impacted Communities in California

In the wake of California's two most destructive wildfire seasons, and as directed by Senate Bill 901 (Dodd, Chapter 626, Statutes of 2018), the Commission on Catastrophic Wildfire Cost and Recovery examined wildfire liability, insurance, financing mechanisms, and community impacts. In its final report, the commission's recommendations recognize the need to balance providing cost recovery for those with serious damages while enabling the financial stability of utilities. The recommendations also highlight the importance of reducing wildfire risk while structuring a system to pay for fire damages.²⁶⁹

Legal experts and researchers on insurance and liability have also been examining the risks and opportunities that the insurance community, utilities, and California residents face in a changing climate. In June 2018, the Center for Law, Energy & the Environment at the University of California, Berkeley, School of Law convened a group of insurance regulators, industry leaders, climate data scientists, nonprofit researchers, advocates, academics, and California energy and climate policy makers for a symposium. The key findings from this symposium²⁷⁰ were directed at insurance regulators, insurers, industry, and state and community policy makers. The recommendations encourage actions that address the intersection of climate mitigation and resiliency with insurance innovation, in areas such as land-use planning, economic transition planning, risk assessment, and industry reform. Suggested actions include:

- Innovation of green insurance products that are designed to shift consumer decisions and investments in sustainable directions and manage risk.
- Employment of enhanced catastrophe modeling.
- Disclosure of physical, transition, and litigation risks.
- Development of accurate estimations of physical risks to major facilities that are key drivers of the California economy.
- Assessment of and action to address risk on a community and statewide scale.

269 *Final Report of the Commission on Catastrophic Wildfire Cost and Recovery*. Governor's Office of Planning and Research, OPR, June 2019. [Link to Final Report of the Commission on Catastrophic Wildfire Cost and Recovery](http://opr.ca.gov/docs/20190618-Commission_on_Catastrophic_Wildfire_Report_FINAL_for_transmittal.pdf) http://opr.ca.gov/docs/20190618-Commission_on_Catastrophic_Wildfire_Report_FINAL_for_transmittal.pdf.

270 Ethan Elkind, and Ted Lamm. "Insuring California in a Changing Climate. Adapting the Industry to New Needs, Risks and Opportunities." Symposium Brief, Center for Law, Energy & the Environment, Berkeley Law, University of California, March 2019. [Information on Insuring California in a Changing Climate from the University of California, Berkeley Center for Law, Energy, and the Environment website](https://www.law.berkeley.edu/wp-content/uploads/2019/03/Insuring-California-in-a-Changing-Climate-March-2019.pdf) <https://www.law.berkeley.edu/wp-content/uploads/2019/03/Insuring-California-in-a-Changing-Climate-March-2019.pdf>.

The symposium also led to a report supported by the California Department of Insurance.²⁷¹ The report more fully identifies climate risks and discusses how insurers, regulators, and policy makers are responding. Moving forward, stakeholders will need to discuss issues related to examining the interdependence between the state and local governments, incorporating costs (such as fire risk prevention), and identifying and agreeing on ways to transfer perceived risk.

One step underway is the yearlong effort launched by the California Department of Insurance and the United Nations Environmental Program to develop a Sustainable Insurance Roadmap to confront California's climate risks. Announced in July 2019, the Roadmap "is envisioned to pave the way for innovative risk management, insurance and investment solutions that reduce climate risks and protect natural ecosystems."²⁷² Inspired by emerging insurance solutions in other countries, the effort could also examine development of new, insurance solutions utilizing California's protective, life-supporting natural infrastructure—such as wetlands and forests— that could reduce climate and disaster risk.

California Public Utility Commission's Adaptation Rulemaking

Recognizing the risks posed by climate change, the California Public Utilities Commission (CPUC) began a rulemaking (R.18-04-019)²⁷³ to develop strategies and guidance on climate adaptation for IOUs. Led by Commissioner Liane M. Randolph, the rulemaking is informed by working groups that provide feedback to CPUC staff proposals on five topics:

- 1) Definitions of climate adaptation for utilities
- 2) Appropriate data sources, models, and tools for climate adaptation decision-making
- 3) Guidelines for utility climate adaptation assessment and planning
- 4) Identification and prioritization of actions to address the climate change-related needs of vulnerable and disadvantaged communities
- 5) Framework for climate-related decision-making and accountability²⁷⁴

On November 1, 2019, the CPUC issued a decision²⁷⁵ on Topics 1 and 2. This decision:

271 Mills, Evan, Ted Lamm, Sadaf Sukhia, Ethan Elkind, and Aaron Ezroj. 2018. *Trial by Fire: Managing Climate Risks Facing Insurers in the Golden State*. Sacramento, California: California Department of Insurance.

272 [Link to Department of Insurance press release](http://www.insurance.ca.gov/0400-news/0100-press-releases/2019/release056-19.cfm), July 24, 2019. <http://www.insurance.ca.gov/0400-news/0100-press-releases/2019/release056-19.cfm>

273 May 7, 2018, [Order Instituting Rulemaking to Consider Strategies and Guidance for Climate Change Adaptation](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M213/K511/213511543.PDF), Rulemaking 18-04-019. <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M213/K511/213511543.PDF>.

274 October 10, 2019, Assigned Commissioner's Scoping Memo and Ruling, R.18-04-019, p. 3.

275 Decision 19-10-054 on Rulemaking 19-04-019. "Decision on Phase 1 Topics 1 and 2." Date of Issuance 11/1/2019. [Link to CPUC's Decision](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M319/K075/319075453.PDF). <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M319/K075/319075453.PDF>.

- Defines climate change adaptation for energy utilities in the state.
- Anchors acceptable data for IOUs to use in adaptation planning to California’s Climate Change Assessment process, acknowledging the role of the Climate Action Team Research Working Group in selecting recommended scenarios.
- Directs IOUs to Cal-Adapt as a source of data.
- Establishes criteria for acceptability of additional data or models.
- Establishes criteria for any further data or models that energy utilities may develop to understand climate impacts.

CPUC’s Public Safety Power Shutoff Rulemaking

In response to the increasing frequency and severity of wildfires in California, the CPUC launched a rulemaking (R.18-12-005)²⁷⁶ to examine policies and guidelines regarding *de-energization*²⁷⁷ under extreme fire weather conditions. The rulemaking examines conditions in which proactive and planned power shutoffs are practiced, ensure electric utilities coordinate with first responders, and addresses the need to provide effective notice to affected stakeholders. On May 30, 2019, the CPUC made its Phase 1 decision in the proceeding, improving utility communication and notification protocols before the 2019 wildfire season. The CPUC launched Phase 2 through a scoping memo on August 14, 2019, with two tracks. Track 1 will be on a faster timeline to inform public safety power shutoffs (PSPS),²⁷⁸ with a decision expected in the first quarter of 2020.

The CPUC has approved IOU plans to reduce fire ignition risk, including public safety power shutoffs. IOUs have been working on several efforts to make more effective use of these shutoffs:

- Improving weather data and analytics
- Hardening infrastructure
- Improving customer notification methods when public safety power shutoffs are planned and when lines are to be re-energized.²⁷⁹ For example, SDG&E provides

²⁷⁶ December 13, 2018, Order Instituting Rulemaking to Examine Electric Utility De-Energization of Power Lines in Dangerous Conditions, Rulemaking 18-12-005. Related documents, ruling, and decisions available through CPUC’s docket web portal.

²⁷⁷ *De-energization* refers to utilities shutting off power to customers to protect public safety, generally due to wildfire risk. It is also referred to as a “public safety power shutoff.”

²⁷⁸ [Information on de-energization from the CPUC's website](https://www.cpuc.ca.gov/deenergization/) https://www.cpuc.ca.gov/deenergization/.

²⁷⁹ [Comments from PG&E on the August 8, 2019, workshop on Climate Adaptation in California's Energy Sector](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229512&DocumentContentId=60923) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229512&DocumentContentId=60923.

customer notifications through multiple channels (email, text, and phone) in eight languages.²⁸⁰

In October 2019, Californians experienced unprecedented power shutoffs. On October 5–6, 2019, PG&E shut off power to nearly 730,000 customers in 35 counties, which was estimated to have directly impacted more than 2 million people.²⁸¹ PG&E also initiated PSPS events on October 9–12, October 23–25, and October 26–29, 2019. Southern California Edison (SCE) turned off power to nearly 24,000 customers between October 10 and October 12, 2019,²⁸² and de-energized customers at various timeframes between October 17 and October 21, 2019.²⁸³ SDG&E also de-energized parts of its system on October 10–11, 2019, but was able to de-energize portions of four circuits rather than the entire circuit to reduce customer impacts.²⁸⁴ The PSPS were aimed at reducing the risk of electrical equipment igniting wildfire during sustained extreme winds with gusts and dry conditions. These events affected millions of Californians who were subject to possible power shut off or actually lost service for hours or several days at a time.

PG&E acknowledged “falling short in several areas of execution” of the October 6, 2019, event while a letter from Governor Newsom stated that “PG&E implemented this extraordinary measure with astounding neglect and lack of preparation.” Further, Governor Newsom called on the CPUC to take further action to build on “the measures to prevent utility-caused wildfires

280 Presentation by Brian D’Agostino, Director – Fire Science & Climate Adaptation, SDG&E. [“Resilience Across Climate-Vulnerable Backcountry Populations: Anticipating Extreme Fire Weather and Providing Resources during De-Energization.”](#) 19-IEPR-10, TN# 229245. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229245&DocumentContentId=60652>.

281 [PG&E’s ESRB-8 Report Regarding Proactive De-Energization Event for Oct. 9-12, 2019](#), https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/PGE%20Public%20Safety%20Power%20Shutoff%20Oct.%209-12%20Report.pdf.

[Letter to Mr. William Johnson, Chief Executive Officer at PG&E, from CPUC President Marybel Batjer, October 14, 2019](#), https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/PGE%20Letter%20-%20PSPS%2010-14-19.pdf.

282 [SCE’s ESRB-8 Report Regarding Pro-Active De-Energization Event for Oct 2-12, 2019](#), https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/SCE%20Post%20Event%20Reporting%20October%202%20through%20October%2012%202019.pdf.

283 SCE, Letter to Leslie Palmer at the CPUC, PPS Post Event Report Regarding Pro-Active De-Energization Event – October 12 to October 21, 2019.

284 SDG&E, Letter to Ms. Elizaveta Malashenko at the CPUC, San Diego Gas & Electric Company (SDG&E) Public Safety Power Shutoff Report, October 25, 2019.

and improve utility safety that were put in place by [Assembly Bill] 1054.”²⁸⁵ In response, the CPUC:²⁸⁶

- Initiated a formal investigation of the 2019 PSPS events.
- Issued a new ruling to reexamine how utilities use PSPS events with an examination of actions that utilities can take in the next six months to minimize the impacts of future events.
- Is working to ensure additional consumer protection so that customers are not charged for services they do not receive during public safety power shutoff events.
- Will direct the utilities to expand their wildfire mitigation plans.
- Will convene a panel of experts to identify specific projects that can be implemented in coming months to minimize the use and scope of PSPS events in the next fire season.

Scientific Developments in the Understanding of Climate Change in California

California’s rapidly evolving energy system must prepare for physical and indirect climate impacts, such as those related to wildfires, changes in precipitation, and extreme heat. The state must also chart a decarbonization trajectory that optimizes health benefits, particularly those associated with disadvantaged communities who have long endured the most environmental pollution. This section briefly reviews recent scientific developments relevant to these topics.

Drivers and Impacts of Wildfires in California

Since 1972, California has experienced a fivefold increase in average annual burned area, with the largest increases in the North Coast and Sierra Nevada. A recent analysis²⁸⁷ looked at wildfire trends by region, vegetation type, and season over the 1972–2018 period and found that the increase in annual burned area is driven primarily by an eightfold increase in the extent of summer forest fires. The increased fires correspond with substantial increases in dryness of forest fuels due to an increase in summer season temperatures of about 1.4 degrees Celsius (2.5 degrees Fahrenheit) since the early 1970s. With substantial increases in

285 [Letter from Governor Newsom to CPUC President Marybel Batjer](https://www.gov.ca.gov/wp-content/uploads/2019/10/10.14.19-CPUC-Letter.pdf), October 14, 2019, <https://www.gov.ca.gov/wp-content/uploads/2019/10/10.14.19-CPUC-Letter.pdf>

286 CPUC, press release, October 28, 2019, CPUC Takes Additional Decisive Actions to Hold Utilities Accountable and Increase Public Safety. <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M318/K885/318885370.PDF>.

287 P. A. Williams, J. T. Abatzoglou, A. Gershunov, J. Guzman-Morales, D. A. Bishop, and D. P. Lettenmaier (2019). “Observed Impacts of Anthropogenic Climate Change on Wildfire in California.” *Earth’s Future*. [Observed Impacts of Anthropogenic Climate Change on Wildfire in California research article](https://doi.org/10.1029/2019EF001210) <https://doi.org/10.1029/2019EF001210>.

summer season temperatures projected for California, forested area burned is expected to continue rising over the next few decades,²⁸⁸ although efforts to curb this risk through forest health initiatives are underway. Warmer summers also elevate the likelihood that extreme winds in the autumn, such as those associated with offshore Santa Ana and Diablo winds, will coincide with very dry fuel conditions and, thus, high fire risk.

Given the role of seasonal winds that are directed offshore—such as Santa Ana and Diablo winds—as a contributor to wildfire risk and behavior in coastal California, several studies have explored how offshore-directed winds may change in frequency, magnitude, and timing as the climate changes. Research projecting Santa Ana winds suggests reduced frequency and intensity of these extreme wind events.²⁸⁹ Similarly, through analysis of the mechanisms governing Santa Ana winds, a study²⁹⁰ predicted significantly weaker winds by the mid-21st century. A different study,²⁹¹ however, found that while Santa Ana winds are expected to decline on average, the historical peak of the Santa Ana wind season (November–January) would be less affected by a projected decrease in frequency of extreme wind events. Coupled with projections of less frequent rain in Southern California and a shorter wet season that begins later in the year, these considerations suggest that climate change may continue to drive heightened risks of winter fires in Southern California. Indeed, one of the largest wildfires in California’s recorded history, the Thomas Fire (December 2017–January 2018), was a product of Santa Ana conditions, an abundance of dry fuel produced by a wet spring followed by a hot dry summer, and delayed seasonal precipitation (most of which did not begin until January 2018).

Recognizing that nonclimate, human-associated factors also affect changes in forest fires, a 2019 study²⁹² considered forest fire trends over a longer timescale, comparing an “early fire suppression” (1911–1924) and a “contemporary fire suppression” (2002–2015) period. These

288 A. L. Westerling (2018). *Wildfire Simulations for California’s Fourth Climate Change Assessment: Projecting Changes in Extreme Wildfire Events with a Warming Climate*. California’s Fourth Climate Change Assessment, CEC. Publication Number: CCCA4-CEC-2018- 014.

289 J. Guzman-Morales and A. Gershunov (2019). “Climate Change Suppresses Santa Ana Winds of Southern California and Sharpens Their Seasonality.” *Geophys. Res. Letters*. [Climate Change Suppresses Santa Ana Winds of Southern California and Sharpens Their Seasonality research letter](https://doi.org/10.1029/2018GL080261) <https://doi.org/10.1029/2018GL080261>.

290 M. Hughes, A. Hall, J. Kim (2011). “Human-Induced Changes in Wind, Temperature, and Relative Humidity During Santa Ana Events.” *Climatic Change*. [Abstract for Human-Induced Changes in Wind, Temperature, and Relative Humidity During Santa Ana Events](https://doi.org/10.1007/s10584-011-0300-9) <https://doi.org/10.1007/s10584-011-0300-9>.

291 Pierce, D. W., D. R. Cayan, J. F. Kalansky. (2018). *Climate, Drought, and Sea Level Rise Scenarios for the Fourth California Climate Assessment*. California’s Fourth Climate Change Assessment, CEC. Publication number: CCCA4-CEC-2018-006.

292 B. M. Collins, J. D. Miller, E. E. Knapp, and D. B. Sapsis. 2019. “A Quantitative Comparison of Forest Fires in Central and Northern California Under Early (1911–1924) and Contemporary (2002–2015) Fire Suppression.” *Int. J. Wildland Fire*. [Abstract for A Quantitative Comparison of Forest Fires in Central and Northern California Under Early and Contemporary Fire Suppression research article](http://www.publish.csiro.au/WF/WF18137) <http://www.publish.csiro.au/WF/WF18137>.

periods represent conditions of less dense (“early fire suppression”) and dramatically denser and more continuous (“contemporary”) fuels that are more susceptible to severe and extensive forest fires. The study found that large fires (those greater than 12,145 hectares)²⁹³ accounted for a small fraction (less than 10 percent) of total area burned in the early 1900s. Yet large fires represent 53 percent to 73 percent of total area burned in the contemporary period, with greater incidence of these large fires early in the season. These larger fires are typically associated with more extreme conditions in terms of fuel (density and continuity) as well as meteorology (humidity, temperature, wind). Somewhat counterintuitively, the study also observed that average frequencies of human-caused fire (which includes but is not limited to fires associated with utilities) are similar in the early and contemporary periods, despite a more than tenfold increase in California’s population. It noted that understanding changes in forest fire regimes require analysis of the interacting roles of climate, suppression activities, and capacity to suppress multiple simultaneous ignitions (due, for example, to lightning strikes).

Wildfire coupled with climate change can also cause ecosystem transitions, such as shifts from conifer forests dominated by Douglas fir and ponderosa pine to nonforested ecosystems.²⁹⁴ Moreover, severe wildfires create landscapes that are prone to landslides and mudflows, such as California’s deadliest debris flow on record—the 2018 Montecito landslides that also caused severe disruption to the natural gas system.²⁹⁵

The 2011–2015 drought and bark beetle outbreak, both of which were exacerbated by warmer temperatures associated with climate change, contributed to the death of unprecedented numbers of trees in California’s conifer forests. This massive increase in dead trees led to fears of further worsening of fire risk, particularly in the southern Sierra Nevada, where the die-off was most pronounced. Because tree mortality was at an unprecedented scale, there have been insufficient empirical data to describe this factor in fire severity models. As dead trees fall, the buildup of heavy ground fuels could create very hot, slow moving “mass fires” that California has not experienced before. The effects of tree mortality on fuels and fire severity should be investigated due to the unparalleled nature of the situation.

293 A *hectare* is a metric system unit of area equal to about 2.47 acres.

294 Davis, K.T., S. Z. Dobrowski, P. E. Higuera, Z. A. Holden, T. T. Veblen, M. T. Rother, S. A. Parks, A. Sala, and M. P. Maneta. 2019. “Wildfires and Climate Change Push Low-Elevation Forests Across a Critical Climate Threshold for Tree Regeneration.” *PNAS*. [Abstract for Wildfires and Climate Change Push Low-elevation Forests Across a Critical Climate Threshold for Tree Regeneration article](https://doi.org/10.1073/pnas.1815107116) <https://doi.org/10.1073/pnas.1815107116>.

295 [Link to NY Times' interactive map of California mudslides](https://www.nytimes.com/interactive/2018/01/16/us/map-california-mudslides.html) <https://www.nytimes.com/interactive/2018/01/16/us/map-california-mudslides.html>.

Given increased wildfire-related risks, with impacts to natural and managed resources and infrastructure, the role of strategically placed landscape area treatments²⁹⁶ designed to reduce fire severity is increasingly important. Recent empirical analysis indicates that treated landscapes were characterized by a smaller severe burn area, improved resistance to wildfire, and better indicators of recovery from fire.²⁹⁷ Such treatments can protect infrastructure, reduce ignition risk of electricity system-ignited fires, and improve forest health.

An example of a strategically placed landscape area treatment that leverages IOU investments to reduce ignition hazards is the California Tahoe Conservancy partnership with the U.S. Forest Service, Liberty Utilities, California State Parks, and the Tahoe Fire and Fuels Team (a group of roughly 20 fire districts, land managers, and regulatory agencies). This partnership developed a strategy crossing several jurisdictions that complemented Liberty Utilities' vegetation management with fuels reduction and forest health treatments. California Tahoe Conservancy presented on the Powerline Resilience Corridors at the August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector. This partnership creates efficiencies that increase the pace and scale of treatments to protect communities and restore forest health better than individually managed interventions could achieve.²⁹⁸

Climate Change, Precipitation, and Atmospheric Rivers

California's Fourth Climate Change Assessment (Fourth Assessment) notes that projected changes in precipitation patterns (snow and rain) indicate a future with fewer days when precipitation occurs, stronger variability between years, more dry years, and increases in maximum daily precipitation.²⁹⁹ The Fourth Assessment cites Swain et al.'s finding that extreme flooding, such as the devastating 1861–1862 flood that inundated Sacramento and much of the Central Valley, may become more frequent as the climate changes.³⁰⁰ At the same time, the Fourth Assessment acknowledges the prospect of multidecadal drought in California's

296 Strategically placed *landscape area treatments* are fuel reduction interventions that are designed to reduce fire severity across an entire landscape through strategic fuel reduction on a fraction of the overall landscape.

297 Tubbesing, C.L., D. L. Fry, G. B. Roller, B. M. Collins, V. A. Fedorova, S. L. Stephens, and J. J. Battles. 2019. "Strategically Placed Landscape Fuel Treatments Decrease Fire Severity and Promote Recovery in the Northern Sierra Nevada." *Forest Ecology and Management*. [Abstract for Strategically Placed Landscape Fuel Treatments Decrease Fire Severity and Promote Recovery in the Northern Sierra Nevada article](https://doi.org/10.1016/j.foreco.2019.01.010) <https://doi.org/10.1016/j.foreco.2019.01.010>,

298 California Tahoe Conservancy. Presentation by Dorian Fougères. "Powerline Resilience Corridors: Leveraging Investor-Owned Utilities' Ignition Prevention Efforts With Additional Fuel Reduction and Forest Health Activities That Benefit Local Communities." 19-IEPR-10. TN# 229248.

299 Bedsworth, L., D. Cayan, G. Franco, L. Fisher, and S. Ziaja. 2018. California Governor's Office of Planning and Research, Scripps Institution of Oceanography, CEC, CPUC. *Statewide Summary Report*. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-013.

300 Swain, D. L., Langenbrunner, B., Neelin, J. D., & Hall, A. 2018. "[Increasing Precipitation Volatility in Twenty-First Century California.](https://doi.org/10.1038/s41558-018-0140-y)" *Nature Climate Change*, 8(5), 427–433. <https://doi.org/10.1038/s41558-018-0140-y>

future and identified extended drought scenarios based on downscaled climate projections as a basis for exploring impacts of a near-term and late-century, 20-year drought.³⁰¹

More recently, a study investigated meteorological mechanisms that govern projected changes in precipitation in California.³⁰² The authors show that the projected increased frequency of days without precipitation is driven by a decline in nonatmospheric river precipitation.³⁰³ The study also found that atmospheric rivers are expected to become stronger, delivering more precipitation when they occur and accounting for a greater proportion of California's precipitation. Atmospheric rivers have historically accounted for the majority of floods in California.

Changes in precipitation patterns will increase the challenges already faced by water reservoir managers who must balance flood risks with ecological, urban, agricultural, and hydropower demand for water resources. Meeting these challenges will require improving near-term and seasonal forecasts of atmospheric rivers, as well as development of adaptive management strategies informed by probabilistic forecasts—which provide estimated probabilities of possible outcomes—to optimize resource management in uncertain situations.

Implications of Climate Change on California's Transition to a Carbon-Neutral Electricity System

Successful decarbonization of California's energy system requires consideration of the impacts of a changing climate on a high-renewables electric grid. For example, an EPIC-funded³⁰⁴ study shows the importance of developing long-term energy scenarios that meet the state's carbon goals and account for climate-related considerations, in addition to costs, grid operation requirements, and environmental performance. The analysis of zero-carbon energy pathways includes consideration of issues such as:

- Changes to the overall amount of hydropower available.
- Projected increases in variability of hydropower resources.

301 Note that Tarroja et al. (2019), include analysis of extended drought scenario in their assessment of impacts of climate change on hydropower in a renewables-dominated grid. [Highlights and abstract for "Implications of Hydropower Variability From Climate Change for a Future, Highly -Renewable Electric Grid in California."](https://www.sciencedirect.com/science/article/pii/S030626191831897X) <https://www.sciencedirect.com/science/article/pii/S030626191831897X>.

302 Gershunov, A., T. Shulgina, R. E. S. Clemesha, K. Guirguis, D. W. Pierce, M. D. Dettinger, D. A. Lavers, D. R. Cayan, S. D. Polade, J. Kalansky, and F. M. Ralph. 2019. "Precipitation Regime Change in Western North America: The Role of Atmospheric Rivers." *Scientific Reports*.

303 An "atmospheric river" is a narrow band of concentrated water vapor in the atmosphere that can transport tropical moisture and disperse it in large precipitation events. In California, a few annual precipitation events associated with atmospheric rivers can account for about one-third to one-half of annual precipitation.

304 Burillo, D., M. Chester, S. Pincetl, E. Fournier, K. Reich, A. Hall. 2018. University of California Los Angeles. *Climate Change in Los Angeles County: Grid Vulnerability to Extreme Heat*. California's Fourth Climate Change Assessment, CEC. Publication number: CCCA4-CEC-2018-013.

- Impacts of climate change on solar thermal and geothermal power plants, which are constrained by water resources.
- Implications of increased heat, more extreme heat storms, and regional heat waves on demand from homes and businesses.

Hydropower is particularly valuable in a high-renewables, zero-carbon grid because it is a fast-ramping, dispatchable electricity resource that maintains high efficiency at partial load. Hydropower has historically been a highly variable resource, and climate change is expected to exacerbate this variability. Recent research provides a detailed assessment of how climate-related changes in hydropower capacity and timing could affect a renewables-dominated grid. The research indicates that changes to hydropower availability and variability are not expected to reduce renewable penetration or impact overall levelized cost of electricity. However, additional dispatchable capacity would be needed to compensate for the increasing variability of hydropower resources that, on average, appear to be in decline.³⁰⁵

Funded in part by EPIC, a study³⁰⁶ analyzed the challenges of, as well as potential strategies for coping with, extreme heat with regard to the Los Angeles electrical grid. Researchers considered projected peak demand as a function of population growth, building stock, appliance efficiency and turnover, and projected temperatures.³⁰⁷ Based on these factors, the study projects peak demand in Los Angeles County to increase by 2 percent to 51 percent by 2060, with rising temperatures accounting for a 4 percent to 8 percent increase. (For more information on how the statewide electricity forecast accounts for the effects of climate change on energy demand, see Chapter 7.) The study's approach to developing neighborhood-scale demand forecasts enables exploration of reliability issues at various scales, including transmission, distribution circuit, and neighborhood levels of granularity. This analysis helps identify constraints that can lead to grid failures and can inform the design of infrastructure that is low-carbon and climate resilient. Researchers developed advanced tools and techniques to enable high-resolution peak demand forecasting discussed above. To make their modeling techniques accessible to others, they developed prototypes of advanced functionalities for

305 B. Tarroja, K. Forrest, F. Chiang, A. AghaKouchak, S. Samuelson. 2019. "[Implications of Hydropower Variability From Climate Change for a Future, Highly-Renewable Electric Grid in California.](https://doi.org/10.1016/j.apenergy.2018.12.079)" *Applied Energy*. <https://doi.org/10.1016/j.apenergy.2018.12.079>.

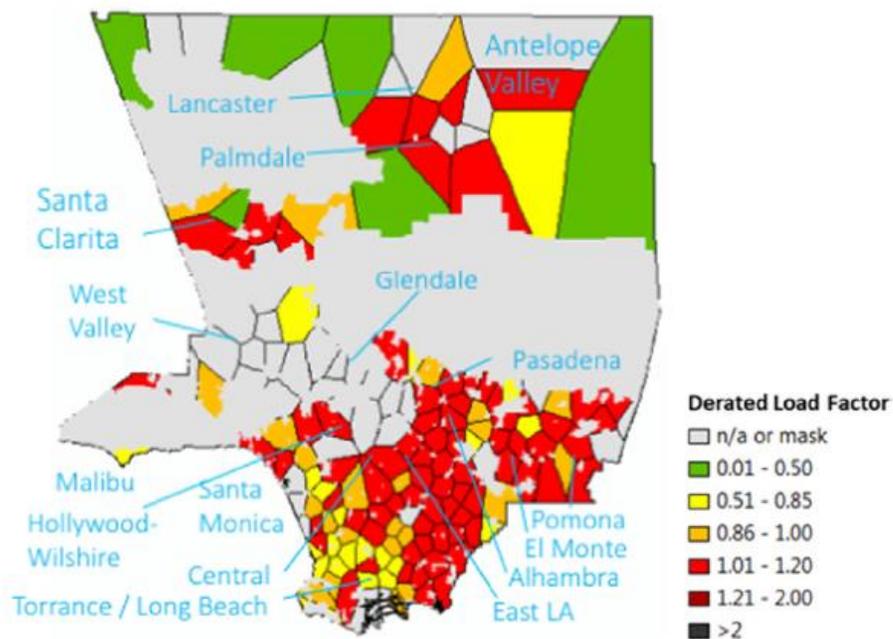
306 Burillo, D., M. Chester, S. Pincetl, E. Fournier, K. Reich, A. Hall. 2018. University of California Los Angeles. *Climate Change in Los Angeles County: Grid Vulnerability to Extreme Heat*. California's Fourth Climate Change Assessment, CEC. Publication number: CCCA4-CEC-2018-013.

307 Burillo, D., M.V. Chester, S. Pincetl, E. Fournier, and J. Reyna. 2019. "Forecasting Peak Electricity Demand for Los Angeles Considering Higher Air Temperatures Due to Climate Change." *Applied Energy*. [Abstract for Forecasting Peak Electricity Demand for Los Angeles Considering Higher Air Temperatures Due to Climate Change article](https://doi.org/10.1016/j.apenergy.2018.11.039) <https://doi.org/10.1016/j.apenergy.2018.11.039>.

building energy models and software platforms managed by the U.S. Department of Energy and national labs.³⁰⁸

Through sensitivity analysis, researchers identified key factors for the high-resolution peak demand forecasting to be population growth, building and appliance efficiencies, air-conditioner penetration, and daily maximum air temperatures. Researchers found that shared-wall housing could reduce peak demand by up to 50 percent for each building unit. While raising the air conditioner Seasonal Energy Efficiency Ratio (SEER) standards in California would reduce annual energy demand, researchers conclude that it would not reduce peak demand during summertime heat waves. With access to SCE's distributed energy interconnection map data, researchers were also able to identify congested areas where strategic siting of distributed energy resources and storage can ensure continued reliability at a lower total cost than traditional grid technologies (Figure 20).

Figure 20: Map of SCE Substation Vulnerabilities to Heat Waves in 2018



Source: Burillo et al., 2019 "Derated load factor" is a temperature-adjusted utilization rating that researchers developed to show conditions under which substations are expected to be overloaded under high demand and reduced capacity conditions during extreme heat. The large amount of areas in red indicate that most substations in the county will be overloaded by 1 to 20 percent during a heat wave.

308 The energy models and software platforms are EnergyPlus ([Link to download EnergyPlus program](https://energyplus.net/) <https://energyplus.net/>) and Building Energy Optimization Tool, also known as BEopt ([Link to Building Energy Optimization tool](https://beopt.nrel.gov/home) <https://beopt.nrel.gov/home>).

Health and Equity Issues in the Context of Climate Change

Recent research has highlighted the potential for transportation electrification and decarbonization to help California meet its midcentury GHG emissions reductions goals and reduce air pollution associated with human illnesses and deaths.³⁰⁹ By 2050, the benefits of reduced mortality due to lower particulate matter pollution could have a similar economic value as the cost of meeting an 80 percent emissions reductions target. Additional benefits would accrue from reduced numbers of illnesses and deaths (such as asthma), as well as from improved indoor air quality resulting from electrification of home heating and cooking. Improved accounting of cobenefits is needed to support development of statewide decarbonization strategies, as well as local strategies aimed at generating benefits for disadvantaged communities and vulnerable populations.

Climate Resilience and Interconnected Systems

Assessing climate vulnerability and developing strategies to preserve the energy distribution and transmission systems require considering interconnected systems that may not be designed, regulated, or managed as having interdependencies.³¹⁰ For example, interdependencies between the energy, water, transportation, and other critical sectors can result in complex disruptions affecting multiple sectors (see Figure 21).³¹¹ Recent research underscores how interconnections between, for example, transportation and energy systems with other sectors such as communications, can thwart traditional risk analysis and limit the effectiveness of resilience strategies that consider a single sector in isolation.³¹² Preparing

309 See *Statewide Summary Report* (2018) and Zapata, C.B., C. Yang, S. Yeh, J. Ogden, and M. J. Kleeman. 2018. "Low-Carbon Energy Generates Public Health Savings in California." *Atmospheric Chemistry and Physics*. [Abstract for Low-Carbon Energy Generates Public Health Savings in California article](https://doi.org/10.5194/acp-18-4817-2018) <https://doi.org/10.5194/acp-18-4817-2018>.

310 Moser, S. and J. F. Hart. 2018. *The Adaptation Blind Spot—Electrical Grid Teleconnected and Cascading Climate Change Impacts on Community Lifelines in Los Angeles*. California's Fourth Climate Change Assessment, CEC. Publication Number: CCCA4-CEC-2018-008.

Radke, J.D., G.S. Biging, K. Roberts, M. Schmidt-Poolman, H. Foster, E. Roe, Y. Ju, S. Lindbergh, T. Beach, L. Maier, Y. He, M. Ashenfarb, P. Norton, M. Wray, A. Alruheili, S. Yi, R. Rau, J. Collins, D. Radke, M. Coufal, S. Marx, A. Gohar, D. Moanga, V. Ulyashin, and A. Dalal. 2018. *Assessing Extreme Weather-Related Vulnerability and Identifying Resilience Options for California's Interdependent Transportation Fuel Sector*. California's Fourth Climate Change Assessment. CEC. Publication Number: CCCA4-CEC-2018-012.

CEC staff. 2016. *2016 Integrated Energy Policy Report Update*. CEC. Publication Number: CEC-100-2016-003-CMF. p. 122

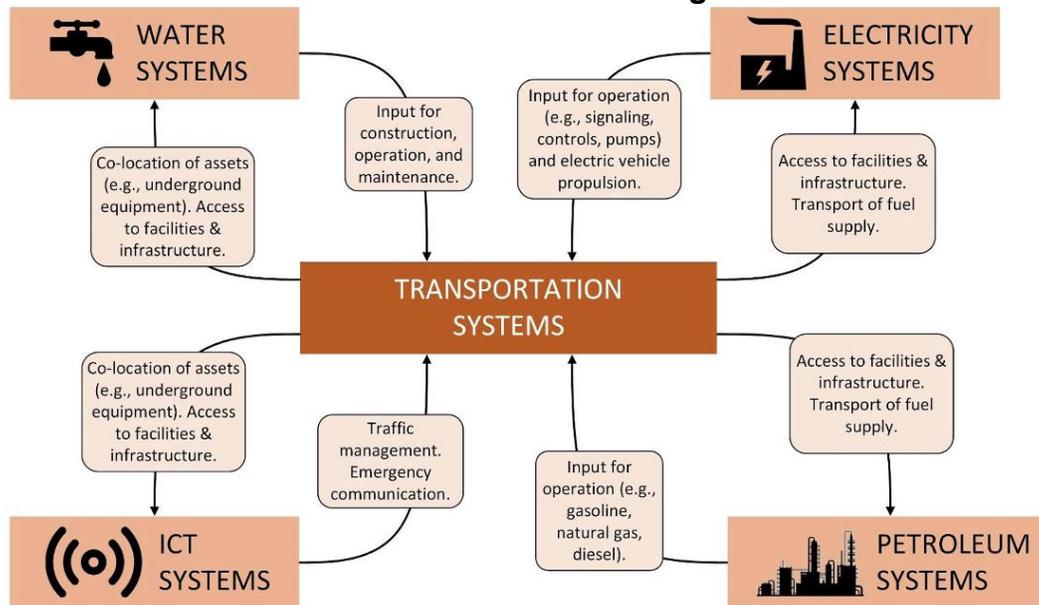
311 Markolf et al. 2019.

312 Clark, S.S., M.V. Chester, T.P. Seager, and D.A. Eisenberg. 2019. "The Vulnerability of Interdependent Urban Infrastructure Systems to Climate Change: Could Phoenix Experience a Katrina of Extreme Heat?" *Sustainable and Resilient Infrastructure*. [Abstract for The Vulnerability of Interdependent Urban Infrastructure Systems to Climate Change article](https://www.tandfonline.com/doi/abs/10.1080/23789689.2018.1448668) <https://www.tandfonline.com/doi/abs/10.1080/23789689.2018.1448668>.

Markolf, S.A., C. Hoehne, A. Fraser, M.V. Chester, and B.S. Underwood. 2019. "Transportation Resilience to Climate Change and Extreme Weather Events— Beyond Risk and Robustness," *Transport Policy*. [Abstract for Transportation Resilience to Climate Change and Extreme Weather Events article](https://www.sciencedirect.com/science/article/pii/S0967070X17305000) <https://www.sciencedirect.com/science/article/pii/S0967070X17305000>.

complex, interconnected systems for climate change may require—in addition to traditional risk analysis for infrastructure and operations— designing systems to operate with flexibility and agility to support robust adaptation.

Figure 21: The Importance of Considering Interconnected Systems When Designing Climate Resilience Strategies



Source: Markolf et al., 2019

Crucial Role of Research in Supporting Climate-Resilient Planning and Investment for the Energy Sector

Investing in a climate-resilient, decarbonized energy system requires understanding of the interplay between a changing climate and energy sector infrastructure and operations. As noted by Governor Newsom’s strike force report, “Climate change has rendered many assumptions about California’s climate outdated. Historical records for humidity, wind, rain, and temperature are regularly broken.” The strike force report emphasizes the critical need for utilities to ensure that capital investments are tailored to the realities of a changing climate, and for the state to provide—through its climate assessment process and adaptation clearinghouse—updated climate models to inform those investments.³¹³ In addition, the *Paying it Forward: The Path Toward Climate-Safe Infrastructure in California* report developed in response to Assembly Bill 2800 (Quirk, Chapter 580, Statutes of 2016) provides

³¹³ *Wildfires and Climate Change: California’s Energy Future*. A Report from Governor Newsom’s Strike Force. April 2019.

recommendations highlighting the importance of sustained financial support for climate science efforts and for collaborative interaction among engineers, architects, and climate scientists to support development of climate-safe infrastructure.

Foundational research illuminating projected climate impacts at a fine scale is essential to preparing for our globally warmed world. High-resolution climate projections for California—and the data products that derive from those projections—allow decision makers to identify vulnerabilities to assets and operations, craft science-based adaptation strategies, and understand the appropriate timing and prioritization of adaptation actions. Understanding local and regional impacts is crucial because climate change will affect different climate zones, neighborhoods, and communities in different ways.

This section provides an overview of the CEC’s leadership in developing high-resolution climate projections for California. The section also emphasizes the importance of engaging stakeholders to produce scientifically rigorous research for supporting action.

Climate Projections to Support Resilient Infrastructure Investment and Planning for a Decarbonized Energy System

The global climate models that represent how the planet will respond to changes in GHG emissions do not describe local and regional impacts to California with sufficient detail to characterize the nature of threats to key sectors (such as energy, water, or agriculture) or infrastructure and operations (which require very fine resolution in space and time). To fill this critical gap, the state has invested in cutting-edge research to develop downscaled projections, which rely on statistical methods or explicit modeling of chemistry and physics to produce high-resolution, accurate representations of how climate change may affect California.³¹⁴ Over more than a decade of research, the state’s climate projections have evolved to represent bias-corrected trends and variability of weather-related parameters that most impact the energy system. State-sponsored research has also advanced understanding of underlying science, which, in turn, has illuminated a path to producing projections of wind, solar irradiation, and other difficult-to-characterize parameters essential for capturing impacts relevant to renewable energy resources, demand forecasting, wildfire-related risks, and other issues germane to a resilient energy transition.

California’s electricity and natural gas IOUs have expressed an interest in having projected and historical climate data at 2 kilometer (km) spatial resolution and hourly temporal resolution.³¹⁵

314 Climate Action Team. CalEPA. February 2015. *Climate Change Research Plan for California*. [Link to Climate Change Research Plan for California report](https://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf) https://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf.

315 CMIP 6 is the sixth phase of the Coupled Model Intercomparison Project, which began in 1995 under the auspices of the World Climate Research Programme (WCRP). “The objective of the CMIP is to better understand past, present and future climate changes arising from natural, unforced variability or in response to changes in radiative forcing in a multi-model context.” A suite of global climate modeling results

Projections and historical data at discrete points (such as weather stations) are also needed to complement “gridded” data that represent averages over an area (such as a 2 km by 2 km grid). These data are needed to assess vulnerabilities for natural gas and electricity system assets and operations, as well as develop flexible adaptation pathways and adaptive management strategies. “Adaptive management strategies” are characterized by a “decision-making framework that maintains flexibility and incorporates new knowledge and experience over time.”³¹⁶ Such strategies enable institutional learning and are well-suited to situations where historical approaches are not adequate and future circumstances are characterized by uncertainty. “Flexible adaptation pathways” are an adaptive management approach that identifies circumstances that merit reassessment and possible refinement, as well as allow for adjustment of adaptation measures when new or unforeseen information becomes available.³¹⁷

Developing climate projections on a scale that utilities request to inform infrastructure investments, risk analysis, and highly granular demand forecast and management strategies is challenging. For example, the next generation of global climate models³¹⁸ that will serve as a foundation for international negotiations and assessments does not provide hourly resolution—rather, only a small percentage of projections will provide six-hour resolution or better.³¹⁹ Meeting the expectations of IOUs will require methods that portray temporal and spatial patterns of California’s microclimates reliably.³²⁰ As PG&E notes, “presently, our understanding of historical climate at fine resolution limits our ability to develop models of future projected climate.”³²¹

from more than 30 research groups around the world based on the same GHG emissions and land use scenarios are available online. These projections inform international analyses and negotiations. [Information on CMIP Phase 6 on the World Climate Research Programme's Web page](https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6) <https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6>.

316 Butler, P., C. Swanston, M. Janowiak, L. Parker, M.S. Pierre, and L. Brandt. 2012. “Adaptation Strategies and Approaches: Chapter 2.” In: Swanston, Chris; Janowiak, Maria, eds. *Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers*. Gen. Tech. Rep. NRS-87. Newtown Square, Pennsylvania: US Department of Agriculture, Forest Service, Northern Research Station: 15-34., 87, 15-34.

317 See, for example, Bruzgul, Judsen, Robert Kay, Andy Petrow, Tommy Hendrickson, Beth Rodehorst, David Revell, Maya Bruguera, Dan Moreno, and Ken Collison. (ICF and Revell Coastal). 2018. *Rising Seas and Electricity Infrastructure: Potential Impacts and Adaptation Actions for San Diego Gas & Electric*. California’s Fourth Climate Change Assessment. CEC. Publication Number: CCCA4-CEC- 2018-004.

318 The Coupled Model Intercomparison Project 6 (CMIP6) is a product of the World Climate Research Programme. CMIP6 provides a suite of global climate modeling results from more than 30 research groups around the world based on the same GHG emissions and land use scenarios. These projections inform international analyses and negotiations.

319 Originally noted from public comment TN 228670 to 19-ERDD-01, submitted by Dr. Owen Doherty of Eagle Rock Analytics on June 5, 2019.

320 Public Comment from Eagle Rock Analytics to CEC Docket 19-ERDD-01, TN #228670 submitted June 5, 2019.

321 Public comment from PG&E to CEC Docket 19-ERDD-01, TN#228650, submitted June 5, 2019.

The CEC is supporting ongoing research to help meet the IOU's highly granular climate data needs. For example, an ongoing EPIC grant³²² supports development of a hybrid downscaling technique that leverages strengths of different approaches to produce high-resolution climate projections based on global climate model outputs—to improve on several critical climate-related parameters, including wind fields (speed, direction, variability). In addition to the role of wind fields as a key determinant of extreme fire weather, understanding projected changes in wind fields is important to support an energy system based on renewable generation. For example, long periods with very low wind may affect planning and operations of a high-renewables grid. Ongoing EPIC grants have also provided hourly temperature data (projected and historical) that can be used to support highly granular demand forecasts and integration of climate projections in support of SB 100 and SB 350 goals.

Another newly initiated EPIC research project will advance scientific understanding of wildfire behavior in a changing climate and produce updated models of wildfire risk to support electricity sector resilience.³²³ This research seeks to improve understanding of fire behavior in current and future fuel and climate conditions, including issues related to tree mortality and development of human infrastructure near wildlands. Ultimately, the work will provide stakeholders with actionable wildfire risk forecasts at fine-scale resolution in the near-term (0–7 day forecasts) and longer-term (end-of-century) projections at coarse-scale (5 km) resolution. Stakeholders involved with the effort include not only utilities, but also agencies such as the California Tahoe Conservancy and the U.S. Forest Service, who are working in partnership with other local entities to leverage IOU vegetation treatments with additional measures to provide more comprehensive community-scale forest resilience.

Actionable Adaptation Research: Beyond Information Provision to Decision Support

Generating research that informs resilient infrastructure investment and planning is critical. A valuable strategy is to conduct coproduced research, which involves engagement of stakeholders as collaborators. Decades of analysis have shown that coproduced research is more likely to lead to the generation of usable knowledge than research that does not involve collaboration of target users.³²⁴ These studies indicate that successful coproduction processes

322 Ongoing research under EPIC grant number EPC-16-063 with Scripps Institution of Oceanography, University of California, San Diego. "Advanced Statistical-Dynamical Downscaling Methods and Products for California Electricity System Climate Planning."

323 EPC-18-026 with Spatial Informatics Group. "Comprehensive Open Source Development of Next Generation Wildfire Models for Grid Resiliency."

324 Lemos, M. C., & B.J. Morehouse. 2005. "The Co-Production of Science and Policy in Integrated Climate Assessments." *Global Environmental Change*, 15(1), 57-68.

require participation and input from stakeholders at multiple stages of the research, from developing the research focus and design to disseminating the research findings. Opportunities to align research focus toward the needs of utilities, communities, and other stakeholders require more vigorous stakeholder engagement during the presolicitation stage. In addition, research proposals should be assessed to ensure engagement plans and stakeholder input are incorporated throughout the research process.

An example of one such successful collaboration is the development of the Integrated Forecast and Reservoir Management (INFORM) framework, which resulted in the adoption of a hydropower and reservoir decision-support tool. Research funded by the CEC's Public Interest Energy Research (PIER) program demonstrated the usefulness of probabilistic forecasting through the development of INFORM.³²⁵ INFORM's probabilistic approach was coupled with a decision support system designed to help reservoir operators use short- and long-term runoff forecasts to make informed decisions. Research showed that this approach would lead to improved outcomes under a highly variable and changing climate while balancing among often competing demands, such as hydropower generation, water supply, and flood control.³²⁶ As presented at the August 2019 IEPR Climate Adaptation Workshop, the demonstration phase of INFORM illustrated how adaptive, risk-based reservoir regulation strategies are self-tuning to a changing climate and deliver more robust performance than current management practices.³²⁷ However, research and demonstration efforts were not enough to ensure acceptance of this powerful decision-support tool. Instead, ongoing collaboration between the research team and a network of policy makers and managers was crucial.³²⁸

Cal-Adapt, the state's interactive website for exploring local climate-related risks, presents an opportunity to strengthen stakeholder engagement to promote the use of climate projections in energy sector climate resilience decision-making. Initial development of Cal-Adapt focused on making California's vast research related to projected climate risks publicly available and

Meadow, A. M., Ferguson, D.B., Guido, Z., Horangic, A., Owen, G., and Wall, T. 2015. "Moving Toward the Deliberate Coproduction of Climate Science Knowledge." *Weather, Climate, and Society*. 7(2), 179-191.

325 HRC-GWRI (2007). *Integrated Forecast and Reservoir Management (INFORM) for Northern California: System Development and Initial Demonstration*. CEC, PIER Energy Related Environmental Research. CEC-500-2006-109. [Link to Integrated Forecast and Reservoir Management for Northern California report](https://ww2.energy.ca.gov/2006publications/CEC-500-2006-109/CEC-500-2006-109.PDF) <https://ww2.energy.ca.gov/2006publications/CEC-500-2006-109/CEC-500-2006-109.PDF>.

326 Georgakakos, K.P. et al. 2014. *Integrated Forecast and Reservoir Management (INFORM) Enhancements and Demonstration Results for Northern California (2008-2012)*. CEC Report No. CEC-500-2014-019.

327 Presentation by Konstantine P. Georgakakos, Sc.D (Hydrologic Research Center). "Enhancing the resilience of energy and water resources through integrated management and the use of probabilistic forecasts." Presented at the California Energy Commission's August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector.

328 Ziaja, S. 2019. "Role of Knowledge Networks and Boundary Organizations in Coproduction: A Short History of a Decision Support Tool and Model for Adapting Multiuse Reservoir and Water-Energy Governance to Climate Change in California." *Weather, Climate, and Society*. [Abstract for Role of Knowledge Networks and Boundary Organizations In Coproduction article](https://doi.org/10.1175/WCAS-D-19-0007.1). <https://doi.org/10.1175/WCAS-D-19-0007.1>.

easy to access. Moving forward, energy sector adaptation planning and integration of resilience into investments will require:

- Resources dedicated to stakeholder engagement and outreach to describe precise decision-support needs.
- Support for analytics and research by climate scientists to provide analyses, custom datasets, and tools that align with the CPUC's guidance climate data and projections to support adaptation, address stakeholder needs, and maintain scientific rigor.

These elements will foster energy investments and planning.

California's Climate Change Assessments

California has been assessing climate change impacts on the state for more than 30 years, with an initial report on *The Impacts of Global Warming on California* released by the CEC in 1989. California's first three modern climate change assessments, released in 2006, 2009, and 2012, have been instrumental in guiding California's ambitious, comprehensive, science-based climate policy. California's most recent assessment has made strides in:

- Providing climate projections with sufficient detail to illuminate risks to infrastructure and communities.
- Making locally relevant data on climate-related risks freely accessible.
- Building regional capacity to adapt to climate change.

California's Fourth Assessment: Building Capacity for Regional Engagement

Released in 2018, the Fourth Assessment provides information to support flexible and adaptive actions to increase California's resilience to climate change. The assessment included 16 peer-reviewed technical reports dedicated to energy sector issues, including development of climate projections of parameters relevant to California's energy sector. Key findings from the energy studies as well as the statewide report,³²⁹ which offered a synthesis of technical work, include:

- Analysis of nearly two billion residential energy bills was used to quantify projected regional changes in peak and total residential electricity demand, as well as natural gas demand. Because of increased penetration and use of air conditioning, residential electricity demand is projected to increase, particularly in inland and Southern

329 Bedsworth, L., D. Cayan, G. Franco, L. Fisher, S. Ziaja. (California Governor's Office of Planning and Research, Scripps Institution of Oceanography, California Energy Commission, California Public Utilities Commission). 2018. Statewide Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-013.

California, with more moderate increases expected in cooler coastal areas. Peak demand is expected to increase by a greater percentage than total demand.³³⁰

- An analysis of projected increases in peak hourly electricity demand in Los Angeles County indicates that projected peak summer demand puts local energy infrastructure at risk of service disruptions by about midcentury because of local substations' and distribution circuits' capacity being exceeded. Adaptation measures such as installation of additional substation capacity, strategic deployment of distributed energy resources, or load shifting could reduce grid vulnerabilities in Los Angeles County.³³¹
- Results from a field study in the Sacramento-San Joaquin River Delta indicate subsidence rates for some Delta levees of about 1 to 2 centimeters per year. This subsidence compounds risks associated with rising seas and storm, effectively accelerating the timeline in which storm surge could result in levee overtopping and expose natural gas pipelines and other infrastructure to damage related to inundation or scouring.³³²

Over a fifteen-year period (2001–2016), a small fraction of wildfires was responsible for most of the damage to California's electricity grid. Wildfire-related threats to the electricity grid in Northern California are expected to increase in the near term, while uncertain impacts of climate change on Santa Ana wind events create uncertainty in projected wildfire-related risks to Southern California's grid.³³³

Climate adaptation strategies are typically implemented at local and regional scales through planning and land-use decisions, climate resiliency investments, and community-based efforts.

Responding to a need to interpret technical results in the context of regional and local practitioner needs, the Fourth Assessment included nine regional reports, as well as a comprehensive statewide report and three reports on climate-related topics of statewide importance—ocean and coast, tribal and indigenous communities, and climate justice. In 2018

330 Auffhammer, Maximilian. (University of California, Berkeley and NBER). 2018. Climate Adaptive Response Estimation: Short and Long Run Impacts of Climate Change on Residential Electricity and Natural Gas Consumption Using Big Data. California's Fourth Climate Change Assessment. Publication number: CCCA4-EXT-2018-005.

331 Burillo, Daniel, Mikhail Chester, Stephanie Pincetl, Eric Fournier, Katharine Reich, Alex Hall. (University of California Los Angeles). 2018. Climate Change in Los Angeles County: Grid Vulnerability to Extreme Heat. California's Fourth Climate Change Assessment, California Energy Commission. Publication number: CCCA4-CEC-2018-013.

332 Brooks, Benjamin, Jennifer Telling, Todd Ericksen, Craig L. Glennie, Noah Knowles, Dan Cayan, Darren Hauser, Adam LeWinter. (U.S. Geological Survey). 2018. High Resolution Measurement of Levee Subsidence Related to Energy Infrastructure in the Sacramento-San Joaquin Delta. California's Fourth Climate Change Assessment, California Energy Commission. Publication number: CCCA4-CEC-2018-003.

333 Dale, Larry, Michael Carnall, Gary Fitts, Sarah Lewis McDonald, Max Wei. (Lawrence Berkeley National Laboratory). 2018. *Assessing the Impact of Wildfires on the California Electricity Grid*. California's Fourth Climate Change Assessment, California Energy Commission. Publication number: CCCA4-CEC-2018-002.

and 2019, hundreds of people participated in events throughout California to discuss the findings of the Fourth Assessment in regional contexts. This strengthened dialogue among scientists, policy makers, and practitioners and laid the foundation for more vigorous, science-based adaptation action.

California’s Fifth Climate Change Assessment: Organization, Scenarios, Key Research Gaps

Research to provide foundational scenarios for California’s Fifth Climate Change Assessment is already underway. Interagency efforts involving California’s Natural Resources Agency, the Governor’s Office of Planning and Research, the Strategic Growth Council, and the CEC are ongoing to scope a governance process that supports the scale and aspirations of the next assessment, identify priority research areas to support local and regional adaptation efforts, and lay a foundation for sustained engagement throughout the assessment. Early, sustained engagement will be crucial to advancing science that addresses regional priorities.

In July 2019, the CEC and the Bishop Paiute Tribe cohosted a conference on Sustaining Tribal Resources.³³⁴ This event advanced the CEC’s mission to provide meaningful tribal input into the development of regulations, plans, and activities that may affect tribes. The event also served to build capacity for early engagement in the scoping of the Fifth Assessment.

The CEC anticipates holding workshops to engage energy sector stakeholders and the research community in discussions to help delineate and focus supporting research, including:

- Coproduction of climate projections and decision-support analytics with sufficient resolution to support asset-level vulnerability assessment, infrastructure planning, and charting flexible adaptation pathways that are responsive to changes in scientific understanding, policy, and on-the-ground conditions.
- Integration of climate readiness into electricity system operations, tools, and models, including those that support long-term planning for a high-renewables electricity grid.
- Clarification of interactions between renewable electricity systems and climate change to ensure an effective, resilient transition to low-carbon energy.
- Development of long-term energy scenarios that meet California’s climate and energy mandates in a manner that is resilient to projected changes in climate, including changes in climate variability and extreme events.

³³⁴ [Link to agenda for Sustaining Tribal Resources Conference on July 10-11,2019](https://www.energy.ca.gov/sites/default/files/2019-07/Sustaining-Tribal-Resources-Conference-Agenda-July-2019-V3.pdf) https://www.energy.ca.gov/sites/default/files/2019-07/Sustaining-Tribal-Resources-Conference-Agenda-July-2019-V3.pdf.

Fortifying Community-Level Climate Resilience and Disaster Preparedness Through Energy Sector Innovation

California's energy sector is rapidly innovating to meet ambitious GHG emissions reductions goals. This innovation creates opportunity to integrate implementation of low-carbon technologies with climate resilience considerations and concerns related to local hazard mitigation planning, disaster preparedness, emergency response, and disaster recovery. As discussed during the Fostering Community Resilience Through Energy Sector Innovation panel at the August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector, advances in controllers coupled with reductions in solar cost and storage options have created a more fertile commercial environment for renewable powered microgrid systems. These systems can promote the resilience of critical facilities and provide an alternative to backup diesel generators.³³⁵

EPIC Investments in Community-Level Resilience and Disaster Preparedness

Through its EPIC research program, the CEC has made investments in promoting community resilience through energy sector innovation. Investment in energy storage and microgrids³³⁶ provides new technology solutions and improves resiliency for California's energy sector by helping maintain critical operations and services during grid outages due to extreme weather, wildfires, and other natural disasters. Critical facilities, such as hospitals, fire stations, and emergency shelters, have traditionally relied on backup diesel generators to maintain power during grid outages. Using onsite renewable generation and energy storage to offer a clean source of backup power, renewably powered microgrids allow continued operation in the face of grid outages. These renewably powered microgrids also offer benefits related to GHG emissions reductions and management of peak demand. The following projects describe the flexibility and benefits offered by energy storage and microgrid technologies, ranging from stand-alone building structures to supporting entire communities.

City of Fremont Fire Stations Microgrid Project

Fire stations are vulnerable to power outages that could handicap local emergency response. Possible causes of power outages include extreme weather and earthquakes. With funding from the CEC, Gridscape Solutions designed and built microgrids at three fire stations in

³³⁵ [Link to WebEx recording of August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector](https://ww2.energy.ca.gov/php/yt_player.php?vidNo=icnqtDYPU1g&title=IEPR%20Commissioner%20Workshop%20on%20Climate%20Adaptation%20in%20California%20through%20two%20sessions%20focused%20on%20community%20resilience%20needs%20and%20collaborative%20research%20to%20improve%20energy%20sector%20planning%20and%20management)

https://ww2.energy.ca.gov/php/yt_player.php?vidNo=icnqtDYPU1g&title=IEPR%20Commissioner%20Workshop%20on%20Climate%20Adaptation%20in%20California%20through%20two%20sessions%20focused%20on%20community%20resilience%20needs%20and%20collaborative%20research%20to%20improve%20energy%20sector%20planning%20and%20management

³³⁶ Microgrids combine distributed energy resources with a controller to manage energy use. A key feature of many microgrids is the ability to continue operating even if the surrounding electricity grid experiences an outage, referred to as *islanding*.

Fremont (Alameda County), designed to provide at least three hours per day of power for critical loads during a utility power outage. Each microgrid consists of a microgrid energy management system, a parking lot canopy solar photovoltaic (PV) system, and a battery energy storage system. The three microgrids are anticipated to provide savings of \$20,000 per year while producing low-carbon power. These microgrids ensure that critical infrastructure can deliver services in emergencies and avoid competing for limited emergency fuel supplies to power backup diesel generation. Further, these microgrids improve the resiliency of the distribution system by reducing the utility load at substations by providing local renewable generation and energy storage. As Gridscape Solutions noted at the August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector, project performance has exceeded the design goals, including successful islanding for more than 12 hours with renewable power.³³⁷ The project has also resulted in a good business model for replication of renewably powered backup generation and storage systems, which are now being implemented by Gridscape Solutions at public sector schools and fire and police stations, and for industrial customers.³³⁸

Kaiser Permanente Medical Center Microgrid

Richmond's Kaiser Permanente Medical Center is a highly used hospital, with urgent care, emergency, and pharmaceutical capacities. Microgrids can maintain critical life safety functions in the event of a grid outage and reduce electrical demand in normal operation, increasing grid resiliency. With funding from the CEC, the Charge Bliss research team successfully designed and built a microgrid system at the Kaiser Permanente Medical Center, consisting of a 250-kilowatt (kW) solar installation and 1 MWh/250 kW of battery storage. The next-generation microgrid system can optimize renewable energy generation, storage, and power delivery to connected loads, as well as islanding³³⁹ to provide critical emergency power to the life safety branch of the hospital for at least three hours in case of an outage. This system supplements existing backup generators, which improves the energy reliability of hospitals in crises and reduces energy expenses by up to 50 percent. The Richmond Medical Center's system is one of nearly 50 PV systems hosted by Kaiser Permanente, supporting the company's goal of carbon neutrality by 2020 and serving as an example for other medical centers interested in

337 [Link to WebEx recording of August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector](https://ww2.energy.ca.gov/php/yt_player.php?vidNo=icnqtDYPUIg&title=IEPR%20Commissioner%20Workshop%20on%20Climate%20Adaptation%20in%20California%E2%80%99s%20Energy%20Sector&desc=This%20workshop%20explores%20energy%20sector%20climate%20adaptation%20in%20California%20through%20two%20sessions%20focused%20on%20community%20resilience%20needs%20and%20collaborative%20research%20to%20improve%20energy%20sector%20planning%20and%20management)

https://ww2.energy.ca.gov/php/yt_player.php?vidNo=icnqtDYPUIg&title=IEPR%20Commissioner%20Workshop%20on%20Climate%20Adaptation%20in%20California%E2%80%99s%20Energy%20Sector&desc=This%20workshop%20explores%20energy%20sector%20climate%20adaptation%20in%20California%20through%20two%20sessions%20focused%20on%20community%20resilience%20needs%20and%20collaborative%20research%20to%20improve%20energy%20sector%20planning%20and%20management.

338 Ibid., Quote from Peter Lehman, Founding Director, Schatz Energy Research Center.

339 Microgrid systems can power a local distribution circuit even when the electrical grid is no longer providing power to that circuit. Intentional islanding controls enable microgrids to disconnect a local circuit from the grid and derive power from distributed energy resources.

replication. As of August 8, 2018, “more than a half dozen inquiries from...facilities around California and beyond, including Hawaii” had reached out to inquire “exactly how fast and in what ways ... [they might] replicate the Richmond project.”³⁴⁰

Chemehuevi Valley Reservation

High winds and seasonal flooding have historically caused frequent power outages for the Chemehuevi Valley reservation. Due to its remoteness in the Mojave Desert and elderly residents’ vulnerability to extreme heat, a loss of power poses a substantial risk to the community. With support from the CEC, the University of California, Riverside, developed a microgrid for the Chemehuevi Valley Tribe. This microgrid is at the community center, which tribal members depend on for emergency response and community services. It also serves as a cooling center when power disruption coincides with extreme heat.

In addition to providing reliability and stability to the Chemehuevi community, the system also lowers demand at peak times, reducing utility costs and generating GHG emissions savings. As articulated by Dr. Alfredo A. Martinez-Morales, managing director and research faculty at UC Riverside’s Southern California Research Initiative for Solar Energy, a key “part of our mission is to work closely with the community in terms of outreach and education.”³⁴¹ The opportunity to work closely with the community has been and will continue to be critical to the long-term success of the project.

Valencia Gardens Energy Storage

The Valencia Gardens Energy Storage project, located in a disadvantaged community of central San Francisco’s Mission District, is an important example of using clean local energy to enhance grid resiliency in a dense urban environment. With funding from the CEC, the project is using distributed energy storage in front of the meter as part of an optimized local energy system to increase support for nearby distributed solar PV generation, while improving the overall quality of grid operations and economics. The project will improve distribution system reliability and improve balancing of local electric supply and demand. Furthermore, this project will serve as a model that supports California’s emissions reduction goals, increases the state’s resilience and security, drives regional economic development, and lowers the cost of operating the power grid.

340 Seth Baruch, National Director Energy and Utilities, Kaiser Permanente Quote from an interview in “The Planning Report,” August 24, 2018. [Link to Kaiser Permanente's Richmond Medical Center Solar-Battery Microgrid a CEC-funded Model article](https://www.planningreport.com/2018/08/24/kaiser-permanente-s-richmond-medical-center-solar-battery-microgrid-cec-funded-model) <https://www.planningreport.com/2018/08/24/kaiser-permanente-s-richmond-medical-center-solar-battery-microgrid-cec-funded-model>.

341 [Link to August 8, 2019, IEPR workshop transcript](https://efiling.energy.ca.gov/getdocument.aspx?tn=229831). <https://efiling.energy.ca.gov/getdocument.aspx?tn=229831>.

Borrego Springs Microgrid Demonstration Project

The Borrego Springs community, located in San Diego County, experiences frequent grid outages because of severe storms and winds. With funding from the CEC, SDG&E developed an IOU-owned, IOU-operated, front-of-the-meter microgrid system to provide power during emergencies and planned outages. The system demonstrates an advanced microgrid controller, lithium-ion battery storage, and integration with a third-party solar PV system. It optimizes energy usage, provides ancillary services, supports emergency operations, improves customer utility service, and improves reliability and power quality. During an April 2013 grid outage resulting from a windstorm, the microgrid provided power to 1,225 customers for roughly six hours. During a severe storm in September 2013 that downed 20 utility overhead poles, the microgrid provided power to 1,060 customers for roughly 25 hours. Further, the Borrego Springs microgrid controller avoided adverse grid impacts by using more energy from a large, local solar plant and coordinating generation with resources available from various energy storage units.

Research to Develop Replicable Strategies for Implementation

The EPIC projects previously discussed resulted from two solicitations developed to advance the sophistication and decrease the cost of enabling technologies (such as solar, storage, and controllers). Though lessons have been learned from prior projects, issues with streamlined implementation of innovative energy solutions, such as permitting and interconnection with the grid, require further streamlining and packaged designs. Recognizing the need for communities to have proven, replicable models to promote effective, affordable, and timely deployment, CEC awarded nine additional microgrid projects in 2018 to design and demonstrate commercially replicable systems.³⁴²

Community Perspectives on Energy Sector Innovation: Challenges and Opportunities

As illustrated above, California's EPIC program provides many examples of innovative demonstration projects that advance energy sector resilience and support uninterrupted critical services in vulnerable communities. These energy technologies have an important role to play as communities work to build resilience. As discussed by panelists at the August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector, on-the-ground experience has confirmed that communities grapple with many issues as they seek to identify and implement energy innovations. Critical services such as telecommunications, emergency alerts, and first response highlight the importance of coordination and engagement. At the workshop,

³⁴² David Erne. [Link to Workshop Transcript](https://efiling.energy.ca.gov/getdocument.aspx?tn=229831). <https://efiling.energy.ca.gov/getdocument.aspx?tn=229831>.

panelists shared challenges encountered in communities and approaches that proved effective. These examples include:

- Community-driven planning to build a holistic vision and broad base of support, including vulnerable and historically marginalized communities.
- Sustained on-the-ground engagement to overcome challenges related to implementation and maintenance.
- Identification of critical facilities.
- Development of a cohesive vision across sectors.

Community-Driven Planning

As articulated by the National Association of Climate Resilience Planners, community-driven processes for adaptation planning “create stronger climate resilience solutions because communities most vulnerable to the effects of climate change have relevant direct experience and information ... not otherwise accessible to public bureaucracies.”³⁴³ The aftermath of the 1999 explosion at Chevron’s Richmond refinery illustrates the importance of community engagement to elicit community needs and put appropriate solutions in place. At the August 2019 IEPR workshop, Sylvia Chi with APEN discussed how an English-language emergency response alert system was in place at the time of the refinery explosion, which sent out a “shelter in place” advisory. However, this advisory was not effective for non-English-speaking households, who make up a significant portion of the local community. In the aftermath of the Richmond incident, the Laotian Organizing Project was founded to bring “community leaders together to organize and advocate for a multilingual emergency warning system.”³⁴⁴ Community members can now receive emergency information in Lao, Khmu, Mien, or Hmong.

Jasneet Sharma with the San Mateo Office of Sustainability highlighted that the concept of community-driven planning seems simple but is actually substantially more challenging than anticipated because it requires a shift in how governance typically occurs. Ms. Sharma discussed the importance of grounding community engagement with on-the-ground experience. She noted that it is extremely challenging because conventional processes generally lead with externally generated framings and technical perspectives.

343 National Association of Climate Resilience Planners (NACRP). 2017. *Community-Driven Resilience Planning: A Framework, Version 2.0*. [Link to Community-Driven Climate Resilience Planning: A Framework from the National Association of Climate Resilience Planners](https://kresge.org/sites/default/files/library/community_drive_resilience_planning_from_movement_strategy_center.pdf) https://kresge.org/sites/default/files/library/community_drive_resilience_planning_from_movement_strategy_center.pdf.

344 [Link to Workshop Transcript](https://efiling.energy.ca.gov/getdocument.aspx?tn=229831). <https://efiling.energy.ca.gov/getdocument.aspx?tn=229831>.

Embracing a community-driven approach for adaptation investments can also promote social cohesion and build community leadership.³⁴⁵ Sylvia Chi with APEN discussed how energy-resilient community sites—which she referred to as community resilience hubs—powered by innovative energy technologies could foster social cohesion. She noted that “using microgrids and solar and storage at community sites, like schools or health centers ... would have the benefit of providing disaster relief and shelter. It would also support community cohesion and trust and provide a space for education and organizing.”³⁴⁶ Community resilience hubs can also provide benefits that accrue in normal operations, such as reduced energy burdens.

Sustained Engagement to Overcome Challenges

As noted at the August 2019 IEPR workshop, community engagement must extend beyond developing a coherent vision and building a base of support. Dr. Martinez-Morales observed, “Technologies can be engineered, they can be tested in the lab, but when you put them out in the field, they are faced by a series of challenges” that may not have been anticipated.³⁴⁷ Best practices informed by on-the-ground experience with new technology systems is powerful. In addition to developing and implementing best practices, sustained engagement with communities housing energy projects can provide feedback for technology developers.

Building Resilience Into Disaster Recovery

Disaster recovery—such as the ongoing fire recovery of the town of Paradise and neighboring areas in Butte County—requires extensive resources and leadership. It also provides opportunities to build a new, more resilient infrastructure and align infrastructure investments across sectors, such as the energy sector, telecommunications, and other utilities. As the lead entity on the Community Building and Capacity Building Recovery Support Function—in partnership with the California Office of Emergency Services (CalOES) and Federal Emergency Management Agency (FEMA)—Nuin-Tara Key with the Governor’s Office of Planning and Research noted, “There’s a tremendous opportunity for alignment and coordination between utility and energy providers and local governments.”³⁴⁸ However, without a cohesive vision and coordinated implementation, investment approaches can be fragmented. Community outreach and education have the potential to develop cohesion and understanding around long-term community resilience goals. Organizing coordinated implementation can ensure near-term

345 NACRP (2017).

346 [Link to Workshop Transcript](https://efiling.energy.ca.gov/getdocument.aspx?tn=229831). <https://efiling.energy.ca.gov/getdocument.aspx?tn=229831>.

347 Ibid.

348 Ibid.

disaster response and recovery efforts are building toward those long-term goals and outcomes.

Prioritizing Resilience of Vulnerable Communities

Prioritizing vulnerable community resilience is not just a matter of investment in innovation, but investment in engagement. At its best, energy sector adaptation in vulnerable communities presents opportunities to address issues including:

- Building community cohesion.
- Promoting trust between historically marginalized populations and local and state jurisdictions.
- Building local capacity to plan for resilience more broadly.
- Alleviating disproportionate energy and air quality burdens.

ICARP's establishment of a definition for vulnerable communities in the context of climate change supports efforts to identify the most vulnerable populations³⁴⁹ and recognizes that "risk shows up in communities very differently. And individuals around the state have very different capacities to be able to respond to climate impacts and ... build toward more resilient outcomes."³⁵⁰

The CPUC's ongoing adaptation rulemaking anticipates developing recommendations for IOUs on "how to identify and prioritize investments and other activities that address the needs of vulnerable and disadvantaged communities as related to climate change impacts prioritizing community organizations."³⁵¹ APEN's recent publication on mapping resilience considers existing frameworks and tools that provide a basis for understanding community vulnerability to climate change, as well as outstanding needs for identifying and prioritizing vulnerable communities.³⁵² In the report the CEC's Social Vulnerability to Climate Change framework was highlighted as one of the strongest examples of a mapping framework in this area. However, promoting broad use of the CEC's Social Vulnerability framework for the prioritization of clean

349 Governor's Office of Planning and Research. July 2018. [Defining Vulnerable Communities in the Context of Climate Adaptation](http://opr.ca.gov/docs/20180723-Vulnerable_Communities.pdf) http://opr.ca.gov/docs/20180723-Vulnerable_Communities.pdf.

350 Nuin-Tara Key, [Transcript for the August 8, 2019, IEPR workshop on Climate Adaptation in California's Energy Sector](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229831&DocumentContentId=61278), TN# 229831, Docket 19-IEPR-10. <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229831&DocumentContentId=61278>.

351 Assigned Commissioner's Scoping Memo and Ruling, Filed 10/10/18. Order Instituting Rulemaking to Consider Strategies and Guidance for Climate Change Adaptation. R.18-04-019. p.7.

352 Ameer Raval et al (2019). Asian Pacific Environmental Network. *Mapping Resilience: A Blueprint for Thriving in the Face of Climate Disasters*.

energy investments may require additional efforts, such as developing an accessible user interface.

Recommendations

- **Identify resources needed to support enhanced technology and knowledge transfer between local jurisdictions and utilities to reduce emissions and enhance resilience.** As noted in the August 8, 2019, IEPR workshop on Climate Adaptation in California’s Energy Sector, local jurisdictions face several challenges in planning for energy sector resilience. The California Energy Commission, in partnership with the Integrated Climate Adaptation and Resilience Program, should work to develop guidance and resources to support successful engagement of local government and utility stakeholders in energy sector resilience planning. Guidance and resources should align with state priorities and goals, identify replicable examples, and leverage lessons learned from prior launches of innovative technologies.
- **Continue to prioritize applied research and action that supports climate resilience in California’s most vulnerable communities.**
- **State agencies need to redouble efforts to coordinate actionable research that informs climate-resilient decarbonization.** Aggressive strategies to secure substantial decarbonization of buildings and transportation sectors must be well underway by 2030. Further, the state must pursue “reach” technologies that are not yet proven and must consider impacts of climate change in planning a carbon-neutral system.
- **Advance next-generation climate projections that improve understanding of uncertain parameters responsible for key climate-related impacts to the energy system.** Parameters of interest include distribution of wind and the associated extremes as a driver of wildfire risks and wind resources, and cloudiness as a driver of energy demand and solar resources.
- **Leverage projections to inform cost-effective, resilient design of low-carbon energy systems.** Probabilistic interpretations informed by the multiplicity of possible futures will be essential, as will analysis of changing risks of compound events. Interpretation of projections as well as enhanced observed historical records will also be crucial for charting pathways for adapting to climate change. To enable timely uptake of research results in support of climate resilience will require vigorous stakeholder

engagement at all stages of the research endeavor, including defining the research scope and desired research products.³⁵³

- **Identify and close knowledge gaps on the role of insurance, costs of inaction, and stability of California’s energy markets in development of California’s Fifth Climate Change Assessment research portfolio.** California’s Fifth Climate Change Assessment provides an opportunity to advance actionable research that supports energy-sector resilience. Early identification of research gaps in this area include quantification of the economic costs and benefits of transitioning to a resilient energy grid, including an exploration of the intersection between energy reliability, fire risk, and insurance costs. These topics should be explored as potential research priorities during scoping of California’s Fifth Climate Change Assessment.

353 Ziaja, S. 2019. "Role of Knowledge Networks and Boundary Organizations in Coproduction: A Short History of a Decision Support Tool and Model for Adapting Multiuse Reservoir and Water-Energy Governance to Climate Change in California." *Weather, Climate, and Society*. [Abstract for Role of Knowledge Networks and Boundary Organizations In Coproduction article](https://doi.org/10.1175/WCAS-D-19-0007.1). <https://doi.org/10.1175/WCAS-D-19-0007.1>.

CHAPTER 6:

Southern California Energy Reliability

Introduction

Over the last decade, the state has worked to address concerns about energy reliability in Southern California. These concerns stem from a series of issues related to the aging energy infrastructure in the region that have constrained the system and put energy reliability at risk. These constraints persist to date, requiring ongoing partnerships to monitor developments, assess reliability, and implement mitigation measures as highlighted in this chapter.

In 2010, the state first grappled with reliability issues as the State Water Resources Control Board (SWRCB) developed a policy to reduce the use of ocean water for cooling power plants. The policy phases out the use of once-through cooling technologies (OTC) and affected more than 20,000 MW of generation, much of which is in Southern California.³⁵⁴

The closure of San Onofre in 2013³⁵⁵ presented reliability challenges that were not anticipated when the SWRCB established OTC compliance schedules. The closure of San Onofre required a rapid response because of the importance of the plant in maintaining grid stability, as well as in balancing electricity flows and keeping transmission lines from overloading. The California Energy Commission (CEC), California Public Utilities Commission (CPUC), and California Independent System Operator (California ISO) developed a reliability action plan, outlining mitigation measures and identifying critical preferred resources, transmission upgrades, and conventional generation needed to ensure reliability in the region.

Further compounding reliability concerns, on October 23, 2015, a massive leak at the Aliso Canyon natural gas storage facility was discovered and continued until it was sealed on February 18, 2016. Aliso Canyon is a depleted oil field that has been used to store natural gas for the Los Angeles region since 1972. SoCalGas has historically used Aliso Canyon to help

³⁵⁴ [SWRCB Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling](https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/)
https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/.

Once-through cooling technologies intake ocean water to cool the steam that is used to spin turbines for electricity generation. The technologies allow the steam to be reused, and the ocean water that was used for cooling becomes warmer and is then discharged back into the ocean. The intake and discharge have negative impacts on marine and estuarine environments.

³⁵⁵ On June 7, 2013 Southern California Edison Company (SCE) announced that it would permanently close the San Onofre Nuclear Generating Station (San Onofre) in southern California.

balance supply and demand in the summer and to help meet peak demand in the winter. However, in response to the leak at the Aliso Canyon, the state limited its use.

In recent years, SoCalGas experienced a number of pipeline outages that have worsened the constraints, leading to price spikes and gas curtailment of noncore³⁵⁶ gas customers in 2018. While a major pipeline, Line 235-2, returned to service in October 2019, these constraints persist to date, requiring ongoing monitoring activities, reliability assessments, and implementation of mitigation measures due to reduced pipeline capacity.

Aliso Canyon Availability

Aliso Canyon operations are restricted under the CPUC's Withdrawal Protocol, which has evolved over time from the first 2016 Aliso Canyon Summer Withdrawal Protocol to the most recent revision on July 23, 2019.³⁵⁷ The November 2, 2017, withdrawal protocol essentially prohibited withdrawals from Aliso Canyon except as an asset of last resort to ensure allowable storage inventory was optimized to meet reliability requirements in Southern California and ensure reasonable costs.

The withdrawal protocol was initially designed in 2016 to push SoCalGas to use storage to support all gas customers in Southern California, not just its core customers, and to assure the public that Aliso Canyon would be used only when necessary. SoCalGas procures gas on behalf of core customers and plans its system, including storage and pipeline infrastructure, to meet core customer demand under adverse conditions forecast to occur once every 35 years as well as noncore customer demand under 1-in-10 conditions.³⁵⁸ Noncore customers, including electric generators, refineries, and other large commercial and industrial users, purchase their own gas supplies and obtain gas transmission and storage services on the SoCalGas system under CPUC-approved transmission rates. With Aliso capabilities and access restricted as a result of the well leak, SoCalGas suspended the sale of gas storage service to noncore customers.³⁵⁹ SoCalGas also indicated to the joint agencies that the company would use its remaining storage only to support core customers, leaving gas service to power plants at risk

356 Noncore customers are typically commercial or industrial customers, some of which burn natural gas to produce electricity. Core customers are owners of homes and small businesses.

357 [Aliso Canyon Withdrawal Protocol](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Signed%20Letter%20to%20Roger%20Schwartz%20on%20Aliso%20Canyon%20Withdrawal%20Protocol.pdf), https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Signed%20Letter%20to%20Roger%20Schwartz%20on%20Aliso%20Canyon%20Withdrawal%20Protocol.pdf.

358 In 1993, the CPUC removed gas utilities' storage service responsibility for noncore customers, along with the cost of this storage service from noncore customers' rates. [Information on natural gas in California from the CPUC's website](https://www.cpuc.ca.gov/General.aspx?id=4802) <https://www.cpuc.ca.gov/General.aspx?id=4802>.

359 SoCalGas has proposed to permanently eliminate the sale of natural gas storage capacity to noncore customers in its 2020 Triennial Cost Allocation Proceeding (Application No. 18-07-024) which allocates gas system costs to the different customer classes and determines natural gas rates.

of curtailment under certain summer conditions.³⁶⁰ The withdrawal protocol addressed this risk.

The CPUC revised the withdrawal protocol on July 23, 2019, with changes it believes improve short-term energy reliability and price stability in Southern California. Specifically, the revisions provide SoCalGas with more flexibility to consider withdrawals from Aliso Canyon on days when the storage field inventory is needed for gas-system balancing or when the inventory of other non-Aliso storage fields in Southern California has substantially declined.³⁶¹

In May 2019, the CPUC and DOGGR, who have regulatory authority over Aliso Canyon, released an independent root cause analysis of the leak.³⁶² The report identified that the direct cause of the leak was from a rupture of the outer well casing due to microbial corrosions and raised concerns about SoCalGas' maintenance practice and safety record. On June 27, 2019, the CPUC opened an Order Instituting Investigation (OII) I.19-06-014³⁶³ to determine whether SoCalGas' and Sempra Energy's organizational culture and governance prioritize safety, and OII I.19-06-016,³⁶⁴ which is reviewing the evidence in the root cause analysis and includes an order to show cause why SoCalGas shouldn't be sanctioned for the leak at Aliso Canyon.

360 Noncore customers (including electric generators) are the first to have their natural gas service curtailed when supplies are short. This priority scheme preserves service to core customers (residential and small commercial customers) who are curtailed in only the most extreme conditions.

361 [Proposed Revisions to the Aliso Canyon Withdrawal Protocol from the CPUC's website](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/AlisoCanyonWithdrawalProtocol-ProposedRevisionsAndDraft-2019-07-01.pdf)
https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/AlisoCanyonWithdrawalProtocol-ProposedRevisionsAndDraft-2019-07-01.pdf.

362 The CPUC has overall authority over rates, the allocation of storage capacity, and the safety of above-ground facilities of SoCal Gas' operation of Aliso Canyon, while the DOGGR has primary responsibility for gas storage well infrastructure, including engineering and maintenance of wells, and safety of below-ground facilities.

363 [I. 19-06-014 Order Instituting Investigation on the Commission's Own Motion to Determine Whether Southern California Gas Company's and Sempra Energy's Organizational Culture and Governance Prioritize Safety](https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:I1812007) (U904G).
https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:I1812007.

364 [I.19-06-016 Order Instituting Investigation on the Commission's Own Motion into the Operations and Practices of Southern California Gas Company with Respect to the Aliso Canyon storage facility and the release of natural gas, and Order to Show Cause Why Southern California Gas Should Not Be Sanctioned for Allowing the Uncontrolled Release of Natural Gas from Its Aliso Canyon Storage Facility](https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:I1906016)
https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:I1906016.

Saddleridge Fire

The October 2019 Saddleridge Fire in Los Angeles County occurred near critical infrastructure, including the Aliso Canyon natural gas storage facility and a major high voltage transmission hub that includes several 500 kV AC transmission lines, the 500 kV DC intertie line and the Sylmar Substation where the DC intertie terminates. At one point, over 16,000 households in the area were evacuated. No critical infrastructure was damaged and at this time, there are no anticipated impacts to Southern California reliability.

Pipeline Constraints

The SoCalGas system continues to operate at less than full capacity because of pipeline outages and restrictions on the use of the Aliso Canyon natural gas storage field. These constraints continue to pose challenges for ensuring a reliable energy supply in Southern California. The operating conditions of the SoCalGas system going into the winter of 2019–2020 are improved compared to the previous winter as long as no additional pipeline outages occur.

Four key pipeline outages have reduced system capacity by more than 700 million cubic feet per day (MMcfd), more than 20 percent from full system capacity. The status of the pipelines changes frequently and is as follows as of October 31, 2019:

- Line 235-2 ruptured on October 1, 2017, and damaged nearby Line 4000.³⁶⁵ Line 235-2 returned to service on October 15, 2019, at reduced pressure.
- Line 4000 has mostly been in service, but at reduced operating capacity. It was removed from service for validation digs on September 19, 2019, and returned to service on October 24, 2019, at reduced pressure.
- Line 3000 went out of service in July 2016 and returned to service at reduced operating pressure on September 16, 2018.
- Line 2000 has been operating at reduced pressure since 2011 and was reduced by 30 MMcfd due to the expiration of the right-of-way through federal lands.

On May 23, 2019, the joint agencies held a workshop to address the ongoing infrastructure outages and the anticipated near-term impact on reliability in the region identified in their Aliso

³⁶⁵ SoCalGas commented, "The remediation work for Line 4000, however, was not caused by damage from the rupture of Line 235-2." (See TN# 26490 in Docket 18-IEPR-01, February 8, 2018.)

Columbia on October 9, 2018, and had the line back in service within several weeks. SoCalGas, in its comments to the workshop, countered this by stating that not all pipelines are the same and the work on Line 235-2 has been challenging due to the remote nature of the multiple worksites and the unique working conditions (such as narrow workspaces and special environmental constraints).³⁶⁸

The workshop discussed the 2019 Summer Assessment, which indicated that SoCalGas has been operating Line 4000 at reduced pressure, allowing only an incremental 270 MMcf into the system. SoCalGas reported that when Line 235-2 returns, it would remove Line 4000 for validation digs. This change was not expected to impact capacity and SoCalGas did remove Line 4000 from service on September 14, 2019, with a projected return to-service date of November 5, 2014. Once Line 4000 is returned to service and both lines are operating at reduced pressure, SoCalGas projects capacity to increase an incremental 80 MMcf. When operating pressure is eventually increased on Line 4000, SoCalGas projects capacity to increase an incremental 300 MMcf. Given the numerous delays in the return to service of Line 235-2 due to additional leaks detected, system capacity did not increase during summer 2019 as expected.

During the workshop, SoCalGas explained that Line 235-2 is a cathodically protected steel pipeline built in the 1950s, making it more than 60 years old, and that is an additional challenge to repairing it expeditiously.³⁶⁹ These types of pipelines generally have a useful life of around 70 to 75 years, so, Line 235-2 may be reaching the end of its useful life. One workshop presentation suggested that repairs or replacements should be limited to hazardous issues, and repairs should be expedited to get pipelines back in service while planning for permanent replacements.³⁷⁰

Planned maintenance events can exacerbate already constrained conditions. As discussed at the May 23, 2019, workshop, there is a need to “optimize the timing of discretionary maintenance to maximize injections while minimizing peak summer and winter season maintenance. This would be done through having SoCalGas provide additional information on its maintenance outlook and whether those maintenance activities are being pursued pursuant to regulatory requirements.”³⁷¹ Determining when planned maintenance can be deferred and

368 SoCalGas comments, TN-228704. [Link to comments received regarding the May 23, 2019, workshop on Energy Reliability in Southern California](https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-05-23-workshop/2019-05-23_comments.php) https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-05-23-workshop/2019-05-23_comments.php.

369 *Cathodic protection* is a technique used to protect the steel pipe from corrosion by making it the cathode of an electrochemical cell.

370 [Presentation by Walker & Associates at the May 23, 2019, workshop on Energy Reliability in Southern California](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228352&DocumentContentId=59538) https://efiling.energy.ca.gov/GetDocument.aspx?tn=228352&DocumentContentId=59538.

371 Simon Baker with the CPUC, [Transcript from January 23, 2019, Joint Agency Workshop on Energy Reliability in Southern California](https://efiling.energy.ca.gov/getdocument.aspx?tn=228898) https://efiling.energy.ca.gov/getdocument.aspx?tn=228898.

when it must be completed immediately due to safety or reliability reasons is a balancing act during these constrained conditions.

In light of California’s climate change policies, decisions about making cost-effective investments in the state’s aging natural gas infrastructure will be challenging but are necessary for maintaining energy reliability. In the near term, aging pipeline infrastructure that result in pipeline outages are the most critical concern affecting Southern California’s energy reliability.

Technical Assessments of Reliability

Over the last few years, the joint agencies have engaged in regular monitoring to address concerns about natural gas curtailments and the related impact on gas customers and electricity system reliability in Southern California. The CEC, CPUC, California ISO, and LADWP performed reliability assessments (summer and winter) to determine the likelihood of curtailments, minimum electric generation gas burn necessary to maintain reliability, and identified actions that could be taken to reduce the possibility of natural gas and electricity interruptions.³⁷² Since the summer of 2015, the joint agencies have developed seven analyses of the short-term electric reliability in the region. The intent is to keep policy makers abreast of reliability risks and propose recommendations to improve reliability in the near term. More than 50 mitigation measures have been developed, many of them ongoing, ranging from tariff changes and better coordination between SoCalGas and the electric balancing authorities to reducing electricity and natural gas use.

Long-term analysis and recommendations of electric reliability in the region are handled in other proceedings or reports. For example, the Legislature directed the CPUC to consider the feasibility of minimizing or eliminating the use of the Aliso Canyon storage field while maintaining energy reliability, and the CPUC opened Order Instituting Investigation I.17-02-002 to examine the long-term viability of the Aliso Canyon gas storage field. In 2017, then-Governor Edmund G. Brown Jr. asked the CEC for a plan to phase out use of the facility within 10 years.

Conditions going into the winter of 2019–2020 are very similar to those going into the winter of 2018–2019, meaning reliability concerns will persist. A review of conditions during last winter is discussed below.

³⁷² Winter is defined as November 1 through March 31, and summer is April 1 to October 31. These dates coincide with the traditional underground gas storage withdrawal and injection seasons for the natural gas industry.

Winter 2018–2019 Look Back

The *Aliso Canyon Risk Assessment Technical Report Winter 2018–2019 Supplement* concluded that reliability challenges remained for the winter of 2018–2019.³⁷³ Similar to winter 2017–2018, Southern California faced the risk of curtailments in winter 2018–2019 because of continued natural gas pipeline outages. It also concluded that the need for curtailments would depend on the weather and how effectively consumers reduce gas demand when requested. Curtailments are not desirable and can lead to increased costs because electric utilities may be required to import more expensive electricity.

Meeting winter 2018–2019 demand turned out to be challenging toward the second half of the season. The weather was mild in the beginning but turned cold in the latter half and remained cold for an extended period. The temperatures in downtown Los Angeles remained below 70 degrees in February, and gas from storage was used to meet demand each day of the month. Prior analysis predicted that the continued pipeline outages could lead to greater reliance on storage, and that forecast was borne out: 42 billion cubic feet (Bcf) was withdrawn from storage in winter 2018–2019 compared to 19 to 21 Bcf during the prior two winters. (See Table 8.) A little over 1 Bcf was withdrawn from Aliso Canyon on six days during the prior winter, but in the 2018–2019 winter, 14 Bcf of gas was withdrawn from Aliso Canyon on 37 gas days.³⁷⁴ The ending inventory level was lower for winter 2018–2019 than prior years.

Table 8: Winter Season Inventory Levels and Withdrawals

(Billion Cubic Feet)	2016–2017	2017–2018	2018–2019
Starting Winter Storage Inventory November 1	60.9	67.0	80.5
Ending Winter Storage Inventory April 1	39.5	47.7	38.7
Total Net Withdrawal	21.4	19.3	41.8

Source: SoCalGas Envoy

The sustained cold weather led to 80 operational flow orders (OFOs),³⁷⁵ 41 days with voluntary electric generator curtailments in effect, and 5 days with Rule 23 curtailments in effect.³⁷⁶ This is the first time SoCalGas used Rule 23 curtailments since the gas leak at Aliso

³⁷³ *Aliso Canyon Winter Risk Assessment Technical Report Winter 2018–2019 Supplement*. TN# 224939. Prepared by the staff of the CPUC, CEC, the California ISO, and LADWP. November 28, 2018. CEC-100-2017-002. [Link to information and documents for the May 22, 2017, workshop on Energy Reliability in Southern California](http://www.energy.ca.gov/2017_energy_policy/documents/#05222017) http://www.energy.ca.gov/2017_energy_policy/documents/#05222017.

³⁷⁴ A “gas day” is from 7:00 a.m. to 7:00 a.m.

³⁷⁵ “Operational flow orders” are an operating tool used by SoCalGas to evaluate the amount of storage withdrawal or injection needed versus what is allocated for balancing.

³⁷⁶ SoCalGas Tariff Rule 23 describes the continuity of service and interruption of delivery in the event of curtailments and is a mandatory curtailment.

Canyon. More details on winter 2018–2019 can be found in the CPUC’s *Winter 2018–2019 SoCalGas Conditions and Operations Report*.³⁷⁷

Natural Gas Prices

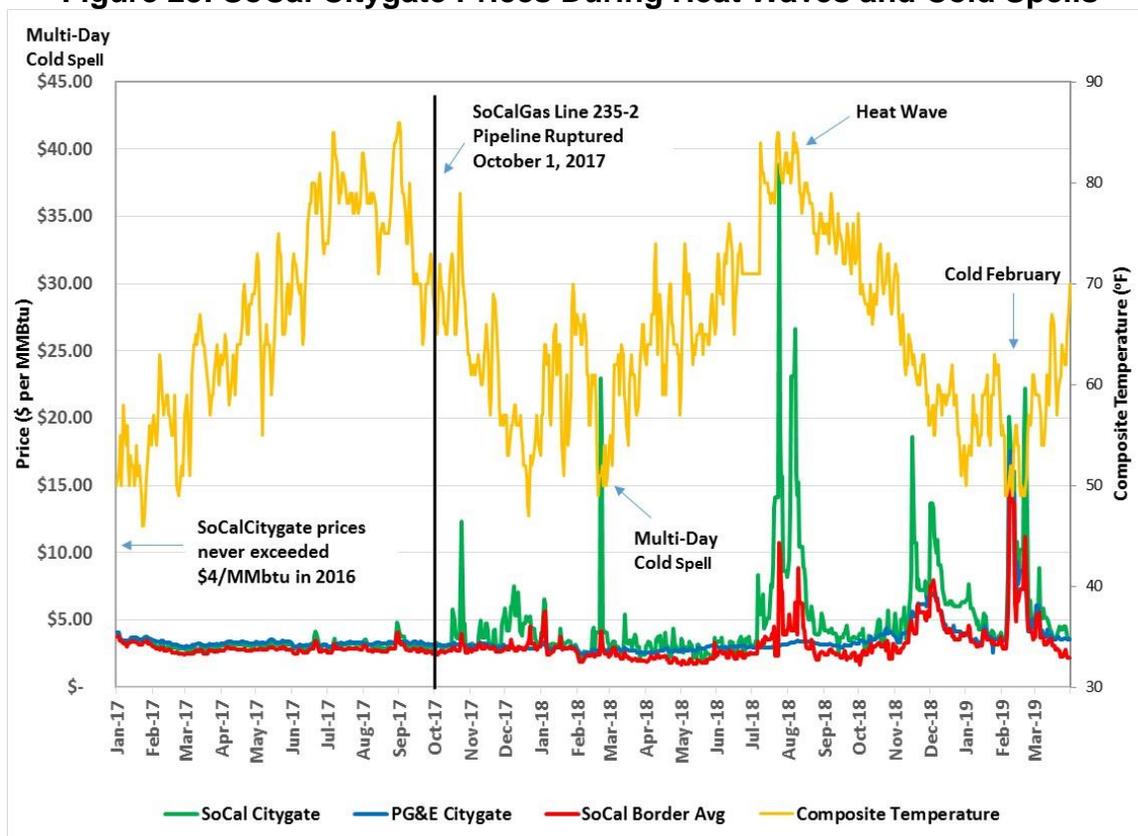
In summer 2018, the number of OFOs increased, and in winter 2018–2019, the number of calls for voluntary and mandatory curtailments of electric generation was greater than previous years. These operational challenges have been reflected in the increased volatility of natural gas prices at the SoCal Citygate.³⁷⁸ The CEC and CPUC held a joint agency workshop on January 11, 2019, to discuss natural gas prices in Southern California, the related impact on customers, and potential mitigation measures to reduce high natural gas prices.³⁷⁹ Figure 23 shows prices for natural gas transactions at the SoCal Citygate, which shows that price spikes have reached as high as \$40/million British Thermal Units (MMBtu) in summer 2018 and \$22/MMBtu in winter 2018–2019, while prices at SoCal Border and PG&E Citygate were much less volatile. This finding is consistent with increased volatility at the SoCal Citygate since the rupture of Line 235-2 and the maintenance outage on Line 4000, which were noted in the CEC’s 2018 IEPR Update.

377 [Link to Winter 2018–2019 SoCalGas Conditions and Operations Report on the CPUC’s website](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Winter2018-19LookbackReport_PublicDraft.pdf)
https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Winter2018-19LookbackReport_PublicDraft.pdf.

378 *SoCal Border* is a trading hub in Southern California on the border with Arizona, while *SoCal Citygate* is a trading hub that provides firm access rights on the SoCalGas system to deliver gas to customers. Transactions at SoCal Citygate include local distribution charges.

379 [Link to transcript from the January 11, 2019, workshop on Southern California Natural Gas Prices](https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019)
https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019.

Figure 23: SoCal Citygate Prices During Heat Waves and Cold Spells



Source: CEC Staff

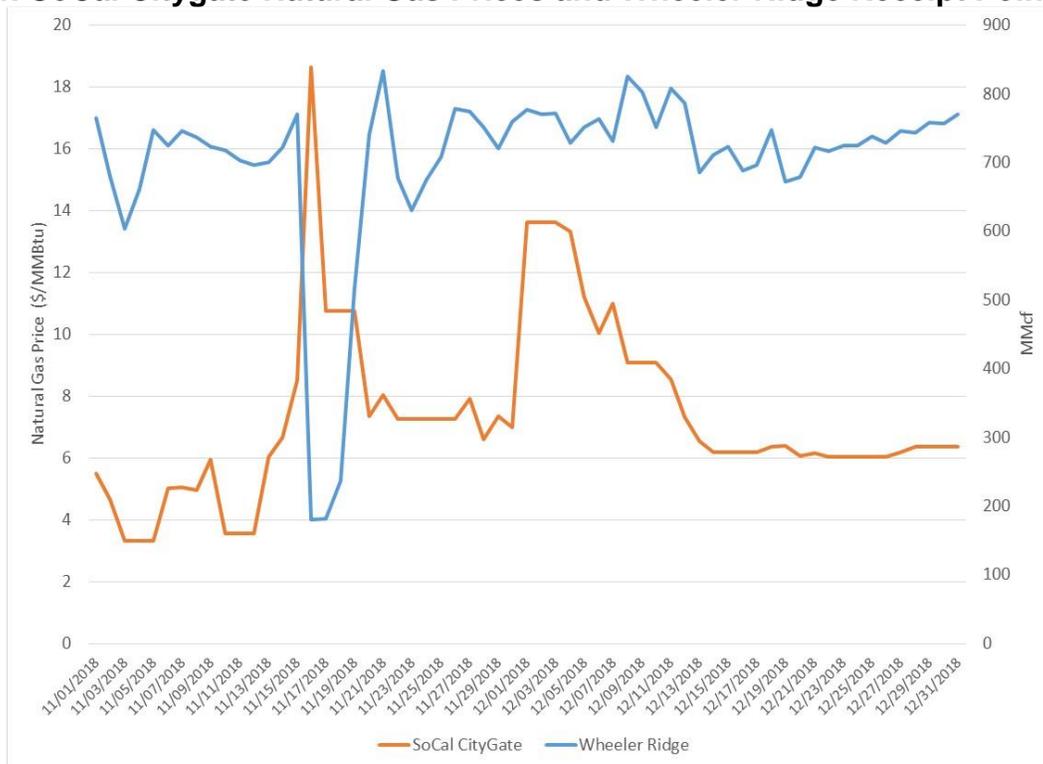
The highest price increases occurred on days that the composite weighted average temperature was at the highest during summer and lowest during winter.³⁸⁰ In winter, price increases tended to coincide with withdrawals from Aliso Canyon. Price spikes also tended to occur when additional maintenance, whether planned or unplanned, further reduced system capacity.

Figure 24 shows that price spikes at SoCal Citygate are somewhat correlated to the utility's scheduled maintenance at Wheeler Ridge. The maintenance that started on November 16, 2018, at Wheeler Ridge reduced firm capacity available from 765 MMcfd to 145 MMcfd. On November 15, 2018, the price of natural gas at SoCal Citygate was \$8.51 per MMBtu, which spiked to \$18.64 per MMBtu on November 16, 2018. For comparison, the winter of 2016–2017 had more high-demand days above 3.2 Bcf than either winter 2017–2018 or winter 2018–

³⁸⁰ *Composite weighted average temperature*, as found on SoCalGas Envoy, takes the average daily temperature of several locations in SoCalGas' territory, and then averages those into one number.

2019, but prices remained stable and reached a high of only \$4.05 in early January 2017. The rupture of Line 235-2 occurred after the winter of 2016–2017 on October 1, 2017, and contributed to the increased price volatility seen since then.

Figure 24: SoCal Citygate Natural Gas Prices and Wheeler Ridge Receipt Point Capacity



Source: CEC

At the January 2019 joint agency workshop on Southern California Natural Gas Prices, a repeating theme was the urgency of SoCalGas repairing its infrastructure.³⁸¹ Workshop participants including the energy agencies, industry stakeholders, and members of the public agreed that pipeline outages were a cause of price spikes. Industry stakeholders such as power plant owners expressed the negative impact of the high natural gas prices on their businesses and further indicated that they needed to file with the Federal Energy Regulatory Commission to recover the costs incurred to operate their natural gas plants.³⁸² Workshop

381 [Link to transcript from the January 11, 2019, workshop on Southern California Natural Gas Prices](https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019) https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019.

382 Jan Smutney Jones, p. 140, Independent Energy Producers, [Link to transcript from the January 11, 2019, workshop on Southern California Natural Gas Prices](https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019), https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019.

participants, including CEC staff, raised concerns about whether there is an incentive problem since end users were bearing the costs of this, not SoCalGas. In addition, removing an asset from rate base was discussed if assets are not used or useful. The issue of removing an out-of-service pipeline asset from customer rate base was also raised at the May 23, 2019, workshop³⁸³ and was discussed as a mediation tool for delays in pipeline repair or replacement that has been used in other parts of the country.³⁸⁴

High natural gas prices also raised electricity prices, as shown in Figure 25. For example, Southern California Edison (SCE) indicated at the January 2019 workshop that its electricity procurement costs for 2018 were under-collected by roughly \$833 million,³⁸⁵ although this amount was later revised to \$815.43 million dollars.³⁸⁶ On November 13, 2018, SCE sent the CPUC an Expedited Application Regarding Energy Resource Recovery Account (ERRA) Trigger Mechanism showing that SCE under-collected \$983.8 million from customers as of December 31, 2018.³⁸⁷ SCE cited high natural gas prices as the main reason for the higher-than-expected electricity costs because natural gas generators are often setting the market clearing price in the California ISO market. The electric utility's ERRA application sought approval to pass these costs to the ratepayers, resulting in higher bills for 2019. Since that time, the CPUC approved a rate increase for SCE to cover these additional costs. The rate increase was about 1.4 cents/kWh, adding roughly \$11.50 to an average customer's electricity bill in the summer and \$7.67 in winter.³⁸⁸

383 CPUC Commissioner Guzman Acevez, p. 173, [Link to transcript from the May 23, 2019, workshop on Energy Reliability in Southern California](https://efiling.energy.ca.gov/getdocument.aspx?tn=228898) <https://efiling.energy.ca.gov/getdocument.aspx?tn=228898>.

384 Rod Walker, pp. 134 and 143, [Link to transcript from the May 23, 2019, workshop on Energy Reliability in Southern California](https://efiling.energy.ca.gov/getdocument.aspx?tn=228898) <https://efiling.energy.ca.gov/getdocument.aspx?tn=228898>. PU Code Section 455.5 and the applicable language reads "In establishing rates for any electrical, gas, heat, or water corporation, the commission may eliminate consideration of the value of any portion of any electric, gas, heat, or water generation or production facility which, after having been placed in service, remains out of service for nine or more consecutive months, and may disallow any expenses related to that facility."

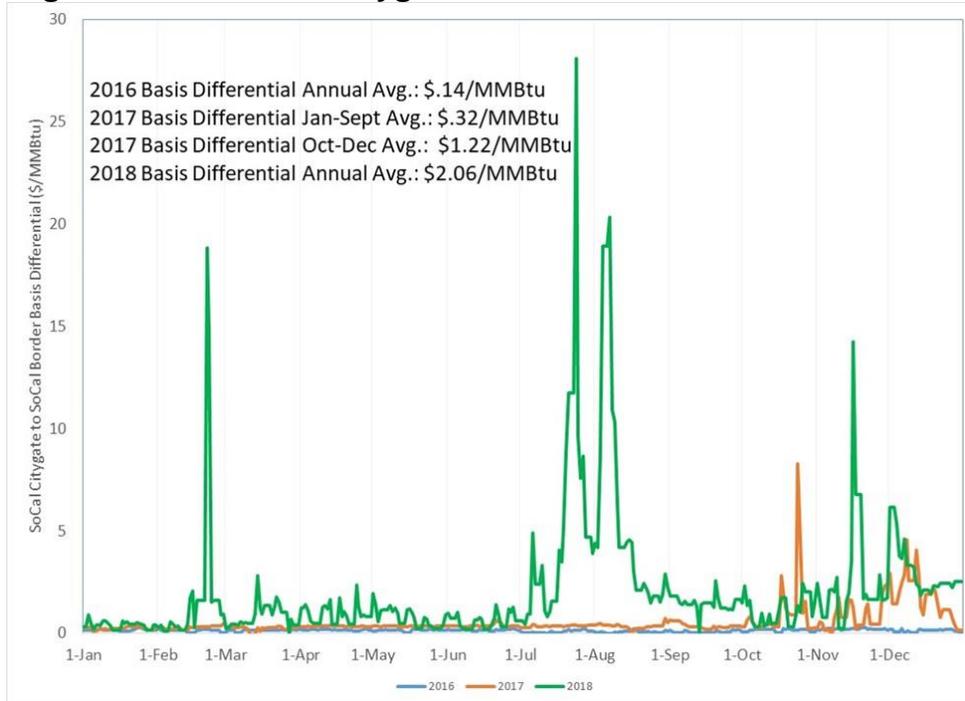
385 [Link to transcript from the January 11, 2019, workshop on Southern California Natural Gas Prices](https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019) https://ww2.energy.ca.gov/2018_energypolicy/documents/#01112019.

386 February 15, 2019, Advice Letter 3954-E from SCE, updating the amount to \$815.432 million.

387 CPUC A.18-11-009.

388 *RTP Insider*, February 5, 2019, "SCE's \$1 Billion Shortfall Perturbs State Regulators." [Link to SCE's \\$1 Billion Shortfall Perturbs State Regulators article](https://www.rtoinsider.com/sce-cpuc-shortfall-110490/) <https://www.rtoinsider.com/sce-cpuc-shortfall-110490/>.

Figure 25: SoCalGas Citygate to SoCal Border Price Differential



Source: CEC

Summer 2019 Assessment

The technical assessment group's 2019 Summer Assessment is a short-term analysis of electric reliability in Southern California. This report was based on the existing and expected operational status of the SoCalGas system as of May 2019. (See the "Update on SoCalGas System Status" sidebar for the status of the gas system in Southern California since the 2019 Summer Assessment.) The 2019 Summer Assessment reported that natural gas pipeline outages from summer 2018 persisted through winter, and that temporary capacity reductions for maintenance work appeared likely through the remainder of 2019.

The analysis also found that with the pipeline outages, it could be difficult for SoCalGas to fill its natural gas storage fields to a level sufficient to ensure energy reliability throughout the coming winter. The study found that if the pipelines return to service, this risk diminishes. Additionally, it noted that customers could be called on to reduce their electricity use, if needed.

The 2019 Summer Assessment includes an assessment of reliability risks for an electric peak day in summer 2019 and a monthly gas balance analysis through the beginning of winter. A gas balance analysis assesses the gaps between capacity and demand that must be met with gas from storage and the impacts of storage drawdown over the winter to evaluate possible storage inventory levels. The assessment includes several analytical components:

- System capacity (or supportable demand)³⁸⁹ calculations for three cases: *base*, *pessimistic*, and *optimistic* that differ by the timing of the remediation work for peak demand conditions.
- An electric impact analysis, including power-flow analysis, by the California ISO and LADWP using the deliverable gas demand estimates to determine whether electric generator gas demand could be served and whether electricity service interruptions could occur on a summer peak day. The analysis includes calculating minimum generation levels to meet reliability and electric import sensitivities.
- Gas balance analysis by the CEC for three cases through December 31, 2019. The cases are based on normal weather conditions and average demand for varying pipeline outages and mitigation scenarios.

The assessment found that the forecast 1-in-10 year electric peak day forecast demand of 3,368 MMcfd could be met under base case results of supportable demand on July 1, 2019, and on August 9, 2019, (which are estimated to have 3,385 MMcfd and 3,465 MMcfd of supportable demand, respectively).³⁹⁰ Conditions were more constrained in June, however, due to additional maintenance on Line 2001 between March 15, 2019, and July 1, 2019, which reduced estimated system capacity.

The *2019 Summer Assessment* found that meeting a 1-in-10 year electric peak in June 2019 (estimated to have 3,035 MMcfd of supportable demand) could be met if regional electric generation is curtailed to minimum generation levels. Curtailing to minimum generation levels is an emergency measure that presumes the balancing authorities can procure the necessary electricity imports to replace natural gas generation, but it leads to higher costs. Minimum generation levels were lower in summer 2019 and have continued their downward trend, in part because of transmission upgrades.

The analysis also considered lower levels of electricity imports to determine whether reliability could be maintained at these lower levels. A lower level of imports means more in-basin gas generation may be needed to meet demand. This sensitivity analysis first assumed minimum generation levels, and any surplus of gas above the amount needed for minimum generation could be used for additional gas generation needed if electricity transmission import use is reduced from 100 percent. The sensitivity analysis found that electric reliability could be maintained on a 1-in-10-year electric peak day, with 85 percent electricity import capability,

³⁸⁹ *Supported* or *supportable demand* is a term used by SoCalGas to describe how much demand its system can support, but it also can be viewed as system capacity.

³⁹⁰ The term *1-in-10-year* represents the warmest condition expected to occur once in 10 years, and analysts use it for planning capacity needed to serve noncore customers that burn natural gas to produce electricity. The 1-in-10 year peak day is most likely to occur in July through September.

without using gas from Aliso Canyon. However, the analysis showed a shortfall at 90 percent of electricity import capability for the month of June. The actual demand for June 2019 was lower than projected and so there was no shortfall.

The technical assessment group developed the gas balance cases assuming normal weather conditions. Cold weather cases were not evaluated for the *2019 Summer Assessment*, but the assessment would be tighter with higher demand under cold weather conditions in early winter months. The gas balance cases showed full inventory of 80 to 81 Bcf by November 1, 2019. However, reserve margins would be 0 percent throughout the summer, leaving no margin for higher-than-average demand or unforeseen events. December month-end storage inventory levels ranged from 69 Bcf in the pessimistic case to 81 Bcf in the optimistic case.

Summer 2019 Storage Inventories

The 2019 Summer Assessment stated that inventory at the non-Aliso fields was likely to be a little lower on July 1, 2019, than in summer 2018, and the corresponding withdrawal capability would be lower.

The technical assessment group projected that use of Aliso Canyon was more likely in summer 2019, compared to summer 2018, when no withdrawals were made from Aliso Canyon. The findings were dependent on whether the July 1, 2019, inventory projection at all of SoCalGas' storage fields was achieved. If the withdrawal capability at the non-Aliso storage fields was insufficient to meet demand, then withdrawals from Aliso Canyon would be necessary.

The technical assessment group projected 57 Bcf in storage by July 1, 2019, and SoCalGas achieved 64 Bcf in storage by that date, which should have provided sufficient withdrawal capability out of the non-Aliso Canyon storage fields. However, the revised Aliso Canyon Withdrawal Protocol allowed more latitude to use Aliso Canyon in summer 2019. Based on the revised withdrawal protocol, use of Aliso Canyon was allowed to avoid the price impacts associated with Stage 2 through Stage 5 low OFOs and was drawn upon once in August 2019 and once in September 2019.

SoCalGas has continued with its Storage Integrity Management Program, which is a continuous well inspection program that includes the conversion of wells to tubing-only flow.³⁹¹ The switch to tubing-only flow was expected to change the maximum withdrawal and injection capacity and the withdrawal and injection curves as each field undergoes this work. The maximum withdrawal capability, if the storage fields are full, was expected to be lower than summer 2018 due to this program.

³⁹¹ "Tubing-only flows" mean that gas from storage can be injected or produced only through the interior metal tubing. Before this change, gas was injected and produced from the tubing and annulus between the tubing and the well casing.

At the May 23, 2019, workshop, participants raised questions about the non-Aliso storage fields—Honor Rancho, La Goleta, and Playa del Rey—and whether there were any obstacles to their usage in meeting reliability. SoCalGas indicated at the workshop that it manages its storage fields and the maintenance schedule for shut-ins³⁹² for field testing and inventory verification, which impacts injection capabilities. Aliso Canyon was the first field to reach its maximum allowable capacity level. Aliso Canyon was full by June 20, 2019, while injections to the other fields were still occurring as of August 28, 2019. It does not appear to be a prudent decision to completely fill Aliso Canyon before filling the other storage fields.

On September 19, 2019, a CPUC Executive Director Letter was sent to SoCalGas directing them to release up to 100 MMcfd of the injection capacity allocated to balancing to the market.³⁹³

Winter 2019-2020 Assessment

On October 24, 2019, the CPUC released a *2019-2020 Winter Assessment* authored by CPUC staff and shared with the technical assessment group for review and comment.³⁹⁴ The assessment includes updates about SoCalGas' pipelines as well as gas balance analyses. The gas balance analysis tool used by CPUC staff was developed by CEC consultants Aspen Environmental Consultants, and may be used to consider a range of scenarios and assumptions from best-to-worst case. The analysis results provide insight about what may happen if natural gas supply, demand, and storage assumptions were to occur.

CEC staff prepared gas balance analysis with slightly different assumptions and presented them at the October 30, 2019 IEPR Lead Commissioner Workshop on Revised Natural Gas Price Forecast and Draft Natural Gas Outlook/Electricity Modeling and Results.³⁹⁵ CEC staff presented an outlook for the upcoming winter 2019/2020 based on the gas balance results. The outlook also considered the CPUC *2019/2020 Winter Assessment* and SoCalGas' *Winter 2019/2020 Technical Assessment* that was released on October 8, 2019.³⁹⁶

392 When a natural gas storage field is *shut-in*, it is not available for injection or withdrawal.

393 [CPUC letter to SoCalGas Subject: Injection Required for SoCalGas Winter Reliability and Storage Inventory](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Signed%20Letter%20to%20Bret%20Lane%20So%20Cal%20Gas%20Company%20re%20Injection%20Required%20for%20SCG%20Winter%20Reliability%20and%20Storage%20Inventory_v2.pdf)
https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Signed%20Letter%20to%20Bret%20Lane%20So%20Cal%20Gas%20Company%20re%20Injection%20Required%20for%20SCG%20Winter%20Reliability%20and%20Storage%20Inventory_v2.pdf.

394 Winter 2019-20 Southern California Reliability Assessment by CPUC staff:
https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/Winter2019-20ReliabilityAssessment_Final.pdf

395 TN 230442 https://ww2.energy.ca.gov/2019_energy/policy/documents/2019-10-30_workshop/2019-10-30_presentations.php

396 TN# 230065, <https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-IEPR-09>.

Overall, the winter 2019/2020 outlooks appear to depict the following:

- Reliability outlook is the best in three winters.
- Pipeline constraints continue because Line 235-2 and Line 4000 are operating at reduced operating pressure and capacity.
- In the best case scenario with both lines in service and average weather, the gas balance shows sufficient inventory to meet demand and no curtailments.
- Use of Aliso Canyon may be necessary to meet 1-in-10 year peak day demand.
- Core reliability is not projected to be at risk.
- Risk of noncore curtailments is diminished with both lines in service.
- Electric reliability can be maintained.
- Pipelines return to service is key to improving reliability.

Mitigation Measures

Energy reliability remains challenging because of the pipeline outages and capacity reductions on the SoCalGas system. Based on the Summer 2019 Assessment, the technical assessment group recommends continuing most of the mitigation measures implemented over the past four years and exploring several others. Some of the mitigation measures have not been implemented, such as contracting for liquefied natural gas (LNG). The U.S. EIA reported that LNG imports played a key role in reducing price spikes in New England this winter.³⁹⁷

More than 50 mitigation measures are in place or have been proposed, including: changing the gas balancing rules, implementing new demand response programs, and revising the Aliso Canyon Withdrawal Protocol. The mitigation measures focus on short-term reliability concerns and managing price volatility. Appendix B of the 2019 Summer Assessment details the full list of mitigation measures, including seven new ones listed below:

- Revise OFO penalty structure. In May 2019, the CPUC approved Decision 19-05-030, which implemented this measure.
- Revise the Aliso Canyon Withdrawal Protocol. The CPUC revised the Aliso Canyon Withdrawal Protocol on July 23, 2019.³⁹⁸

³⁹⁷ EIA reported that liquefied natural gas imports played a key role in reducing price spikes in New England this winter, [Link to Natural Gas Weekly Update for the week ending April 17, 2019 from the U.S. EIA's website](https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2019/04_18/)
https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2019/04_18/.

³⁹⁸ Aliso Canyon Withdrawal Protocol, [Link to July 23, 2019, Aliso Canyon Withdrawal Protocol from the CPUC's website](https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/UpdatedWithdrawalProtocol_2019-07-23%20-%20v2.pdf)
https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/News_Room/NewsUpdates/2019/UpdatedWithdrawalProtocol_2019-07-23%20-%20v2.pdf.

- Revise the OFO formula. The revised Aliso Canyon Withdrawal Protocol includes a provision to allow the withdrawal capacity of Aliso Canyon to be made available when preliminary low OFO calculations result in a Stage 2 through Stage 5 low OFO. This change resulted in SoCalGas calling no low OFOs higher than a Stage 1 in summer 2019.
- Help customers with injection rights use available injection capacity.
- Research any interaction between the gas cost incentive mechanism³⁹⁹ and pipeline usage.
- Continue working six days a week and 12 hours a day to expedite the schedule of repairs.
- Optimize the timing of discretionary maintenance to maximize injections.

Update on Southern California Electricity Reliability

The early retirement of San Onofre required actions to replace not just the 2,200 MW of capacity, but the voltage support and reactive power it provided to maintain grid reliability. Preserving reliability means replacing all those services, as well as planning for the retirement of the various coastal power plants that use ocean water for cooling. Since 2013, the joint agencies, along with representatives from the investor-owned utilities and local air districts in the South Coast Air Basin, have conducted public workshops at least annually to discuss these intertwined issues.

Using the action plan developed in 2013 as a guideline, the joint agencies put in place a multipronged plan of preferred resources, transmission upgrades, and conventional generation to meet the reliability needs of Southern California.⁴⁰⁰ The agencies also developed a backup plan of two contingency mitigation measures in case any of the solutions are delayed or do not come to fruition. The contingency mitigation measures consist of an OTC compliance date deferral process and new gas-fired generation options, which are available to be triggered if needed to meet reliability concerns.⁴⁰¹

The agencies periodically review progress in securing preferred resources, transmission projects, and conventional generation to determine whether further actions are needed. As

³⁹⁹ The *gas cost incentive mechanisms* established by the CPUC encourage utilities to procure natural gas at or below a benchmark price. The benchmark price is based on a basket of monthly and some daily natural gas price indices.

⁴⁰⁰ Southern California Reliability Plan for the greater Los Angeles area and San Diego. See TN 71933, [Link to Preliminary Reliability Plan for LA Basin and San Diego filed on the CEC's website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=71933) https://efiling.energy.ca.gov/GetDocument.aspx?tn=71933.

⁴⁰¹ The *2016 IEPR* and *2017 IEPR* provide details of these two options.

uncertainties become clearer, the agencies will seek mitigation solutions that maintain Southern California grid reliability and promote the state's policy goals.

The 2013 action plan suggested that the shuttered capacity of San Onofre and OTC generation retirements can be replaced with roughly 50 percent preferred resources, 50 percent conventional generation, and transmission infrastructure improvements that could provide voltage support. The joint agency workshop on May 23, 2019, provided an update on overall reliability and the status of projects. The information below updates progress documented in the *2018 IEPR Update*.

Preferred Resources

Historically, the CPUC's Long-Term Procurement Plan (LTPP) proceeding evaluated generation resources in the California ISO system every two years. The intent was to evaluate whether existing and projected resources were sufficient to meet future demand, and to authorize procurement of additional resources in the event that they were insufficient. The CPUC incorporated updates from the OTC retirement schedules into this analysis. In addition to systemwide analyses, the LTPP also evaluated capacity requirements in localized, high-demand areas to ensure electric reliability locally. The CPUC is now implementing the integrated resource planning (IRP) process in response to the legislative requirements of Senate Bill 350 (De León, Chapter 547, Statutes of 2015), which replaced the LTPP and periodically evaluates generation resources in the California ISO system.⁴⁰² Table 9 presents the preferred resources⁴⁰³ and storage that have been procured in the San Onofre area to meet reliability requirements necessitated by retirement of the nuclear plant and pending closures of OTC facilities.

⁴⁰² [Rulemaking 16-02-007 Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements](https://apps.cpuc.ca.gov/apex/?p=401:56:0::NO) https://apps.cpuc.ca.gov/apex/?p=401:56:0::NO.

⁴⁰³ Preferred resources are those used for energy efficiency, demand response, renewable resources, and distributed generation. Preferred resources are described in the [2005 State Energy Action Plan II](http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF) http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF.

Table 9: SCE and SDG&E Approved Applications for Preferred Resources in the San Onofre Area

Resource Type	PTO	Location	Capacity MW	Application Status	Status
Demand Response	SCE ⁴⁰⁴	West LA Basin	5	Approved	On-line
Distributed Solar Generation	SCE	Johanna/Santiago	12	Approved	Expected commercial operation date in 2020
Distributed Solar Generation	SCE	West LA Basin	28	Approved	7.78 MW on-line
Energy Efficiency	SCE	Johanna/Santiago	23	Approved	12.84 MW on-line
Energy Efficiency	SCE	West LA Basin	101	Approved	22.81 MW on-line
Energy Storage	SCE	Johanna/Santiago	153	Approved	10 MW on-line
Energy Storage	SCE	Long Beach	100	Approved	Expected commercial operation date 1/1/2021
Energy Storage	SCE	West LA Basin	138	Approved	45.5 MW on-line
Demand Response	SDG&E ⁴⁰⁵	San Diego/Imperial Valley	4.5	Approved	On-line
Energy Efficiency	SDG&E	San Diego/Imperial Valley	19	Approved	Operational and ramping up through 2023
Energy Storage	SDG&E	San Diego/Imperial Valley	121	Approved	37.5 MW on-line; remainder on-line in 2021 and 2022

Source: 2019 Report of the Statewide Advisory Committee on Cooling Water Intake Structures

404 [Link to SCE's Application 14-11-012 to the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M143/K307/143307429.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M143/K307/143307429.PDF.

[Link to SCE's Application 14-11-016 to the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M143/K307/143307496.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M143/K307/143307496.PDF.

[Link to SCE's Application 15-12-013 to the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M156/K571/156571612.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M156/K571/156571612.PDF.

[Link to SCE's Application 16-11-002 to the CPUC](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M169/K917/169917051.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M169/K917/169917051.PDF.

[Link to Resolution E-4804 from the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M167/K245/167245981.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M167/K245/167245981.PDF.

405 [Link to SDG&E's Application 14-07-009 to the CPUC](https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1407009) https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1407009.

[Link to SDG&E's Application 16-03-014 to the CPUC](https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1603014) https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1603014.

[Link to SDG&E's Application 17-04-017 to the CPUC](https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1704017) https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1704017.

[Link to Resolution E-4798 from the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M166/K269/166269958.PDF) http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M166/K269/166269958.PDF.

Conventional Generation

The joint agency team continues to track conventional generation projects in the San Onofre area. Table 10 presents the status for five projects in the area. The CPUC approved power purchase agreements for all five projects. Legal challenges surfaced for the Carlsbad, Alamitos, and Huntington Beach projects, but they have been resolved. Carlsbad came on-line at the end of 2018. As of August 2019, construction is about 98 percent complete for Huntington Beach and Alamitos. Commissioning of the plants began first with the auxiliary boilers in July 2019. Once those boilers are complete, the commissioning stage will move to the combined-cycle gas turbines first start-up and testing in October 2019. The CEC approved the Stanton Energy Reliability Center’s project application for certification on November 7, 2018; construction is underway and about 25 percent complete as of August 2019.

Table 10: Conventional Generation Projects in San Onofre Area

Conventional Generation Projects	Capacity	Sponsor	Target In-Service Date
Pio Pico	305	SDG&E	Operational 10/20/2016
Carlsbad Energy Center	500	SDG&E	Operational 12/3/2018
AES Alamitos	640	SCE	6/1/2020
AES Huntington Beach	644	SCE	5/1/2020
Stanton Energy Reliability Center	98	SCE	7/1/2020

Source: CEC

Transmission Projects

Numerous transmission projects have come on-line over the last several years to provide voltage and frequency stability or reduce local capacity requirements or both in the San Onofre area. The joint agency team continues to track one remaining active transmission project out of nine projects approved in the San Onofre area. The other eight projects were completed and placed in service as of 2018, as shown in Table 11. The California ISO has found that the synchronous condensers in Southern California have contributed significantly to reliability by providing voltage support, allowing for increased imports into the San Diego area and between San Diego and the greater Los Angeles area, and decreasing dependence on gas-fired generation to provide voltage support during outages.

Table 11: Transmission Projects in San Onofre Area

	Transmission Projects	Sponsor	Target In-Service Dates
1	Talega Synchronous Condensers (2x225 mega volt amps reactive [MVA _r])	SDG&E	In-service 8/7/2015
2	Extension of Huntington Beach Synchronous Condensers (280 MVA _r)	SCE	Retired 12/31/2017
3	Imperial Valley Phase Shifting Transformers (2x400 MVA _r)	SDG&E	In-service 5/1/2017
4	Sycamore Canyon–Peñasquitos 230 kilo volt (kV) Line	SDG&E	In service 8/29/2018
5	Miguel Synchronous Condensers (450/-242 MVA _r)	SDG&E	In-service 4/28/2017
6	San Luis Rey Synchronous Condensers (2x225 MVA _r)	SDG&E	In-service 12/29/2017
7	San Onofre Synchronous Condensers (1x225 MVA _r)	SDG&E	In service 10/16/2018
8	Santiago Synchronous Condensers (1x225 MVA _r)	SCE	In-service 12/31/2017
9	Mesa Loop-In Project and South of Mesa 230kV Line Upgrades	SCE	Delayed until 3/1/2022

Source: CEC

Triggering OTC Compliance Date Extensions

In 2010, the State Water Resources Control Board (SWRCB) adopted a policy on the use of coastal and estuarine waters for power plant cooling, OTC, to reduce harmful effects on marine life associated with cooling intake structures.⁴⁰⁶ To comply with the OTC policy, coastal power plant owners could either install closed-cycle evaporative cooling systems or replace, repower, or retire existing coastal power plants. Recognizing the need to maintain reliability and allow for effective long-term planning of transmission and generation as replacement infrastructure, the SWRCB adopted a compliance schedule with the input from the State Advisory Committee on Cooling Water Intake Structures (SACCWIS), which is composed of representatives from several state agencies, including the CEC.⁴⁰⁷

The SACCWIS ensures the compliance schedule accounts for local and statewide reliability, permitting constraints, and other factors affecting the availability of adequate electricity

⁴⁰⁶ Marine life, including millions of fish, larvae, eggs, seals, sea lions, turtles and other creatures, is harmed through impingement, as larger aquatic organisms are trapped against a power plants intake screen, and entrainment when smaller aquatic organisms are drawn into the plant’s cooling system and killed.

⁴⁰⁷ SACCWIS is composed of the CEC, CPUC, California ISO, California Coastal Commission, California State Lands Commission, the California Air Resources Board, and the SWRCB.

supplies in the state. As noted in Chapter 1, to date, more than 8,100 MW of natural gas OTC power plants have retired, with another 5,300 MW retiring by 2020 and an additional 1,600 MW by 2029. SACCWIS annually reviews reliability and compliance dates to determine whether conditions may warrant an extension.

The Mesa Loop-in project was projected to increase the imports into the Greater Los Angeles Area and reduce the amount of in-basin generation needed to meet reliability requirements. A delay of the Mesa Loop-in project could result in a need to keep older OTC units like Alamos online until the project is completed. With confirmation of the Mesa Loop-in delay, the California ISO conducted a special study to determine whether the OTC compliance schedule for Alamos (December 31, 2020) and the revised on-line date for the Mesa Loop-in would adversely impact electric system reliability. The California ISO prepared the special study to initiate the OTC deferral process. The California ISO found that Alamos is not needed under baseline assumptions. Under sensitivity analysis with higher load and removal of at-risk of retirement generation,⁴⁰⁸ however, between 476 MW to 816 MW of Alamos capacity is needed to maintain reliability.

At the May 23, 2019, joint agency workshop, the CPUC raised the issue of tightening system capacity in the CPUC Resource Adequacy program as a concern, and the California ISO concurred. This concern is a result of various factors including lowering of the effective load-carrying capability factors for wind and solar,⁴⁰⁹ increasing reliance on imports, and a peak shift to later in the evening when solar is not available. On June 20, 2019, the CPUC issued a ruling in its IRP Proceeding R.16-02-007, identifying potential system capacity shortfalls beginning in 2021 due to tightening of the bilateral resource adequacy market. The CPUC ruling identified three simultaneous approaches to meet system needs, including procurement of 2,000 MW new capacity by August 2021, SCE procurement of 500 MW of existing non-OTC capacity, and extension of OTC compliance deadlines.

The CPUC ruling raised the possibility of an OTC compliance date extension to meet system reliability, not just local reliability.⁴¹⁰ Several remaining OTC plants are in Southern California. Based on the information and California ISO special study, SACCWIS decided the best course of action was to recommend that the SWRCB defer the OTC compliance date for Alamos

408 "At-risk of retirement generation" is generation that may retire due to its age and that it is nearing the end of its useful life or due to economic reasons.

409 "Effective load carrying capability factor" refers to the percentage of wind and solar nameplate capacity that can contribute toward meeting peak demand.

410 A system resource can be located anywhere in the California ISO Balancing Authority, whereas a local resource must be within a specified local capacity area.

Units 3, 4, and 5 (1,166 MW) to maintain grid reliability.⁴¹¹ Alamitos Units 1, 2, and 6 are retiring early in 2019 to make way for the new Alamitos Energy Center. SACCWIS documented the findings in the Statewide Advisory Committee on Cooling Water Intake Structures Draft Local and System-wide 2021 Grid Reliability Studies Report⁴¹² and adopted it at an August 23, 2019, SACCWIS meeting with slight revisions. The main revision states the compliance date extension will be based on the minimum amount of capacity and time to meet grid reliability. The report will be presented to the SWRCB as an informational item later in fall 2019.

On November 7, 2019, the CPUC issued a decision⁴¹³ in the IRP Proceeding recommending that the SWRCB extend the OTC compliance deadlines for units currently slated to retire by December 31, 2020, for the time periods specified:

- Alamitos Generating Station, Units 3-5, totaling roughly 1,200 MW, for up to 3 years
- Huntington Beach Generating Station, Unit 2, roughly 200 MW, for up to 3 years
- Redondo Beach Generating Station, Units 5, 6, and 8, roughly 850 MW, for up to 2 years
- Ormond Beach Generating Station, Units 1 and 2, roughly 1,500 MW, for up to 1 year

The decision also required incremental procurement, in addition to the OTC requirement extensions, of system-level resources adequacy capacity of 3,300 MW, by all load-serving entities serving load within the California ISO balancing authority area.⁴¹⁴

Assessing Progress

As evident from workshops in previous IEPR cycles and from the most recent workshop held May 23, 2019, the CEC and collaborating agencies are committed to assuring electrical reliability for the region. The CPUC took action in February 2019 to approve a three-year requirement for local capacity requirements to discourage early retirement of resources. Discussions about using a centralized procurement entity, which would procure resources on behalf of all load-serving entities, for local capacity requirements are also occurring in resource adequacy proceedings. There has been significant progress in implementing the 2013 plan to address San Onofre and OTC generation retirements. The Alamitos, Huntington Beach, and Stanton generation projects are under construction and on-track to be on-line in 2020.

411 AES has stated that Unit 5 is limited to 300 MW (installed capacity 487 MW) due to electrical limitations.

412 [Link to Report of the Statewide Advisory Committee on Cooling Water Intake Structures](https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/saccwis/docs/sccwintrpt.pdf)
https://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/saccwis/docs/sccwintrpt.pdf.

413 [CPUC Decision Requiring Electric System Reliability for 2021-2023, R. 16-02-007, released November 7, 2019](http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=318169119)
<http://docs.cpuc.ca.gov/SearchRes.aspx?docformat=ALL&docid=318169119>.

414 Ibid.

Recommendations

Southern California Gas Company (SoCalGas) Infrastructure

- **Require SoCalGas to explore all options available to safely expedite repair of the natural gas pipelines to full operating service.** In addition, SoCalGas should identify areas where agency assistance is needed to speed up pipeline repairs.
- **Require regular reporting to increase transparency into the emergency maintenance and repair process.** The California Public Utilities Commission (CPUC) should consider requiring SoCalGas to provide, in addition to the information already posted on its Envoy electronic information system, detailed reports indicating specific actions taken to restore pipelines to service on a monthly basis to keep policy makers and the public informed about infrastructure conditions as well as where the new leaks are located, what repair techniques are being applied, and at what pressure the leaks are occurring. Alternatively, the CPUC could retain a third party to prepare a condition assessment and monitor repair work, with regular reports back to the agencies and public.
- **The CPUC should consider financial consequences that balance ratepayer benefits with appropriate shareholder incentives.** The CPUC should align economic incentives with efficient and effective management and operation of SoCalGas' natural gas system, such that ratepayers are not held accountable for management errors. Failure to identify and resolve system vulnerabilities in a timely manner could trigger disallowance of costs associated with service interruptions. Failure to maintain reasonable return-to-service timelines could lead to penalties.
- **Identify and explore the steps needed to implement existing and new mitigation measures.** The California Energy Commission (CEC), the CPUC, the California Independent System Operator, and the Los Angeles Department of Water and Power should collaborate to determine the viability of the existing and any new mitigation measures and the steps needed to implement them. Tighter balancing rules adopted from the first Joint Agency technical assessment in 2016 should continue and SoCalGas should maximize withdrawal capability at La Goleta, Playa del Rey, and Honor Rancho by ensuring they are filled first.
- **Continue developing a long-term strategy that would allow the eventual close of the Aliso Canyon natural gas storage field.** The CPUC should look to the CEC for support as both agencies develop strategies for replacement energy resources that ensure electricity reliability in Southern California and allow retirement of Aliso Canyon. These strategies will be led by advances in building decarbonization, energy efficiency, and distributed energy resources such as demand response and storage of electricity or heat. The agencies should incorporate the findings from the Pacific Northwest transmission study into a long-term plan.

San Onofre Nuclear Generation Station Shutdown and Once-Through Cooling (OTC)

- **To ensure local reliability in the Greater Los Angeles Area and San Diego, the State Water Resources Control Board should approve the Statewide Advisory Committee on Cooling Water Intake Structures' recommendation to extend the OTC compliance date of Alamos units 3, 4, and 5.** The agencies should work together to identify whether any other OTC generator is needed to meet grid reliability through 2025.
- **Continue focus on implementing the Southern California reliability action plan.** The preferred resources, transmission upgrades, and conventional generation identified in the 2013 report are crucial to continuing electric reliability.

CHAPTER 7:

Electricity and Natural Gas Demand Forecast

Background

The California Energy Commission (CEC) provides new forecasts for electricity and natural gas demand every two years as part of the *Integrated Energy Policy Report (IEPR)* process. The CEC develops new forecasts in odd-numbered years such as for this *2019 IEPR*, with updates in the intervening years. The forecasts are used in various proceedings, including the California Public Utilities Commission's (CPUC's) Integrated Resource Planning (IRP) process and the California Independent System Operator's (California ISO's) Transmission Planning Process (TPP). The CPUC identified the *IEPR* process as "the appropriate venue for considering issues of load forecasting, resource assessment, and scenario analyses, to determine the appropriate level and ranges of resource needs for load-serving entities in California."⁴¹⁵ In addition, the CEC provides monthly peak demand forecasts for the resource adequacy process in coordination with the California ISO and the CPUC.

The forecast includes three demand cases designed to capture a reasonable range of demand outcomes over the next 10 years. The "high-energy demand case" incorporates relatively high economic/demographic growth, relatively low electricity and natural gas rates, and relatively low committed efficiency program, self-generation, and climate change impacts. The "low-energy demand case" includes lower economic/demographic growth, higher assumed rates, and higher committed efficiency program and self-generation impacts. The "mid" case uses input assumptions at levels between the "high" and "low" cases.

Staff presents preliminary results below. The CEC plans to adopt the final forecast in January 2020 and reflect those findings in the final version of the 2019 IEPR.

Data and Analytic Improvements

While the 2019 IEPR preliminary forecast employs many of the same models used to develop the forecast update for the 2018 IEPR Update, this forecast will use several updated tools.

Through an Electric Program Investment Charge contract with ADM Associates, the CEC refreshed its hourly electric end-use load profiles, as well as hourly savings profiles for efficiency measure categories, generation profiles for behind-the-meter solar photovoltaic (PV)

⁴¹⁵ Peevey, Michael. September 9, 2004. Assigned Commissioner's Ruling on Interaction Between the CPUC Long-Term Planning Process and the CEC IEPR Process. Rulemaking 04-04-003.

systems, and charging profiles for electric vehicles.⁴¹⁶ These profiles were combined into a new bottom-up hourly electric load model (HELM 2.0) which, for the revised forecast, will be available to translate the CEC’s annual end-use consumption forecasts into hourly and peak-load forecasts. At the same time, the CEC continues to refine its top-down hourly load model (HLM) to be used as a system-level point of comparison for HELM 2.0 or for regional studies not covered by HELM 2.0. For this forecast, staff intends to incorporate the hourly impacts of storage, load-modifying demand response, and Scripps projections of hourly temperatures under climate change. Electric vehicle charging profiles from the ADM analysis will also be included in the HLM.

The CEC’s forecasting is benefiting from newly available data as a direct consequence of Phase I revisions to Title 20.⁴¹⁷ Beginning in 2019, utility distribution companies are required to report regularly to the CEC on all generation and storage system interconnection data. Notably, these data give a comprehensive picture of California’s current and historical behind-the-meter PV installation activity, which will improve forecasts of future adoption.

This year’s IEPR process remains focused on tracking statewide progress toward doubling energy efficiency savings by 2030—a goal outlined in the Clean Energy and Pollution Reduction Act (Senate Bill 350, De León, Chapter 547, Statutes of 2015)—and in developing strategies and targets to meet that goal. (See Chapter 2 for more information.) CEC analysis of programs related to Senate Bill 350 has expanded this year such that additional achievable energy efficiency (AAEE) scenario development may now consider:

- Several publicly owned utility (POU) program potential scenarios, with variability comparable to investor-owned utility (IOU) scenarios.
- A set of nonutility programs expanded to include fuel substitution, conservation voltage reduction, and savings opportunities within the agricultural and industrial customer sectors.

During the 2017 IEPR forecast cycle, staff analyzed the potential ramifications of cannabis legalization on electricity demand.⁴¹⁸ Especially for smaller LSEs, the addition of energy-intensive indoor cultivation facilities can have a sudden and significant impact on load growth.

416 Baroiant, Sasha, John Barnes, Daniel Chapman, Steven Keates, and Jeffrey Phung. ADM Associates, Inc. April 2019. *California Investor-Owned Utility Electricity Load Shapes*. Final Project Report. CEC. Publication Number: CEC-500-2019-046. [Link to California IOU Electricity Load Shapes final project report on the CEC's website](https://ww2.energy.ca.gov/2019publications/CEC-500-2019-046/CEC-500-2019-046.pdf) https://ww2.energy.ca.gov/2019publications/CEC-500-2019-046/CEC-500-2019-046.pdf.

417 [Link to Docket 16-OIR-03 on the CEC's website](https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=16-OIR-03) https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=16-OIR-03.

418 Kavalec, Chris, Asish Gautam, Mike Jaske, Lynn Marshall, Nahid Movassagh, and Ravinderpal Vaid. CEC. February 2018. California Energy Demand 2018-2030 Revised Forecast. Commission Final Report. [Link to California Energy Demand 2018-2030 Revised Forecast on the CEC's website](https://efiling.energy.ca.gov/getdocument.aspx?tn=223244) https://efiling.energy.ca.gov/getdocument.aspx?tn=223244.

Recognizing this possible impact, for the 2019 IEPR preliminary forecast, the CEC adjusted its forecast for Valley Electric Association to account for cannabis cultivation facilities expected to begin operation by 2020 and deemed incremental to embedded forecast assumptions. As part of the revised forecast, staff will incorporate more comprehensive projections of energy use for cultivation into the baseline forecast.

Emerging Issues

The CEC held a workshop on September 26, 2019, to explore topics that present emerging analytic challenges to the CEC's incumbent forecast process. As part of this workshop, Southern California Edison (SCE) described challenges to distribution planning posed by a high-electrification future. For example, SCE's Charge Ready Transport program received dozens of applications over a short period of time to install charging infrastructure for electric vehicle fleets. SCE expressed concern that clusters of such projects could necessitate distribution upgrades which require 7 to 10 years to implement. Because the CEC's forecast sets benchmarks for IOU distribution planning assumptions, SCE suggested that, as part of their annual distribution planning process, utility planners should work with CEC forecasters to identify areas of emerging and significant load growth which may not have been captured in the most recently adopted CEC forecast.

Ten new community choice aggregators began offering electricity service to customers in 2018. Total CCA load in California nearly doubled in 2018, reaching 13 percent of load within IOU service territories. This rapid departure of IOU load to community choice aggregators has implications for several regulatory processes that use the CEC's demand forecast, prompting staff to consider developing a departing load forecast. Through the CPUC's Resource Adequacy program, the CEC has good visibility into likely year-ahead departures. A longer-term forecast, however, requires staff to evaluate new modeling approaches and data needs.

The CEC develops forecasts for particular geographic regions, such as IOU distribution service territories. Load migration within such a territory—all else equal—is an attribution problem having little to no effect on the overall forecast. However, many community choice aggregators have unique tariffs, program offerings, and carbon-reduction strategies that could conceivably alter the expected load growth or profile of their specific customers. Community choice aggregation representatives discussed such programs at the September 26 workshop. Sonoma Clean Power (SCP), for example, offers incentives for electric vehicles as well as free charging stations and encourages customers to enroll in their GridSavvy demand response program. Although GridSavvy currently covers electric vehicle charging, SCP intends to expand the program to cover smart thermostats, heat pump water heaters, heat pump space conditioning, and behind-the-meter storage. East Bay Community Energy recently launched a demand response program consisting of about 500 kW of aggregated commercial and residential battery storage, calling events based on wholesale pricing to mitigate procurement needs. As community choice aggregators serve a growing share of total electric load, it becomes increasingly important for CEC forecasters to collect and consider information from community choice aggregators regarding rates, efficiency, behind-the-meter storage and generation, building and transportation electrification, and other load-management strategies.

At an August 15, 2019, IEPR workshop on the 2019 Preliminary California Energy Demand Electricity and Natural Gas Demand Forecast, CEC forecasters acknowledged that state and local policy sentiment for carbon reduction will likely translate to some amount of electrification in buildings. Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018), for example, requires the CEC to assess the potential for California to reduce the GHG emissions in residential and commercial buildings by 40 percent below 1990 levels by January 1, 2030. Senate Bill 1477 (Stern, Chapter 378, Statutes of 2018) directs \$50 million annually toward fuel substitution programs over four years. The CED 2019 update to additional achievable energy efficiency (AAEE)—discussed later in this chapter—may include impacts from a relatively modest analysis of fuel substitution in newly constructed homes. CEC staff has proposed to present its preliminary analysis of a broader set for potential fuel substitution impacts alongside the CED 2019 revised forecast. This analysis would not be incorporated into the revised forecast because of the high level of uncertainty around how these efforts might unfold. Rather, staff seeks to engage stakeholders in identifying the data and analytic challenges that must be met before fuel substitution can be treated formally and expansively in the demand forecast.

Economic/Demographic Outlook for California

California leads the nation in economic growth. In 2018, according to the U.S. Department of Commerce, California's economy surpassed the United Kingdom's to become the fifth largest in the world. The steady pace of growth is exhibited throughout the state; however, four counties in particular made significant contributions to growth in California's gross state product (GSP): Los Angeles County (\$789.7B), Orange County (\$299.4B), Santa Clara County (\$275.3B), and San Diego County (\$261.4B).⁴¹⁹

Looking forward, economic experts at Moody's Analytics, IHS Global Markit, and the University of California Los Angeles, (UCLA) Anderson Forecast expect growth to slow in their reference scenarios, projecting California's GSP to increase in the range of 2.5 percent to 3 percent in 2019, dropping to 1 percent to 2 percent in 2020 and 2021. These projections are driven by slower growth in the Bay Area's job market, slower growth in California's residential construction, a weaker housing market, and reduced in migration and increased outmigration of firms and individuals seeking cheaper options. These projections do not assume a potential recession in the near term, though there are evident risks that could lead to a more significant economic slowdown.

⁴¹⁹ The CEC uses several sources to develop its economic/demographic outlook including Moody's Analytics, IHS Global Markit, UCLA Anderson Forecast, California Department of Finance, California Employment Development Department, U.S. Bureau of Labor Statistics, and the U.S. Census Bureau. Information was also presented at the CEC's Economic and Demographic workshop held January 17, 2019.

One such risk is the threat of escalating U.S. trade conflicts, which create significant uncertainty for California's economic prospects as the state is home to some of the largest seaports in the country. President Trump announced plans to impose 15 percent tariffs on \$123 billion of Chinese imports, effective September 1, 2019, prompting China to respond with retaliatory tariffs on U.S. goods. Reduced trade would likely impact industries such as manufacturing, logistics, transportation, warehousing, and retail.

According to the California Department of Finance's latest estimates, in 2018, California added nearly 187,000 residents. This number is less than 1 percent year-over-year growth. The state's population growth will continue to be relatively slow, growing less than 1 percent, (as compared to other nearby states) as the demand for housing increases.

The largest in and out migration numbers are flowing into and out of Texas, Nevada, Arizona, and Washington. As a comparison, the U.S. Census states that for 2018 Nevada and Idaho grew 2 percent, 1.7 percent in Arizona, 1.4 percent in Washington, and 1.3 percent in Texas. The attraction to these states is primarily due to overall affordability, including lower housing costs, allowing first-time homebuyers to enter the market and lower taxes. Similarly, people migrate to California to seek opportunities in the high-tech industry with higher incomes.

Labor and housing constraints are increasingly evident. Jerry Nickelsburg, director of the UCLA Anderson Forecast, states that California is running out of people to employ in this tight labor market. Employment growth decreased considerably from a few years ago but is still on pace with the nation. Nonetheless, employment growth is still growing and fueled by the fundamentals that lead to increased consumption and household formation. Statewide unemployment remains low with 4.2 percent, which is significantly lower than the recession era high of more than 12 percent in December 2009.

California has nearly 14 million homes. Single- and multifamily housing building permits are down year-over-year due to constraints on supply. The supply of homes is growing slowly, but home prices are not decreasing, as demand continues to rise. The California Association of Realtors report indicates that 30 percent of California households could afford to purchase the \$608,660 median-priced home with a minimum annual income of \$122,960 in the second quarter of 2019, up from 26 percent a year ago.⁴²⁰ The recent drop in mortgage rates will contribute to higher demand, especially in areas with higher housing costs such as the Bay Area, Los Angeles, and San Diego regions.

420 California Association of Realtors. "Second Quarter Housing Affordability Report." August 7, 2019. [Link to news release about California housing affordability on the California Association of Realtors' website](https://www.car.org/aboutus/mediacenter/newsreleases/2019releases/2qtr2019affordability)
<https://www.car.org/aboutus/mediacenter/newsreleases/2019releases/2qtr2019affordability>.

Recovery is slow following the 2018 wildfires in Butte County, Lake County, Shasta County, and Ventura County that destroyed more than 20,000 structures, further inflating housing demand. Tariffs have kept the price of building materials high, and there is a shortage of available construction workers to rebuild homes.

According to the California Department of Finance, California's statewide housing growth in 2018 (net unit growth in completed housing units) was up 0.6 percent from the previous year, which includes the addition of 77,000 housing units. The total number of housing units in the state now exceeds 14.2 million. Statewide multifamily units represented 31.5 percent of unit growth last year, continuing a seven-year trend. Multifamily units cost less to build and require fewer workers. Los Angeles, San Diego, Irvine, Santa Clarita, and Sacramento added the most housing units in 2018. However, the California Department of Finance has stated the state would need to build 200,000 housing units each year to keep up with population growth. California is not close to that number, with around 120,000 housing units in 2018.

California Energy Demand Preliminary Baseline Forecast, 2019–2030

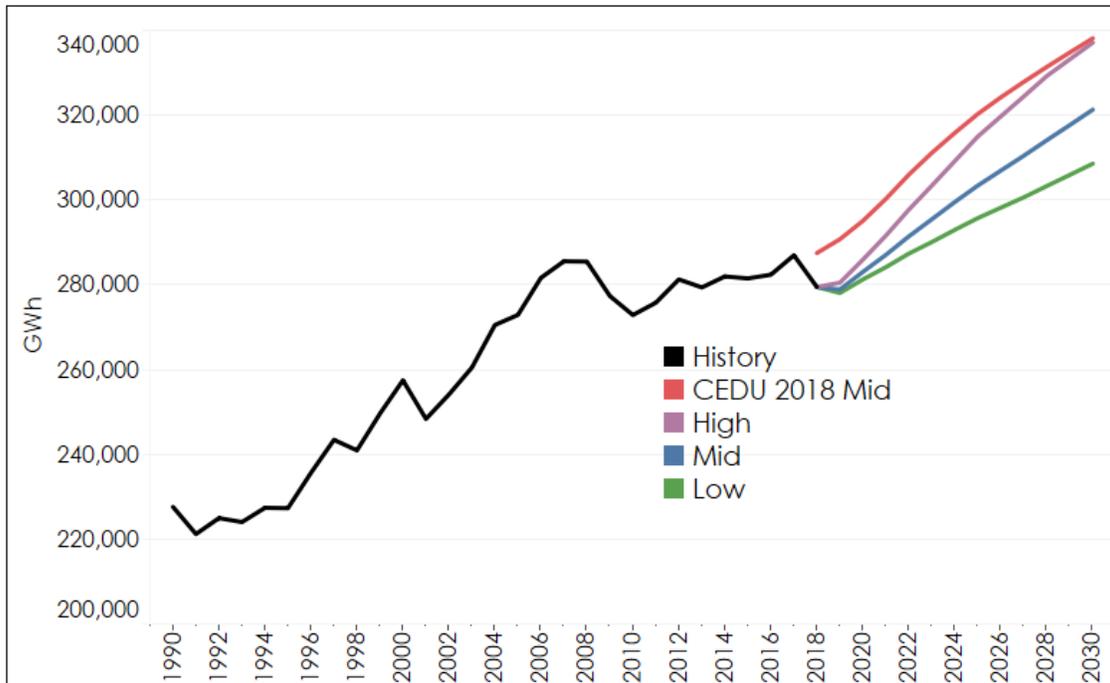
The IEPR forecast process began in November 2018 with a formal request for demand forecast data from load-serving entities. The CEC held two public workshops intended to inform demand-forecasting efforts. The first workshop, held on January 17, 2019, featured moderated panels of expert economists, demographers and industry representatives responding to questions around California's economy, population characteristics, and business outlook. The perspectives presented at the January workshop informed the selection of a reasonable set of forecast inputs and assumptions, which staff then presented at another workshop on March 4, 2019.

Staff presented a preliminary set of baseline forecast results at a public workshop on August 15, 2019 and is considering comments from stakeholders as it develops a revised set of baseline forecasts (CED 2019 revised) and AAEE savings projections. A final workshop will be held December 2, 2019, to present these revised results and receive additional stakeholder comments before the forecast is finalized and considered for adoption in January 2020.

Generally, the CED 2019 preliminary forecast employs the same models and methods used to develop the previous IEPR forecast. Differences between the two reflect changes in economic drivers and other key inputs. Relative to CEDU 2018, the CED 2019 preliminary forecast includes additional historical load data, efficiency program savings, Title 24 building standards impacts, refreshed electricity and natural gas rate projections, and behind-the-meter storage and generation system interconnection data.

Figure 26 shows historical and projected CED 2019 preliminary baseline electricity consumption statewide for three demand scenarios. The CEDU 2018 mid baseline consumption forecast is included for comparison. In 2030, consumption in the new mid case is about 5 percent lower than CEDU 2018, reaching more than 321,000 GWh.

Figure 26: Statewide Baseline Electricity Consumption

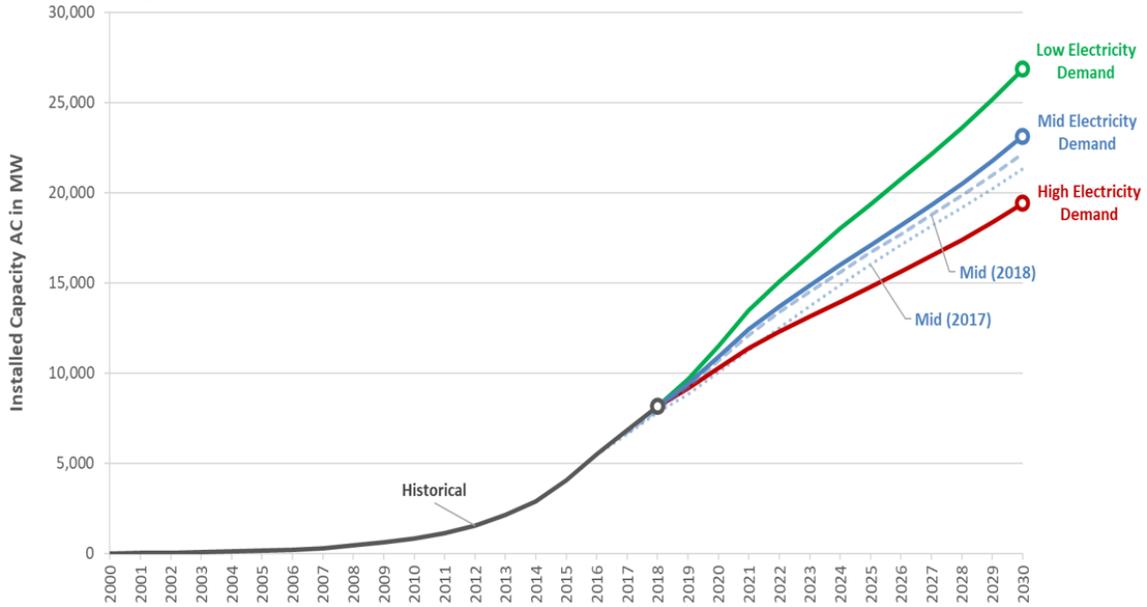


Source: CEC

Adoption of behind-the-meter PV systems is a key consideration in translating between end-user consumption and retail sales and in analyzing the timing and magnitude of system peaks. Historical and projected PV capacities for the three CED 2019 preliminary demand cases and the CEDU 2018 and CEDU 2017 mid cases are shown in Figure 27. In 2018, the state added more than 1,300 MW of new behind-the-meter (BTM) PV, and by the end of 2018, there was more than 8,000 MW of installed BTM PV capacity in California. By 2030, the CED 2019 preliminary forecast projects installed capacity to reach about 19,400 MW, 23,100 MW, and 26,800 MW in the high, mid, and low energy demand scenarios, respectively.

The CEC's 2019 Title 24 building standards update, which requires PV installations on new homes, was adopted by the CEC and approved by the California Buildings Standards Commission. As such, standards-driven system adoption—previously considered additional achievable photovoltaic (AAPV) system adoption—is now incorporated into the baseline forecast. Forecasted adoption from CED 2017 and CEDU 2018 in Figure 27 has been restated to include the contribution of AAPV to provide a consistent point of comparison to CED 2019.

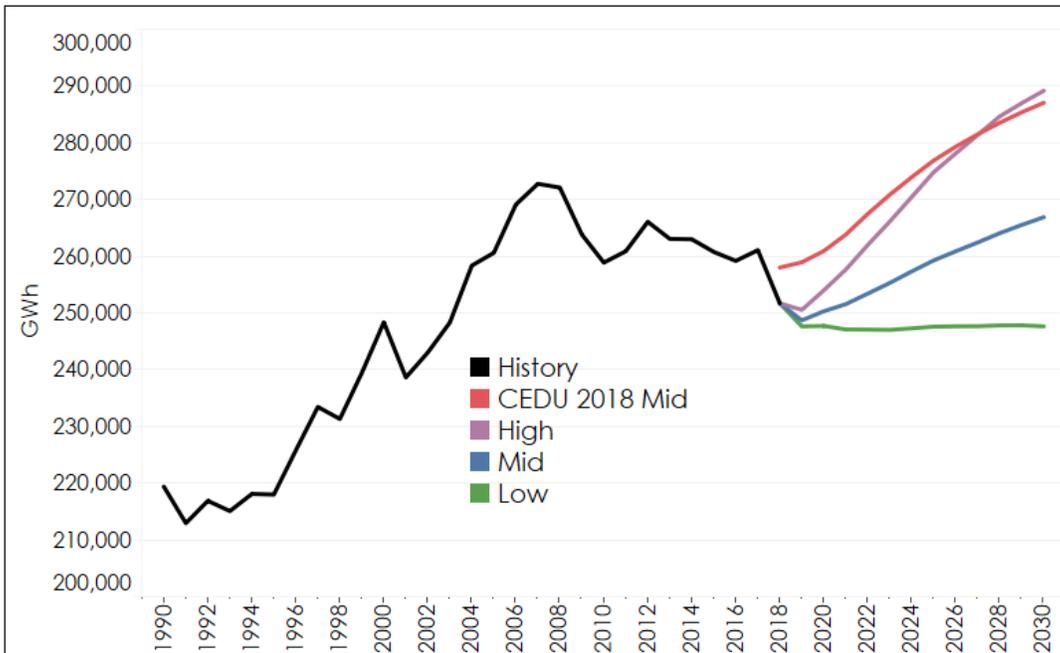
Figure 27: Statewide Behind-the-Meter Photovoltaic Capacity



Source: CEC

Figure 28 shows projected statewide baseline electricity sales for the three CED 2019 preliminary cases and the CEDU 2018 mid demand case. Here, the impact of standards-driven PV adoption can be seen lowering growth in sales relative to CEDU 2018. By 2030, sales in the CED 2019 preliminary mid case are projected to reach nearly 267,000 GWh.

Figure 28: Statewide Baseline Electricity Sales

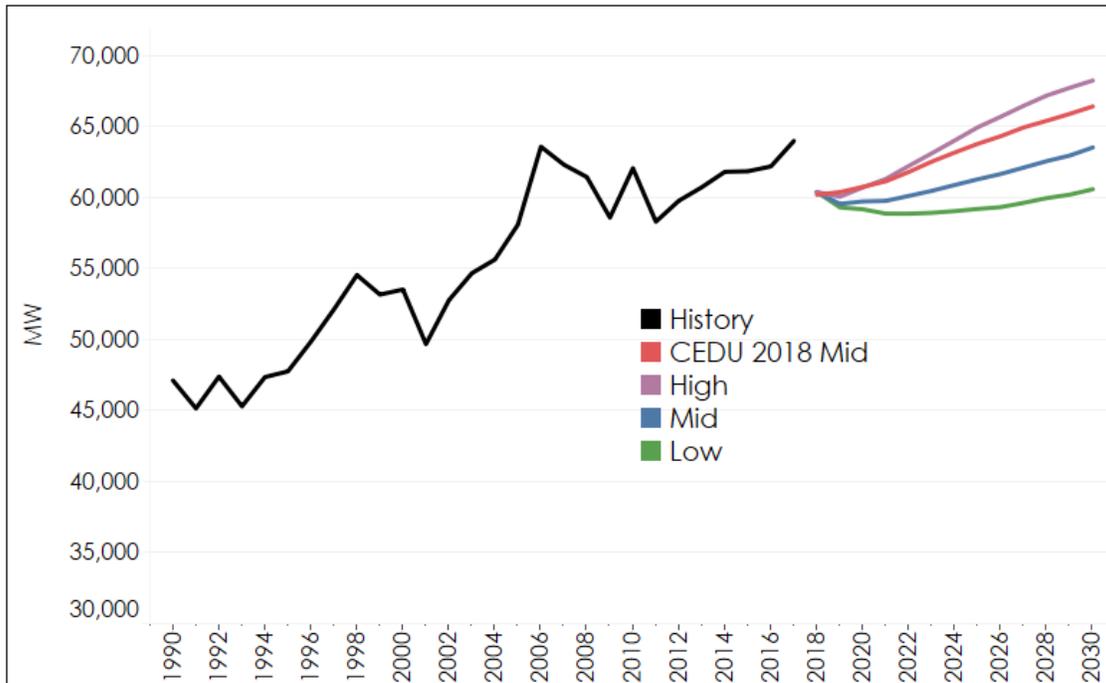


Source: CEC

Figure 29 shows the projected CED 2019 Preliminary noncoincident net peak demand for the three baseline cases and the CEDU 2018 mid demand case. Peak load had not yet been

recorded for the summer of 2019; therefore, the CED 2019 preliminary peak forecast begins from a 2018 weather-normalized value, or from an estimate of what peak load would have been in 2018, assuming average temperatures. Peak shift impacts within the IOU TAC areas add nearly 4,200 MW of demand over traditional peak hours. By 2030, statewide peak demand in the CED 2019 preliminary mid case is projected to reach just more than 63,500 MW.

Figure 29: Statewide Baseline Noncoincident Peak Electricity Demand



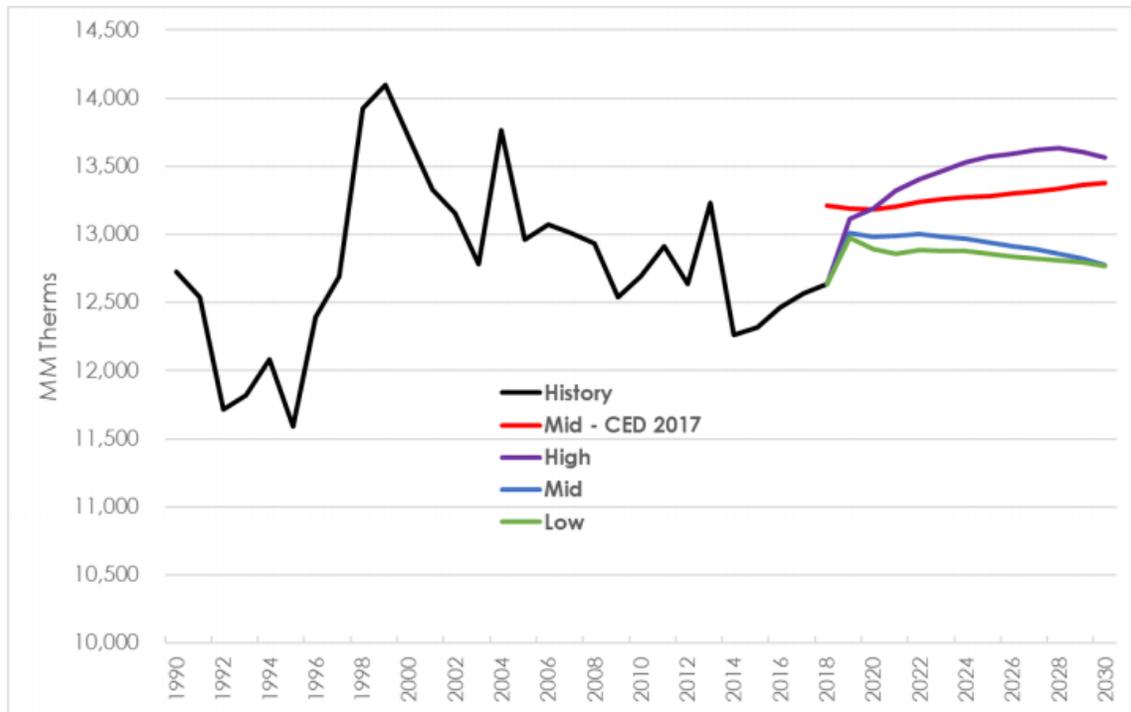
Source: CEC

Figure 30 shows the statewide end user natural gas consumption demand for the three CED 2019 preliminary cases and the CED 2017 mid case.⁴²¹ The historical series shows the variability in consumption from year to year, largely a response to weather. On average, 2018 was a particularly cool year for Southern California; so the forecast begins from a higher normalized starting point relative to the last year of recorded consumption. CED 2019 preliminary includes impacts from projected natural gas vehicle adoption, amounting to an additional 150 million therms by the end of the forecast period. This modest increase is more than offset by the energy savings impacts from new building standards, as well as reduced consumption in the mining sector. Climate change impacts, which reduce heating demand, are

⁴²¹ CED 2017 is shown for comparison as CEDU 2018 did not include a forecast of end-user natural gas consumption.

included only in the mid and high cases, resulting in a relatively small difference between the low and mid case. By 2030, statewide end-user natural gas consumption in the CED 2019 preliminary mid case is projected to reach nearly 12,800 million therms.

Figure 30: Statewide End-Use Natural Gas Consumption



Source: CEC

Additional Achievable Energy Efficiency

CEC staff routinely develops managed forecasts, which adjust baseline demand forecasts for AAEE, or energy savings resulting from efforts that are reasonably expected to occur but lack funding commitments or implementation plans. These efforts include future updates of building standards, appliance regulations, and new or expanded energy efficiency programs. AAEE is central to developing a managed demand forecast, which in turn is the basis for resource planning and procurement efforts at the CPUC and California Independent System Operator.

Senate Bill 350 (De León, Chapter 547, Statutes of 2015) directs the CEC to “establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas final end uses of retail customers by January 1, 2030.” This law also directs the CEC to “base the targets on a doubling of the midcase estimate of AAEE savings, as contained in the California Energy Demand Updated Forecast, 2015–2025.”

AAEE scenarios are designed to reflect reasonably expected savings from programs developed in support of SB 350 aspirational goals, as well as IOU and POU program savings potential assessed by Potential and Goals (P&G) studies. Improvements in this process for the 2020-2030 AAEE forecast include:

- A more robust analysis of beyond-utility programs originally evaluated in the 2017 IEPR cycle,⁴²² as well as consideration of additional programs.
- Further analysis performed on data obtained from the POU P&G study.
- An increased use of software tools to simplify labor-intensive data manipulation and merging of the three main savings streams.

Staff is developing six scenarios to capture a broad range of uncertainty around key drivers of program activity. Since the CEC has explicit agreements with other agencies that plan on using specific AAEE scenarios in various resource planning and transmission planning studies,⁴²³ staff seeks input from these stakeholders throughout the scenario design process.

The savings accounted for in the AAEE scenarios come from three main sources:

- CPUC-jurisdictional program savings derived from the 2019 P&G study⁴²⁴
- POU potential savings derived from the California Municipal Utilities Association's (CMUA) 2017 P&G study⁴²⁵
- Beyond-utility savings from programs run by the CEC and other agencies as well as all savings derived from future ratcheting of codes and standards (C&S)

The sections below describe various elements of the AAEE scenario design for CED 2019. The resulting savings estimates were not available for the preliminary but will be incorporated into the revised forecast.

CPUC Program Savings

The CPUC's 2019 P&G study presents five scenarios that assess program savings potential within each IOU service territory over the next 10 years. This study is undertaken biennially, and the most conspicuous differences between the 2019 P&G study and the predecessor are:

- A significant drop of C&S savings in the attributable portions of Title 24 due to an effective LED lighting baseline in the commercial sector.
- An increase in behavioral, retrocommissioning, and operations savings (BROs).
- Program portfolios must reach a higher level of cost-effectiveness.

422 CEC staff. 2017. [2017 IEPR](https://www.energy.ca.gov/2017_energypolicy/). CEC. Publication Number: CEC-100-2017-001-CMF. https://www.energy.ca.gov/2017_energypolicy/. pp. 54-58.

423 The single forecast set agreement is listed in its entirety elsewhere in this chapter.

424 CPUC. [2020 Potential and Goals Study](https://www.cpuc.ca.gov/General.aspx?id=6442461220) <https://www.cpuc.ca.gov/General.aspx?id=6442461220>.

425 CMUA. [Appendix B Energy Efficiency in California's Public Power Sector, 11th Edition](https://www.cmua.org/Files/Reports/SB1037/2017_Energy_Efficiency_Report.pdf). April 2017. https://www.cmua.org/Files/Reports/SB1037/2017_Energy_Efficiency_Report.pdf.

As in previous IEPR cycles, the reference scenario adopted by the CPUC for its 2020–2030 program goals defines Scenario 3, and the CEC used variations from that starting point to develop more conservative and more aggressive estimates of IOU potential savings for each overall AEE scenario. Table 12 shows the elements chosen for the final six scenarios in the AEE portfolio. Staff carefully processed the scenarios to eliminate duplication with the baseline forecast.

Table 12: AAE Scenario Design Elements for IOU Territories

Lever	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
Building Stock and Retail Prices	2017 IEPR High Case	2017 IEPR Mid Case	2017 IEPR Mid Case	2017 IEPR Mid Case	2017 IEPR Low Case	2017 IEPR Mid Case
AIMs ETs	Reference	Reference	Reference	Average of Reference and Aggressive	Average of Reference and Aggressive	Aggressive
Incentive Levels	Capped at 25 Percent of Incremental Cost	Capped at 50 Percent of Incremental Cost	Capped at 50 Percent of Incremental Cost	Capped at 50 Percent of Incremental Cost	Capped at 50 Percent of Incremental Cost	Capped at 75 Percent of Incremental Cost
Cost-Effectiveness Measure Screening Threshold (Total Resource Cost Using 2019 Avoided Costs)	1.25	1.25	1	0.85	0.85	0.65
Marketing and Outreach	Default Calibrated Value	Default Calibrated Value	Default Calibrated Value	Increased Marketing Strength	Increased Marketing Strength	Increased Marketing Strength
Financing Programs	No Modeled Impacts	No Modeled Impacts	No Modeled Impacts	IOU Financing Programs Broadly Available to Residential and Commercial	IOU Financing Programs Broadly Available to Residential and Commercial	IOU Financing Programs Broadly Available to Residential and Commercial
Low Income	P&G Study Result Unchanged	P&G Study Result Unchanged	P&G Study Result Unchanged	P&G Study Result Unchanged	P&G Study Result Unchanged	P&G Study Result Unchanged
BROs Program Assumptions	Reference	Reference	Reference	Average of Reference and Aggressive	Average of Reference and Aggressive	Aggressive

Source: CEC

As can be seen in Table 20, building stock and retail prices are taken from CED 2017, consistent with the high, mid, and low baseline demand scenarios. The four basic bins of the IOU potential study savings—agricultural, industrial, and mining sector emerging technologies (AIMs ETs), rebate or financing programs, BROs, and low-income programs—are retained from CED 2017, and a range of scenarios is generated for each. AIMs ETs and BROs are treated independently of rebate or financing programs. Financing programs are influenced by marketing and outreach and further bounded by the cost-effectiveness screening methods and

thresholds and incentive levels. Low-income programs have traditionally been included as a scenario lever; however, the 2019 P&G study analyzed these programs using an entirely new stock turnover model, which did not permit analysts to vary assumptions.

POU Program Savings

The CMUA’s 2017 P&G study contains only a single savings estimate and is prepared every four years. During the CED 2017 forecast cycle, staff held this single estimate of POU program savings potential constant across all AEE scenarios. For CED 2019, however, the P&G study results serve as a reference case around which staff developed additional scenarios, comparable to those developed for the CPUC programs. Savings projections for the largest 16 POU are based on three sets of assumptions (consistent across all POU) applied to CMUA’s proprietary ELRAM model. Savings for the remaining POU were extrapolated from those results.

Table 13 below lists the scenario levers chosen for the POU potential savings contributions to the six scenarios in the final AEE portfolio.

Table 13: AEE Scenario Design Elements for POU Territories

Lever	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
Expand Measure List	Reference	Reference	Reference	Add New Measures	Add New Measures	Add New Measures
Incentive Level	Reference x 75 percent	Reference x 75 percent	Reference	Reference	Reference	Reference
Promotional Expenditures	Reference x 5 percent	Reference x 75 percent	Reference	Reference x 125 Percent	Reference x 125 Percent	Reference x 125 Percent
Behavioral Programs	Remove Newly Planned BROs	Remove Newly Planned BROs	Reference	Reference	Reference	Reference
Early Retirement Programs	Reference	Reference	Reference	Implement ER Programs	Implement ER Programs	Implement ER Programs
Net to Gross	IOU	IOU	IOU	IOU	IOU	IOU
Re-participation Rates	IOU	IOU	IOU	IOU	IOU	IOU

Source: CEC

Beyond-Utility Programs Contributions

CED 2019 AAEE will include savings from future ratchets of California Title 24 building efficiency standards, California Title 20 appliance efficiency standards, and federal appliance efficiency standards, as well as additional beyond-utility (BU) programs that have been assessed as potential contributors toward the state’s SB 350 doubling goal. These BU savings elements were adjusted downward from an aspirational SB 350 perspective to levels that can be considered reasonably expected to occur given program specific assumptions.⁴²⁶ Table 14 illustrates how each standards savings category varies by compliance rate and number of assumed ratchets across the six scenarios.

Table 14: AAEE Scenario Design Elements for BU Codes and Standards

Authority	Lever	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
Title 24	Compliance Reduction or Enhancement	No Additional Included	20 Percent Compliance Rate Reduction	Reference Case Compliance	Compliance Enhancements	Compliance Enhancements	Compliance Enhancements
Title 24	Code Cycles (Vintages)	No Additional Included	2022 Nonresidential New Construction and Additions and Alterations (A&A); 2022 Residential A&A BU Workbook	2022 Nonresidential New Construction and Additions and Alterations (A&A); 2022 Residential A&A BU Workbook	2022 Nonresidential New Construction and A&A; 2022 Residential A&A BU Workbook	Same Scope Through 2025 Standards BU Workbook	Same Scope Through 2025 Standards BU Workbook
Title 20	Compliance Reduction or Enhancement	No Additional Included	20 Percent Compliance Rate Reduction		Compliance Enhancements	Compliance Enhancements	Compliance Enhancements
Title 20	Code Cycles (Vintages)	No Additional Included	Selected Standards Through 2022 P&G Study	Selected Standards Through 2022 P&G Study	Selected Standards Through 2022 P&G Study	Selected Standards Through 2027 P&G Study and BU Workbook	Selected Standards Through 2027 P&G Study and BU Workbook

⁴²⁶ [Link to 2017 IEPR on the CEC's website](https://ww2.energy.ca.gov/2017_energypolicy/) https://ww2.energy.ca.gov/2017_energypolicy/. p. 177

Authority	Lever	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
Federal Standards	Compliance Reduction or Enhancement	No Additional Included	No Additional Included	Reference Case Compliance	Compliance Enhancements	Compliance Enhancements	Compliance Enhancements
Federal Standards	Code Cycles (Vintages)	No Additional Included	No Additional Included	Through 2023 (Excluding 2020 General Service Lamp Standard) Plus 2026 Water Source Heat Pump P&G Study	Through 2023 (Excluding 2020 General Service Lamp Standard) Plus 2026 Water Source Heat Pump P&G Study and BU Workbook	Through 2023 Plus 2026 Water Source Heat Pump (Including 2020 General Service Lamp Standard Expanded Scope) P&G Study and BU Workbook	All Through 2026 Water Source Heat Pump Plus Selected Standards Through 2030 P&G Study and BU Workbook

Source: CEC

For CED 2019, BU savings analysis includes additional programs and sectors not previously considered part of AAEE. Specifically, BU now considers programs offered by air quality management districts, proposals for energy asset rating programs, smart-meter data analytics, conservation voltage reduction, agricultural and industrial savings potential, and fuel substitution. The BU scenario savings are assessed statewide and allocated to each utility in proportion to that utility’s retail sales. Program-specific levers are adjusted and grouped to define conservative, reference, and aggressive savings scenarios as indicated in Table 15.

Table 15: AAEE Scenario Design Elements for BU (Programs)

Program Savings Scenario	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
Prop 39	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	High	High
DGS Energy Retrofit	Mid: Established Programs With Historical Performance Data and Expected Future	Mid: Established Programs With Historical Performance Data and Expected Future	Mid: Established Programs With Historical Performance Data and Expected Future	Mid: Established Programs With Historical Performance Data and Expected Future	High	High

Program Savings Scenario	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
	Funding Allocations	Funding Allocations	Funding Allocations	Funding Allocations		
ECAA Financing	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	Mid: Established Programs With Historical Performance Data and Expected Future Funding Allocations	High	High
GGRF: Water Energy Grant	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High
GGRF: Low-income Weatherization	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High
Local Government Ordinances	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High

Program Savings Scenario	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
PACE Financing	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High
Benchmarking and Public Disclosure	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High
Fuel Substitution	Low	Low	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	Mid: Limited Historical Data on a Pilot or Other Subset of Programs and Reasoned Assumption on Future Funding Allocations	High	High
Behavioral, Retrocommissioning, Operational Savings	Not Included	Not Included	Not Included	Not Included	Low	Mid: Assumptions Based on Pilot or Proposed Programs
Local Government Challenge	Not Included	Not Included	Not Included	Not Included	Low	Mid: Assumptions Based on Pilot or Proposed Programs
Energy Asset Ratings	Not Included	Not Included	Not Included	Not Included	Low	Mid: Assumptions Based on Pilot or

Program Savings Scenario	High-Low (Scenario 1)	Mid-Low (Scenario 2)	Mid-Mid (Scenario 3)	Mid-High (Scenario 4)	Low-High (Scenario 5)	Mid-High Plus (Scenario 6)
						Proposed Programs
Smart Meter Data Analytics	Not Included	Not Included	Not Included	Not Included	Low	Mid: Assumptions Based on Pilot or Proposed Programs
Air Quality Management District	Not Included	Not Included	Not Included	Not Included	Not Included	Mid: Limited Assumptions Based on Pilot or Proposed Programs
Agricultural	Not Included	Not Included	Not Included	Not Included	Not Included	Mid: Limited Assumptions Based on Pilot or Proposed Programs
Industrial	Not Included	Not Included	Not Included	Not Included	Not Included	Mid: Limited Assumptions Based on Pilot or Proposed Programs
Conservation Voltage Reduction	Not Included	Not Included	Not Included	Not Included	Not Included	Mid: Limited Assumptions Based on Pilot or Proposed Programs

Source: CEC

For each broad category of AEE savings contribution—CPUC-jurisdictional programs, POU programs, codes and standards, and nonutility programs—the associated scenario design elements described in this chapter were discussed with stakeholders at a meeting of the Demand Analysis Working Group on September 18, 2019. At the planned December 2, 2019, IEPR workshop, staff will show any revisions made to the scenarios in response to stakeholder feedback, along with final savings estimates associated with each scenario. Staff will also show the effect this iteration of AEE will have on the CED 2019 revised annual and hourly electricity demand forecasts.

Recommendations

The California Energy Commission (CEC) should:

- **Further explore options for forecasting load migration.** Identify stakeholders and explore potential use cases for near- and long-term forecasts of load departing from

investor-owned utilities to energy service providers and community choice aggregators. Assess options for developing a forecast that responds to stakeholder needs.

- **Expand IEPR data collection efforts to include community choice aggregator-specific demand-side programs.** During the 2020 revision to the Integrated Energy Policy Report demand forms, engage community choice aggregators to ensure that the CEC's data request adequately captures impacts from load-management and electrification programs that are developed and funded locally.
- **Consider emerging electrification programs and standards in the baseline demand forecast.** Also, identify other drivers of electrification that may be considered reasonably expected to occur and develop scenarios that characterize potential incremental impacts on the forecast.
- **Propose a forum for stakeholders to identify emerging sources of load growth and determine whether they are already embedded in the CEC's demand forecast.**
- **Continue to refine and expand the CEC's hourly forecast.** Further work should prioritize improvements that are responsive to the needs of state planning efforts, such as the CPUC's Integrated Resource Planning process.
- **Continue to refine and develop the CEC's projections of behind-the-meter resources, especially storage adoption and charging patterns.**
- **Collect data on cannabis cultivation in California and estimate load impacts to be included in the baseline demand forecast.**

CHAPTER 8:

Transportation Energy Demand Forecast

Introduction

California is home to roughly 30 million registered cars, trucks, buses, and other motorized on-road vehicles. Over the last 60 years, an increase in vehicle ownership and the number of miles driven has made the transportation sector the largest contributor of greenhouse gas (GHG) emissions in the state, as well as a leading cause of air pollution and ozone-forming gas emissions. Chapter 3 describes the set of rules, policies, goals, and programs to meet federal clean air standards, lower GHG emissions, and reduce California's petroleum dependence. In total, these efforts are essentially transforming California's transportation sector and dramatically changing the way people and goods move throughout the state.

The Public Resources Code, Section 25304, requires the California Energy Commission (CEC) to conduct transportation forecasting and assessment, including a forecast of "statewide and regional transportation energy demand" and assessment of "the factors leading to projected demand growth."⁴²⁷ Forecasting California's transportation sector is challenging given the rapid evolution toward a clean transportation system, and because transportation fuels and vehicles are influenced by developments in the global market.

This chapter provides an overview of the preliminary CEC transportation energy demand forecast, including a comparison of the present and future mix of existing fuels and vehicles against some of the state's goals and benchmarks. The forecast reflects the implications of a mix of existing policies, current consumer preferences, fuel price cases, and projected market and technological conditions.

Summary of Preliminary Forecast Results

CEC staff developed a preliminary transportation energy demand forecast and presented it at a workshop on July 22, 2019.⁴²⁸ Based on feedback from the workshop, along with updated data, CEC staff will develop a revised transportation energy demand forecast for discussion at a workshop in November 2019. The preliminary transportation forecast is integrated into the larger California energy demand forecast for electricity and natural gas that is discussed in

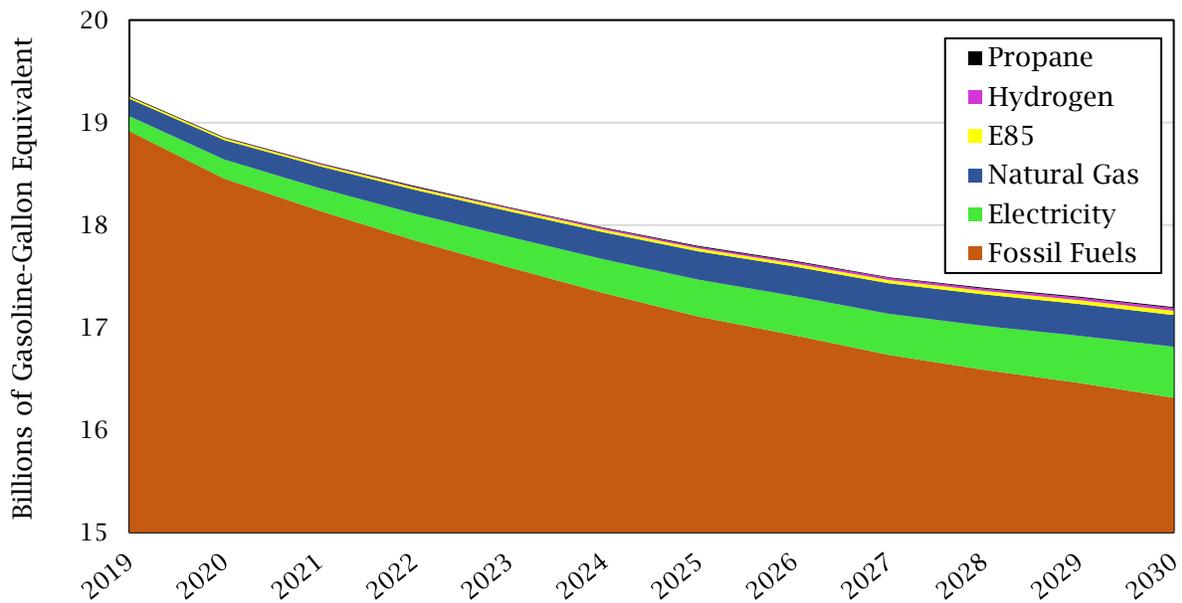
427 Public Resources Code, Section 25304 (b).

428 [Link to workshop documents for the July 22, 2019, workshop on Preliminary Transportation Energy Demand Forecast](https://ww2.energy.ca.gov/2019_energy/policy/documents/#07222019)
https://ww2.energy.ca.gov/2019_energy/policy/documents/#07222019.

Chapter 7, as will be the final transportation energy demand forecast. The preliminary forecast results for transportation energy demand and light, medium, and heavy-duty zero-emission vehicles (ZEVs) are summarized below. The Forecast Results section presents additional results.

Figure 31 shows the distribution of transportation energy demand by fuel type, measured by a common energy unit: gasoline gallon equivalent.⁴²⁹ Petroleum-based fuels continue to represent the largest shares of transportation energy demand, both at present and through the forecasted period. Demand for gasoline is forecasted to decline over time, primarily due to improvements in fuel efficiency and increased electrification. The growth in electricity consumption is mostly a result of growth in light-duty vehicle (LDV) electrification, while the growth in natural gas consumption reflects increased fuel diversification in trucks and buses. In the mid case, the transportation electricity consumption represents 4.6 percent of overall electricity demand in 2030.

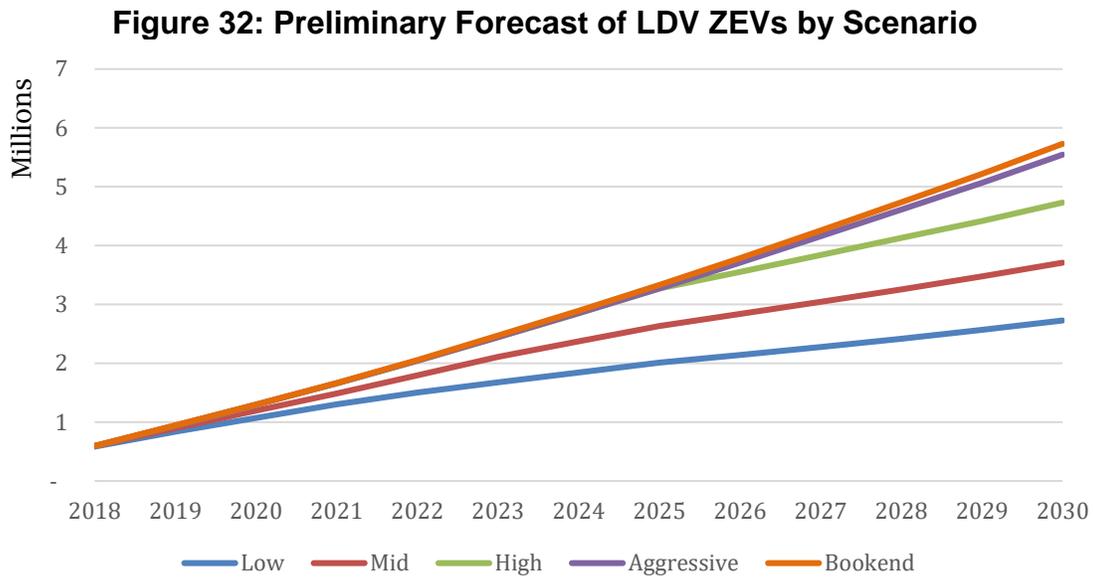
Figure 31: Preliminary Transportation Energy Demand Forecast (Mid Case)



Source: CEC

429 A gasoline gallon equivalent is defined as the amount of alternative fuel equivalent in energy to one gallon of gasoline.

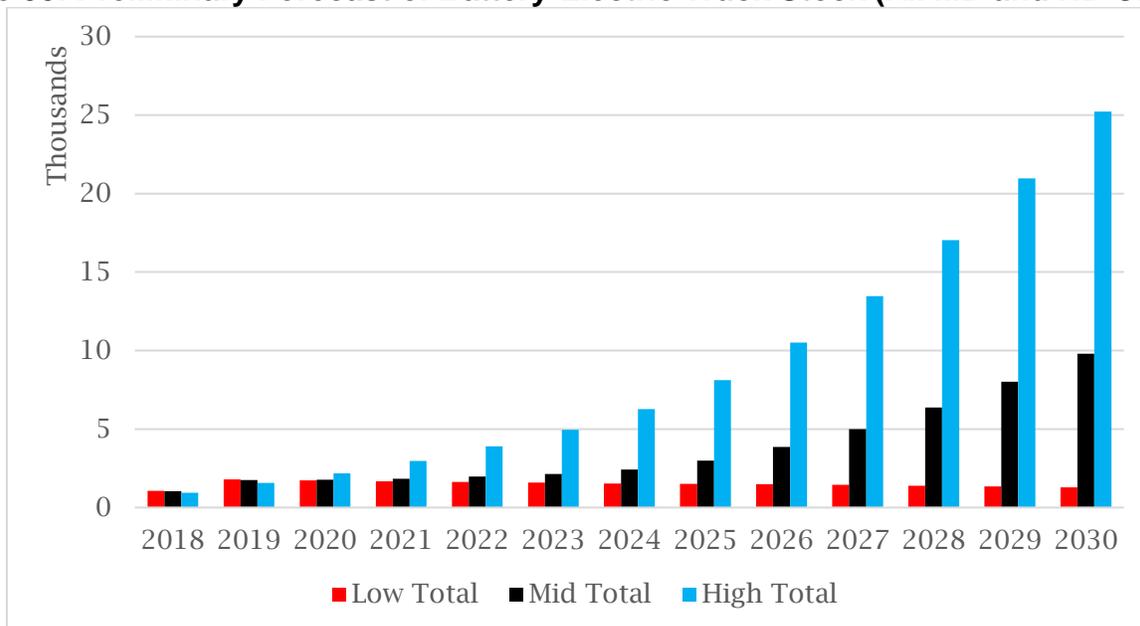
The CEC’s preliminary forecast shows an increase in LDV ZEV population to more than 3.6 million vehicles on the road in 2030 in the mid case and more than 4.6 million in the high case, as shown in Figure 32. ZEVs account for 10.6 percent of all LDVs on the road in 2030 in the mid case and 13.3 percent in the high case. In the aggressive and bookend cases designed to reflect the most optimistic scenarios, ZEV stock is 15.6 percent (5.5 million) and 16.2 percent (5.7 million), respectively.



Source: CEC

The preliminary forecast of medium-duty (MD) and heavy-duty (HD) shows about 25,000 electric trucks across all MD/HD classes by 2030 in the high demand case, as shown in Figure 33.

Figure 33: Preliminary Forecast of Battery-Electric Truck Stock (All MD and HD Classes)



Source: CEC

Forecasting Approach

The CEC's *Transportation Energy Demand Forecast* uses a suite of models (described in Appendix C) that incorporate consumer preferences, regulations, economic and demographic projections, projected improvements in technology, and other market factors to forecast transportation energy demand. The approach starts with current market conditions and projects transportation energy demand based on the inputs briefly described below (and described in more detail in Appendix C). There are no model constraints for the forecast to meet a future target. This approach is in contrast to methods used for strategic planning that begin with a target (such as a quantity of vehicles, fuels, or emissions goals to meet by a future year) and work backward from there to create intermediate goals for the intervening years. In this way, policy makers can use the forecast in conjunction with a corresponding strategic plan to assess progress toward statewide goals.

CEC staff designed different combinations of inputs and assumptions to create several plausible transportation demand cases, consistent with the demand cases used for forecasting total electricity and natural gas demand. The transportation energy demand forecast analyzes three electricity demand cases: low, mid, and high. The three cases are based on economic, demographic, fuel price, and vehicle attribute assumptions (presented in Appendix C) and their relative favorability for ZEV market penetration. The high case represents what is most favorable for ZEVs and the low case represents what is least favorable, while the mid case represents what staff believes to be most likely given current policies and ZEV incentives. The transportation demand forecasts are then integrated into the corresponding demand forecast cases for total electricity and natural gas. Moreover, the transportation energy demand forecast considers aggressive and bookend cases for LDVs.

Major variations among different transportation energy demand cases include assumptions about economic, demographic, and fuel price projections, as displayed in Table 16. These inputs and assumptions influence the vehicle and travel demand forecasts as measured by vehicle population and vehicle miles traveled.

Table 16: Common Electricity Demand Cases Main Inputs

Demand Case	Population Growth	Income Growth	Fuel Prices- Petroleum Fuels	Fuel Prices- Electricity/Natural Gas/Hydrogen
High Demand	High	High	High	Low
Mid Demand	Mid	Mid	Mid	Mid
Low Demand	Low	Low	Low	High

Source: CEC *The aggressive and bookend cases use the same inputs for population, income, and fuel prices as the high demand case Note: Low alternative fuel prices along with high petroleum fuel prices will drive higher adoption of ZEVs (in the high case). Conversely, if petroleum fuel prices are low and alternative fuel prices are high, it will result in a lower adoption of ZEVs (in the low case).

Key Inputs and Assumptions

Table 17 provides an overview of the key inputs to the transportation energy demand forecast, as well as the related data sources. Appendix C provides more details about these inputs.

Table 17: Key Inputs to the Transportation Energy Demand Forecast

Key Input(s)	Description	Data Source(s)
On-road Vehicle Population	The CEC receives vehicle registration data from the DMV and classifies LDV data into 15 vehicle classes, nine fuel and vehicle technology types, model-year vintages, and four market segments (residential, commercial, rental, and government).	California Department of Motor Vehicles
Future Vehicle Attributes	The CEC contracts with outside experts to predict future vehicle attributes, including vehicle price, range, fuel economy, and model availability, that influence consumers' choices.	CEC analysis
Economic and Demographic data	The CEC uses household population, per capita income, and gross state product data to forecast overall future vehicle sales	Moody's and U.S. Department of Finance
Fuel Prices	Future fuel prices are also forecast as an input for consumers' fuel type choices	CEC analysis, U.S. Energy Information Administration
Consumer Preferences	The CEC periodically surveys residential and commercial consumers to determine preferences for fuel type and vehicle class, and importance of attributes	California Vehicle Survey
Policies and Incentives	Government policies and incentives, such as the state EV rebate and federal tax credit, are incorporated into the forecast	CEC analysis
Miles per Vehicle	Average annual miles traveled per vehicle data are used to forecast statewide miles traveled and energy demand	Bureau of Automotive Repair

Source: CEC

ZEV Scenarios

California's transportation sector is quickly transforming due to clean vehicle policies, investments, and market pressures from changing technology and consumer preferences. The CEC's transportation energy demand forecast must keep pace with this transformation, and the CEC must continue robust engagement with transportation sector stakeholders. For this reason, staff formed a subgroup to the Demand Analysis Working Group (DAWG) composed of a diverse set of transportation sector stakeholders to discuss assumptions and technical issues that affect the transportation energy demand forecast for electrification.

Due to the challenge of projecting PEV characteristics over the forecast period, CEC staff created ZEV scenarios designed to capture different levels of LDV electricity consumption. This electricity consumption is the major component of transportation electricity demand that is included in the total electricity demand cases.

At the June 14, 2019, DAWG transportation subgroup meeting, CEC staff presented a set of potential ZEV scenarios to seek feedback from sister agencies, utilities, manufacturers, and other stakeholders and considered the feedback in developing the ZEV scenarios and assumptions. The economic and demographic inputs used in each ZEV scenario correspond with those used in total electricity demand forecast cases. Table 18 shows consumer preferences, vehicle attributes, ZEV incentives, and infrastructure assumptions for each

scenario. All preliminary scenarios use the same vehicle attributes as the ones used in the 2018 IEPR Update. One exception is the bookend scenario that incorporates make and models in additional LDV size classes for FCEVs and plug-in hybrid FCEVs.

The inputs and assumptions for these scenarios range from less favorable for ZEV adoption in the low scenario to more favorable for ZEV adoption in the high, aggressive, and bookend scenarios. The high, aggressive, and bookend scenarios used the economic, demographic, and fuel price inputs from the high demand case.

Table 18: Inputs and Assumptions for ZEV Scenarios

	ZEV Scenarios 2019				
Inputs	Low	Reference	High	Aggressive	Bookend
Preferences					
Consumers' ZEV Preference	Constant at 2017 Level	Increase With ZEV Market Growth			
Incentives					
Federal Tax Credit	Decreasing Starting 2019, Eliminated After 2022	Decreasing Starting 2019	Decreasing Starting 2019	Decreasing Starting 2019	Decreasing Starting 2019
State Rebate	To 2025	To 2025	To 2025	To 2030 for BEV/FCEV	To 2030 for BEV/FCEV
HOV Lane Access	To 2021	To 2023	To 2025	To 2025 for PHEV, to 2030 for BEV/FCEV	To 2025 for PHEV, to 2030 for BEV/FCEV
Attributes					
Availability (in 2030)	Models Available in 11 of 15 BEV and 14 of 15 PHEV Classes	Models Available in 12 of 15 BEV and 14 of 15 PHEV Classes	Models Available in 13 of 15 BEV and 14 of 15 PHEV Classes	Models Available in 13 of 15 BEV and 14 of 15 PHEV Classes	Models Available: BEV in 15, PHEV in 14, FCEV in 8, PHFCEV in 7 CEC LDV Classes
Vehicle/Battery Price (by 2030)	ZEV Prices Based on Battery Price Declining to ~\$120/kWh	ZEV Prices Based on Battery Price Declining to ~\$100/kWh	ZEV Prices Based on Battery Price Declining to ~\$80/kWh	ZEV Prices Based on Battery Price Declining to ~\$70/kWh	ZEV Prices Based on Battery Price Declining to ~\$70/kWh
Max Range (Midsize, 2030)	~333 Miles	~341 Miles	~341 Miles	~341 Miles	~341 Miles
Refuel Time (2030)	15-21 Minutes	15-21 Minutes	10-16 Minutes	10-16 Minutes	10-16 Minutes
Time to Station (2030)	7-8 Minutes	Same as Gasoline	Same as Gasoline	Same as Gasoline by 2025	Same as Gasoline by 2025
Forecast Results					
2030 ZEV Population	2.7 Million	3.7 Million	4.7 Million	5.5 Million	5.7 Million

Source: CEC

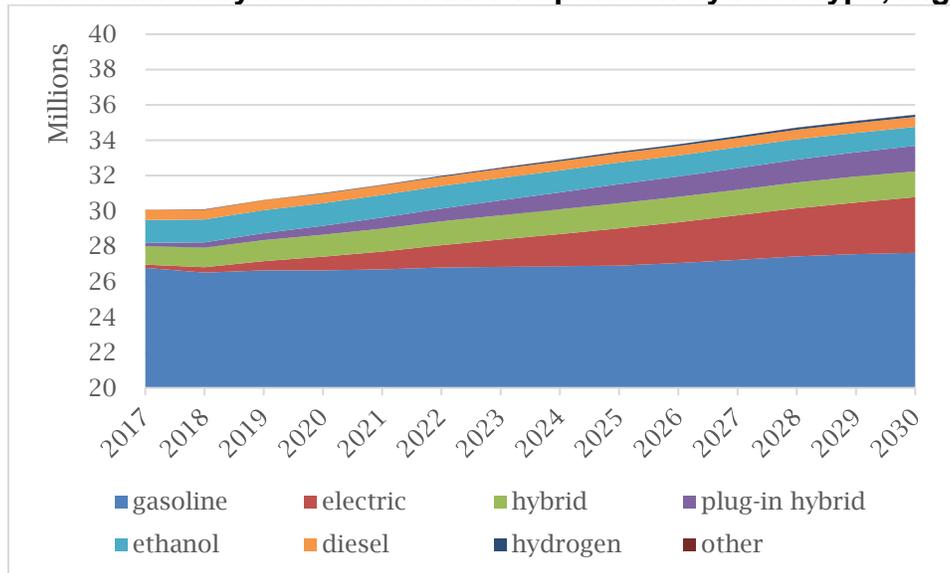
Forecast Results

Using the assumptions and inputs in the suite of models, CEC staff developed a forecast for LD, MD, and HD vehicles and the associated transportation energy demand.

LDV Population Forecast

The LDV demand forecast indicates significant market penetration by plug-in EVs. Through 2018, there were about 500,000 LD ZEVs on the road in California, and the CEC forecasts more than 3.6 million by 2030 in the mid case. Figure 34 shows that the high demand case is even more optimistic for ZEV population growth, as it surpasses 4.6 million by 2030. The aggressive and bookend cases forecast 5.5 million and 5.7 million ZEVs, respectively, in 2030.

Figure 34: Preliminary Forecast of LDV Population by Fuel Type, High Case



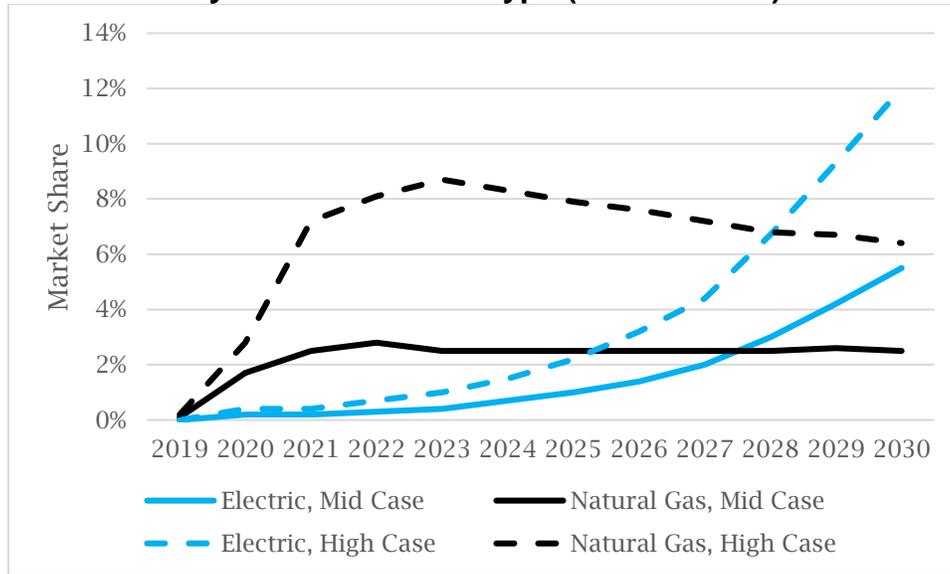
Source: CEC

MD and HD Vehicle Population Forecast

Results from the preliminary forecast show an expansion of alternative fuel and advanced technology vehicles among trucks and buses, assisted by the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP).⁴³⁰ As an example, Figure 35 highlights the growth of both electric and natural gas Class 8 (tractor trailer) truck market share in the mid and high demand cases, with electric trucks at about 12 percent of the sales in 2030, in the high demand case. Fuel cell trucks are not shown in this figure because the forecast shows near-zero market share because of high hydrogen vehicle and fuel prices. Overall, the CEC forecasts about 25,000 electric trucks in the MD and HD truck stock across all classes in 2030, as shown earlier in this chapter.

⁴³⁰ CARB and CALSTART partnered to offer incentives to accelerate the purchase of cleaner and more efficient trucks and buses. [Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project](https://www.californiahvip.org/) <https://www.californiahvip.org/>.

Figure 35: Preliminary Forecast of the Market Share of In-State, New Class 8 Truck Sales by Alternative Fuel Type (Incentivized*)

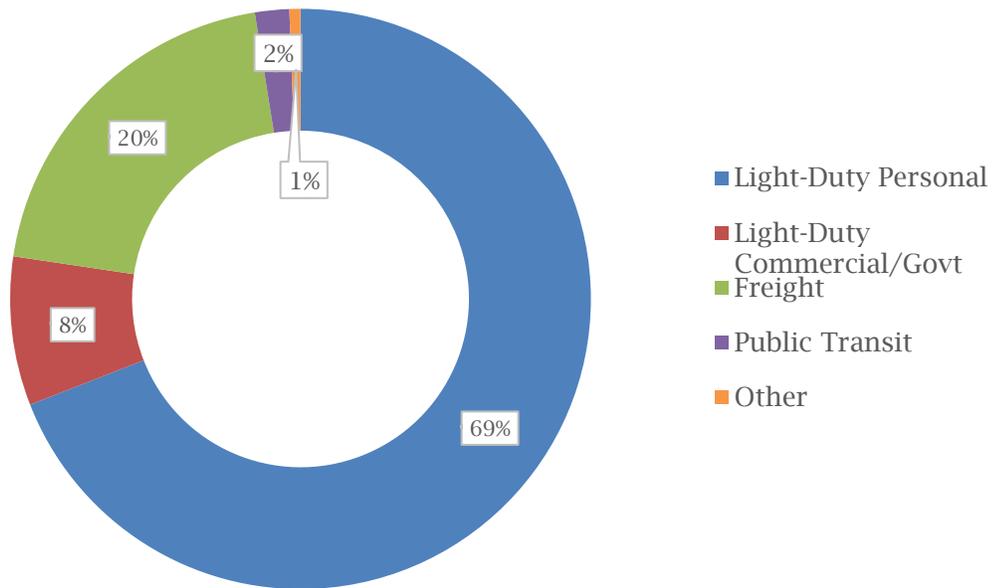


Source: CEC *Catenary electric trucks are not offered incentives

Preliminary Forecast of Transportation Energy Demand

Energy demand by sector is the primary product of the transportation demand forecast. Figure 36 shows the forecast distribution of total on-road and rail energy consumption in different transportation segments in 2030. LDVs represent 77 percent of on-road transportation energy demand in California, while freight accounts for 20 percent.

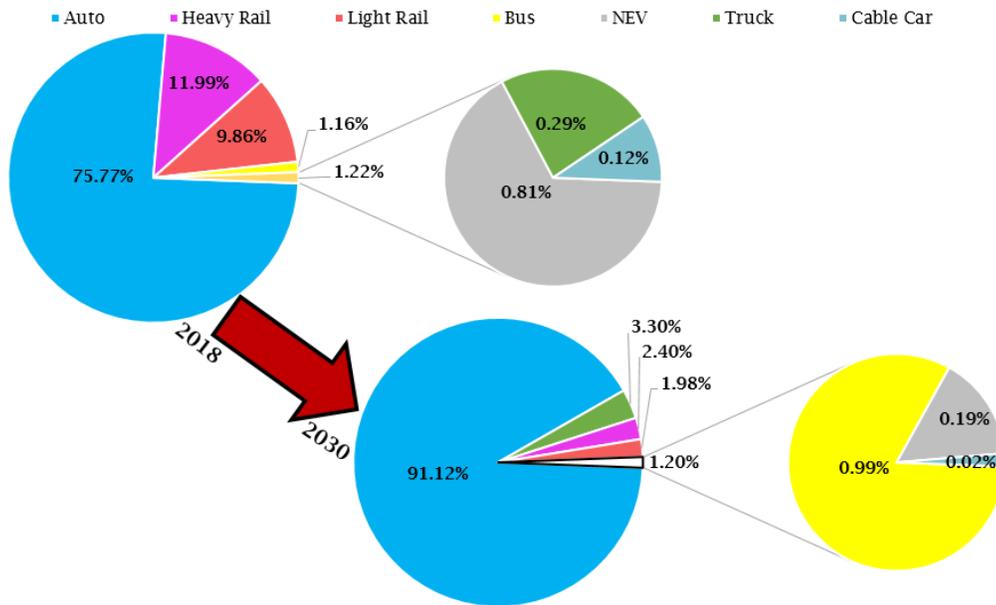
Figure 36: Preliminary Forecast of 2030 Total On-Road Energy Consumption by Transportation Segment, Mid Case



Source: CEC (*On-road* includes rail energy demand, but excludes aviation energy demand as well as motorcycles and off-road transportation energy demand.)

As the amount of alternative fuel consumed within the transportation sector grows, the role of the transportation sector in the broader forecast becomes increasingly relevant. Figure 37 shows the changes in distribution of electricity consumption by vehicle type, between 2018 and 2030, in the high demand case.

Figure 37: Distribution of Transportation Electricity Consumption by Vehicle Type in 2018 and 2030, High Case



Source: CEC. Note: NEVs refers to neighborhood electric vehicles (for example, golf carts).

Emerging Trends

CEC staff is considering ways to better incorporate emerging transportation trends in future forecasts. These trends are related to the implementation of Senate Bill 375 (Steinberg, Chapter 728, Statutes of 2008) and the 3 Revolutions⁴³¹ (electrification, autonomy, and mobility as a service) and were discussed at a workshop on September 26, 2019.⁴³²

SB 375 requires regional transportation plans to adopt a sustainable communities strategy (for example, walkable and bike-friendly neighborhoods near transit) that will reduce GHG emissions from vehicles. Sustainable community development could reduce vehicle miles traveled (VMT), thereby reducing transportation fuel consumption and emissions.

The 3 Revolutions of electrification, autonomy, and mobility as a service will also affect transportation fuel consumption. The potential effects are difficult to forecast because fully autonomous vehicles are not yet market-ready and data on mobility as a service are limited.

⁴³¹ [Link to the 3 Revolutions Future Mobility Program website](https://3rev.ucdavis.edu/) https://3rev.ucdavis.edu/.

⁴³² [Link to presentations from the September 26, 2019, IEPR workshop on Emerging Trends for the California Energy Demand Forecast](https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-09-26_workshop/2019-09-26_presentations.php) https://ww2.energy.ca.gov/2019_energypolicy/documents/2019-09-26_workshop/2019-09-26_presentations.php.

Moreover, the effects will be based largely on consumer decisions and behavior. For example, widespread adoption of ridesharing using electric autonomous vehicles could decrease VMT, transportation fuel consumption, and emissions. Conversely, if autonomous gasoline vehicles are used by individuals riding alone or vehicles frequently travel unoccupied between drop-off and pick-up locations, then VMT, fuel consumption, and emissions could increase. There are also other considerations around how future policies, incentives, or partnerships could influence transportation options and decisions. For example, partnerships between transportation network companies (TNCs) and regional transit agencies where TNC trip costs are subsidized when the rider is connecting to transit could decrease reliance on personal vehicles and VMT. Electrification, autonomy, and mobility as a service could have large impacts on the forecast; so it is important for the CEC to stay engaged with partner agencies and organizations as technologies, incentives, collaborations, and policies evolve.

Recommendations

The California Energy Commission (CEC) offers the following recommendations to consider for future assessments of transportation energy demand.

- **Continue assessing progress toward state goals and assessing transportation market trends.** In collaboration with other agencies, the CEC should continue monitoring which emerging market trends and policies are succeeding in the transportation sector. The CEC should continue to conduct the California Vehicle Survey to ensure consumer preferences used in the forecast reflect the rapidly changing vehicle market. The CEC should also continue to track changes to vehicle attributes; in particular, the zero-emission vehicle market is continuously evolving and staff should monitor fuel cell and battery prices and efficiency improvements.
- **Assess how time-of-use electricity rates and charging infrastructure availability affect the plug-in electric vehicle forecast.** Compared to other transportation fuels, electricity cannot easily be stored over time. As a result, the timing and location of electricity demand by plug-in electric vehicles are also a key element of incorporating the transportation sector into the larger electricity demand forecast. The CEC continues to work with partner agencies and organizations to determine the current charging patterns of electric vehicle owners, as well as the strategies for how vehicle grid integration technologies might help address other goals. For instance, the state can use this new electricity load to reshape hourly load curves in ways that promote renewable energy production and grid stability.
- **Expand scope of data and models to respond to the evolving transportation sector.** The transportation sector has been and will continue to keep changing rapidly, requiring frequent updates to forecasting methodology to incorporate new technologies and new ways that transportation is used. For example, CEC staff is considering how ridesharing and autonomous vehicles will influence vehicle miles traveled. There are limited data from transportation network companies, and more comprehensive data would improve the forecast of vehicle miles traveled.
- **Leverage the transportation energy demand forecasting models to assess zero-emission transportation policies.** The CEC's forecast data and models can be

useful in assessing clean new transportation policies that improve air quality and reduce greenhouse gas emissions. For example, the models can be used to assess the effect of state incentive levels or time-of-use electricity prices on the adoption rates of zero-emission vehicles. CEC staff shall be proactive in conducting analyses that inform current, proposed, and innovative transportation policies.

CHAPTER 9:

Natural Gas Assessment

Introduction

This chapter reviews market trends and provides updates on natural gas supply and production, consumption, and infrastructure on national and state levels. It also provides the California Energy Commission's (CEC's) natural gas price projections for the continental United States and California from 2019 to 2030. A recurring theme of the chapter is the potential effect that recently enacted clean energy and decarbonization policies in the state may have on California's fossil natural gas use and consumption in the short and long terms. An overview of the two major gas utilities provides updates on pipelines, storage, and reliability concerns. In addition, this chapter assesses natural gas trends in Canada and Mexico and provides data on natural gas imports and exports and the potential effect on California (including liquefied natural gas).

Key findings and recommendations include the following:

- On a national level, staff expects Henry Hub⁴³³ natural gas prices to remain below \$3.50 per Mcf through 2030 and below \$5.00 Mcf through 2050. Statewide, staff expects the natural gas wholesale border price average to remain below \$3.50 Mcf through 2030 and below \$4.00 Mcf through 2050. Furthermore, staff expects the average natural gas citygate⁴³⁴ price to remain just below \$4.00 Mcf through 2030 and below \$4.50 Mcf through 2050.
- California will continue to rely on out-of-state natural gas imports for roughly 85 percent to 90 percent of its supply as in-state production continues to decline.
- The transition to cleaner energy sources will result in declining fossil natural gas consumption in California over the next few decades.
- The use of renewable natural gas (RNG) in the transportation sector is likely to grow due to the Low Carbon Fuel Standard (LCFS) and state-funded research and development that promotes the use of RNG in the transportation sector.

433 "Henry Hub" is a pipeline hub on the Louisiana Gulf Coast. It is the delivery point for the natural gas futures contract on the New York Mercantile Exchange (NYMEX).

434 The point where gas leaves the backbone transportation system for the local transmission and distribution system.

- The quantity of RNG is limited and will not be sufficient to meet emissions reduction goals of 80 percent below 1990 levels by 2050.
- California should initiate a planning process to identify the short- and long-term natural gas needs as the state transitions to cleaner energy sources.
- California will need to address aging natural gas infrastructure and the costs to maintain it as the state transitions to electrification and zero-carbon fuels.
- California’s natural gas system could be used for transporting alternatives to fossil natural gas, such as RNG and hydrogen.

California's goal of achieving a near carbon-free electricity sector by 2045 under Senate Bill 100 (De León, Chapter 310, Statutes of 2018)—along with building electrification, electric vehicle adoption, the Renewables Portfolio Standard (RPS), and increased use of renewable natural gas—sets the stage for the eventual phaseout of most fossil natural gas use in California.⁴³⁵ As such, the expectation is that natural gas production and consumption will continue to decline in the state over the next few decades. During this transition, and while California continues to rely on natural gas as an energy resource, the CEC will provide a biennial natural gas market outlook on trends and issues that could affect the state.

In California, natural gas still plays an important role for space heating, oil refining, industrial processes, cooking, electricity generation, and grid reliability. The CEC tracks trends and issues associated with natural gas infrastructure, including natural gas pipeline flows, storage injections and withdrawals, maintenance events and outages, and regulatory proceedings. The CEC analyzes how these trends affect prices, supply (including in-state production), out-of-state deliveries, and demand (particularly by power plants). In addition to tracking trends, the CEC looks ahead by producing a forecast of natural gas prices at key trading hubs.⁴³⁶

In California, signs of a transition away from natural gas are reflected in market trends. In the electricity sector, as renewable resource prices have dramatically dropped, particularly for solar photovoltaic (PV), in-state solar generation increased by 12 percent between 2017 and 2018. California also is looking to retire aging coastal natural gas plants that use ocean water for cooling. These retirements were previously scheduled for 2020, but the California Public Utilities Commission (CPUC) recently recommended a delay due to reliability concerns. (See Chapter 6 for more information.) Some of this capacity will be replaced by gas-fired generation, but renewables, transmission upgrades, and energy storage will replace the

435 There may be industrial uses of natural gas as a chemical feedstock, rather than an energy source, in commercially important organic chemicals or processes for which it may be difficult to find substitutes.

436 A “natural gas hub” is a central pricing point for natural gas usually at the heart of natural gas infrastructure such as pipelines and LNG hubs.

remainder, as part of the strategy to meet air quality goals and reduce GHG emissions. California is also the first state to require rooftop solar on new homes under new building standards that go into effect on January 1, 2020. Additionally, building electrification is a key strategy for the state's residential and commercial building stock to meet new requirements calling for GHG reductions from buildings to 40 percent below 1990 levels by January 1, 2030.⁴³⁷ (See Chapter 2 for more information.)

As the state reduces reliance on fossil natural gas, it must ensure a safe natural gas system while minimizing environmental impacts associated with natural gas infrastructure, including methane leakage. In addition, implementing the most cost-effective uses of renewable natural gas—including for transportation—will require research and development. To prepare California for the energy system of the future, the CEC is collaborating with state and federal agencies, utilities, private industry, and other stakeholders to develop:

- Natural gas vehicle technologies and infrastructure.
- Low-carbon fuels such as renewable natural gas and hydrogen.
- Technologies to track and account for methane emissions.
- Technologies that aim to enhance the safety and reduce the environmental impact of the natural gas system.

The CEC's Energy Research and Development Division is also assessing pathways to the decarbonizing the energy system, as discussed in more detail in Chapter 1. Through the Electric Program Investment Charge (EPIC) Program, the CEC funded a study, which evaluates deep decarbonization scenarios in California for the 2030 and 2050 timeframes. The study was published in June 2018 and provides results from a model that developed eleven long-term energy scenarios to examine the amount of GHG reductions possible with a variety of technologies and mitigation strategies.⁴³⁸ A major focal point of the study is the strategy of "high electrification" that includes, among other clean energy goals, a high rate of electrification in buildings. This scenario predicts a dramatic reduction in natural gas demand at the distribution level, yet it raises concerns regarding reliability and economic impacts. A recent study by Gridworks urges the state to develop a plan to transition the state's natural gas system to meet electrification and carbon neutrality goals.⁴³⁹

437 Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018).

438 Energy and Environmental Economics (E3) produced the study, [Deep Decarbonization in a High Renewables Future](https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf), https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf.

439 Gridworks, [California's Gas System in Transition](https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf), https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.

In addition, this chapter includes CEC proposals for future analysis in these areas. Finally, Assembly Bill 1257 (Bocanegra, Chapter 749, Statutes of 2013) requires the CEC to identify strategies that maximize the benefits of natural gas. Appendix A of the 2019 Integrated Energy Policy Report (2019 IEPR) addresses these requirements and references other IEPR chapters for more information regarding strategies or actions relating to natural gas.⁴⁴⁰ For more details, see Appendix A.

Natural Gas Price Outlook

CEC staff uses the North American Market Gas-Trade model (NAMGas) to simulate the economic behavior of natural gas producers in supply basins and natural gas consumers in demand centers. The structure of the model includes representations of intrastate and interstate pipelines, liquefied natural gas (LNG), import and export centers, and other infrastructure.

The model encompasses regions of the continental United States, as well as Canada and Mexico. Staff developed three “common” cases for the 2019 IEPR—high demand, mid demand, and low demand—using inputs and assumptions that will affect the natural gas market. These inputs and assumptions include the effect of increased energy efficiency, renewable generation growth under the state’s RPS, and varying amounts of coal-fired electrical generation retirements on demand for natural gas. Values for proved and potential reserves in North America appear on the supply side of the NAMGas model.⁴⁴¹

The model provides projections of prices and supply of natural gas for California and the continental United States for 2019 through 2030.⁴⁴² In recent years, natural gas prices have been low. Staff calculated that after accounting for inflation, prices dropped an average of 6.7 percent per year between 2010 through 2016. The development of shale-deposited natural gas accounts for much of the lowering of real prices.⁴⁴³ Assuming current trends in shale gas production, in the mid demand forecast, the model estimates that the Henry Hub price for

440 This legislation states, “Beginning November 1, 2015, and every four years thereafter, the commission shall, with the integrated energy policy report prepared pursuant to Section 25302, identify strategies to maximize the benefits obtained from natural gas, including biomethane for purposes of this section, as an energy source, helping the state realize the environmental and cost benefits afforded by natural gas.”

441 In general, the gas industry categorizes reserves as either proved or potential, and the natural gas resource base consists of proved plus potential reserves. “Proved reserves” tend to have a high degree of recovery certainty. Production of potential reserves is more costly and recovery tends to be less certain.

442 The NAMGas model provides estimates through 2050. However, staff publishes projections only through 2030 to maintain consistency with the CEC’s demand forecast and PLEXOS electricity dispatch modeling.

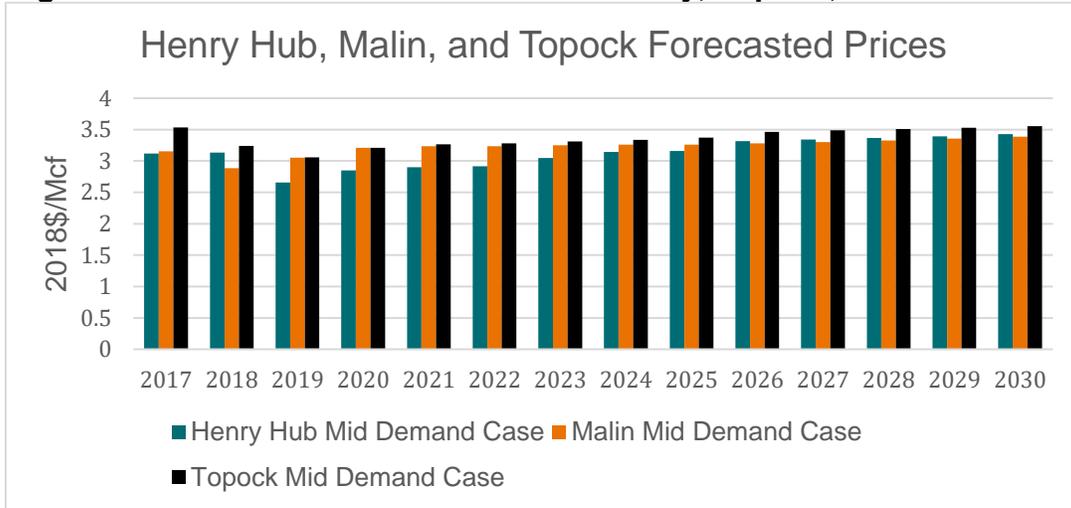
443 Inflation adjusted.

2019 will be \$2.66 (2018 \$) per thousand cubic feet (Mcf).⁴⁴⁴ Prices are expected to rise at about 2.37 percent per year between 2019 and 2030 to \$3.42 Mcf.

North American natural gas supply is assumed to remain abundant for several generations to come, despite continued low prices. The implementation of technology is driving production costs lower and allowing producers to operate economically in the low-price environment the market is now experiencing. This trend, along with high amounts of associated gas production in the Permian Basin and the Bakken Shale (North Dakota), are leading to projections of inflation-adjusted natural gas spot prices at Henry Hub remaining below \$5 (2018\$)/Mcf until 2050. The CEC will need to assess production data for shale gas on an ongoing basis to determine the long-term availability of supplies, since this resource is a relatively recent development.

Figure 38 shows the forecasted mid case demand prices (2018–2030) for Henry Hub and the Malin and Topock hubs. The Malin and Topock hubs are at the state line and represent key trading locations into California. Prices at Henry Hub are lower than Malin and Topock in 2019; however, Henry Hub becomes higher than Malin in 2026 and higher than Topock in 2035. This decrease is due to low production costs of natural gas in the Permian, Rockies, San Juan, and Western Canadian sedimentary basins.

Figure 38: Mid Demand Case Prices for Henry, Topock, and Malin Hubs



Source: CEC staff

444 "Henry Hub" is a pipeline hub on the Louisiana Gulf Coast. It is significant as the delivery point for the natural gas futures contract on the New York Mercantile Exchange (NYMEX). [Link to definition of Henry Hub on U.S. EIA's website](https://www.eia.gov/tools/glossary/index.php?id=H)
<https://www.eia.gov/tools/glossary/index.php?id=H>.

For California, staff assumed that pipeline capacities for interstate and intrastate lines that deliver to California would not change during the forecasted period. As such, the model shows that California’s natural gas supply portfolio—the production basins (Western Canada, Rocky Mountains, San Juan, and Permian Basins) that supply California—will not change from 2018 to 2030. Staff assumed that pipeline capacities for interstate lines and intrastate lines would not increase.⁴⁴⁵ Much of California’s in-state natural gas production comes from existing resources in the Central Valley, and the model projects that production from those resources will decline over time.

The full results of the modeling efforts, method and the calculations appear in the 2019 Natural Gas Market Trends and Outlook Report.⁴⁴⁶

Natural Gas Supply and Production

United States

Natural gas reserves have increased in the United States largely due to shale gas development.⁴⁴⁷ The Potential Gas Committee is a group of industry experts (organized by the Colorado School of Mines) who compile estimates of natural gas reserves for the United States. In 2004, it published an estimate of total U.S. natural gas reserves of 1,311.8 trillion cubic feet (Tcf). The resource base expanded at an average rate of 7.5 percent per year and, by 2016, total natural gas reserves reached 3,141.0 Tcf. At current consumption levels in the United States, this translates into a reserve life index of about 125 years.⁴⁴⁸

Since 2005, U.S. natural gas production has been growing at an annual rate of about 4.1 percent, and since 2009, the United States has been the world’s largest producer of natural gas.⁴⁴⁹ In 2018, production averaged about 83,400 million cubic feet per day (MMcfd). Figure 39 displays U.S. dry natural gas (equivalent) production relative to consumption between 2000 and 2018. Since 2011, natural gas production has outpaced natural gas consumption.

445 Interstate pipelines cross state borders and deliver natural gas to California and intrastate pipelines do not cross state borders and deliver gas within the state.

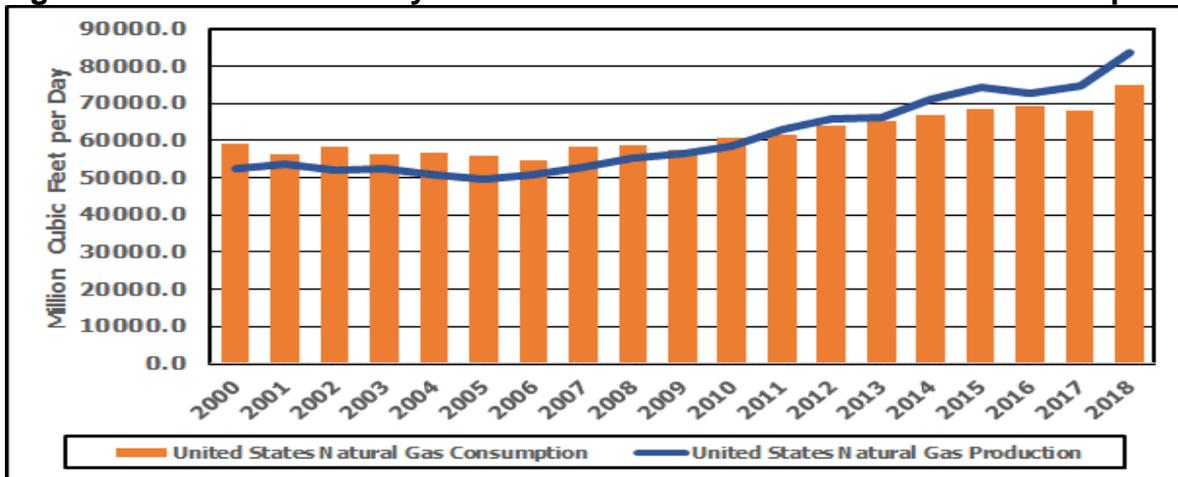
446 CEC, 2019 Natural Gas Market Trends and Outlook Report.

447 The combination of hydraulic fracturing and horizontal drilling in the United States has significantly increased the production of natural gas particularly from tight oil formations.

448 Reserve life index is the total natural gas reserves divided by current consumption. This number represents a *broad approximation* of the life of natural gas reserves within a jurisdiction and does not include due to less favorable economics and reservoirs that are less susceptible to increased production via hydraulic fracturing, imports, or exports of natural gas.

449 [Link to information on the U.S. EIA's website about U.S. petroleum and natural gas production](https://www.eia.gov/todayinenergy/detail.php?id=36292)
<https://www.eia.gov/todayinenergy/detail.php?id=36292>.

Figure 39: United States Dry Natural Gas Production and Annual Consumption



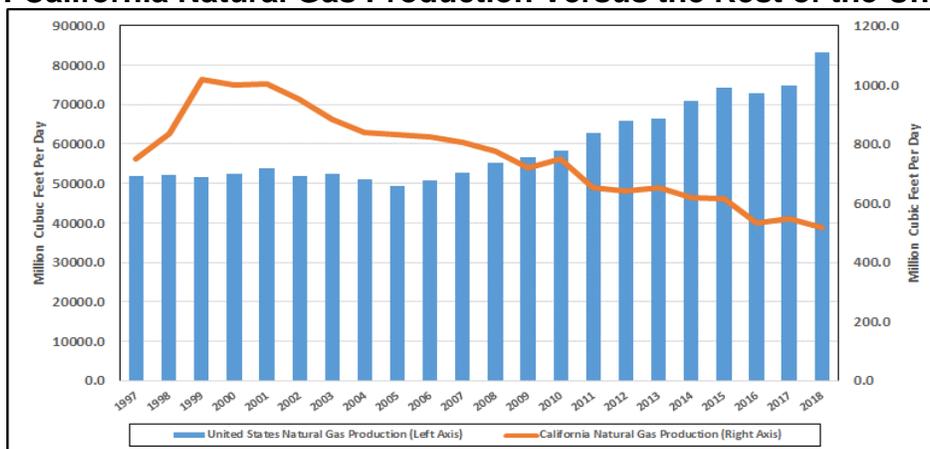
Source: U.S. Energy Information Administration (U.S. EIA)

In 2018, the production of natural gas from shale formations (reservoir pools) provided about 66 percent of U.S. natural gas production. This growth has created opportunities for increased U.S. exports by pipeline and LNG shipments, and in 2017, the United States became a net exporter of natural gas. The national natural gas supply-demand balance, as it stands, shows enough supply from U.S. natural gas production, pipeline imports from Canada, and LNG imports to satisfy U.S. domestic consumption/demand, pipeline exports to Mexico, and LNG exports.

California

California’s in-state natural gas production, much of which comes from geologic basins in the Central Valley, will continue to decline because of less favorable economics and reservoirs that are less susceptible to increased production via hydraulic fracturing. In 2017, in-state sources provided about 548 MMcf/d, or 10 percent, of the natural gas consumed in California, while interstate pipeline shipments satisfied the remaining 90 percent. Figure 40 shows California’s natural gas production as compared to the rest of the United States between 2000 and 2018.

Figure 40: California Natural Gas Production Versus the Rest of the United States



Sources: U.S. EIA and California Division of Oil, Gas, and Geothermal Resources (DOGGR)

Most of California's out-of-state supply comes from the Western Canadian Sedimentary Basin (Alberta and British Columbia, Canada), Permian Basin (west Texas and southwestern New Mexico), San Juan Basin (northwestern New Mexico and southwestern Colorado), and Rocky Mountains (Wyoming). Concerns over greenhouse gas (GHG) emissions associated with these imports led to the passage of Assembly Bill 2195 (Chau, Chapter 371, Statutes of 2018), which requires the California Air Resources Board (CARB) to establish an out-of-state emissions tracking system.

Starting January 1, 2020, CARB will annually publish the amount of GHG emissions resulting from the loss or release of uncombusted natural gas and emissions from natural gas flares associated with the production, processing, and transporting of natural gas imported into the state from out-of-state sources.⁴⁵⁰

Canada

The oil and gas industry in Canada has implemented many of the same technological innovations seen in the United States. Since 2012, natural gas production has been growing at a rate of 2.5 percent per year, reaching an average of 16,154 Mmcf in 2018. In addition, the Canadian Association of Petroleum Producers estimates that the country has about 1,225 Tcf of natural gas reserves, signaling a reserves life index of about 300 years. Natural gas satisfies one-third of Canada's energy requirements. The growth in natural gas production, along with the size of reserves, supports the country's exports to the United States, which averaged about 7,800 Mmcf in 2018.

Mexico

Mexico produced about 4,500 Mmcf in 2014, but this amount declined to an estimated 3,800 Mmcf in 2017.⁴⁵¹ The country has a vast amount of proved reserves, ranging between 200 and 280 Tcf.⁴⁵² Potential reserves exceed 545 Tcf.⁴⁵³ Yet, the development of the country's natural gas resources lags behind that of the United States and Canada because Mexico has not implemented the technical innovations realized in the rest of North America. As a result, over the last five years, Mexico's natural gas production has been falling and the need for imports is rising.

450 Assembly Bill 2195 (Chau, Chapter 371, Statutes of 2018).

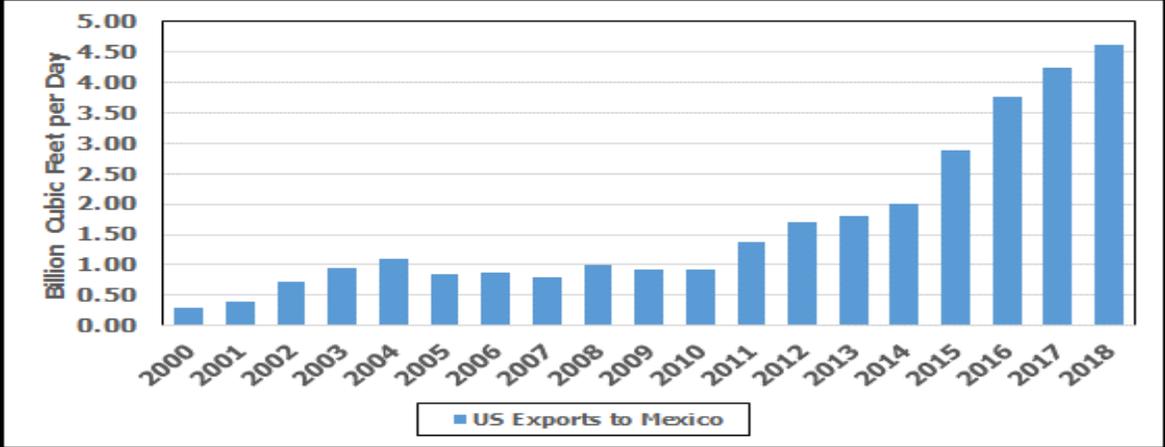
451 Estimated from EIA production data.

452 [Link to information on Mexico's petroleum production](https://www.eia.gov/beta/international/analysis.php?iso=MEX) <https://www.eia.gov/beta/international/analysis.php?iso=MEX>. "Proved reserves" are those for which sufficient drilling has occurred that geologists are relatively certain the reserves can be produced.

453 "Potential reserves" are those that geologists believe exist but for which there remains uncertainty.

In 2010, shipments from the United States to Mexico averaged less than 1 Bcf/d. Since then, pipeline shipments to Mexico have been expanding at an annualized rate of 22.5 percent as Mexico’s natural gas demand has increased for power generation and industrial use. By 2018, shipment volumes exceeded 4.5 Bcf/d. As Mexico imports natural gas from the Permian Basin, increased demand there may reduce the volume of Permian Basin supply available to California. Figure 41 displays annual pipeline shipments to Mexico between 2000 and 2018.

Figure 41: United States Pipeline Shipments to Mexico



Source: U.S. EIA

This growing export market has attracted investments in pipeline construction. However, since early July, Mexico’s President Andrés Manuel López Obrador, has been negotiating contracts for seven natural gas pipeline systems that were in various stages of construction. In late August 2019, Mexico’s president announced a deal that will allow natural gas deliveries to his country to increase.⁴⁵⁴

The imports from these pipelines will help Mexico meet its energy demands. Mexico has struggled to meet its energy demand requirements in several sectors, particularly in power generation, and the delays add uncertainty to its markets. More than 75 percent of feedstock in power generation originates from fossil energy (fuel oil and natural gas).

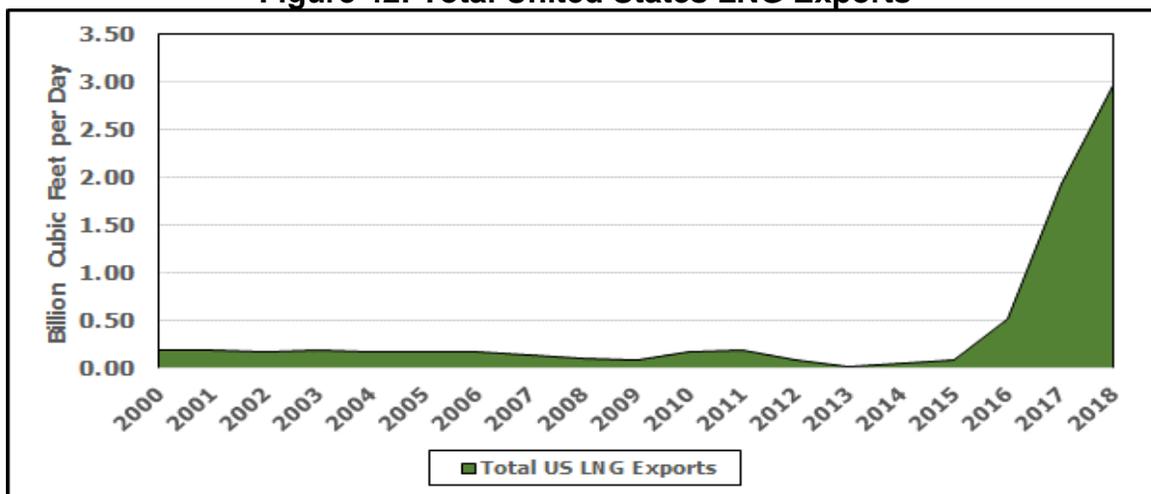
North America LNG Exports

The growth in natural gas production in excess of domestic demand in the United States has resulted in the United States becoming a net exporter of LNG in 2018. Demand from other countries because of rapid growth in natural gas consumption is driving demand for U.S. LNG

454 Wall Street Journal, ["Mexico Reaches Deal with Pipeline Operators on Gas Delivery Contracts"](https://www.wsj.com/articles/mexico-reaches-deal-with-pipeline-operators-on-gas-delivery-contracts-11566916579) https://www.wsj.com/articles/mexico-reaches-deal-with-pipeline-operators-on-gas-delivery-contracts-11566916579.

exports. With new LNG export facilities coming on-line in recent years, the amount of exports has grown rapidly. Between 2000 and 2015, U.S. LNG exports averaged about 0.13 Bcf/d. Three new LNG facilities added between 2016 and 2018,⁴⁵⁵ brought total export capacity at the end of 2018 to 4.3 Bcf/d, while export volume reached almost 3.0 Bcf/d. As of 2019, there are more than 110 LNG plants in the United States.⁴⁵⁶ Figure 42 displays the profile of LNG exports between 2000 and 2018.

Figure 42: Total United States LNG Exports



Source: U.S. EIA

Shipments from the Sempra-Cameron LNG facility in Hackberry, Louisiana, began in June 2019. Sempra-Cameron LNG is the fourth new plant to come on-line since 2016, raising U.S. LNG export capacity to about 4.8 Bcf/d.⁴⁵⁷ By the end of 2020, new export plants should push capacity to almost 9.0 Bcf/d.⁴⁵⁸ Further, pipeline projects coming on-line between 2020 and 2022 to deliver natural gas to the Gulf Coast for LNG export will increase California’s competition for Permian Basin natural gas. This chapter provides more information about these pipeline projects in the infrastructure section below.

455 Since 2016, Trains 1-5 of the Cheniere/Sabine Pass LNG facility in Sabine, Louisiana, the Dominion-Cove Point LNG facility in Cove Point, Maryland, and Train 1 of the Cheniere-Corpus Christi LNG facility in Corpus Christi, Texas, came on-line. [PowerPoint slide showing North American LNG export terminals](https://www.ferc.gov/industries/gas/indus-act/lng/lng-existing-export.pdf) <https://www.ferc.gov/industries/gas/indus-act/lng/lng-existing-export.pdf>.

456 FERC, LNG, [Link to information on LNG from the FERC website](https://www.ferc.gov/industries/gas/indus-act/lng.asp) <https://www.ferc.gov/industries/gas/indus-act/lng.asp>.

457 The Cameron LNG project is located in southwest Louisiana. [Link to Cameron LNG's website](https://cameronlng.com/lng-import-export/) <https://cameronlng.com/lng-import-export/>.

458 [Link to information on LNG facilities from the U.S. EIA's website](https://www.eia.gov/todayinenergy/detail.php?id=39312) <https://www.eia.gov/todayinenergy/detail.php?id=39312>.

In addition to the newly constructed LNG export plants on the Gulf Coast and Atlantic Ocean, there are proposals to construct facilities in Oregon; Baja California, Mexico; and British Columbia, Canada, to serve markets in Asia and the Pacific. These proposed facilities, if they export gas upon completion, would compete with California for natural gas supplies, as these plants would receive gas from the same natural gas supply basins that serve California.

Early in 2020, the Federal Energy Regulatory Commission (FERC) is expected to make a decision on the application for the proposed 1.08 Bcf/d Jordan Cove LNG export facility in Coos Bay, Oregon.⁴⁵⁹ The project includes a 229-mile feeder pipeline that will bring natural gas from the Ruby and Gas Transmission Northwest pipelines in Malin, Oregon, to Coos Bay. Malin is near the border with California and Pacific Gas and Electric's (PG&E's) Redwood Path (Lines 400/401) and connects to the Ruby and Gas Transmission Northwest pipelines there. FERC accepted public comment until July 2019 on the draft environmental impact statement issued by FERC staff.

Across the U.S. border in Baja California, Mexico, Sempra announced in March 2019 that it received authorizations to export U.S.-produced natural gas to its Energía Costa Azul (Costa Azul) LNG facility near Ensenada. In addition, Sempra can re-export LNG from Costa Azul to countries that do not have a free-trade agreement with the United States. Adjacent to the existing Costa Azul import terminal, Sempra plans to construct a three-train export facility in two phases that will serve natural gas demand in Mexico and Asia.⁴⁶⁰ Development of the Costa Azul LNG export project is contingent upon obtaining binding customer commitments, permits (including additional export authorization from the Mexican and U.S. governments), financing, incentives and other factors, and reaching a final investment decision.

According to Natural Resources Canada, there are 13 proposed export terminals in British Columbia ranging in capacity from 0.3 Bcf/d to 4.3 Bcf/d.⁴⁶¹ These 13 proposed terminals have been issued export licenses.

Natural Gas Consumption/Demand

United States

Demand for natural gas in the United States has been growing at an annualized rate of 2.3 percent since 2005. In 2018, the five demand sectors of the United States consumed 27.4 Tcf

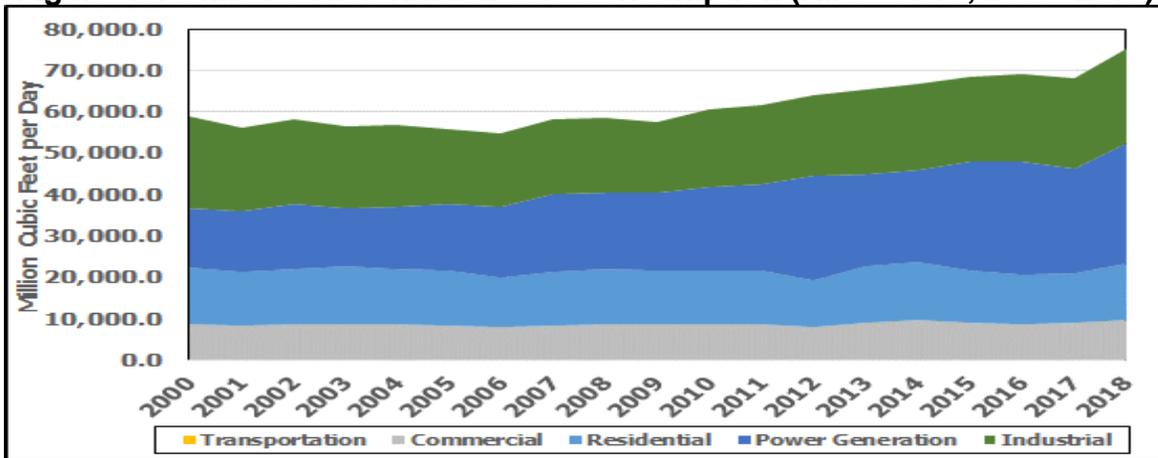
⁴⁵⁹ [Final Environmental Impact Statement on FERC's Web page](https://www.ferc.gov/industries/gas/enviro/eis/2015/09-30-15-eis.asp) <https://www.ferc.gov/industries/gas/enviro/eis/2015/09-30-15-eis.asp>.

⁴⁶⁰ An "LNG train" is a liquefaction and purification facility for an LNG plant, where clean feed gas is cooled using refrigerants. The liquefaction plant may consist of several parallel units arranged in a sequential manner, which is why they are called LNG trains.

⁴⁶¹ [Information on Canadian LNG Projects on the Natural Resources Canada website](https://www.nrcan.gc.ca/energy/energy-sources-distribution/natural-gas/canadian-lng-projects/5683) <https://www.nrcan.gc.ca/energy/energy-sources-distribution/natural-gas/canadian-lng-projects/5683>.

(or an average of 75,087 Mmcf).⁴⁶² Since 2005, demand from the residential and commercial sectors has remained flat. Most of the growth in natural gas demand originated in the industrial and power generation sectors. The share of natural gas usage in the transportation sector, while growing, reaches only about 0.2 percent of total U.S. consumption. Figure 43 shows U.S. natural gas consumption, segregated by sector, between 2000 and 2018.

Figure 43: United States Natural Gas Consumption (All Sectors, 2000–2018)



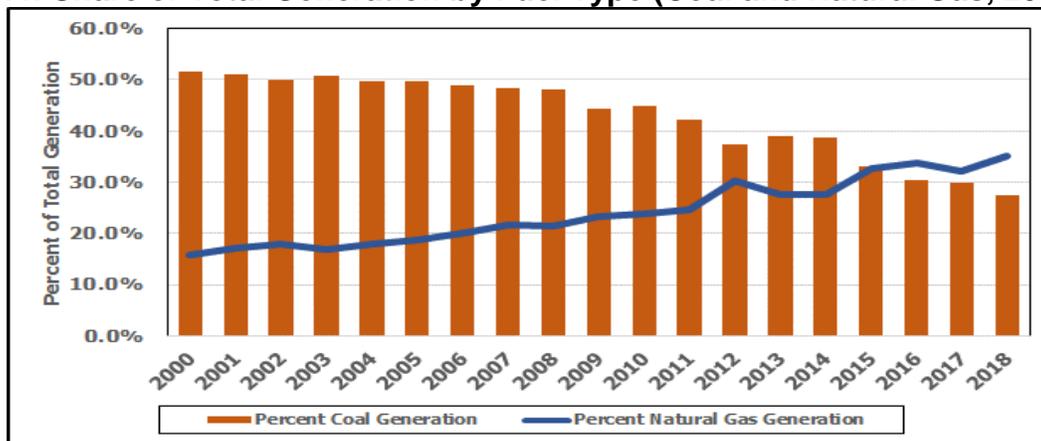
Source: U.S. EIA

The U.S. EIA projects that overall growth will continue at an annual rate of about 0.49 percent between 2018 and 2050. The growth in natural gas production and the lower-than-average prices seen in the last few years support the expanded usage of natural gas, particularly in the industrial and power generation sectors.

An ongoing trend outside California is the shift from coal-fired generation to natural gas. In 2005, coal-fired generation accounted for almost 50 percent of total generation and, in 2018, accounted for only about 27 percent of total generation, a continuation of the decline that started more than a decade prior. Low natural gas prices coupled with compliance with environmental regulations are transforming generation preferences. Coal-fired power plants are facing retirement, are undergoing retrofit, or may need to invest in expensive additional retrofits to remain operating. Lower-than-average natural gas prices are pushing plant owners and operators to replace the lost generation with natural gas-fired electric generation. Figure 44 displays the share of total generation by fuel type (coal and natural gas).

462 U.S. EIA. Natural Gas Monthly. [Link to Natural Gas Monthly Report for June 2019 on the U.S. EIA's website](#)

Figure 44: Share of Total Generation by Fuel Type (Coal and Natural Gas, 2000–2018)



Source: U.S. EIA

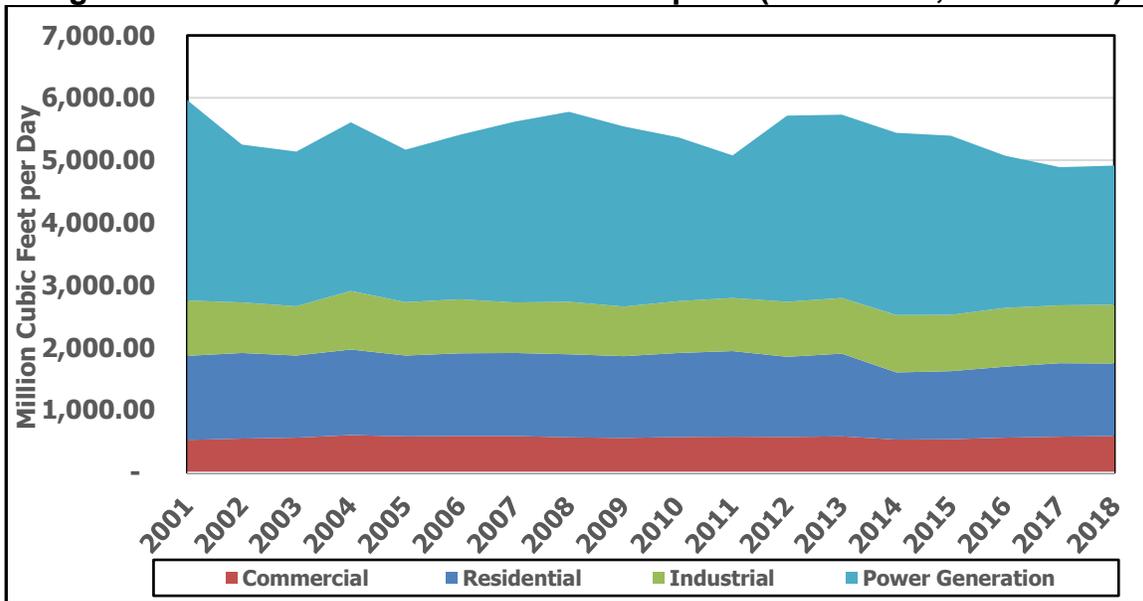
The U.S. EIA estimates that, by the end of 2017, plant operators had retired about 62 gigawatts of coal-fired generation. Natural gas-fired generation is filling the shortfall, climbing to 35.1 percent of total generation in 2018.

California

While natural gas demand is growing in most of the United States, California will experience a decline because of policies such as Senate Bill 350 (De León, Chapter 547, Statutes of 2015) and SB 100. (See Chapter 1 for more discussion of SB 100.) Clean energy goals, such as building electrification, are pushing the state further away from the use of natural gas. Yet, in 2017 and 2018, natural gas was still the most consumed fuel or energy source in California, according to the CEC. California’s five end-use sectors—residential, commercial, industrial, transportation, and electric generation—consumed 1,799,292 MMcf (4,930 MMcfd average) of natural gas in 2018. Figure 45 displays California natural gas consumption for the four major consuming sectors between 2001 and 2018.⁴⁶³

⁴⁶³ The transportation sector accounts for only about 1 percent of consumption of natural gas so figures 7 and 8 do not show this sector.

Figure 45: California Natural Gas Consumption (All Sectors, 2000–2018)

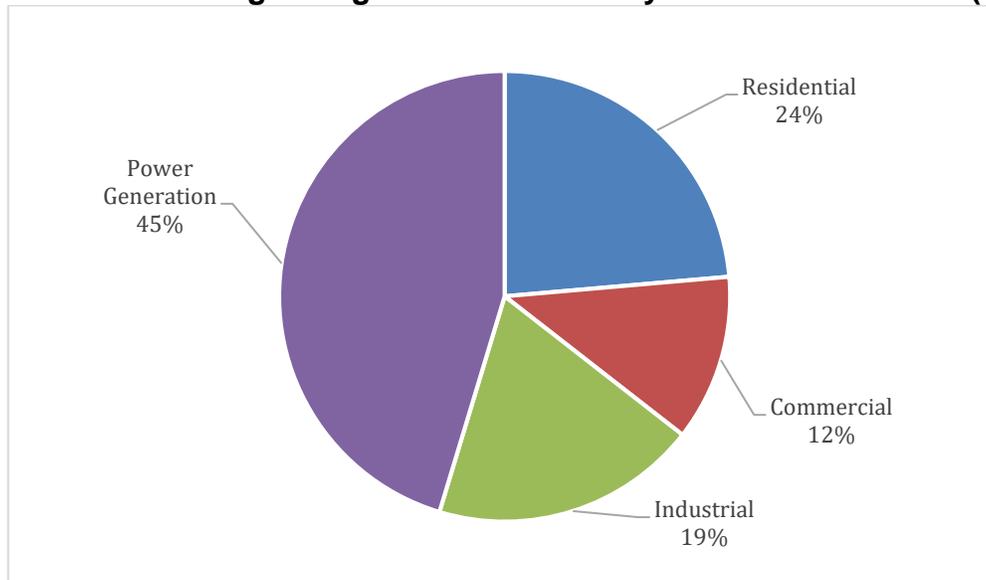


Source: CEC staff

The power generation sector comprises the largest share of the state’s natural gas consumption at 45 percent. At 24 percent, the residential sector runs second. Figure 46 below breaks down the percentage use by the power generation, residential, industrial, and commercial sectors.⁴⁶⁴

464 Based on CEC data.

Figure 46: Percentage Usage of Natural Gas by Sector in California (2018)



Source: CEC staff

As noted in the 2017 IEPR, natural gas demand in the residential sector has experienced a slight yet continuous decline since 1990, while demand has been relatively flat in the commercial, industrial, and power generation sectors.⁴⁶⁵ The CEC reports that in 2018, the power generation sector in California consumed 813,238 MMcf of natural gas—a slight increase from 2017.

Staff expects demand for RNG in the transportation sector to continue to grow throughout the forecast period. The LCFS, which is part of the Global Warming Solutions Act of 2006 (Assembly Bill 32, Núñez, Chapter 488, Statutes of 2006), aims to reduce transportation carbon intensity 20 percent by 2030. CARB revised the LCFS, effective January 4, 2019, making RNG a viable alternative to gasoline or diesel.⁴⁶⁶ RNG has a carbon intensity lower than the new CARB target, which means the fuel will generate LCFS credits that regulated parties can use to offset LCFS deficits. According to the U.S. EIA, RNG accounted for about 7 percent of LCFS credits during the first three quarters of 2018.⁴⁶⁷ RNG is used commonly in heavy-duty

465 [2017 IEPR](https://ww2.energy.ca.gov/2017_energypolicy/) https://ww2.energy.ca.gov/2017_energypolicy/. p. 225.

466 CARB, [Low Carbon Fuel Standards](https://ww3.arb.ca.gov/fuels/lcfs/lcfs.htm) https://ww3.arb.ca.gov/fuels/lcfs/lcfs.htm.

467 [Link to Natural Gas Weekly Update for the week ending March 27, 2019, on the U.S. EIA's website](https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2019/03_28/) https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2019/03_28/.

commercial fleets. In 2018, the transportation sector's consumption of natural gas totaled 19,819 MMcf, representing about 1 percent of the state's natural gas consumption.

Despite this increase in natural gas vehicles, the availability of RNG could constrain its use on a large scale. The CEC-funded study, *Deep Decarbonization in a High Renewables Future*, identifies a high biofuel scenario for transportation as "high risk" due to concerns about the long-term availability and sustainability of growing crops for biofuels.⁴⁶⁸

In the power generation sector, over the last decade there has been a large influx of renewable generation on California's electricity system that is reducing natural gas use. The amount of generation from natural gas plants has decreased by roughly 22 percent, from 117 GWh in 2009 to 91 GWh in 2018. At the same time, renewable generation, including rooftop solar, has more than doubled from 33 GWh in 2009 to 77 GWh in 2018. In terms of installed capacity, the change is even more dramatic. During the last decade, installed renewable capacity in the state more than tripled, increasing from 9,313 MW in 2009 to 32,313 MW in 2018.

Between 2009 and 2018, California retired more than 6,600 MW of natural gas power plants using once through cooling and expects to retire another almost 9,000 MW by the end of 2020 and 1,600 MW more by 2029. Over the last decade, natural gas installed capacity declined from 43,676 MW to 42,885 MW. Peaking gas plants, which run much less frequently than other natural gas plants—in most cases only a few hours on the hottest days—make up only a portion of the once through cooling plant retirements. For power generation, natural gas generation has typically been the swing generation to make up for loss of hydro resources during droughts. In recent years, renewable generation has begun to serve that purpose, further reducing California's reliance on natural gas in the power generation sector.

Infrastructure and Reliability

United States

Production of natural gas from the Permian Basin of West Texas has been growing, and some industry observers expect production will double by 2025. However, the pipeline transmission infrastructure needed to move natural gas from this basin is lagging behind the surge in production. Three pipelines, at differing stages of planning and construction, are attempting to close the gap. Each gas transmission line will haul about 2.0 Bcf/d from the Permian Basin to the Texas Gulf Coast and will mostly serve the LNG export market.

⁴⁶⁸ E3, [Deep Decarbonization in a High Renewables Future](https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf), June 2018, p. 59, https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf.

These pipelines, expected to begin service between 2020 and 2023, will add a dimension of competition for natural gas coming from the Permian Basin. Natural gas that now flows to western and other markets, including California, could experience upward pressure on prices as new markets emerge for gas from this basin. However, the abundance of natural gas now available may lower the risk of higher prices.

California

Pipeline infrastructure serving California remains largely unchanged over the last two years. The state expects no expansions, but Questar Southern Trails (a small pipeline with a capacity of 300 Bcf) discontinued service to California in 2019 due to economic considerations. The CEC expects that this closure will have little or no effect on California's natural gas supply, as deliveries on Southern Trails into California had dropped significantly—from 1,791 MMcf in 2017 to 7.4 MMcf in June 2019, when the pipeline service ended. This delivery amount was small and this demand can be met with other pipelines.

Given the state's clean energy goals, it is unlikely that any new natural gas pipelines or storage fields will be built in California. As such, even as the state transitions away from natural gas, reliance on an existing infrastructure that is aging raises concerns. The San Bruno pipeline explosion in 2010, the gas leak at Aliso Canyon natural gas storage facility in 2015, and ongoing pipeline maintenance issues discussed in detail in Chapter 6 highlight the potential problems.

Should the state transition to RNG or hydrogen (or both) for pipeline injection, pipeline leakage and other potential safety issues would remain. However, estimates of RNG availability show that this resource is limited. The University of California, Davis, estimated 93 billion bcf/year of RNG potential in 2013—enough to meet about 4.5 percent of an average day's demand in California.⁴⁶⁹ In addition, *Deep Decarbonization in a High Renewables Future* states that there is an insufficient amount of RNG in California to meet long-term demand for low-carbon fuels in buildings and industries without widespread electrification.⁴⁷⁰ It is uncertain how much of a role RNG will play in power generation but the state should give this issue more attention as part of its long-term planning process.

Underground natural gas storage plays an important role in balancing California's demand requirements with supply availability. This component of the natural gas system is necessary to meet winter demand. It also maintains the daily supply/demand balance and keeps natural gas flowing to customers in the event of temporary disruptions in production. These

469 Catherine Elder, *Effects on California of Winding Down Natural Gas* <https://www.onlinelibrary.wiley.com/doi/10.1002/gas.22108>.

470 E3, *Deep Decarbonization in a High Renewables Future*, June 2018, https://www.ethree.com/wp-content/uploads/2018/06/Deep_Decarbonization_in_a_High_Renewables_Future_CEC-500-2018-012-1.pdf.

operations ensure reliability since operators withdraw or inject natural gas or both, as demand dictates. As a result, about 20 percent of all natural gas consumed each winter comes from underground storage.

In California, the working gas capacity of natural gas storage fields connected to the systems of PG&E and Southern California Gas Company (SoCalGas) totals 376 Bcf.⁴⁷¹ Natural gas storage fields (including independently owned)⁴⁷² that are interconnected to PG&E's natural gas system have a working gas capacity of 238 Bcf. SoCalGas operates four storage fields that interconnect with its transmission system and have a working gas capacity totaling 138 Bcf. In 2018, the U.S. EIA reported that operators injected 149,116 MMcf into California's storage fields and withdrew 201,291 MMcf.

There is a need to address California's aging natural gas infrastructure and the costs to maintain it as the state transitions to electrification and zero-carbon fuels. The state should also be mindful about potential impacts to customers. A recent Gridworks report notes "As the state transitions to higher electrification, the last customers remaining on the gas system could face unreasonably high rates and potential safety issues. These groups may well be those among us who are least able to afford high rates and least able to finance the new appliances needed to convert to electricity."⁴⁷³ The CEC recognizes this concern and acknowledges that short- and long-term planning efforts must examine the role of the natural gas system, aging infrastructure, and the cost impacts on consumers of moving away from natural gas.

The CEC continues to monitor infrastructure issues for the state's two major gas utilities—SoCalGas and PG&E—to assist with energy planning. Below are updates on new or existing infrastructure issues for both utilities.

Sempra/SoCalGas

Southern California has been the focus of major electric reliability concerns, starting with the unexpected retirement of Southern California Edison's (SCE's) San Onofre Units 2 and 3 in 2013, years ahead of schedule. At the same time, several natural gas-fired power plants along the Southern California coast have closed, and others are scheduled to close in compliance with requirements to phase out the use of once-through cooling.⁴⁷⁴ In addition, a major gas

471 PG&E, in its 2018 gas transmission and storage rate case has asked the CPUC for permission to retire and decommission two of these facilities.

472 Independently owned storage facilities include Lodi Gas Storage, Wild Goose Storage, Central Valley Storage, and Gill Ranch Storage.

473 Gridworks, [California's Gas System in Transition](https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf) https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.

474 "Once-through cooling" refers to the use of coastal water sources for the cooling of power plants, which has detrimental impacts on marine life and estuarine ecosystems. In 2010, the State Water Control Board established a policy to eliminate once-through cooling at power plants by 2020.

leak at the Aliso Canyon natural gas storage field has constrained the operation of the facility that SoCalGas historically used to balance gas supply and demand throughout the year and used in winter to meet peak heating demand. These events, coupled with the multiyear outages of natural gas pipelines 235-2, 4000, and 3000 on the SoCalGas system, are tightening the region's energy supply. For details and updates on pipeline maintenance and related issues in Southern California, see Chapter 6.

In the 2017 IEPR, the CEC reported on a pending application from SoCalGas and San Diego Gas & Electric Company (SDG&E) seeking permission from the CPUC to build a new 47-mile pipeline, Line 3602, to replace an aging Line 1600 in San Diego County.⁴⁷⁵ SoCalGas and SDG&E argued that the new line and derating of Line 1600 would provide a measure of redundancy and additional safety and reliability for gas service into San Diego. Opponents to the project cited concerns over the path of the pipeline through neighborhoods and regional parks. The CPUC rejected the application on June 21, 2018, because the company had not shown why it needed to increase gas pipeline capacity in an era of declining demand and the state moving away from fossil fuels.⁴⁷⁶

PG&E

While storage has played an important role in PG&E's gas balancing requirements, the utility has introduced a new storage strategy that reduces its role in managing seasonal prices for core customers. Currently, PG&E owns three natural gas storage fields in California—McDonald Island, Los Medanos, and Pleasant Creek. Furthermore, PG&E owns 25 percent of the Gill Ranch Storage LLC facility. PG&E's largest facility, McDonald Island, has an operating capacity of 82 Bcf.⁴⁷⁷ Pleasant Creek and Los Medanos are considerably smaller, with operating capacities of 2.0 and 17.9 Bcf, respectively. In addition to Gill Ranch Storage, PG&E's system is connected to three independently owned storage facilities in Northern California—Wild Goose Storage, Central Valley Gas Storage, and Lodi Gas Storage.

As part of its 2019 Gas Transmission and Storage Rate Case (A. 17-11-009), PG&E is proposing to change its storage asset holdings to help decrease long-term costs.⁴⁷⁸ Reasons for the change include increased maintenance costs under DOGGR's new safety regulations

475 The new pipeline would have transported natural gas from the existing Rainbow Metering Station at the Riverside/San Diego County line, south to the Marine Corps Air Station Miramar in San Diego.

476 CPUC. December 4, 2018. [Information on SDG&E and SoCalGas' Application 15-09-013 to the CPUC on the CPUC's website](https://www.cpuc.ca.gov/Environment/info/ene/sandiego/sandiego.html) <https://www.cpuc.ca.gov/Environment/info/ene/sandiego/sandiego.html>.

477 McDonald Island is located on a man-made island in the Sacramento-San Joaquin River Delta.

478 Chapter 11, [Natural Gas Storage Strategy](http://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A1711009/1700/228895701.pdf), <http://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A1711009/1700/228895701.pdf>.

(effective October 2018),⁴⁷⁹ the abundance of natural gas, lower seasonal price differences, and a decline in natural gas use in California.⁴⁸⁰ PG&E also has a robust natural gas backbone pipeline system (primarily composed of Lines 300, 400, and 401) that stretches from the California-Arizona border in Topock, Arizona, to the California-Oregon border in Malin, Oregon. In addition to storage resources, PG&E can use “line pack” within its backbone system as a form of storage.⁴⁸¹

California Incentives for Natural Gas Research and Development, Clean Transportation, and RNG

In addition to the declining costs of renewables and storage, the state offers financial incentives for natural gas research and development and for promoting the use of RNG in the transportation sector. The CEC administers two research and development programs targeted at improving natural gas efficiency: the Natural Gas Research and Development Program and the Food Production Investment Program. In addition to the research and development programs, the CEC administers the Renewable Energy for Agriculture Program, which uses cap and trade dollars to provide grants for the installation of onsite renewable energy on agricultural operations in California, to reduce GHG emissions.

The Natural Gas Research and Development Program is ratepayer-funded for energy efficiency programs and public interest research and development projects benefiting natural gas ratepayers. One role of this program is to examine the role of natural gas in California’s transition to a low-carbon economy. The projects funded by this program support the following strategic objectives:

- Reduce vulnerabilities and fugitive methane emissions in the natural gas infrastructure
- Drive large-scale customer adoption of energy-efficient and low-carbon technology solutions for natural gas end uses that will be challenging to electrify
- Improve the cost-competitiveness of renewable gas
- Minimize air quality impacts from natural gas end uses to zero or near-zero levels

479 California Department of Conservation, DOGGR, [Link to regulations](https://www.conservation.ca.gov/dog/general_information/Pages/Pipelines.aspx)
https://www.conservation.ca.gov/dog/general_information/Pages/Pipelines.aspx.

480 [Volume 1 of PG&E's 2019 Gas Transmission and Storage Rate Case on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A1711009/1700/228895701.pdf)
<http://docs.cpuc.ca.gov/PublishedDocs/SupDoc/A1711009/1700/228895701.pdf>. See Chapter 11.

481 “Line pack” refers to the volume of gas that can be stored in a pipeline. Gas can be injected at a receipt point on a pipeline (or pipeline segment), increasing the pressure in the line, and can be removed later at a delivery point, lowering the pressure in the line.

The Natural Gas Research and Development has funded the following successful projects:⁴⁸²

- The Gas Technology Institute developed a platform for notifying utilities and heavy-equipment operators when they are conducting construction work near natural gas pipelines. This solution also provides real-time visibility. It is anticipated that use of this technology by third-party contractors will result in a 43 percent reduction of nonfatal and noninjury excavation incidents caused by excavators, backhoes, and trenchers.
- The demonstration of a technology developed by Mosaic Materials that aims to lower the cost of cleaning and upgrading biogas. Instead of using a liquid solvent, Mosaic uses low-cost, solid adsorbent pellets. Not only did the solid adsorbent pellets remove carbon dioxide to the purity required to meet pipeline-quality natural gas standards, the simpler process and the use of less equipment showed a capital cost reduction of about 14 percent compared to conventional systems.
- The University of California, Merced, developed aluminum minichannel solar thermal collectors that use flat minichannels or tiny tubes, as opposed to a conventional, copper flat-plate collector. The minichannel technology increases the surface area exposed to sunlight for heat transfer, which improves the efficiency of the collector. The aluminum minichannel solar thermal technology has the potential to lower the cost of solar thermal water heating in single-family and multifamily homes by up to 30 percent while improving the efficiency of the solar collectors by 10 to 15 percent.
- The University of California, Davis' Western Cooling Efficiency Center developed a portable automated process for sealing gaps and tightening the envelope of a building. In real-world tests, a two-person team reduced the air leakage of a 2,200 square-foot, three-bedroom house by 68 percent in fewer than three hours compared to traditional sealing methods that require more than 20 hours of labor.

For Fiscal Year 2019–2020, the CEC submitted a program plan and funding request to the CPUC for the Natural Gas Research and Development Program that proposes the addition of two crosscutting program areas—Natural Gas Strategic Planning Research and a Natural Gas Small Grants Program.⁴⁸³ Projects under the proposed strategic planning research program area are conducting a long-term strategic plan for natural gas technology research and exploring a strategic approach to natural gas pipeline decommissioning. The proposed natural

482 [Link to Natural Gas Research and Development Program Annual Report on the CEC's website](https://ww2.energy.ca.gov/2019publications/CEC-500-2019-026/CEC-500-2019-026.pdf)
<https://ww2.energy.ca.gov/2019publications/CEC-500-2019-026/CEC-500-2019-026.pdf>.

483 CPUC Resolution G-3555. [Link to Resolution G-3555 on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M303/K479/303479245.PDF)
<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M303/K479/303479245.PDF>.

gas small grants program would provide a recurring opportunity for entrepreneurs to apply for funding to test the feasibility of their energy concepts.

The CEC provides grants to help food processors save energy and money while reducing GHG emissions through the Food Production Investment Program. Funding comes from the California Climate Investments program, a statewide initiative that uses cap-and-trade dollars to help reduce GHG emissions, strengthen the economy, and improve public health and the environment. At its February 2019 Business Meeting, the CEC approved Food Production Investment Program funding for projects that aim to reduce natural gas use in various plants including dehydrated food manufacturing, dairy processing, meat processing, and tomato processing. Technologies funded include waste heat capture and recycling, solar thermal energy systems, and factory electrification.

In June 2019, the CEC awarded nearly \$9 million for solar energy and electric vehicle fast chargers on farms, orchards, vineyards, and other facilities in top agricultural counties statewide through the Renewable Energy for Agriculture Program. Agricultural facilities awarded funds include a school, a winery, and orchards.

Recommendations

- **California should initiate an interagency strategic transition planning process to identify the short- and long-term natural gas needs as the state transitions to cleaner energy sources.** Potential needs include improved forecasting, technology assessment, and assessment of existing infrastructure.
- **California will need to address aging natural gas infrastructure and the costs to maintain it as the state transitions to electrification and zero-carbon fuels.**
- **California should deepen the understanding of current and future end uses of natural gas, especially in the industrial and commercial noncore sector.**

CHAPTER 10:

Senate Bill 350 Integrated Resource Plans

Senate Bill 350 (De León, Chapter 547, Statutes of 2015) transformed California’s electricity system planning model by shifting to integrated resource plans (IRPs) that are required to meet several mandates and goals in 2030, including Renewables Portfolio Standard (RPS) procurement requirements and greenhouse gas (GHG) emission reduction goals. IRPs are long-term planning documents that outline how utilities and load-serving entities (LSEs) will meet demand reliably and cost-effectively while achieving state policy goals and mandates. Before SB 350, investor-owned utility (IOU) procurement planning was done through the Long Term Procurement Plan (LTPP) process at the California Public Utilities Commission (CPUC), though for decades publicly owned utilities (POUs) have generally used IRPs to guide their resource procurement.

The process for developing IRPs for CPUC jurisdictional entities and POU differ in significant ways. The CPUC is responsible for overseeing the process of developing IRPs for IOUs, community choice aggregators, and other LSEs. In contrast, POU are responsible for developing their own IRPs. In its IRP process, the CPUC attempts to ensure consistency in inputs and assumptions used in the analysis supporting the IRPs to make comparing and aggregating them easier. However, LSEs can deviate from the Reference System Plan’s (RSP’s) resource mix when developing their respective IRP as long as their IRP complies with the planning standards outlined in the filing requirements accompanying the RSP.⁴⁸⁴ In contrast, SB 350 allows the POU to decide which inputs and assumptions to include in analysis supporting their IRPs. All LSEs and POU must meet GHG emissions targets, RPS procurement requirements, as well as several planning goals. The CPUC adopts or certifies LSE IRPs, while the CEC reviews POU’s IRPs to determine consistency with these requirements.

As discussed below, the GHG emissions from the CPUC’s preferred resource plan developed through its IRP process combined with the emissions from the POU IRPs shows a statewide total that is within the GHG emission target range for 2030.

⁴⁸⁴ The Reference System Plan is the portfolio that an optimal resource mix for the California ISO system based on capacity expansion modelling and is adopted by the CPUC in Year 1 of the IRP cycle. The Preferred System Plan is the portfolio informed by the aggregation individual LSE plans and is adopted in Year 2 of the IRP cycle.

CPUC IRP Process

SB 350 requires the CPUC to develop a portfolio of resources for LSEs including IOUs, community choice aggregators, small and multijurisdictional utilities, and electric service providers (ESPs). Commission Decision D.18-02-018 established a two-year IRP planning cycle.

Year one is focused on:

- Generating and evaluating optimal resource portfolios at the California ISO system-level using a capacity expansion model and production cost model in parallel.
- Adopting one portfolio as the reference system portfolio to be used in statewide planning and in the California ISO transmission planning process.
- Identifying actions needed to implement the selected portfolio, such as new procurement authorization.
- Developing filing requirements for LSEs to use when developing their respective IRPs.

Year two is focused on:

- LSEs developing their respective IRPs.
- Staff evaluation of LSE IRPs, both individually and in aggregate.
- Commission adoption of a preferred system portfolio, informed by the aggregation of LSE IRP plans, to be used in statewide planning and in the California ISO transmission planning process.
- The preferred system plan, which also includes actions needed to implement the selected portfolio, such as new procurement authorization.

Reference System Plan

The CPUC adopted a statewide GHG target of 32,000 MT CO₂e for 2030 for the reference system plan based on targets established by CARB, in consultation with the CEC and CPUC (discussed in the “POU IRPs—Common Themes and Trends” section of this chapter). The modeling of the California ISO footprint resulted in the new resource buildout, or the collection of resource additions necessary in 2030 to meet demand, shown in Table 19.

SB 350 requires LSEs with an average annual load of 700 GWh or more to file IRPs with the CPUC. In their IRPs, LSEs were required to develop at least one portfolio meeting a GHG benchmark set by the CPUC using assumptions matching those used to develop the reference system plan. LSEs are also allowed to develop alternative or preferred portfolios that use different assumptions. LSEs are required to describe the impacts on air pollution and

disadvantaged communities, costs and rates, and local needs, and to describe future actions and lessons learned.⁴⁸⁵

Table 19: Reference System Plan Resource Buildout in 2030

Resource Type	Total Capacity (MW)
Lithium Battery	1,992
Solar	8,828
Wind	1,145
Geothermal	202
Total New Renewables	10,175
Total New Renewables and Storage	12,167

Source: Administrative Law Judge’s Ruling Seeking Comment on Proposed Reference System Plan and Related Commission Policy Actions Attachment, [Link to Attachment C "Summary of Resolve Inputs and Outputs" from the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M195/K910/195910922.PDF)
<http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M195/K910/195910922.PDF>.

CPUC Decision on Preferred System Plan

SB 350 requires LSEs with an average annual load of 700 GWh or more to file IRPs with the CPUC. In their IRPs, LSEs were required to develop at least one portfolio meeting a GHG benchmark set by the CPUC using assumptions matching those used to develop the Reference System Plan. LSEs were also allowed to develop alternative or preferred portfolios that used different assumptions. LSEs were required to describe the impacts on air pollution and disadvantaged communities, costs and rates, and local needs, and to describe future actions and lessons learned.⁴⁸⁶

Six IOUs, 20 community choice aggregators, 17 ESPs, and four electric cooperatives filed IRPs with the CPUC.⁴⁸⁷ Table 20 shows the total resource buildout proposed in the LSE IRPs collectively. The CPUC’s decision approving LSE IRPs noted that many LSEs indicated that

485 Alternative IRPs were required for LSEs with an average annual load under 700 GWh. Under alternative plans, small LSEs, with an annual load less than 700 GWh, filed IRPs including a portfolio conforming to the reference system plan, supply forms already required by the CEC and EIA, as well as qualitative descriptions of how the LSE was planning on meeting each SB 350 requirement.

486 Alternative IRPs were required for LSEs with an average annual load under 700 GWh. Under alternative plans, small LSEs, with an annual load less than 700 GWh, filed IRPs including a portfolio conforming to the reference system plan, supply forms already required by the CEC and EIA, as well as qualitative descriptions of how the LSE was planning on meeting each SB 350 requirement.

487 One ESP did not file on time but did file late. 19 LSE IRPs were initially rejected and required refileing due to not meeting the criteria pollutant reporting requirements.

resources ultimately procured could vary depending on supply availability, supply cost, and other market conditions.⁴⁸⁸

Table 20: Aggregated LSE New Resource Buildout in 2030

Resource Type	Fully Deliverable Capacity (MW)	Energy Only Capacity (MW)	Total Capacity (MW)
Lithium Battery, 1 hour	90		90
Lithium Battery, 4 hour	1,065		1,065
Solar	4,412	2,396	6,807
Wind, In-State	917	412	1,329
Wind, Out-of-state	1,399	375	1,773
Geothermal	310		310
Biomass	7	156	163
Total New Renewables	7,044	3,338	10,382
Total New Renewables and Storage	8,199	3,338	11,537

Source: CPUC, D.19-04-040, pp. 112–113

For the development of the preferred system plan, the CPUC combined the portfolios proposed in the individual LSE plans, relocating some resources due to transmission availability, and termed it the *hybrid conforming portfolio*. Despite each LSE IRP portfolio meeting the individual GHG target, the modeling of the portfolio of the California ISO footprint resulted in an estimated 42,700 MT CO₂e of GHG emissions—exceeding the midpoint of the CARB-adopted GHG target range selected by the CPUC for use in the IRP by 10,700 MT CO₂e.

In Decision 19-04-040, the CPUC rejected the hybrid conforming portfolio, citing “[it] would not result in emissions reductions consistent with the electricity sector GHG goals established by this Commission.”⁴⁸⁹ The CPUC instead adopted a version of the reference system plan, modified to include updated *2017 IEPR* demand forecast assumptions, a 40-year age-based retirement assumption for gas-fired power plants, and updated transmission assumptions from

488 CPUC, D.19-04-040, *Decision Adopting Preferred System Portfolio and Plan for 2017-2018 Integrated Resource Plan Cycle*, April 25, 2019, p. 17.

489 *Ibid.*, p 106.

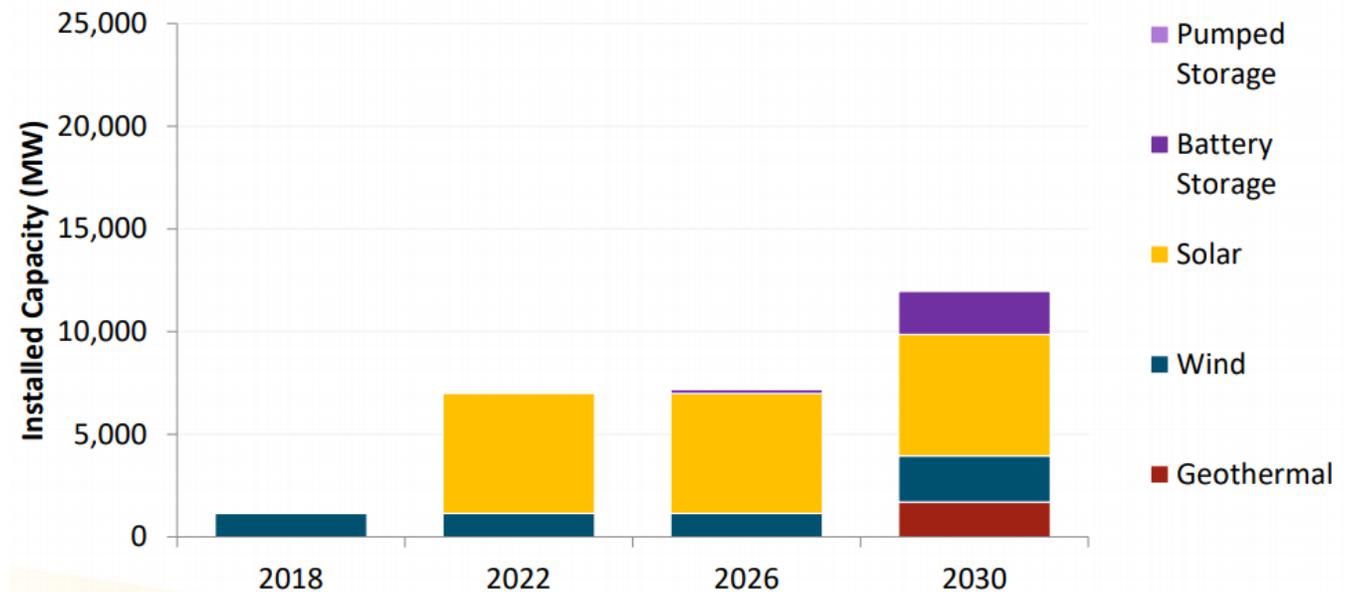
the California ISO. Table 21 and Figure 47 detail the new resource buildout for this portfolio through 2030.

Table 21: Preferred System Plan New Resource Buildout in 2030

Resource Type	Fully Deliverable Capacity (MW)	Energy Only Capacity (MW)	Total Capacity (MW)
Lithium Battery, 1 hour	2,104		2,104
Solar	2,709	3,207	5,619
Wind, In-State	341	803	1,145
Wind, Out-of-State	1,101		1,101
Geothermal	1,048	652	1,700
Total New Renewables	5,200	4,662	9,862
Total New Renewables and Storage	7,304	4,662	11,966

Source: CPUC, D.19-04-040, pp. 112-113.

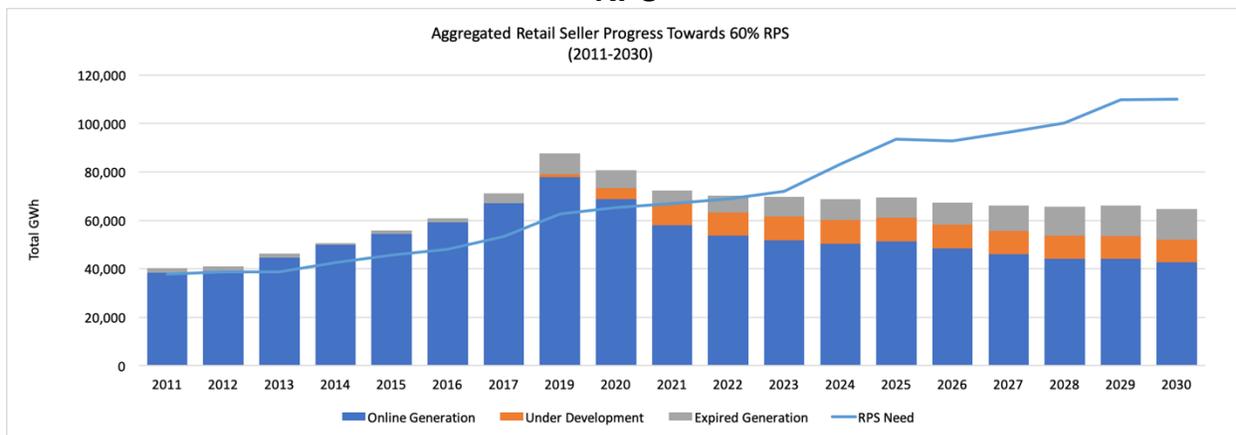
Figure 47: CPUC-Adopted Preferred System Plan



Source: Senate Bill 100 Joint Agency Kick-off Workshop Presentation, CPUC slide no. 59, September 5, 2019, Docket no. 19-SB-100, [Link to SB 100 Joint Agency Kickoff Workshop Presentation](#)
file:///C:/Users/SBailey/Downloads/TN229654_20190905T083005_Senate%20Bill%20100%20Report%20Joint%20Agency%20Kickoff%20Workshop%20%20Presentation%20Final.pdf.

Figure 48 shows the aggregate forecast need and progress in achieving the 60 percent RPS for CPUC jurisdictional load-serving entities.

Figure 48: CPUC Jurisdictional Load-Serving Entity Forecast Need and Progress on RPS



Source: CPUC Renewable Net Short calculations, 2019 RPS Procurement Plans. June 21, 2019.

CPUC IRP Procurement Tracks

CPUC Decision 19-04-040 identified the need for a procurement track in the 2019–2020 IRP cycle to act as a backstop for LSE procurement and ensure that the resources required to meet the clean energy goals and maintain reliability are procured.⁴⁹⁰ The CPUC formally established the procurement track for the 2019–2020 IRP cycle in June 2019.⁴⁹¹ The ruling identified three resource types, or *attributes*, to be addressed through the procurement track: short- to medium-term renewable integration and reliability, renewables, and long-term reliability.

The preliminary schedule prioritized near- to medium-term reliability, with comments and workshops scheduled for summer 2019 and procurement activities initiated by early 2020. Renewables procurement track is scheduled to be initiated in early 2020, while long-term reliability track will be initiated in summer 2020.

POU IRPs—Progress and Trends

The state’s POU are a diverse group of not-for-profit utilities with wide variations in the number and types of customers they serve, the size of their service areas, the types of loads

490 Ibid., pp. 139-141.

491 CPUC, *Assigned Commissioner and Administrative Law Judge’s Ruling Initiating Procurement Track and Seeking Comment on Potential Reliability Issues*, June 20, 2019, pp. 2-5.

they meet, and the resources in their current portfolios.⁴⁹² Local boards govern the POU and, as a result, they answer directly to their customers. The POU are subject to state laws with respect to achieving RPS procurement requirements, attaining the SB 350 doubling targets for energy efficiency, meeting SB 350 IRP requirements, and other state policies and mandates.⁴⁹³ SB 350 requires the state's 16 largest POU to develop IRPs and submit them to the CEC for review.⁴⁹⁴ The CEC reviewed the POU IRPs to determine consistency with SB 350 requirements, including meeting GHG reduction targets and RPS procurement requirements and meeting several other planning goals.⁴⁹⁵

The POU relied on public input in developing their IRPs and found that their customers generally support increasing the amount of renewables in their future resource portfolios. POU customers also supported efforts to move toward clean energy sources. While cost considerations were paramount to the POU in selecting resource portfolios, none identified major increases in costs or rates, even though they include significant amounts of renewables. The POU's IRPs demonstrate their commitment to meeting the state's clean energy goals and aligning their resource portfolios to achieve GHG reductions.

Unique Characteristics of POU

California's POU have some distinct characteristics that set them apart from the state's IOU and some load-serving entities. POU were not subject to electricity market restructuring in the late 1990s and, as such, remain vertically integrated utilities.⁴⁹⁶ The following discusses some of factors that make them unique.

POU Size Differences

The largest POU in terms of number of customers is LADWP, with more than 1.5 million residential and business customers. LADWP's service territory encompasses 465 square miles. In contrast, Imperial Irrigation District's (IID's) has the largest service area, covering 6,741

492 Since only 16 of the POU are required to file IRPs with the CEC, the discussion in this section is specific to those POU and does not address the state's smallest POU.

493 For example, Senate Bill 1368 (Perata, Chapter 598, Statutes of 2006) established the emission performance standard, which limits utilities long-term investments in baseload generation of high GHG-emitting power plants, set at 1,100 pounds of carbon dioxide per megawatt-hour of electricity.

494 The governing board of a POU with an annual electrical demand exceeding 700 GWh is required to adopt an IRP and a process for updating it at least once every five years by January 1, 2019.

495 The CEC adopted the *Publicly Owned Utility Integrated Resource Plan Submission and Review Guidelines (POU IRP Guidelines)* to govern the submission of the POU's IRPs. [Link to information on POU IRPs on the CEC's website](https://ww2.energy.ca.gov/sb350/IRPs/) <https://ww2.energy.ca.gov/sb350/IRPs/>.

496 "Vertically integrated utilities" are monopoly businesses that have a franchise service territory and provide a full suite of services including generation, transmission, distribution, metering and billing, and customer service. Following restructuring, the IOU no longer provide transmission and generation services, although they do own some legacy generation and are subject to retail competition.

square miles, but it has only 150,000 customers. The smallest POU in terms of area served is the City of Vernon, with a service territory of only 5 square miles and 1,910 customers. The size of the load served by POU's also varies widely, with LADWP as the largest, supplying 27,144 GWh of energy and meeting a peak demand (including a 15 percent reserve margin) of 9,104 MW in 2019. The smallest is the City of Redding, which delivers 767 MWh of energy and meets a peak demand (including a 15 percent reserve margin) of 273 MW in 2019.

Variations in Load

The types of customers POU's serve vary significantly, which means their load shapes, or the average change in load served over a 24-hour period, are markedly different. Burbank Water and Power serves almost exclusively residential and commercial customers. As a result, Burbank Water and Power experiences a relatively sharp peak demand occurring from 4:00 p.m. to 6:00 p.m., with an average load factor of 40 percent.⁴⁹⁷ Other POU's that serve significant residential and commercial loads and have low load factors, include the City of Glendale at 37 percent, the City of Redding at 38 percent, and IID and the City of Pasadena each at about 40 percent. Programs such as demand response can help utilities with low load factors reduce their peak load, improving reliability and lowering costs.

In contrast, the City of Vernon is composed primarily of industrial areas, with 99 percent of its demand and energy sales serving commercial and industrial customers. Consequently, it has a slight peak, typically between 12:00 p.m. and 2:00 p.m., with an average load factor of 70 percent. Silicon Valley Power has a similar load factor of roughly 70 percent largely because commercial and industrial customers make up more than 90 percent of its retail sales. Expected growth in data centers for Silicon Valley Power, with load factors as high as 85 percent, will mean loads that are relatively flat throughout the day. Other POU's with high load factors include San Francisco at almost 78 percent and Palo Alto at about 65 percent. Utilities with high load factors have less opportunity for deployment of demand response programs; however, energy efficiency programs can reduce their overall loads and lower costs.

Differences in Resource Portfolios

Some POU's have substantial amounts of large hydro resources in their portfolios, while others have large amounts of fossil generation such as coal and natural gas. Each utility is unique in terms of its current resource mix. The resource mixes of each of the 16 POU's that filed IRPs for 2019, 2025, and 2030 are provided in Appendix D.

⁴⁹⁷ A "load factor" is the ratio of average energy demand to peak demand. A high load factor implies a relatively constant load throughout the day, where a low load factor indicates a high peak demand and low off-peak demand.

A few POU's have high proportions of large hydro resources in their portfolios and, as a result, have low GHG emissions. For example, the City of Palo Alto Utilities relies heavily on large hydro, which accounts for about 59 percent of its resources in 2019. Other POU's that rely heavily on large hydro include the San Francisco Public Utilities Commission with more than 70 percent large hydro and Redding Public Utility with 38 percent large hydro in 2019. Utilities with significant amounts of large hydro are reevaluating large hydro contracts as they begin expiring in the mid-2020s. Even though they help reduce GHG emissions, there is uncertainty about future costs and availability of large hydro resources, which depend on unpredictable precipitation, especially in light of the potential impacts of climate change.

Several POU's have large amounts of fossil resources in their portfolios, including natural gas and coal generation. In 2019, nearly 88 percent of the City of Anaheim's supply is from fossil fuels, with about 50 percent coal and 38 percent natural gas. The City of Burbank relies on fossil fuel for more than 86 percent of its supply in 2019, with 38 percent from coal and 48 percent from natural gas. LADWP relies on fossil resources for about 50 percent of its supplies in 2019, with coal accounting for almost 17 percent and natural gas at about 33 percent. The POU's as a group are eliminating their reliance on coal resources by 2025 to reduce their GHG emissions.

Sacramento Municipal Utility District (SMUD) has no coal generation in 2019 but relies on natural gas for about 48 percent of its supplies. Similarly, Vernon has no coal resources in 2019 but relies on natural gas for about 61 percent in 2019. Turlock Irrigation District also has no coal resources in 2019 but relies on natural gas for about 40 percent of its supply. Utilities with significant amounts of natural gas generation are looking to limit their use of these resources to reduce GHG emissions.

At the other end of the spectrum, because it has so much large hydro generation, San Francisco has no coal or natural gas resources in 2019. Palo Alto also has no coal or natural gas generation in 2019, although it does rely on market purchases, which are assumed to have some level of fossil generation as their source. Redding has less than 1 percent natural gas in its portfolio and no coal.

Disadvantaged and Low-Income Communities

The proportion of disadvantaged and low-income communities, which are exposed to a combination of economic, health, and environmental burdens, varies significantly among the POU's.⁴⁹⁸ LADWP has a high percentage of disadvantaged communities. A key indicator for it is air pollution, since most of LADWP's service territory exceeds federal public health standards

⁴⁹⁸ One way the state identifies disadvantaged communities is by using CalEnviroScreen, an analytical tool that combines census tract data into scores that define disadvantaged communities.

for ozone and particulate matter. To improve air quality, LADWP's IRP focuses on finding clean alternatives to repowering of aging in-basin natural gas plants and transportation electrification.

Similarly, Riverside has high pollution levels, which is why much of its service territory is designated a disadvantaged community. Forty percent of Riverside's population resides in disadvantaged communities, with 30 percent of households having incomes below 200 percent of the federal poverty level. Like LADWP, Riverside is promoting transportation electrification. Most of Turlock's service territory is classified as either low-income or disadvantaged. Turlock has focused on maintaining low rates and offers discount electricity demand charges and weatherizes homes to reduce customer bills. IID also has a high proportion of disadvantaged communities and low-income customers and provides residential and emergency energy assistance.

In contrast, Palo Alto has no areas that are classified as disadvantaged communities, but it does offer rate assistance for customers with low incomes who qualify. Similarly, Redding does not have any disadvantaged communities but deems many of its customers as low-income, offering bill assistance and weatherization programs. Silicon Valley Power has only one disadvantaged community, situated between Highway 101 and the San Jose Airport. Consequently, local governments have limited residential housing development in the area to minimize impacts. While Vernon does not have any disadvantaged communities, many such communities lie at its borders, so it designed programs for its customers that will minimize impacts on neighboring disadvantaged communities.

Other Distinguishing Characteristics

Several POU's serve not only as vertically integrated utilities, but also as balancing authorities that must control generation and transmission throughout their control areas to balance supply and demand continuously. LADWP serves as its own balancing authority and provides these services to other POU's, including Burbank and Glendale. It is the largest POU balancing authority and California's second largest balancing authority outside the California ISO. The Balancing Authority of Northern California, a joint power authority consisting of SMUD, Modesto Irrigation District, Roseville Electric Utility, Redding, and a few smaller POU's, operates the third largest system in California. IID and TID are also California balancing authorities. In addition, several POU's are members of the California ISO balancing authority, including Anaheim, Pasadena, and Riverside. Balancing authorities are required to meet stringent

reliability requirements, which places some constraints on POU in terms of the types and amounts of resources they must carry.⁴⁹⁹

POU IRP Trends and Issues

In general, the POU's IRPs demonstrate their commitment to meeting the state's clean energy goals and aligning their resource portfolios to achieve GHG reductions. The following discusses how the POU's conducted their portfolio planning and the trends and issues that emerged from aggregating individual POU IRPs. These issues include GHG emission reductions, RPS resource additions, forecasted energy and peak needs, fossil fuel (coal and natural gas) use, energy efficiency, transportation electrification, and others. Chapter 2 includes a discussion of how energy efficiency is addressed in IRPs and Chapter 3 includes a summary of transportation electrification in IRPs.

POU Future Resource Needs

Most POU's are forecasting very slow or flat growth in energy and peak demand between now and 2030. One exception is Silicon Valley Power, which is projecting load growth because of the expected addition of new data centers as noted above. The POU's energy demand forecasts generally align with the CEC's demand forecast. However, several POU's expect higher peak demand than forecasted by the CEC. Differences between POU forecasts and the CEC's forecast are likely the result of using differing forecasting methods and assumptions.⁵⁰⁰

In general, POU's are fully resourced through 2025-2027, meaning they have sufficient resources to meet forecasted energy and peak demand. Many of the POU's have natural gas-fired generation that they could use to meet demand. However, without the addition of renewables, POU's would not be able to meet their RPS requirements and GHG emissions targets. Many POU's have long-term contracts that do not expire until later in the planning period that are likely to be replaced by renewable resources.

The IRPs demonstrate that POU's have committed to lowering their GHG emissions by eliminating coal from their portfolios by 2025. Several POU's, including LADWP, Burbank, Glendale, Pasadena, Riverside, and Anaheim, have long-term contracts with the Intermountain Power Plant coal plant in Utah that will expire late in the forecast period. LADWP and other owners of IPP intend to convert the facility from a coal-fired power plant to a combined-cycle

⁴⁹⁹ Reliability standards and protocols are established by the Western Electric Coordinating Council and the North American Electric Reliability Corporation, which have delegated authority over reliability from the Federal Energy Regulatory Commission.

⁵⁰⁰ POU's were not required to use the CEC's forecast in their IRPs but were required to provide information on the methods and assumptions used in their forecasts.

natural gas power plant by 2025.⁵⁰¹ This conversion allows LADWP and the other POU to accelerate their divestiture of coal by two years and eliminates coal from California’s resources mix.⁵⁰²

Several POU also accelerated their divestiture of the San Juan Generating Station, a coal generator in New Mexico. Southern California Public Power Authority members—including IID, Modesto Irrigation District, Silicon Valley Power, and the cities of Glendale, Redding, and Anaheim—held interests in the San Juan Generating Station.⁵⁰³ The early retirement of two units of the power plant provided an opportunity for POU owners to accelerate divestiture of their interests in the coal plant by the end of 2017.

Other POU have long-term contracts with hydroelectric plants operated by the Western Area Power Administration, which expire in the mid-2020s. Some POU have raised concerns about too much reliance on hydro resources due to the associated year-to-year variability and the potential long-term impacts of climate change on hydro availability. Because they do not have to make these decisions about these contracts for several years, they have time to evaluate their options.

Aggregate POU Resources

POU resource portfolios are expected to change significantly between 2019 and 2030. Table 22 shows the aggregated generation resources from the individual POU IRP portfolios. Most of the POU resource portfolios in 2030 contain large increases in solar resources, both rooftop PV and utility-scale solar. The total amount of solar for the POU increases from more than 6,000 GWh in 2019 to more than 16,000 GWh in 2030, more than doubling. The combination of utility-scale and rooftop solar accounts for 22 percent of total POU generation in 2030. Wind resources increase more moderately from about 6,300 GWh to 10,000 GWh, accounting for about 10 percent of total resources in 2019 and increasing to 13 percent in 2030. Over the same period, total renewable resources increases from almost 21,000 GWh to almost 36,000 GWh. However, the total amounts of renewable generation resources include some

501 Riverside and Anaheim are not participating in the long-term repower of IPP. Since the current contract does not end until 2027, they will receive electricity from the project between 2025 and 2027.

502 LADWP, Burbank, Glendale, and Pasadena intend to participate in the repowering of IPP, while Anaheim and Riverside have chosen to not participate. LADWP, Burbank, Glendale, and Pasadena provided the CEC with the necessary compliance filings demonstrating that their renewed contracts for the repowered IPP project meet the Emission Performance Standard.

503 Other POU that were participants in the San Juan plant but were not required to file IRPs include the cities of Colton, Azusa, and Banning,

renewables that are not RPS-eligible. POU progress in achieving RPS requirements is discussed below.⁵⁰⁴

By 2030, POUs plan to eliminate reliance on coal resources, accounting for significant reductions in GHG emissions, as discussed below. Natural gas use decreases from 33 percent of total generation in 2019 to 27 percent in 2030. Natural gas continues to play a large role in meeting peak and ensuring reliability, as well as integrating increasing amounts of renewable resources. Large hydro resources increase only slightly over the planning period. Energy storage accounts for about 2 percent of generation in 2030; however, POUs will be evaluating the costs and performance of energy storage over the planning period to determine whether and when to include additional storage.

Table 22: POU Resources by Type by Year (MWh)

	Generation by Resource (Gwhs)	Generation by Resource (Gwhs)	Generation by Resource (Gwhs)	Percent
Fuel/Technology Type	2019	2025	2030	2030
Solar	6,134	12,067	16,103	22
Other Renewables	8,490	8,692	9,352	13
Wind	6,278	7,991	10,023	13
Energy Storage	133	874	1,325	2
Large Hydro	5,764	5,818	6,051	8
Nuclear	3,725	3,724	3,724	5
Coal	7,185	3,412	0	0
Natural Gas	21,892	21,174	20,271	27
Net Market Purchases	6,589	7,096	7,960	11
Total Energy	66,190	70,848	74,809	100

Source: CEC Energy Assessments Division staff using data from POU IRP Filings

POUs Are Meeting GHG Targets

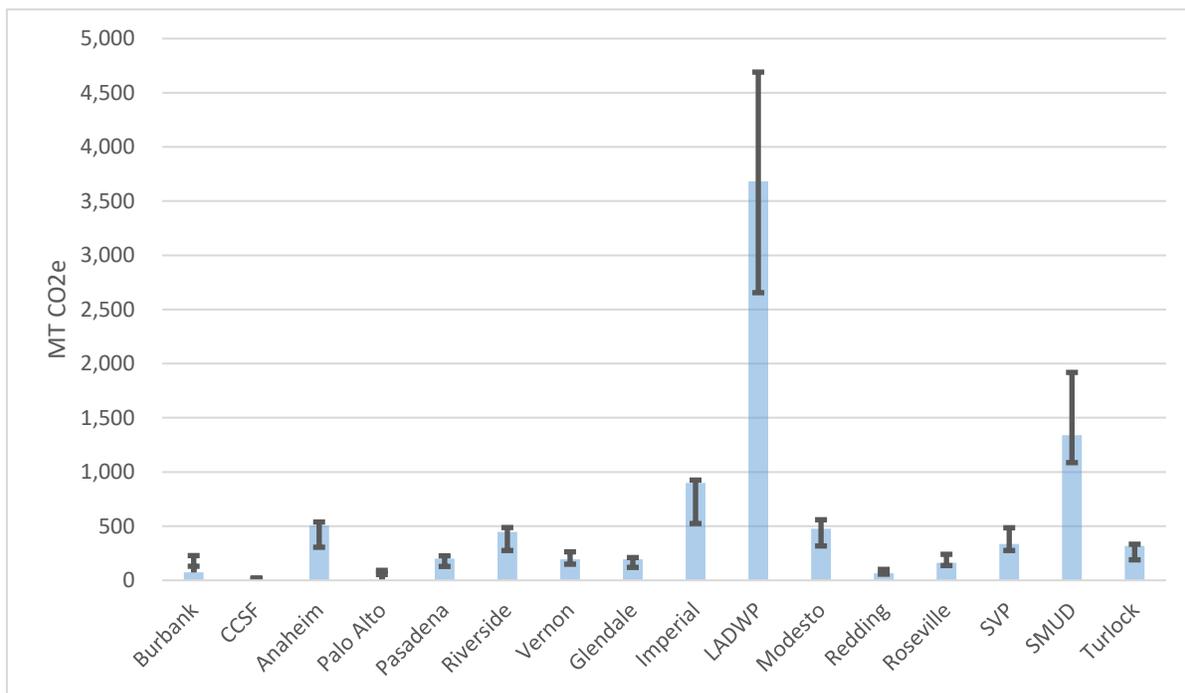
To ease planning and achievement of GHG reductions, SB 350 required CARB, in coordination with the CEC and CPUC, to establish GHG reduction targets for the electricity sector and individual LSEs and POUs. GHG emissions for the electricity sector are generally a function of the demand for electricity and the carbon intensity of the fuel used to generate electricity. The

⁵⁰⁴ Rooftop solar is not an RPS-eligible resource. In addition, the RPS is calculated as the percentage of retail sales, where total generation in Table 5 represents net energy for load. RPS resources are shown in Figure 50.

GHG targets for the state’s POUs and other LSEs reflect the electricity sector’s percentage in achieving the economywide GHG emission reductions of 40 percent from 1990 levels by 2030.⁵⁰⁵ CARB’s GHG planning target for the electricity sector is a range of roughly 30,000 MT CO₂e to 53,000 MT CO₂e, which it determined was sufficiently ambitious on the low end to support POU and LSEs in planning for greater reductions.⁵⁰⁶ Figure 49 shows the resulting emission targets for POU.

All 16 POU’s IRPs meet these targets, with several falling at or below the low end of the target range. Table 23 shows the GHG emission associated with each POU’s portfolio of resources in 2030. The total amount of emissions from POU in 2030 is 8,900 MT CO₂e, which is about 21 percent below the high end of the target range.

Figure 49: POU GHG Emission Target Ranges (MT CO₂e)



Source: CEC Energy Assessments Division based on CARB SB 350 IRP GHG Planning Targets

505 In setting the GHG targets CARB relied on the [2017 Scoping Plan Update](https://ww3.arb.ca.gov/cc/scopingplan/scopingplan.htm), which identifies an achievable and cost-effective path to reducing GHG emissions and establishes target ranges for each sector of the economy including the electricity sector. <https://ww3.arb.ca.gov/cc/scopingplan/scopingplan.htm>.

506 CARB used information about loads and resources developed for allocating emission allowances under the Cap-and-Trade Program as the basis for apportioning emissions targets to individual POU and LSEs. [Staff Report: SB 350 IRP Planning Electricity Sector GHG Planning Targets on CARB’s website](https://ww3.arb.ca.gov/cc/sb350/staffreport_sb350_irp.pdf) https://ww3.arb.ca.gov/cc/sb350/staffreport_sb350_irp.pdf.

Table 23: POU GHG Emissions

POU	2030 GHG Planning Target Range, 30-53 MMT CO₂e- Low	2030 GHG Planning Target Range, 30-53 MMT CO₂e- High	Utility Projections- IRP Emissions Projection (MMT CO₂e)	Utility Projections- Percentage Below High End of Range
Burbank Water and Power	129	228	73	68
City & County of San Francisco	12	22	0	100
Anaheim Public Utilities	305	538	505	6
City of Palo Alto	52	92	3	97
Pasadena Water and Power	128	226	201	11
Riverside Public Utilities	275	487	486	0
Vernon Public Utilities	149	263	193	27
Glendale Water and Power	119	210	193	8
Imperial Irrigation District	524	925	899	3
LADWP	2,665	4,691	3,683	21
Modesto Irrigation District	317	559	476	15
Redding Electric Utility	57	101	64	36
Roseville Electric	136	240	161	33
Silicon Valley Power	275	485	334	31
SMUD	1,086	1,919	1,338	30
Turlock Irrigation District	189	333	316	5
POU Total	6,408	11,319	8,926	21
Reference System Plan	23,077	40,764	34,000	17
Statewide Total	29,485	52,083	42,926	18

Source: CEC Energy Assessments Division staff using POU IRP Filings

The CPUC evaluated the individual IRPs submitted by the LSEs, which, when aggregated, met the LSE-specific GHG emission targets. The modeling of the combined portfolio of LSEs resulted in an estimated 42,700 MT CO₂e of GHG emissions, which exceeds the target by 10,700 MT CO₂e.⁵⁰⁷ However, as noted before, the CPUC rejected that portfolio and instead selected a preferred resource plan, which has 34,000 MT CO₂e, slightly above the CPUC’s GHG target. When added to the POU GHG emissions, the statewide total GHG emissions for the

507 CPUC Decision Adopting Preferred System Portfolio and Plan for 2017-2019 Integrated Resource Plan Cycle Attachment at slide 89.

electricity sector in 2030 is nearly 43,000 MT CO₂e, which falls about 18 percent below the high end of the target range by 2030.

POU RPS Plans—Emphasis on Solar Resources

SB 350 requires that POU IRPs ensure procurement of at least 50 percent renewable energy resources under the RPS by 2030. SB 100 increases the RPS requirement for 2030 from 50 to 60 percent. However, since POUs were required to adopt their IRPs before SB 100 went into effect, POUs were only required to plan for the 50 percent RPS in their IRP. Despite this, many of the POUs updated IRPs that were already underway to include the 60 percent RPS and several filed updated RPS procurement plans to reflect the increased RPS.⁵⁰⁸ All POUs meet the 50 percent RPS in 2030 and plan to update IRPs to meet the 60 percent RPS.⁵⁰⁹

Many of the POUs made early commitments to RPS-eligible resources under long-term contracts or ownership shares, which will allow them to meet their RPS requirements by banking the renewable energy credits from the generation and applying them to meet their future procurement obligations.⁵¹⁰ All POU IRPs demonstrate that they plan to meet the RPS requirement of SB 350 in 2030 and interim compliance periods.⁵¹¹ Table 24 shows the amount of RPS-eligible renewable resources in the POU portfolios in 2019, 2025, and 2030. Figure 50 shows the aggregate POU forecast need and progress in achieving the 60 percent RPS. The resource additions identified in their IRPs are primarily utility-scale solar PV with some wind generation.

508 The CEC requires POUs to adopt and file a renewable energy procurement plan detailing how the POU will achieve its RPS procurement requirements for each compliance period and RPS targets annually under April 2016 amended regulations. [Amended regulations for Enforcement Procedures for the RPS for Local POUs on the CEC's website](https://ww2.energy.ca.gov/2016publications/CEC-300-2016-002/CEC-300-2016-002-CMF.pdf) <https://ww2.energy.ca.gov/2016publications/CEC-300-2016-002/CEC-300-2016-002-CMF.pdf>.

509 PUC Section 9621(b) requires POUs with an electrical demand exceeding 700 GWh to adopt an IRP and a process for updating the plan at least once every five years.

510 A renewable energy credit consists of the renewable and environmental attributes associated with the production of electricity from a renewable source. Renewable energy credits are "created" by a renewable generator simultaneous to the production of electricity and can subsequently be sold separately from the underlying energy.

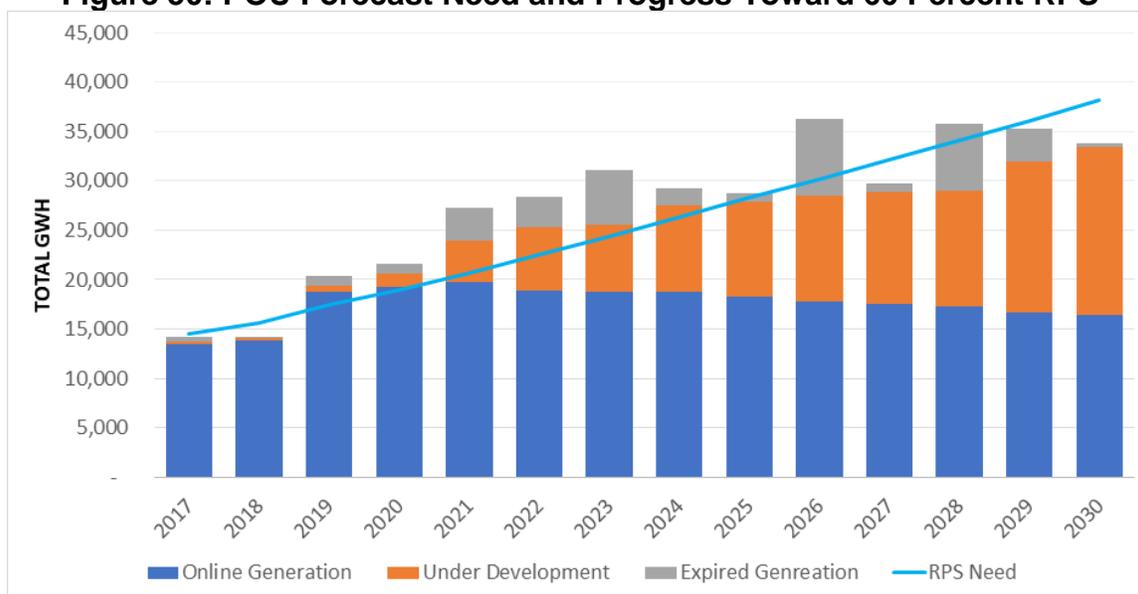
511 Actual procurement of resources in the future may vary from those identified in IRPs. Staff performed analysis to determine whether the plans would meet future RPS requirements prospectively. Staff did not perform the type of detailed analysis used in verifying compliance with RPS requirements, since that can be done only retrospectively.

Table 24: POU RPS Resources (GWh)

POU	2019	2025	2030	2030 Percentage RPS of Retail Sales
Anaheim Public Utilities	732	977	1,172	50 percent
Burbank Water and Power	354	793	728	76 percent
City & County of San Francisco	10	10	10	NA
Glendale Water and Power	315	484	653	50 percent
Imperial Irrigation District	1,048	1,513	1,935	50 percent
LADWP	6,599	9,881	12,793	50 percent
Modesto Irrigation District	774	1,074	1,338	50 percent
City of Palo Alto	417	364	507	58 percent
Pasadena Water and Power	330	516	672	60 percent
Redding Electric Utility	216	293	359	50 percent
Roseville Electric	363	486	557	53 percent
Riverside Public Utilities	1,001	1,135	1,421	57 percent
SMUD	3,253	4,371	5,466	52 percent
Silicon Valley Power	1,190	2,304	2,405	53 percent
Turlock Irrigation District	660	1,010	1,321	60 percent
Vernon Public Utilities	356	579	772	62 percent
POU Total	17,619	25,791	32,109	52 percent

Source: CEC Energy Assessments Division using data from POU IRP filings.

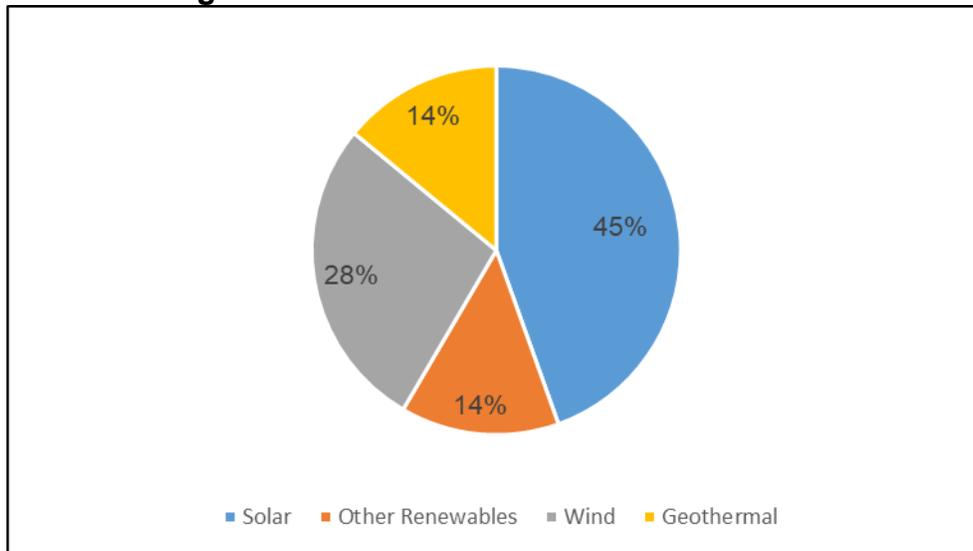
Figure 50: POU Forecast Need and Progress Toward 60 Percent RPS



Source: Presentation by Simon Baker with the CPUC at the Senate Bill 100 kickoff workshop on September 5, 2019

In 2030, the POUs’ portfolio of RPS resources is made up of 44 percent solar, 28 percent wind, 14 percent geothermal, and the remainder small hydro and biomass resources, as shown in Figure 51.

Figure 51: POU RPS Resources Mix in 2030



Source: CEC Energy Assessments Division using data from POU IRP filings.

The projected reliance on solar resources by POU, combined with an additional 5,600 MW of solar capacity in the CPUC's Preferred System Plan,⁵¹² results in additions of solar resources that raise concerns about potential solar over generation and the future availability of flexible resources to meet ramping requirements associated with solar. In addition, large amounts of wind resources will pose integration challenges. The state's POU and LSEs, along with the California ISO and other balancing authorities, will need to continue to plan for sufficient tools to help reliably integrate intermittent renewable resources, as discussed.

512 CPUC, D.19-04-040. April 25, 2019. [Decision Adopting Preferred System Portfolio and Plan for 2017-2018 Integrated Resource Plan Cycle](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M287/K437/287437887.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M287/K437/287437887.PDF>.

Acronyms

AAEE	—	additional achievable energy efficiency
AB	—	Assembly Bill
APEN	—	Asian Pacific Environmental Network
AV	—	autonomous vehicle
Bcf	—	billion cubic feet
BEES	—	Building Energy Efficiency Standards
BEV	—	battery-electric vehicle
BOSR	—	Body of State Regulators
Btu	—	British Thermal Unit
BUILD	—	Building Initiative for Low-Emissions Development
CAEATFA	—	California Alternative Energy and Advanced Transportation Financing Authority
CAL FIRE	—	California Department of Forestry and Fire Protection
California ISO	—	California Independent System Operator
CAPCOA	—	California Air Pollution Control Officers Association
CARB	—	California Air Resources Board
CCR	—	California Code of Regulations
CEC	—	California Energy Commission
CED	—	<i>California Energy Demand Forecast</i>
CEDU	—	<i>California Energy Demand Updated Forecast</i>
CH ₄	—	methane
CLIMB	—	Clean Energy in Low-Income Multifamily Buildings
CNG	—	compressed natural gas
CO ₂	—	carbon dioxide
CO ₂ e	—	carbon dioxide equivalent
CPUC	—	California Public Utilities Commission
CSD	—	Department of Community Services and Development
CSGT	—	Community Solar Green Tariff
CWDB	—	California Workforce Development Board
DAC-GT	—	Disadvantaged Communities Green Tariff Program
DAC-SASH	—	Disadvantaged Communities Single-Family Affordable Solar Homes Program
DAWG	—	Demand Analysis Working Group
DC	—	direct current
DCFC	—	direct current fast charging
DER	—	distributed energy resource
DGS	—	Department of General Services
DPM	—	diesel particulate matter
DR	—	demand response
DRAM	—	Demand Response Auction Mechanism

dth	—	Dekatherm
E3	—	Energy and Environmental Economics
EDD	—	Employment Development Department
EDF	—	Environmental Defense Fund
EIM	—	energy imbalance market
EPIC	—	Electric Program Investment Charge
ESCO	—	energy service company
ESP	—	electric service provider
EV	—	electric vehicle
EVI-Pro	—	Electric Vehicle Infrastructure Projections tool
EVSE	—	electric vehicle supply equipment
FCEV	—	fuel cell electric vehicle
FERC	—	Federal Energy Regulatory Commission
GHG	—	greenhouse gas
Go-Biz	—	Governor's Office of Business and Economic Development
GovOPS	—	California Government Operations Agency
GRC	—	Governance Review Committee
GWh	—	gigawatt hours
GWP	—	global warming potential
HD	—	heavy-duty
HFC	—	hydrofluorocarbon
HVAC	—	heating, ventilation, and air conditioning
ICARP	—	Integrated Climate Adaptation and Resiliency Program
ICCT	—	International Council on Clean Transportation
IEPR	—	Integrated Energy Policy Report
IID	—	Imperial Irrigation District
INFORM	—	Integrated Forecast and Reservoir Management
IOU	—	investor-owned utility
IRP	—	integrated resource plan
kV	—	kilovolt
kW	—	kilowatt
LADWP	—	Los Angeles Department of Water and Power
LBNL	—	Lawrence Berkeley National Laboratory
LCFS	—	Low Carbon Fuel Standard
LSE	—	load-serving entity
LTPP	—	Long-Term Procurement Plan
MD	—	medium-duty
MMBtu	—	million British Thermal Units
MMcf	—	million cubic feet
MMcfd	—	million cubic feet per day
MTC	—	Metropolitan Transportation Commission
MMT CO ₂ e	—	million metric tons of carbon dioxide equivalent
MT CO ₂ e	—	metric tons of carbon dioxide equivalent

MVA _r	—	mega volt amp reactive
MW	—	megawatt
MWh	—	megawatt-hour
NERC	—	North American Electric Reliability Corporation
NF ₃	—	nitrogen trifluoride
NO _x	—	oxides of nitrogen
NREL	—	National Renewable Energy Laboratory
OFO	—	operational flow order
OIR	—	order instituting rulemaking
OPR	—	Governor's Office of Planning and Research
OTC	—	once-through cooling
PEV	—	plug-in electric vehicle
PFC	—	perfluorocarbon
PG&E	—	Pacific Gas and Electric
PHEV	—	plug-in hybrid electric vehicle
PIER	—	Public Interest Energy Research
POU	—	publicly owned utility
PPA	—	power purchase agreement
PSPS	—	public safety power shutoff
PV	—	photovoltaic
Quad Btus	—	quadrillion British thermal units
RASS	—	Residential Appliance Saturation Survey
RD&D	—	research, development, and demonstration
RFS2	—	Renewable Fuel Standard
RNG	—	renewable natural gas
RPS	—	Renewables Portfolio Standard
SACOG	—	Sacramento Council of Governments
SANDAG	—	San Diego Association of Governments
San Onofre	—	San Onofre Nuclear Generating Station
SB	—	Senate Bill
SCAG	—	Southern California Association of Governments
SCE	—	Southern California Edison
SCP	—	Sonoma Clean Power
SCRIP	—	Southern California Reliability Project
SDG&E	—	San Diego Gas & Electric
SF ₆	—	sulfur
SMUD	—	Sacramento Municipal Utility District
SoCalGas	—	Southern California Gas Company
SOMAH	—	Solar on Multifamily Affordable Housing Program
TCOE	—	total cost of energy
TECH	—	Technology and Equipment for Clean Heating
TOU	—	time-of-use
TRU	—	transportation refrigeration units

TPP	—	Transmission Planning Process
UCD	—	University of California, Davis
U.S. DOE	—	United States Department of Energy
U.S. EIA	—	United States Energy Information Administration
U.S. EPA	—	United States Environmental Protection Agency
V2G	—	vehicle-to-grid
VGI	—	vehicle grid integration
Western EIM	—	Western Energy Imbalance Market
WIEB	—	Western Interstate Energy Board
WIRAB	—	Western Interconnection Regional Advisory Board
ZEV	—	zero-emission vehicle

Glossary

Additional achievable energy efficiency

Additional achievable energy efficiency savings include incremental savings from the future market potential identified in utility potential studies not included in the baseline demand forecast, but reasonably expected to occur, including future updates of building codes, appliance regulations, and new or expanded investor-owned utility or publicly owned utility efficiency programs.

Biogas

Biogas is a type of biofuel that is naturally produced from the decomposition of organic waste (such as food scraps). Biofuels differ from fossil fuels because a biofuel is fuel from recently living biological matter, where fossil fuels come from long dead biological matter.

Biomass

Biomass refers to plant or animal matter used for energy production.

Carbon intensity

Carbon intensity refers to the amount of carbon (in terms of weight) emitted per unit of energy consumed.

Climate adaptation

A growing body of new policies—referred to as “climate adaptation”—is intended to grapple with what is known from climate science and incorporate planning for climate change into the routine business of governance, infrastructure management, and administration.

Community choice aggregation

Community choice aggregation (or CCA) lets local jurisdictions aggregate, or combine, their electricity load to purchase power on behalf of their residents. In California, community choice aggregators are legally defined by state law as electric service providers and work together with the region’s existing utility, which continues to provide customer services (for example, grid maintenance and power delivery). (For more information see [“What Is CCA?”](http://www.leanenergyus.org/what-is-cca/) <http://www.leanenergyus.org/what-is-cca/> or [“Community Choice Is Transforming the California Energy Industry,”](http://newsroom.ucla.edu/releases/community-choice-is-transforming-the-california-energy-industry) [http://newsroom.ucla.edu/releases/community-choice-is-transforming-the-california-energy-industry.](http://newsroom.ucla.edu/releases/community-choice-is-transforming-the-california-energy-industry))

Disadvantaged Communities Green Tariff Program

The *Disadvantaged Communities Green Tariff Program*, or *DAC-GT*, allows disadvantaged community residents to subscribe to receive electricity generated from a solar generating plant in California and receive a 20 percent discount on their overall bill.

Disadvantaged Communities Single-Family Affordable Solar Homes Program

The *Disadvantaged Communities Single-Family Affordable Solar Homes Program*, or *DAC-SASH*, provides upfront incentives for solar installations by low-income residents/owners of single-family homes in disadvantaged communities.

Distributed energy resources

Distributed energy resources include:

- *Demand response*, which has been used traditionally to shed load in emergencies. It also has the potential to be used as a low-greenhouse gas, low-cost, price-responsive option to help integrate renewable energy and provide grid-stabilizing services, especially when multiple distributed energy resources are used in combination and opportunities to earn income make the investment worthwhile. Demand response generally refers to a temporary change in energy consumption, generally with a decrease in service level.
- Distributed renewable energy generation, primarily rooftop photovoltaic energy systems.
- “Vehicle grid integration,” or all the ways plug-in electric vehicles can provide services to the grid, including coordinating the timing of vehicle charging with grid conditions.
- Energy storage in the electric power sector to capture electricity or heat for use later to help manage fluctuations in supply and demand.

Electric service provider

An *electric service provider* is a company that purchases wholesale electricity from electricity generators and sells it at a retail level to the general public.

Federal Energy Regulatory Commission

The *Federal Energy Regulatory Commission*, also known as *FERC*, is an independent agency that regulates interstate transmission of electricity, oil, and natural gas. It also regulates natural gas and hydropower projects in the United States.

Greenhouse gas emission profile

A *greenhouse gas emission profile* offers detailed information about the energy use of a building and levels of greenhouse gas emissions and identifies initiatives that could reduce energy use and cost.

Inverter

An *inverter* is an electronic device or circuitry that converts power from a direct current source (such as solar panels or a wind turbine) to alternating current, so that it can be moved over the transmission and distribution system and be used by consumers.

Load-serving entity

A load-serving entity is defined by the California Independent System Operator as an entity that has been “granted authority by state or local law, regulation or franchise to serve [their] own load directly through wholesale energy purchases.” For more information see the [California Independent System Operator’s Web page](#).

Metric ton

A *metric ton* is a unit of weight equal to 1,000 kilograms (or 2,205 pounds).

Microgrid

A *microgrid* is a small, self-contained electricity system with the ability to “manage critical customer resources, provide services for the utility grid operator, disconnect from the grid when the need arises, and provide the customer and the utility different levels of critical support when the need exists.”

Net load

Net load is electricity load minus solar and wind generation.

North American Electric Reliability Corporation

The *North American Electric Reliability Corporation*, also known as *NERC*, is an international regulatory authority whose mission is to reduce risks to the reliability and security of the grid. Its area of responsibility spans the continental United States, Canada, and the northern part of Baja California, Mexico.

Once-through cooling

Once-through cooling technologies intake ocean water to cool the steam that is used to spin turbines for electricity generation. The technologies allow the steam to be reused, and the ocean water that was used for cooling becomes warmer and is then discharged back into the ocean. The intake and discharge have negative impacts on marine and estuarine environments.

Public safety power shutoff

A *public safety power shutoff*, also known as *PSPS*, is a system used by utilities to prevent wildfires by proactively turning off electricity when gusty winds and dry conditions present a heightened fire risk. More information can be found at the [Prepare for Power Down Web page](#).

Renewables Portfolio Standard

The *Renewables Portfolio Standard*, also referred to as *RPS*, is a program that sets continuously escalating renewable energy procurement requirements for California’s load-serving entities. The generation must be procured from RPS-certified plants and the California Energy Commission verifies RPS claims.

Solar-plus-storage

A *solar-plus-storage* project is a battery system that is charged by a connected solar system.

Solar on Multifamily Affordable Housing Program

The *Solar on Multifamily Affordable Housing Program*, or *SOMAH*, provides funding to encourage the installation of solar on existing multifamily affordable housing.

Transmission Planning Process

The California Independent System Operator's annual transmission plan serves as the formal roadmap for infrastructure requirements. This process includes stakeholder and public input and uses the best analysis possible (including the Energy Commission's annual demand forecast) to assess short- and long-term transmission infrastructure needs.

Western Electricity Coordinating Council

The *Western Electricity Coordinating Council*, also known as *WECC*, is a nonprofit organization that works to address risks to the reliability and security of the Western Interconnection's power system.

Western Energy Imbalance Market

The *Western Energy Imbalance Market*, or Western EIM, is a real-time bulk power trading market. The Western EIM's systems automatically find the lowest-cost energy to serve customer demand across a wide geographic area in the western United States.

Western Interconnection

The *Western Interconnection* is a wide area synchronous grid. It is one of the two major alternating current power grids in the continental United States (the other is the Eastern Interconnection).

Western Interstate Energy Board

The *Western Interstate Energy Board* is an organization of 11 western states and three Canadian provinces. The Board promotes energy policy that is developed cooperatively among member states and provinces and with the federal government.

Zero-emission vehicles

There are three types of zero-emission vehicles:

- Battery-electric vehicles (BEVs) that refuel exclusively with electricity.
- Plug-in hybrid electric vehicles (PHEVs) that can refuel with either electricity or another fuel, typically gasoline. BEVs and PHEVs are collectively known as "plug-in electric vehicles," or PEVs.
- Fuel cell electric vehicles (FCEVs) that refuel with hydrogen.

APPENDIX A:

Assembly Bill 1257- Natural Gas Benefits

Background

This appendix meets the requirements of Assembly Bill 1257 (Bocanegra, Chapter 749, Statutes of 2013), referred to as the Natural Gas Act. The legislation directs the California Energy Commission (CEC) to “identify strategies to maximize the benefits obtained from natural gas, including biomethane for purposes of this section, as an energy source, helping the state realize the environmental and cost benefits afforded by natural gas.” The statute required the CEC to perform this analysis first as part of the 2015 Integrated Energy Policy Report (2015 IEPR) and then every four years thereafter. This analysis for the 2019 IEPR is the first update to the one completed as part of the 2015 IEPR.

Since the passage of AB 1257, Senate Bill 1374 (Hueso, Chapter 611, Statutes of 2018) amended the Natural Gas Act statutes by ending the reporting requirement on November 1, 2025.⁵¹³ Further, the state has enacted policies with potentially significant impacts on natural gas use, including Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) and Senate Bill 100 (De León, Chapter 310, Statutes of 2018).

As directed by AB 1257, the CEC is consulting with the California Public Utilities Commission (CPUC); the State Water Resources Control Board (SWRCB); the California Independent System Operator (California ISO); the California Air Resources Board (CARB); the Department of Oil, Gas, and Geothermal Resources (DOGGR); and the Department of Conservation to obtain relevant input. The CEC is also collaborating with California’s gas utilities, other state and federal agencies, and other organizations on developing low-emission natural gas and hydrogen technologies for the transportation sector, more efficient uses for natural gas, low-carbon fuels and a fueling infrastructure, as well as pathways to decarbonize California’s energy system. In addition, the CEC’s Natural Gas Research and Development Program and the Clean Transportation Program (formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program) have provided funding and technical expertise in support of these collaborations.

⁵¹³ The last report will be due in 2026.

This section discusses these strategies, which include studies, research, projects, and other initiatives by the CEC and other agencies to optimize the use of natural gas while working to achieve carbon neutrality.

Requirements of the Statute

Section 25303.5(b) (1): Optimizing Natural Gas as a Transportation Fuel

This section summarizes CEC compliance with AB 1257 requirements to optimize natural gas as a transportation fuel, using funding from the CEC's Natural Gas Research and Development Program and the Clean Transportation Program.

Natural Gas Vehicles

Natural gas vehicles and fueling infrastructure are commercially mature alternative transportation technologies, and California has deployed a significant number of these vehicles. Nearly 19,000 medium- and heavy-duty natural gas vehicles operate in California, making this fuel type the most common alternative fuel vehicle in each of these vehicle classes. California leads the nation in the number of compressed natural gas (CNG) and liquefied natural gas (LNG) fueling stations, with 328 public or private CNG stations and 46 public or private LNG stations. Low-carbon biomethane and the latest natural gas engine emission control technologies can also provide substantial reductions in greenhouse gas (GHG) and criteria pollutant emissions compared to a conventional diesel truck. Biomethane has some of the lowest carbon intensity values. Biomethane from wastewater biogas offers life-cycle GHG emissions reductions of as much as 92 percent compared to diesel, while biomethane derived from high-solids anaerobic digestion can reduce life-cycle GHG emissions by upward of 125 percent.⁵¹⁴

The CEC's Natural Gas Research and Development Program supports the development of advanced near-zero emission natural gas engines that use renewable gas and hybrid gas/electric fuels. Past funding awards supported natural gas engines designed to meet the 2010 emissions standard. The program funded the development of Cummins Westport Inc.'s Near-Zero natural gas engines to provide low-emission alternatives to diesel engines for the heavy-duty vehicle market to power transit buses, refuse haulers, vocational trucks, and goods movement trucks. With this funding, Cummins Westport Inc. was able to certify 9-liter and 12-liter variations of the Near-Zero engines that met the CARB's most stringent optional low NO_x

514 Brecht, Patrick. 2019. 2019-2020 Investment Plan Update for the Clean Transportation Program. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2018-005-LCF-REV2.

standard.⁵¹⁵ Cummins Westport Inc. has produced 3,900 Near-Zero engines as of June 2018. Since the introduction of the Near-Zero engines into the market, several state and local clean transportation incentive programs have provided funding for fleets to accelerate adoption of these engines because of the associated low NO_x and GHG emissions compared to diesel engines.

In its Fiscal Year 2019–2020 funding request and program plan for the Natural Gas Research and Development Program submitted to the CPUC, the CEC proposed projects that will demonstrate advanced zero-emission fuel cell technologies in rail and marine applications at California ports because these are difficult to decarbonize using battery-electric alternatives. Possible projects include the conversion of an existing diesel switcher or intrastate locomotive operating at a California port to zero emissions. The conversion would entail using fuel cell technology and the development of a zero-emission fuel cell harbor craft such a tugboat or ferry with sufficient torque, speed, and operating range to support the specific duty cycle.

Clean Transportation Program

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007), created the Clean Transportation Program. The statute authorizes the CEC to develop and launch alternative and renewable fuels and advanced transportation technologies to help attain the state’s climate change goals. These fuels include biomethane, which, along with fossil natural gas, fuels some of the advanced transportation technologies supported by the Clean Transportation Program. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and required the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year’s funds) for hydrogen station development until at least 100 stations are operational. These policies have shifted motor vehicle programs, grants, and other incentives away from petroleum-based fuels and fossil natural gas to reach GHG emissions goals at the lowest cost by promoting the transformation of zero-emission vehicle (ZEV) markets.

As of March 2019, the Clean Transportation Program has provided \$83 million for the deployment of natural gas vehicles. This amount includes funding to the San Joaquin Valley Unified Air Pollution Control District and the South Coast Air Quality Management District to support incentive programs for natural gas vehicles. Additional Clean Transportation Program funds targeted the oldest diesel school buses operating in districts with disadvantaged communities and high participation in free or reduced price lunches. While most of the available funding was for electric buses the Clean Transportation Program awarded a limited

⁵¹⁵ “NO_x,” also known as oxides of nitrogen, forms when fuel is burned at high temperatures. [Information on Earth's atmosphere from the Cool Cosmos Web page](http://coolcosmos.ipac.caltech.edu/ask/64-What-is-the-atmosphere-of-Earth-made-of-) <http://coolcosmos.ipac.caltech.edu/ask/64-What-is-the-atmosphere-of-Earth-made-of->.

amount of funding for natural gas vehicle deployment that could go toward natural gas school buses for school districts that certified an electric school bus would be unable to meet their needs. The Clean Transportation Program has also funded natural gas fueling infrastructure—nearly \$22 million toward the installation or upgrade of about 64 natural gas fueling stations.

The CEC did not allocate any Fiscal Year 2019–2020 Clean Transportation Program funding for natural gas vehicle incentives or infrastructure projects.⁵¹⁶ However, incentives for natural gas vehicles are available through CARB’s Hybrid and Zero-Emission Truck and Bus Voucher Initiative and Low NO_x Engine Incentives.⁵¹⁷

Section 25303.5(b) (2): Determining the Role of Natural Gas-Fired Generation as Part of a Resource Portfolio

Natural Gas for Electric Generation

Through SB 100, the Legislature has directed state energy agencies to accelerate the transformation of California’s electric grid to 100 percent zero-carbon resources by 2045. Natural gas-fired generation accounts for the largest share of in-state generation,⁵¹⁸ and has declined in recent years. In the near term, natural gas will continue to play an important role in the integration of renewable resources and ensuring reliability. A proposed decision, issued by the CPUC on September 12, 2019, requires electric system reliability procurement by all CPUC-jurisdictional load-serving entities (LSEs) from 2021 through 2023 and calls for extending the retirement dates of 2,500 megawatts (MW) to 3,750 MW of natural gas-fired once-through cooling (OTC) capacity on the South Coast beyond the current December 31, 2020, retirements.⁵¹⁹ Chapters 1 and 6 discuss these topics further.

Combined Heat and Power

A properly sized and operated combined heat and power—also known as cogeneration—plant can produce thermal, mechanical, and electrical energy using less fuel than would otherwise be used to produce the same energy via a more traditional system of boilers and central-station grid electricity. In the near term, large-scale combined heat and power use will continue as energy-intensive industries make use of efficiency and cost-saving opportunities,

516 Brecht, Patrick. 2019. 2019-2020 Investment Plan Update for the Clean Transportation Program. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2018-005-LCF-REV2.

517 CARB, in partnership with CALSTART, launched this program in 2009. [Link to program information](https://www.californiahvip.org/how-to-participate/#steps-to-participate-in-hvip) <https://www.californiahvip.org/how-to-participate/#steps-to-participate-in-hvip>.

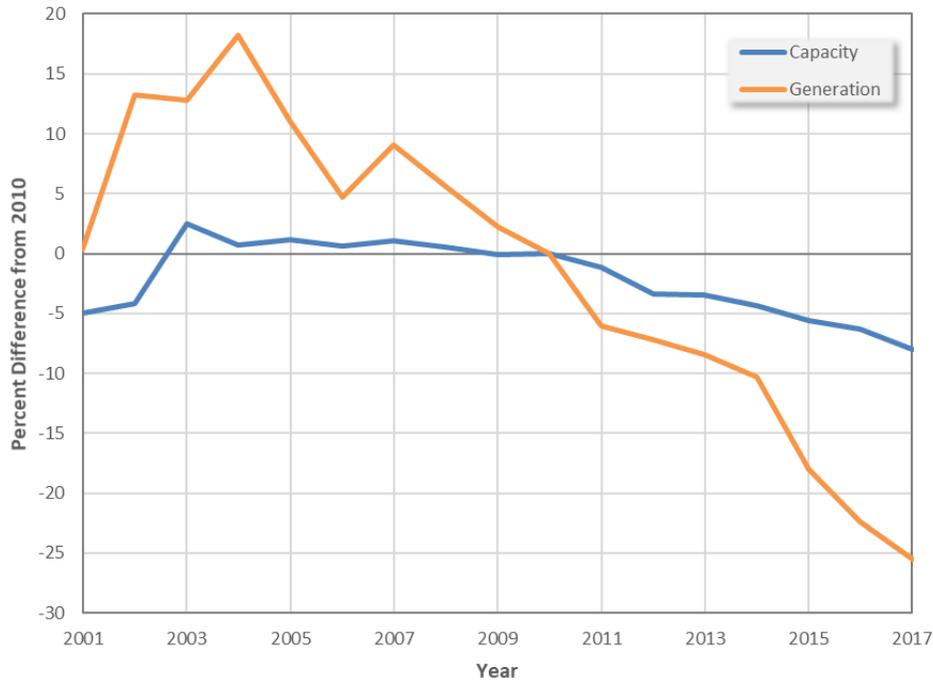
518 CEC. California Electrical Energy Generation. [Link to download California Electrical Energy Generation file from the CEC's website](https://ww2.energy.ca.gov/almanac/electricity_data/electricity_gen_2001-current.xlsx) https://ww2.energy.ca.gov/almanac/electricity_data/electricity_gen_2001-current.xlsx.

519 CPUC. 2019. Decision Requiring Electric System Reliability Procurement for 2021-2023 (R.16-02-007). [Link to Proposed Decision in Rulemaking 16-02-007 on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M312/K522/312522263.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M312/K522/312522263.PDF>.

particularly at refineries, chemical plants, and food processing plants. However, as California looks to decrease its use of fossil natural gas as required by SB 100, combined heat and power generation is expected to decline.

Recent years have seen a decline in capacity and output from existing resources that significantly outpaces the addition of new combined heat and power plants. From 2010 to 2017, California’s combined heat and power fleet has decreased 8 percent in nameplate capacity and 25 percent in annual electrical generation. Figure 52 shows the annual percentage changes to combined heat and power capacity and generation relative to 2010.

Figure 52: Historical Capacity and Generation Relative to 2010



Source: CEC staff

California’s primary combined heat and power program is the CPUC-administered Qualifying Facilities and Combined Heat and Power Program.⁵²⁰ The Qualifying Facilities Settlement Agreement sets capacity targets for investor-owned utilities (IOUs) to contract (through competitive solicitations) with eligible combined heat and power plants and sets GHG emissions reduction targets. Tables 25 and 26 show the settlement targets and progress to

520 [Link to Overview of the Combined Heat and Power Program at the CPUC](https://www.cpuc.ca.gov/General.aspx?id=5432) https://www.cpuc.ca.gov/General.aspx?id=5432.

date. The IOUs based the revised GHG targets and progress toward their procurement and GHG reduction targets on their April 2016 semiannual reports to the CPUC. These are subject to change as more data become available.

Table 25: Tracking QF Settlement MW Targets (MW)

Utility	Combined Heat and Power Capacity Procured by IOUs to Date	IOUs 2015 Combined Heat and Power Targets	Remaining Capacity to Procure
Pacific Gas and Electric (PG&E)	1,497	1,387	0
Southern California Edison (SCE)	1,455	1,402	0
San Diego Gas & Electric (SDG&E)	134	211	77
Total	3,086	3,000	77

Source: CPUC

Table 26: Tracking Qualifying Facilities Settlement GHG Targets (in Million Metric Tons Carbon Dioxide Equivalent [MMT CO₂e])

Utility	Revised GHG Target (D.15-06-028)	Utility Progress Toward GHG Target	Remaining Reductions
PG&E	1.23	1.53	0
SCE	1.23	1.01	0.22
SDG&E	0.283	0.02	0.26
Total	2.74		0.48

Source: CPUC

Assembly Bill 1613 (Blakeslee, Chapter 713, Statutes of 2007), the Waste Heat and Carbon Emissions Reduction Act, established a feed-in tariff for eligible combined heat and power projects less than 20 MW that meet certain performance and emission standards.⁵²¹ However, participation has been minimal. To date, there are six certified projects totaling 53.9 MW.

⁵²¹ Assembly Bill 1613 (Blakeslee, Chapter 713, Statutes of 2007).

The Self-Generation Incentive Program provides incentives to eligible distributed energy systems installed on the customer's side of the utility meter, including small, clean, and efficient combined heat and power units. The program has been modified over the years to support the commercialization of emerging technologies, reduce emissions, and provide GHG benefits. As the program evolved, funding was reduced from a majority allocated to combined heat and power and fuel cells in 2015 to mostly energy storage to date.⁵²² Starting in 2016, new generation projects (including CHP) were allocated 25 percent of the funds in 2016 and 15 percent of the funds in 2017.⁵²³ In addition, beginning in 2017, natural gas technologies had to be fueled by a mixture of at least 10 percent biogas to retain program eligibility. This requirement becomes more stringent each year, reaching 100 percent biogas in 2020.

There is potential for combined heat and power at plants that produce biogas, as the heat can be used to maintain digester temperatures. Development at potential digester sites, such as wastewater treatment plants and dairy farms, is supported by Senate Bill 1122 (Rebio, Chapter 612, Statutes of 2012), the Bioenergy Feed-in Tariff Program. While the biogas may be used onsite to generate electricity, the greatest financial incentive is to use the gas as vehicle fuel. However, this use as a vehicle fuel relies on the use of substantial federal and California environmental credits, which are vulnerable to the risk of policy change.

In May 2017, the CPUC followed through with a previous decision to enact a Distributed Energy Resources Tariff. This tariff allows Southern California Gas Company (SoCalGas) to design, install, own, operate, and maintain advanced energy systems, including many forms of combined heat and power, on or near the customer's premises. It is designed to help overcome barriers for potential customers that might lack the internal capital and experience necessary to develop and operate such facilities. The Distributed Energy Resources Tariff could help develop the largely untapped market potential of combined heat and power plants with 20 MW or less in nameplate capacity.

In March 2019, the CEC issued a report on the assessment of small-scale combined heat and power technical and market potential in California.⁵²⁴ In addition to identifying potential, the report highlights the role of combined heat and power in microgrid applications and the ability

522 CPUC, Decision 16-06-055, Rulemaking 12-11-005, July 1, 2016, <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M163/K928/163928075.PDF>

523 CPUC, [Decision17-04-017](#), Rulemaking 12-11-005, April 13, 2017, <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M183/K843/183843620.PDF>.

524 [Link to A Comprehensive Assessment of Small Combined Heat and Power Technical and Market Potential in California report on the CEC's website](#) <https://ww2.energy.ca.gov/2019publications/CEC-500-2019-030/CEC-500-2019-030.pdf>.

of flexible combined heat and power systems to support the grid while enabling further adoption of renewable energy resources.

Section 25303.5(b) (3): Optimizing Natural Gas as a Low-Emission Resource

Renewable Natural Gas

According to the United States Energy Information Administration (U.S. EIA), the share of renewable natural gas (RNG) in the total natural gas quantity supplied to California's transportation sector grew from roughly 10 percent in 2013 to 70 percent in 2018. This share has reached more than 30 million diesel gallons equivalent, or about 45 million cubic feet per day, for the first time during the third quarter of 2018.⁵²⁵

State policies spurred much of this progress. Senate Bill 1440 (Hueso, Chapter 739, Statutes of 2018) requires the CPUC, in consultation with CARB, to consider adopting "specific biomethane procurement targets or goals for each gas corporation."⁵²⁶ Through March 2019, the CEC also provided almost \$77 million to 27 biomethane projects and \$8 million to two renewable hydrogen projects under the Clean Transportation Program. For Fiscal Year 2019–2020, CEC staff proposes a \$10 million allocation for zero- and near-zero-carbon fuel production under the Clean Transportation Program.⁵²⁷ The CEC will continue to use this funding to support low-carbon fuel and renewable hydrogen production plants in California.

Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016) supports policies that improve the cost-effectiveness and environmentally beneficial uses of biomethane derived from solid waste as part of a strategy to reduce emissions of methane and other short-lived climate pollutants and reduce organic waste in landfills. As part of this legislation, the CPUC is directing natural gas utilities to start at least five pilot projects to demonstrate pipeline injection of biomethane produced by California dairies. On December 14, 2017, the CPUC established an implementation and selection framework for these dairy pilot projects, including a requirement that they demonstrate interconnections with the natural gas pipeline system that meet existing regulations.⁵²⁸ The procurement program must be a cost-effective means of achieving the forecasted reduction in emissions and short-lived climate pollutants and must adhere to

525 [Link to Natural Gas Weekly Update for the week ending March 27, 2019, on the U.S. EIA's website](#)

526 CEC staff. 2018. *2018 Integrated Energy Policy Report Update, Volume II*. CEC. Publication Number: 100-2018-001-V2- CMF. p. 16.

527 Brecht, Patrick. 2019. *2019-2020 Investment Plan Update for the Clean Transportation Program*. CEC, Fuels and Transportation Division. Publication Number: CEC-600-2018-005-LCF-REV2., p. 96, Table 22. [Link to 2019-2020 Investment Plan Update for the Clean Transportation Program on the CEC's website](#) <https://efiling.energy.ca.gov/getdocument.aspx?tn=229582>. Retrieved September 10, 2019.

528 CPUC Decision 17-12-004, Rulemaking 17-06-015, [Link to information on Dairy Biomethane pilot projects on the CPUC's website](#) https://www.cpuc.ca.gov/General.aspx?id=6442455827#Dairy_Biomethane_Pilot_Projects.

[Link to Decision 17-12-004 on the CPUC's website](#) <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M201/K352/201352373.PDF>.

environmental and energy policies. The CPUC expects these pilot projects to demonstrate the feasibility of these project types and provide a model to increase the use of biomethane fuel in California. In December 2018, the CPUC, CARB, and the California Department of Food and Agriculture (CDFA) announced funding for six pilot projects in the San Joaquin and Sacramento Valleys designed to demonstrate the collection of biomethane from dairy digesters and the associated injection into natural gas pipelines. Forty-five dairies will participate in the pilot projects, and the six projects will receive roughly \$319 million in infrastructure investments and operation expenses over a 20-year period. More information on these projects is provided below.⁵²⁹

Moreover, Assembly Bill 3187 (Grayson, Chapter 598, Statutes of 2018) required the CPUC, to open a proceeding by July 1, 2019, to consider funding biomethane interconnection infrastructure through a gas corporation's utility rates. In February 2019, SoCalGas and SDG&E filed an application with the CPUC requesting authority to offer a voluntary RNG tariff program that gives their residential, small commercial, and industrial customers the option to purchase this fuel as part of their natural gas service. Under this proposal, customers could designate a portion or all of their natural gas service to come from renewable resources. The CPUC released a scoping memo for this proceeding on August 6, 2019, which set a schedule for a rate-setting proceeding.⁵³⁰ A proposed decision is expected in spring 2020. While SoCalGas and SDG&E filed the application to offer a voluntary RNG tariff program, PG&E seeks CPUC authority to participate in a program that will allow the utility to begin adding RNG to its supply portfolio, limited initially to its compressed natural gas fueling stations.

The CPUC held a workshop on May 23 and 24, 2019, to consider a standard RNG interconnection tariff and an inquiry into standards required to inject and interconnect renewable methane and hydrogen projects.⁵³¹ The CPUC held a follow-up workshop on August 20, 2019, to consider a joint utility proposal to establish a process for considering interconnection requests that would allow RNG blending in pipelines. In R.13-02-008, on August 20, 2019, the CPUC ordered a rulemaking to adopt biomethane standards and

529 [Link to press release on dairy biomethane projects on the CPUC's website](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M246/K748/246748640.PDF)
<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M246/K748/246748640.PDF>.

Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016). [Link to bill analysis of SB 1383](https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160SB1383#)
https://leginfo.legislature.ca.gov/faces/billAnalysisClient.xhtml?bill_id=201520160SB1383#.

530 CPUC. [Scoping Ruling](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M310/K226/310226767.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M310/K226/310226767.PDF>.

531 [Link to information on workshops related to dairy biomethane pilot projects on the CPUC's website](https://www.cpuc.ca.gov/General.aspx?id=6442455827#R._13-02-008___Phase_3)
https://www.cpuc.ca.gov/General.aspx?id=6442455827#R._13-02-008___Phase_3.

requirements, pipeline open access rules, and related enforcement provisions. This proceeding remains open.⁵³²

CDFA Dairy Digester Research and Development Program

The CDFA Dairy Digester Research and Development Program offers financial assistance for the installation of dairy digesters in California, which reduce dairy manure GHG emissions. The Dairy Digester Research and Development Program Demonstration Projects award competitive grants to California dairy operations and digester developers for implementing dairy digester projects that demonstrate innovative technologies to achieve long-term methane emission reductions from California dairies and minimize or address adverse environmental impacts.⁵³³ This program awarded \$35.2 million in October 2017 for anaerobic digesters at dairies, along with an additional \$72.4 million for additional dairy digester projects in 2018. For the Dairy Digester Research and Development Program, the CDFA receives funding from California Climate Investments, a statewide program that puts billions of cap-and-trade dollars to work reducing GHG emissions, strengthening the economy and improving public health and the environment—particularly in disadvantaged communities. The CDFA posted invitations to apply for 2019 grants on December 28, 2018, with an April 3, 2019, deadline to submit applications. It received 66 applications for the 2019 Dairy Digester Research and Development Program requesting \$101,691,712 and received four applications for 2019 Dairy Digester Research and Development Program Demonstration Projects requesting \$7,015,333.

California Department of Resources Recycling and Recovery (CalRecycle)

CalRecycle's Organics Grant Program conducted three grant cycles in 2014, 2017, and 2018, which awarded \$32.9 million to nine biomethane-producing projects. This competitive grant program sought to lower overall GHG emissions by expanding existing capacity or establishing new plants in California to reduce the amount of California-generated green materials, food materials, alternative daily cover,⁵³⁴ or a combination thereof, sent to landfills. California Climate Investments funds this program.

Summary

These programs demonstrate the commitment by the CEC, with the support of other state agencies, to meeting the directives of this section of AB 1257.

532 CPUC. [Link to upcoming schedule on the CPUC's Web page](https://www.cpuc.ca.gov/General.aspx?id=6442455827#R._13-02-008__Phase_3) https://www.cpuc.ca.gov/General.aspx?id=6442455827#R._13-02-008__Phase_3.

533 [Link to information on DDRDP demonstration projects on CDFA's website](https://www.cdfa.ca.gov/oefi/ddrdp/DemoProject.html) <https://www.cdfa.ca.gov/oefi/ddrdp/DemoProject.html>.

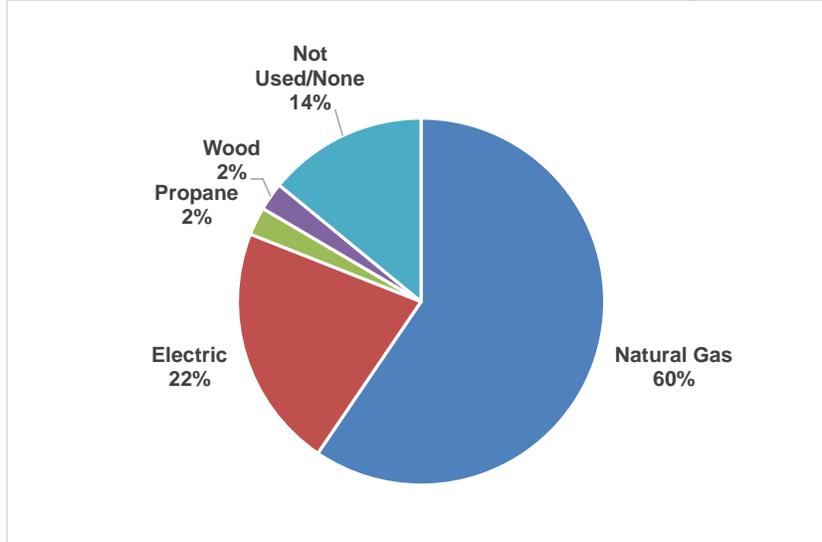
534 "Alternative daily cover" refers to cover material other than earthen material that is placed on the surface of a landfill at the end of each day.

Section 25303.5(b) (4): Optimizing Natural Gas for Heating, Water Heating, Cooling, Cooking, Engine Operation, and Other End Uses

Building Decarbonization

As discussed in Chapter 2, homes use about two-thirds of California’s natural gas, 90 percent of which is for space and water heating. Figure 53 below provides a breakdown of space heating by source or fuel type and shows that natural gas is the dominant fuel source over electric.

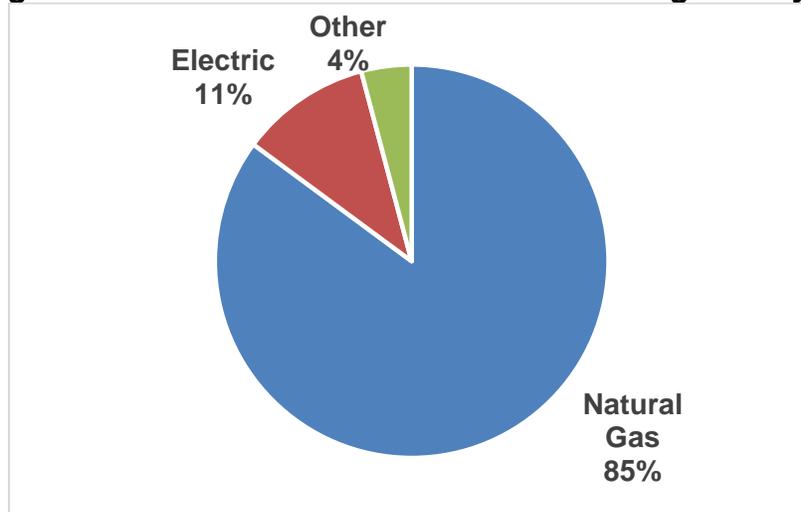
Figure 53: California Residential Space Heating Fuel Type



Source: U.S. EIA Office of Energy Consumption and Efficiency Statistics, Forms EIA-457 A and C of the 2009 Residential Energy Consumption Survey

Figure 54 shows that at 85 percent, natural gas is also the dominant fuel source for residential water heating.

Figure 54: California Residential Water Heating Fuel Type



Source: U.S. EIA, Office of Energy Consumption and Efficiency Statistics, Forms EIA-457 A and C of the 2009 Residential Energy Consumption Survey

In commercial buildings, space heating accounts for a similarly large portion of gas use.⁵³⁵ The 2018 IEPR Update reviewed research on methane emissions inside California homes, finding that average emissions are equivalent to about 0.5 percent of total natural gas consumed in the residential sector, or 5.8 MMcf per day.⁵³⁶ The CEC is also funding research testing of 60 to 80 commercial buildings and a handful of industrial plants for fugitive methane emissions.⁵³⁷

Building decarbonization was a policy focal point of the 2018 IEPR Update. The 2018 IEPR Update discussed policy goals, sources of GHG emissions in buildings, reasons for pursuing building electrification strategies, the challenges to building decarbonization, utility and CPUC efforts in electrification, and research and development efforts.⁵³⁸ The potential GHG emissions reductions from building decarbonization prompted the Legislature to pass two bills to offer incentives for the development and deployment of building decarbonization solutions: Senate Bill 1477 (Stern, Chapter 378, Statutes of 2018)⁵³⁹ and Assembly Bill 3232 (Friedman, Chapter 373, Statutes of 2018).⁵⁴⁰ Chapter 2 provides more information on work to implement these bills.

The CEC is funding research to evaluate long-term decarbonization scenarios that identify these solutions, and how they can be integrated into the building stock in the most cost-effective, consumer-friendly manner. The Energy Research and Development Division's Electric Program Investment Charge (EPIC) Program funded the E3 study, *Deep Decarbonization in a High Renewables Future* published in 2018.⁵⁴¹ The E3 report analyzed long-term energy scenarios for meeting the state's GHG emissions reduction goals in 2030 (40 percent below 1990 levels) and 2050 (80 percent below 1990 levels). E3 found that the high electrification

535 CEC staff. 2018. *Draft 2018 Integrated Energy Policy Report Update*. California Energy Commission. Publication Number: 100-2018-001-V2-CMF.

536 Based on statewide residential demand of 1,160 MMcf per day, as estimated by the 2018 California Gas Report, p. 17, "Statewide Total Supply Sources and Requirements."

537 CEC staff. 2018. *Draft 2018 Integrated Energy Policy Report Update*. California Energy Commission. Publication Number: 100-2018-001-V2-CMF, p. 47.

538 *Ibid.*, p. 16.

539 Under CPUC's oversight, SB 1477 provides incentives for near-zero emission homes through incentives and market support of low emission space- and water-heating equipment and technologies in new and existing homes. The bill also provides incentives for low-income residents.

540 AB 3232 commits the CEC to developing by 2021 a feasibility assessment of a 40 percent reduction in building GHG emissions from 1990 levels by 2030.

CEC. 2019. "Notice of Joint Agency Workshop on Building Decarbonization." [Link to Notice of Joint Agency Workshop on Building Decarbonization filed on the CEC's website](https://efiling.energy.ca.gov/getdocument.aspx?tn=227441) <https://efiling.energy.ca.gov/getdocument.aspx?tn=227441>.

541 Mahone, Amber, Zachary Subin, Jenya Kahn-Lang, Douglas Allen, Vivian Li, Gerrit De Moor, Nancy Ryan, Snuller Price. 2018. *Deep Decarbonization in a High Renewables Future: Updated Results from the California PATHWAYS Model*. California Energy Commission. Publication Number: CEC-500-2018-012.

scenario is one of the lower-cost, lower-mitigation scenarios. This scenario includes high levels of energy efficiency and conservation, renewable electricity, and transportation electrification. It also assumes that the state’s residential and commercial buildings transition from using natural gas to electricity for heating. Further, it includes pipeline-supplied biomethane to serve mainly industrial end uses, which can include heating, water heating, cooling, cooking, and engine operations.

EFI conducted a study that used a different approach and inputs to analyze pathways to decarbonize the energy system. Its 2019 study *Optionality, Flexibility, and Innovation, Pathways for Deep Decarbonization in California* analyzed a wide range of sector-specific pathways for meeting the state’s 2030 and 2050 targets.⁵⁴² In the industrial sector, EFI found that the biggest GHG emission reductions by 2030 came from carbon capture, utilization, and storage (CCUS) technologies.⁵⁴³ EFI’s analysis also showed that, in the building sector, energy efficiency achieved the largest reduction of emissions by 2030 and therefore was more cost-effective than building electrification.⁵⁴⁴

Section 25303.5(b) (5): Identifying Effective Methods by Which Electric and Natural Gas Industries Can Facilitate Implementation of Any of These Strategies

As discussed above, natural gas-fired generation is poised to continue to support electric load in circumstances where other resources are not reliable or cost-effective. These circumstances are described in Chapters 1 and 10 in the discussion of the grid support provided by natural gas-fired capacity as the state integrates increasing amounts of renewable resources.

As the CEC, CPUC, California ISO, and other state agencies plan for the energy future mandated by Senate Bill 100 (De León, Chapter 312, Statutes of 2018), Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016), and other climate and energy legislation, there are opportunities for the electric and natural gas industries to ease implementation of the strategies identified by AB 1257. These opportunities are being explored through SB 100.

542 EFI. May 2019. *Optionality, Flexibility, and Innovation, Pathways for Deep Decarbonization in California* https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5ced6fc515fcc0b190b60cd2/1559064542876/EFI_CA_Decarbonization_Full.pdf.

543 Ibid, pp. XVI-XVII.

544 Ibid.

Section 25303.5(b) (6): Determining the Need for a Long-Term Infrastructure Reliability Policy

Methane Leak Reduction on the Natural Gas System

Methane is a GHG that is 25 times more potent than carbon dioxide. The production and distribution of natural gas results in intentional (vented or flared) and unintentional (leaked or fugitive) emissions from the wellhead through the transmission and distribution system to the homes, businesses, and manufacturers that use natural gas. The CEC has funded research quantifying methane leakage from oil and gas production fields, oil refineries, natural gas storage fields and compressor stations, natural gas refueling stations, and single-family homes.⁵⁴⁵ Oil and gas production, processing, and storage facilities and natural gas compressor stations allow the escape of the largest amount of emissions in the natural gas supply chain. In March 2017, CARB addressed these emissions with the adoption of the GHG Emission Standards for Crude Oil and Natural Gas Facilities, which CARB designed to reduce methane emissions from oil and gas facilities and equipment.⁵⁴⁶ These facilities account for an estimated 4 percent of methane emissions in California.⁵⁴⁷ The regulatory framework requires oil and gas entities to take actions to limit all emissions. (See Chapter 2 for more information on methane leakage.)

California's aging natural gas infrastructure further complicates efforts to reduce GHG emissions. However, climate change policies and economic losses are pushing natural gas pipeline operators to implement programs aimed at methane leak reductions from this infrastructure. Further, the CEC's Natural Gas Research and Development Program has funded technologies that increased the cost-effectiveness of methane leak detection and developed innovative methods to protect natural gas infrastructure. In 2016, the CEC awarded Natural Gas Research and Development funds to the National Aeronautics and Space Administration's Jet Propulsion Laboratory to conduct an aerial survey of natural gas infrastructure in high priority parts of the state to identify locations emitting large amounts of methane.

The CEC provided funding for research that will support life-cycle accounting of methane emissions from the natural gas supply chain and to conduct a comprehensive field study

⁵⁴⁵ Fischer, Marc, Seongeun Jeong, Ian Faloona, and Shobhit Mehrota. 2016. *A Survey of Methane Emissions from the California Natural Gas System*. California Energy Commission. Publication Number: CEC-500-2017-033.

Fischer, Marc L., Wanyu Chan, Seongeun Jeong, and Zhimin Zhu. Lawrence Berkeley National Laboratory. 2018. *Natural Gas Methane Emissions From California Homes*. California Energy Commission. Publication Number: CEC-500-2018-021.

⁵⁴⁶ California Air Resources Board (California Environmental Protection Agency). 2018. [CARB's Oil and Gas Methane Regulation](https://ww2.arb.ca.gov/sites/default/files/2018-08/CARB_Oil_and_Gas_Fact_Sheet_8-15-18_0.pdf) https://ww2.arb.ca.gov/sites/default/files/2018-08/CARB_Oil_and_Gas_Fact_Sheet_8-15-18_0.pdf.

⁵⁴⁷ [Information on oil and natural gas production, processing, and storage from CARB's website](https://ww2.arb.ca.gov/our-work/programs/oil-and-natural-gas-production-processing-and-storage) <https://ww2.arb.ca.gov/our-work/programs/oil-and-natural-gas-production-processing-and-storage>. Retrieved September 12, 2019.

identifying and addressing methane emissions in the southern San Joaquin Valley. Climate change policies and economic losses are also leading natural gas pipeline operators to implement programs aimed at reducing methane leaks. Pipeline operators of transmission and distribution systems are using innovative technologies for detecting leaks, monitoring pipelines, and prioritizing leak repair. Technologies include optical gas imaging cameras, remote methane leak detection, combustible gas detectors, and optical methane detectors. Finally, the Environmental Defense Fund and Google Earth Outreach are piloting a program for gas utilities throughout the United States that demonstrates new technologies (mobile monitoring equipment) to locate and assess methane leaking from underground natural gas pipelines and other infrastructures.⁵⁴⁸

Assembly Bill 1420 (Salas, Chapter 601, Statutes of 2015) requires stricter natural gas pipeline safety rules, effective January 1, 2018. Previous law only required minimum safety standards for oil and gas production facilities, including pipelines. Owners or operators of gathering⁵⁴⁹ or urban pipelines over 4 inches in diameter were required to “perform a mechanical integrity test on the pipeline every 2 years, unless it was less than 10 years old.” The new safety regulations, promulgated by DOGGR at the California Department of Conservation, as directed by AB 1420, require the following:

“Operators shall inspect all active gas pipelines in sensitive areas that are 10 or more years old for leaks or other defects at least once a year, or at a frequency approved by the Supervisor and listed in the operator’s Pipeline Management Plan. The operator shall conduct the inspection in accordance with applicable regulatory standards or, in the absence thereof, an accepted industry standard that is specified by the operator and listed in the Pipeline Management Plan.”⁵⁵⁰

In the wake of the massive leak at the Aliso Canyon gas storage facility, the CEC has partnered with DOGGR and other agencies in conducting research and considering regulation and remediation efforts to satisfy the Legislature’s directives to ensure pipeline safety while protecting sensitive areas.⁵⁵¹

548 [Link to Four Steps to Reduce Natural Gas Leaks article on EDF's website](https://www.edf.org/climate/methanemaps/four-steps-reduce-natural-gas-leaks) <https://www.edf.org/climate/methanemaps/four-steps-reduce-natural-gas-leaks>.

549 “Gathering pipelines” are those that transport gas from a production facility to a transmission line or main.

550 California Code of Regulations, Section 1774.1. [Link to final text of regulations for California Code of Regulations Title 14, Chapter 4](https://www.conservacion.ca.gov/index/SiteAssets/Pages/rulemaking/Final%20Text%20of%20Regulations.pdf) <https://www.conservacion.ca.gov/index/SiteAssets/Pages/rulemaking/Final%20Text%20of%20Regulations.pdf>.

551 AB 1420 defines “sensitive areas” as areas containing a building for human occupancy, areas that present a significant potential threat to life, health, property, or natural resources, and areas with an active gas pipeline with a history of chronic leaks.

Potential Natural Gas System Impacts From Hydrogen

Hydrogen offers multiple uses as a sustainable energy source for stationary fuel cell systems for buildings, backup power, and distributed generation, and fuel cell electric vehicles used in transportation. Hydrogen also serves as a “power-to-gas” fuel that stores renewable energy at utility scale.⁵⁵² Consequently, policy makers have taken action to promote its production and supply in California. One way to distribute hydrogen is through the natural gas infrastructure. Relatively low concentrations of hydrogen of 5 to 15 percent by volume may be feasible with few modifications to existing pipeline systems or end-use appliances; however, this feasibility assessment will vary from location to location. Higher concentrations introduce challenges, as different types of steel pipe are susceptible to becoming weak or embrittled due to hydrogen exposure, which can increase the risk of pipeline rupture. Policy makers have introduced legislation to research and address these issues and plan and develop an electrolytic hydrogen production and supply infrastructure.

Senate Bill 1369 (Skinner, Chapter 567, Statutes of 2018) requires the CPUC and CEC to, where feasible, authorize procurement of energy storage using “green electrolytic hydrogen,” which the statute defines as hydrogen gas produced through electrolysis alone. This legislation therefore rules out hydrogen gas manufactured using steam reformation of natural gas or any other fossil fuel feedstock.

Section 25303.5(b) (7): Determining the Role of Natural Gas in Zero Net Energy Buildings

In the 2018 IEPR Update, the CEC recommended that “the state should replace its zero-net-energy policy goals with appropriate goals for low-carbon buildings. Zero-emission building goals, while ambitious, are a necessary component of the state’s aggressive GHG emission reduction policy initiatives.”⁵⁵³ Chapter 2 discusses the efforts to moving toward zero-emission buildings. Research suggests that reducing emissions from buildings at the lowest cost and with the widest public benefit may require a more comprehensive suite of measures, which can only be efficiently implemented at the larger scale and in phases. Natural gas will continue to be used as existing buildings and new construction transition to zero-emission buildings.

⁵⁵² “Power-to-gas” refers to the strategy of converting electrical energy into gaseous chemical energy for energy storage or other useful purposes.

⁵⁵³ CEC staff. 2018. *2018 Integrated Energy Policy Report Update, Volume II*. CEC. Publication Number: 100-2018-001-V2-CMF. (p. 197) [Link to 2018 IEPR Update on the CEC’s website](https://ww2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf) https://ww2.energy.ca.gov/2018publications/CEC-100-2018-001/CEC-100-2018-001-V2-CMF.pdf.

Section 25303.5(b) (8): Optimizing Jobs Development in the Private Sector, Particularly in Distressed Areas

The CEC continues to support investment in jobs that develop the infrastructure needed to satisfy legislative mandates for a carbon-neutral economy. With respect to the natural gas sector, these jobs include production of natural gas from dairy digesters, municipal solid waste and wastewater treatment plants, wood waste plants, and other biomass sources. Much of this support is funded by the CEC’s Natural Gas Research and Development Program, which complies with the statutory requirement of SB 350 (De León, Chapter 547, Statutes of 2015) to improve participation by applicants from distressed communities and other historically underrepresented stakeholders. The proposed program plan and funding request for Fiscal Year 2019–2020 affirms both SB 350 and the CEC’s April 2015 Diversity Policy Resolution to improve fair and equal opportunities for economically disadvantaged and underserved communities to participate in and benefit from CEC programs.⁵⁵⁴

Section 25303.5(b) (9): Optimizing Facilitation of Proposed Strategies with State and Federal Policy

The CEC enables participation of all interested state, regional, and federal agencies in the preparation of the IEPR, of which this AB 1257 analysis is included as an Appendix. The IEPR contains assessments of major energy trends and issues facing California’s electricity, natural gas, and transportation fuel sectors and provides policy recommendations for energy policies and programs to address those issues.

The CEC works closely with other agencies through other forums as well, for example:

- Natural Gas Research and Development Program— Each year the CEC’s Energy Research and Development Division holds workshops to receive input from experts in energy research to explore research initiatives and to help develop the annual Natural Gas Research and Development Program Proposed Program Plan and Funding Request submitted annually to the CPUC. Additionally topical workshops are held throughout the year to gather input on various research areas and topics. Participants include the state’s investor-owned gas utilities, state agencies (such as CARB) and federal agencies (such as the U.S. Department of Energy [U.S. DOE]), industrial experts, academic researchers, and other interested parties. These workshops help avoid research duplication; generate new research ideas; create the best research industry practices; and, bring together utilities, researchers, manufacturers, end users, and policy makers from state and federal agencies.

⁵⁵⁴ Uy, Kevin. 2019. *Natural Gas Research and Development Program Proposed Program Plan and Funding Request for Fiscal Year 2019–2020*. California Energy Commission Research and Development Division. Publication Number: CEC-500-2019-035. pp. 18–21.

- U.S. DOE Advance Research Projects Agency-Energy (ARPA-E) Energy Innovation Summit—The ARPA-E Energy Innovation Summit was held near Washington, D.C. March 13–15, 2018. Energy Commission staff attended the event where experts from different technical disciplines and professional communities discussed energy challenges and innovations in terms of industry, research, and policy. Participants discussed program concepts and “out-of-the-box” opportunities. Insights from the summit informed ongoing work by the CEC to coordinate with ARPA-E. Guided by an interagency memorandum of understanding, the CEC and ARPA-E work together to move transformational energy technologies out of the lab and into the market. Common areas of R&D include energy efficiency, energy storage, transportation, DERs, and power electronics.
- Clean Transportation Program—Under the Clean Transportation Program, the CEC has previously partnered with SCAQMD to develop and demonstrate low-oxides of nitrogen natural gas engines. These medium- and heavy-duty vehicles subsequently became available for incentives under CARB’s HVIP incentive project.

Under SB 1383, the CEC, has worked with the CPUC, CARB, CDFA, and CalRecycle, to identify cost-effective strategies that are consistent with existing state policy and climate change goals, prioritizing end uses of renewable gas, and providing recommendations to other state agencies on policy. Some of those recommendations included CalRecycle’s policies to reduce statewide disposal of organic waste, and CPUC’s pilot program for pipeline injection dairy biomethane.

In implementing its School Bus Replacement Program, the CEC worked closely with CARB (as they administered natural gas school bus funds) to ensure that schools with route profiles not suited for an electric school bus could still replace older, polluting diesel school buses with alternative fueled vehicles.

Section 25303.5(b) (10): Evaluating Incremental Economic and Environmental Costs and Benefits of Proposed Strategies

The Legislature required CARB to evaluate “the total potential costs and total potential economic and noneconomic benefits of the plan for reducing greenhouse gases to California’s economy, environment, and public health, using the best available economic models, emission estimation techniques, and other scientific methods.”⁵⁵⁵ CARB leads the Climate Action Team, which includes 18 state agencies, including the CEC.⁵⁵⁶ The Climate Action Team implements

555 Health and Safety Code Section 38561(d).

556 [Link to Climate Action Team Members](https://www.climatechange.ca.gov/climate_action_team/members.html) https://www.climatechange.ca.gov/climate_action_team/members.html.

the Scoping Plan.⁵⁵⁷ The CEC and other participating state agencies work together to comply with the statutory mandate to provide evaluations of the economic and environmental costs and benefits of different potential energy resource options, including impacts on natural gas and other fuels. These evaluations are included in the CEC's Integrated Energy Policy Report and other planning documents that guide research and clean energy investments, which include stakeholder and public participation in workshops and other meetings. The CEC will continue to identify strategies by supporting research and analysis of the natural gas system and related health and safety issues. In its proposed decision, the CPUC recommends the CEC include the following elements in its Fiscal Year 2020–2022 natural gas research and development plan:

- a) Ensure coordination and consistency with goals of CARB's 2017 Climate Change Scoping Plan Update by 1) ensuring safety of the natural gas system, 2) decreasing fugitive methane emissions, and 3) reducing dependence on fossil fuel natural gas.
- b) Consider the health impacts associated with natural gas usage inside homes.
- c) Ensure coordination with the CPUC's Methane Leak Proceeding (R.15-01-008) for any leakage-related gas research and development, especially energy-related environmental research.
- d) Examine the causes, diagnostics, and mitigation of microbiologically influenced corrosion of pipelines and storage fields in the California natural gas industry.
- e) Assess the effects of delivering hydrogen through the existing natural gas pipeline network, including the impact on pipelines, natural gas generators, and appliances.
- f) Research the operational, health, and safety consequences of various concentrations of siloxane in biomethane supplies.
- g) Perform research to establish a standard test method approved by the National Environmental Laboratory Accreditation Program and Department of Defense Environmental Laboratory Accreditation Program for detecting siloxane in biomethane.

As shown in this review of legislative and regulatory activity since the passage of AB 1257, the state has been highly responsive to the legislative and administrative direction for a transition to a carbon-neutral economy that increases the environmental benefits for and welfare of more Californians at a reasonable cost. The CEC will stay engaged on these important issues.

557 CARB. 2017. [California's 2017 Climate Change Scoping Plan](https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf), https://ww3.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

APPENDIX B:

Clean Transportation Program Successes and Benefits

To help achieve the decarbonization policies outlined in Chapter 1, the California Energy Commission (CEC) administers the Clean Transportation Program (formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program [ARFVTP]), which was created by the Legislature under Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007). Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) subsequently extended the collection of fees that support the ARFVTP through January 1, 2024. With roughly \$100 million per year from vehicle registration fees, the Clean Transportation Program provides funding to “develop and deploy innovative technologies that transform California’s fuel and vehicle types to help attain the state’s climate change policies.”⁵⁵⁸

The statutes also require the CEC evaluate of Clean Transportation Program efforts as part of each biennial Integrated Energy Policy Report (IEPR).

Funding Summary

Each year, the CEC develops an investment plan update to guide funding allocations for the coming fiscal year. The allocations reflect a combination of the state’s clean transportation priorities, the barriers and opportunities for achieving the state’s goals, and an awareness of the role of the Clean Transportation Program as part of a broader suite of state policies and programs. The 2019–2020 Investment Plan Update, adopted at the CEC business meeting in September 2019, was the eleventh and most recent edition of this report.

Since its first Clean Transportation Program grant in 2009, the CEC has provided \$829.4 million in funding. These project awards are summarized in Table 27.

⁵⁵⁸ California Health and Safety Code Section 44272(a).

Table 27: Clean Transportation Program Awards as of March 1, 2019

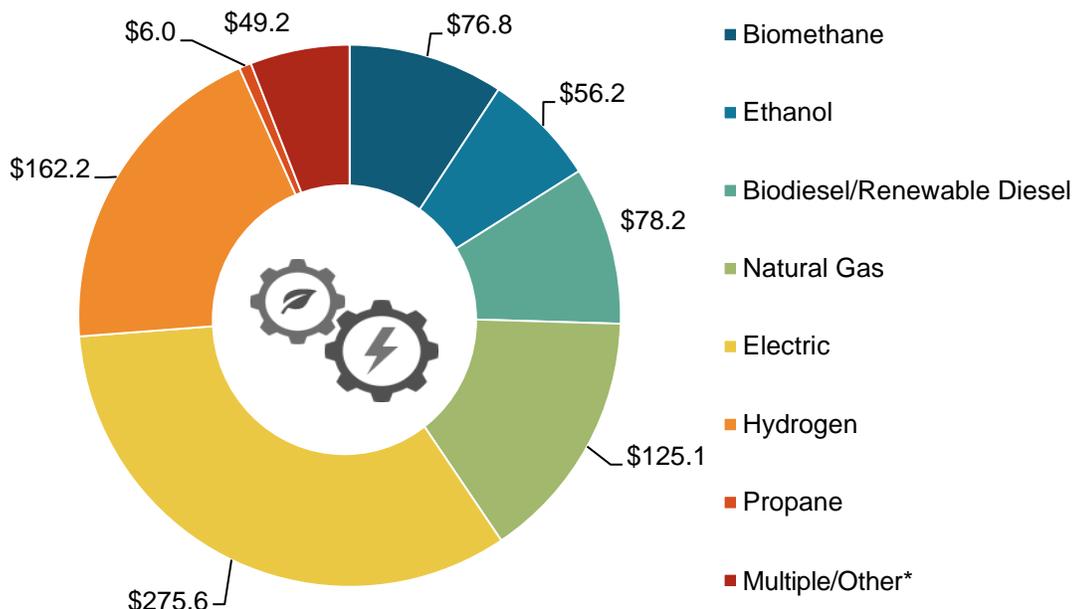
Category	Funded Activity	Cumulative Awards to Date (in millions)	Number of Projects or Units
Alternative Fuel Production	Biomethane Production	\$76.8	27 Projects
Alternative Fuel Production	Gasoline Substitutes Production	\$39.5	16 Projects
Alternative Fuel Production	Diesel Substitutes Production	\$74.2	26 Projects
Alternative Fuel Production	Renewable Hydrogen Production	\$7.9	2 Projects
Alternative Fuel Infrastructure	Electric Vehicle Charging Infrastructure**	\$94.9	9,655 Charging Connectors
Alternative Fuel Infrastructure	Hydrogen Refueling Infrastructure	\$140.6	64 Fueling Stations
Alternative Fuel Infrastructure	E85 Fueling Infrastructure	\$13.7	59 Fueling Stations
Alternative Fuel Infrastructure	Upstream Biodiesel Infrastructure	\$4.0	4 Infrastructure Sites
Alternative Fuel Infrastructure	Natural Gas Fueling Infrastructure	\$24.1	70 Fueling Stations
Alternative Fuel and Advanced Technology Vehicles	Natural Gas Vehicle Deployment***	\$86.8	3,252+ Vehicles
Alternative Fuel and Advanced Technology Vehicles	Propane Vehicle Deployment	\$6.0	514 Trucks
Alternative Fuel and Advanced Technology Vehicles	Hybrid and Zero-emission Vehicle Deployment	\$32.0	10,700 Cars and 150 Trucks
Alternative Fuel and Advanced Technology Vehicles	Advanced Technology Freight and Fleet Vehicles	\$126.3	48 Demonstrations
Related Needs and Opportunities	Manufacturing	\$43.6	21 Manufacturing Projects
Related Needs and Opportunities	Workforce Training and Development	\$30.2	17,440 Trainees
Related Needs and Opportunities	Fuel Standards and Equipment Certification	\$3.9	1 Project
Related Needs and Opportunities	Sustainability Studies	\$2.0	2 Projects

Category	Funded Activity	Cumulative Awards to Date (in millions)	Number of Projects or Units
Related Needs and Opportunities	Regional Alternative Fuel Readiness and Planning	\$11.4	52 Regional Plans
Related Needs and Opportunities	Centers for Alternative Fuels	\$5.6	5 Centers
Related Needs and Opportunities	Technical Assistance and Program Evaluation	\$5.7	N/A
	TOTAL	\$829.4	

Source: CEC *Includes all agreements that have been approved at a CEC business meeting or are expected for business meeting approval following a notice of proposed award. For canceled and completed projects, includes only funding received from Clean Transportation Program, which may be smaller than initial award. Due to rounding, "total" may not match sum of rows. **Includes \$38.8 million for the California Electric Vehicle Infrastructure Project to provide electric vehicle incentives throughout California, which will fund a yet-to-be-determined number of electric vehicle chargers. ***Funding includes completed and pending vehicle incentives, as well as funds reserved for future incentives. ****Includes projects from the former Medium- and Heavy-Duty Vehicle Technology Demonstration category.

These funding allocations can also be grouped by fuel or technology type. As Figure 55 depicts, roughly one-quarter of Clean Transportation Program funds have gone toward the production or distribution of low-carbon alternative fuels that can directly displace fossil fuels, such as biomethane (also known as renewable natural gas), ethanol, biodiesel, or renewable diesel. About 15 percent, or \$125 million, has gone toward natural gas vehicle or fueling infrastructure projects. Roughly half of the Clean Transportation Program funds have gone toward zero-emission vehicle (ZEV) technologies (hydrogen and electricity), including a mixture of refueling infrastructure investments and vehicle demonstration, deployment, or manufacturing projects, or a combination thereof. The remaining funds, about 7 percent, have gone toward projects that do not have a specific fuel type or involve multiple fuel types (such as workforce development projects or localized alternative fuel readiness plans).

**Figure 55: Clean Transportation Program Funding by Fuel Type as of March 1, 2019
(in Millions)**



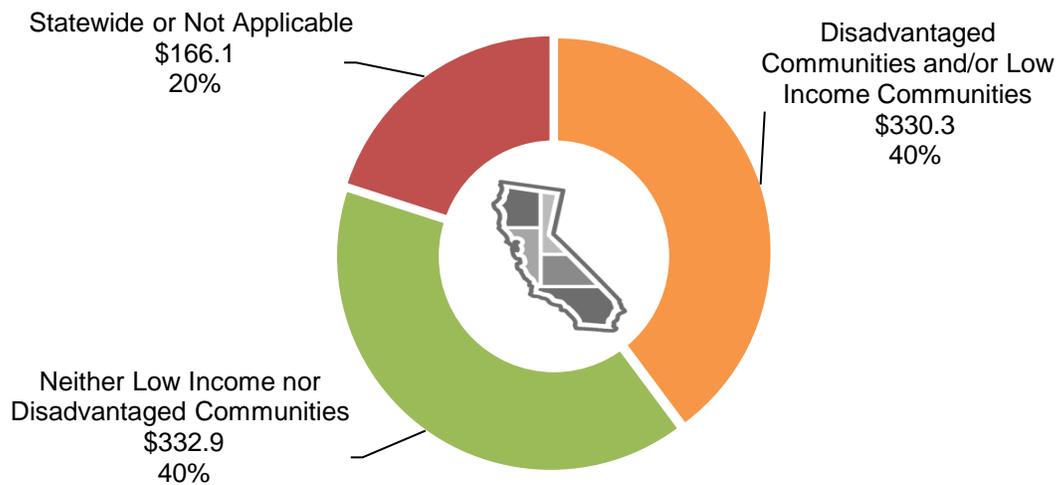
Source: CEC

Within its funding portfolio, the CEC seeks to increase the participation of disadvantaged and underrepresented communities from a diverse range of regions in implementing the Clean Transportation Program. As shown in Figure 56, roughly 40 percent of Clean Transportation Program project funding has gone into disadvantaged communities as defined by CalEnviroScreen. (When not including “Statewide or Not Applicable” projects, the number is closer to 50 percent.)

However, the funding amounts of projects are not a complete metric for assessing the benefit of a project to disadvantaged communities. In response to a request for feedback from the CEC, the Disadvantaged Community Advisory Group recommended that the CEC revise the approach of the program toward defining, measuring, and tracking the program benefits toward disadvantaged communities.⁵⁵⁹ As the CEC continues to implement the program, this revised approach will need to be discussed and assessed.

559 SB 350 Disadvantaged Communities Advisory Group, ["SB 350 Disadvantaged Communities Advisory Group Comments on 2019-2020 Investment Plan Update,"](https://efiling.energy.ca.gov/GetDocument.aspx?tn=228878&DocumentContentId=60238) https://efiling.energy.ca.gov/GetDocument.aspx?tn=228878&DocumentContentId=60238. June 28, 2019. Submitted to Docket 18-ALT-01, TN# 228878.

Figure 56: Clean Transportation Funding Toward Disadvantaged Communities (in Millions)



Source: CEC

Overall Contributions of the Clean Transportation Program

Charging Infrastructure

The mass-market adoption of plug-in electric vehicles (PEVs) will depend on the availability of a convenient and reliable network of charging stations within the state. Recognizing this dependency, the CEC, through its Clean Transportation Program, has funded the installation of nearly 10,000 charging connectors within the state since the program’s inception. Table 28 summarizes the number and types of connectors funded by the Clean Transportation Program to date. While a large number of initially funded charging connectors focused on single-family Level 2 residential charging, the CEC has since shifted its funding to focus on shared charging connectors, such as multifamily charging, workplace charging, fleet charging, and DC fast charging.

Table 28: Charging Connectors Funded by the Clean Transportation Program as of March 1, 2019

Status	Private Access-Residential (Single and Multifamily)	Private Access-Fleet	Private Access-Workplace	Publicly Accessible-Multifamily Housing	Publicly Accessible-Public	Publicly Accessible-Corridor/Urban Metro	Total
Installed	3,936	115	364	341	3,118	226	8,100
Planned	0	0	76	8	191	1,280	1,555
Total	3,936	115	440	349	3,309	1,506	9,655

Source: CEC (Does not include connectors that have yet to be approved at a CEC business meeting, or connectors that have yet to be funded under CALeVIP.)

To estimate California’s charging infrastructure needs for the near future, the CEC and the U.S. Department of Energy’s National Renewable Energy Laboratory codeveloped the Electric Vehicle Infrastructure Projections (EVI-Pro) tool. EVI-Pro estimates the number of charging connectors that will be needed at the local level while accounting for differing charger power levels, location types, and PEV adoption rates.⁵⁶⁰ The EVI-Pro estimates of the amount of charging infrastructure needed to support 1.5 million ZEVs by 2025 helped inform Executive Order B-48-18, which calls for 250,000 charging points (including at least 10,000 DC fast chargers) by 2025.

To track progress toward this 2025 goal, CEC staff sought data and estimates regarding the number of public or shared charging connectors that exist within California, as well as the recent and proposed charging infrastructure investments of the Clean Transportation Program and other key state funding mechanisms. Table 29 includes:

- The estimated number of existing public or shared or both Level 2 and DC fast-charging connectors within the state.
- The estimated number of connectors to be installed with previous years’ Clean Transportation Program funds, as well as announced plans from other major funding programs (such as utility investments and settlement agreements).
- The estimated shortfall in charging infrastructure relative to the goals of Executive Order B-48-18.

As shown in Table 29, nearly 80,000 additional Level 2 connectors are needed within next six years, along with 3,000 to 4,000 direct current (DC) fast chargers.

⁵⁶⁰ Bedir, Abdulkadir, Noel Crisostomo, Jennifer Allen, Eric Wood, and Clément Rames. 2018. *California Plug-In Electric Vehicle Infrastructure Projections: 2017-2025*. CEC. Publication Number: CEC-600-2018-001. [Link to California PEV Infrastructure Projections 2017-2025 report on the CEC’s website](https://efiling.energy.ca.gov/GetDocument.aspx?tn=223286&DocumentContentId=31667) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=223286&DocumentContentId=31667>. An interactive EVI-Pro map is also available online. [Link to interactive EVI-Pro map](https://maps.nrel.gov/cec/) <https://maps.nrel.gov/cec/>.

Table 29: Progress Toward 250,000 Charging Connectors by 2025

	Level 2 Charging Connectors	DC Fast Charging Connectors
Existing Charging Connectors (Estimated)*	37,400	2,900
Allocated Funding for Chargers (includes anticipated funding from Clean Transportation Program)	124,600	3,500
Total	162,000	6,400
<i>2025 Goal (Executive Order B-48-18)</i>	<i>240,000</i>	<i>10,000</i>
Gap From Goal	78,000	3,600

Source: CEC (Analysis as of March 8, 2019.) *Existing charging ports estimated based on available data from the U.S. Department of Energy's Alternative Fuels Data Center as well as informal interviews with some (but not all) major charging infrastructure providers.

**Estimate of ports from other state programs derived from public presentations and statements by utilities, California Public Utilities Commission, CARB, other entities, and the CEC.

To streamline the targeting and funding of additional charging infrastructure, the CEC introduced the California Electric Vehicle Infrastructure Project (CALeVIP). The incentives provided through CALeVIP simplify the funding process and accelerate charger deployment compared to the previously used grant solicitations. Each CALeVIP project provides incentives for infrastructure in specific regions throughout the state, with funding targeted at regions that have low rates of infrastructure installation or lack adequate incentives from utilities and other sources.

To date, the CEC has funded the installation of about 6,750 public or shared charging connectors that will count toward the state's goals under Executive Order B-48-18. This number does not yet include any of the to-be-installed charging connectors funded under CALeVIP through June 2019, for which the CEC has allocated roughly \$76 million.

"The CALeVIP program really represents the maturity of the Clean Transportation Program and acknowledges where the market needs to go while increasing velocity. The Clean Transportation Program were very critical investments, matched with private investments that we utilized to be able to grow our business. Looking at where we've come in 12 years, we now have approximately 100,000 EV charging spots in North America, and about 700 employees that are strictly dedicated to EV charging."

Quote from John Schott, ChargePoint, Inc., July 18, 2019, staff workshop on Clean Transportation Program Benefits Report and Successes for 2019 IEPR, Sacramento, CA. ChargePoint, Inc. has received six awards totaling over \$91 million and provided match funding of over \$8.5 million.

Hydrogen Refueling Infrastructure

Since the inception of the program, the Clean Transportation Program has been the state's primary funding mechanism for the state's hydrogen refueling stations. As of March 2019, the CEC had approved nearly \$125 million in Clean Transportation Funding for 64 new or upgraded hydrogen refueling stations. These stations will help serve an emerging population of fuel cell electric vehicles, as well as the development of retail fueling standards to enable hydrogen sales on a per-kilogram basis. As of August 2019, 40 stations were open for retail service, with another 24 under various stages of permitting and construction. These 64

Figure 58: Hydrogen Refueling Stations in the Greater Los Angeles Area



Source: CEC

“FirstElement Fuel would not exist were it not for the Clean Transportation Program’s investment in hydrogen refueling stations. We built 19 stations—with 12 more stations in the works—at unprecedented speed and scale. This creates a stable and statewide network of hydrogen stations across California.”

Quote from Dr. Shane Stephens, FirstElement Fuel, Inc., July 18, 2019 staff workshop on Clean Transportation Program Benefits Report and Success for 2019 IEPR, Sacramento, CA. FirstElement Fuel, Inc., has been the recipient of multiple awards totaling more than \$52 million and provided nearly \$20 million in match funding.

Alternative Fuel Production

The Clean Transportation Program investments in low-carbon alternative fuel production have focused on two main outcomes: developing and demonstrating next-generation biofuel production processes and feedstocks and expanding in-state production of low-carbon fuels. Biofuels such as nonpetroleum diesel substitutes, gasoline substitutes, and biomethane represent the largest existing stock of alternative fuel in California transportation sector. In addition, the production of and demand for renewable hydrogen are expected to increase in the coming years as more hydrogen fuel cell electric vehicles enter the market.

Tables 30 and 31 summarize key attributes of pre-commercial and commercial-scale alternative fuel production projects funded under the Clean Transportation Program, including their feedstock or production pathway or both; greenhouse gas (GHG) emission reduction relative to gasoline or diesel; and (in the case of commercial-scale projects) the estimated increases in annual production capacity in diesel gallon equivalents (DGE).

Table 30: Commercial-Scale Alternative Fuel Production Projects

Fuel Type	Feedstock Descriptions	Average GHG Emission Reduction*	Range of Annual Capacity for Individual Projects
Biomethane	Dairy manure; fats, oils, & grease; food, green, yard, and municipal waste	166 percent	140,000 – 2,870,000 DGE
Diesel Substitutes	Waste oils* (various)	83 percent	1,928,311 – 20,000,000 DGE
Gasoline Substitutes	Sugar beets; grain sorghum	47 percent	2,600,000 – 26,000,000 GGE
Renewable Hydrogen	Renewable electricity & water	100 percent	750,000 GGE

Source: CEC *Compared to conventional diesel (for biomethane and diesel substitutes) or gasoline (for gasoline substitutes and renewable hydrogen).

“The AltAir Renewable Fuels Project, funded by the Clean Transportation Program, was located at an old petroleum refinery that was ramping down operations. We created renewable jet fuel. We’re the only commercial producer of this fuel in the world. Additionally, the project allowed us to keep about 65 direct employees and 25 indirect employees in the community.”

Quote from Erin Donnette, July 18, 2019, staff workshop on Clean Transportation Program Benefits Report and Success for 2019 IEPR, Sacramento, CA. AltAir Fuels, LLC, received a \$5 million award for this project.

Table 31: Sample of Pre-Commercial Alternative Fuel Production Projects

Fuel Type	Pathway Description	Average GHG Emission Reduction*
Biomethane	Anaerobic codigestion of wastewater; manure; or food, beverage, or green waste	89 percent - 150 percent
Diesel Substitutes	Esterification or trans-esterification ⁵⁶¹ of algae, manure, or food waste	45 percent - 55 percent
Diesel Substitutes	Gasification of green waste or manure	67 percent
Gasoline Substitutes	Fermentation of cellulosic or agricultural residues*	76 percent - 85 percent

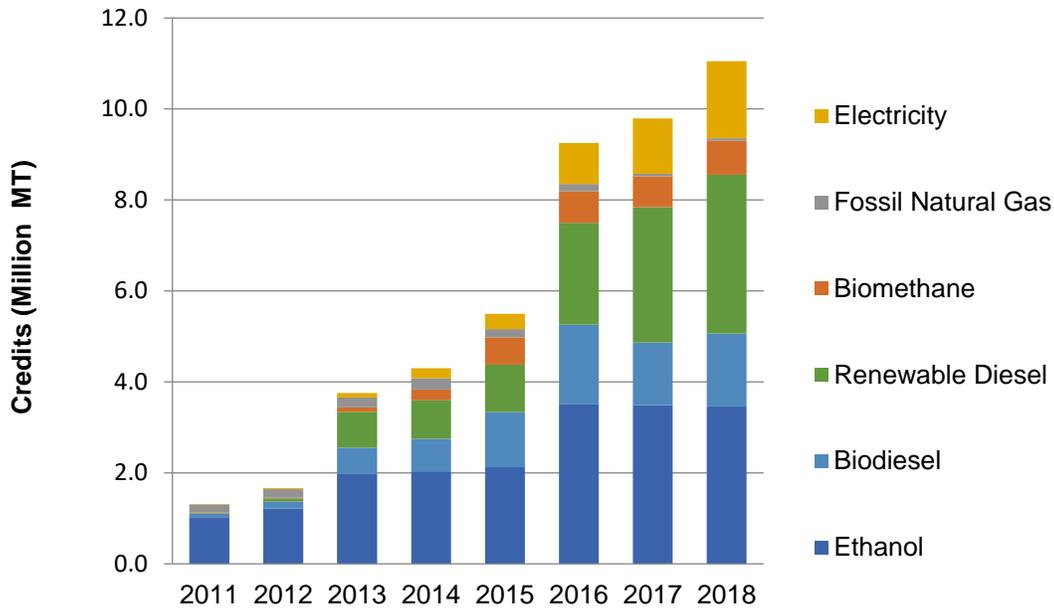
Source: CEC *Compared to conventional diesel (for biomethane and diesel substitutes) or gasoline (for gasoline substitutes and renewable hydrogen).

Fuel production projects funded by the Clean Transportation Program support the in-state production of alternative fuels, as well as the repurposing of waste-based feedstocks. These projects also benefit significantly from credits under the Low Carbon Fuel Standard (LCFS) and, in turn, support the state’s ability to meet its near-term GHG emission reduction requirements with in-state investments. As Figure 59 shows, biofuels have historically represented (and continue to represent) the vast majority of credits under the LCFS. With LCFS credits nearing \$200 per metric through early 2019, this represents a sizeable per-gallon incentive to support the continued production (or importation) of low-carbon alternative fuels.

This makes it especially difficult to separate the GHG reduction benefits of the Clean Transportation Program fuel production projects from the GHG reduction benefits of the LCFS. While this connection generally applies to any low-carbon fuel project funded under the Clean Transportation Program, it is especially relevant for biofuels, given the significant volume of credits they have generated (and corresponding amount of funding they have received) under the LCFS.

⁵⁶¹ “Esterification and transesterification” are defined in this context as a chemical reaction between oil and alcohol to produce esters, which are the primary component of biodiesel.

Figure 59: LCFS Credits by Fuel Type



Source: California Air Resources Board (CARB)

Vehicle Investments

The Clean Transportation Program has made significant investments into alternative fuel and advanced technology vehicles, with a special emphasis on medium- and heavy-duty vehicles that generate a disproportionate share of the state's GHG and criteria pollutant emissions. The earlier incentives of the program for more than 500 propane trucks and more than 3,000 natural gas vehicles represented near-term opportunities to bring quick criteria emission reductions and, in the case of natural gas, expand the potential population of trucks that could utilize ultra-low-carbon biomethane. Before the availability of funding from the Greenhouse Gas Reduction Fund, the CEC also partnered with CARB to provide funding for hybrid and ZEV deployment projects, such as the Clean Vehicle Rebate Project and the California Hybrid and Zero-Emission Truck and Bus Incentive Project.

However, Clean Transportation Program investments have especially focused on the development and demonstration of advanced technology trucks and buses. Given the diversity of sizes and duty cycles for medium- and heavy-duty vehicles, the CEC has invested in a broad variety of low-carbon solutions. As of March 1, 2019, the CEC had invested \$126 million in program funds into 54 technology demonstration projects for freight and fleet vehicles. These projects include in-use demonstrations of medium- and heavy-duty hybrids, plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles (BEVs); fuel cell buses and trucks; low-NO_x natural gas engines; and vehicle-to-grid and intelligent transportation systems.

“The Energy Commission has played a major role in advancing vehicle technology at the San Pedro Bay Ports. What is unique about the Clean Transportation Program is that it integrates different aspects of the transition to zero-emissions technologies, including freight workforce analysis, EV infrastructure planning, or cost-effectively demonstrating trucks so that these technologies can advance industry.”

Quote from Morgan Caswell, July 18, 2019 staff workshop on Clean Transportation Program Benefits Report and Success for 2019 IEPR, Sacramento, CA. The Port of Long Beach has received three awards totaling nearly \$18 million and has provided nearly \$13 million in match funding.

Related Needs and Opportunities

The Clean Transportation Program has also provided funding for related needs and opportunities that support the aforementioned fuel, infrastructure, and vehicle projects. The CEC’s investment in workforce training and development, for instance, has grown in size and scope since the program began. To date, the CEC’s training and development investments have reached more than 17,000 trainees. Most of this training has been delivered under the CEC’s funding agreement with the California Employment Training Panel, which funds training for incumbent workers in the alternative fuel production, infrastructure, or vehicle industries, or a combination thereof.

Under the Clean Transportation Program, the CEC has similarly invested in the ability of California’s community college system to provide training and coursework on alternative fuel vehicles. Under an agreement with the Advanced Transportation and Logistics Initiative within the California Community Colleges Chancellor’s Office, the CEC has provided funding to 15 campuses around the state to purchase specialty equipment required for hands-on training, as well as technical training for instructors to stay at the forefront of clean transportation technologies.

Funding from the Clean Transportation Program is also supporting in-state ZEV and ZEV infrastructure manufacturers, with nearly \$50 million encumbered across more than 20 projects as of July 2019. These investments into the ZEV and ZEV infrastructure supply chain, while minor compared to the overall costs of bringing new technologies to market, address niche opportunities to ramp up innovative products for early commercialization. The awards also provide prospective investors with a signal of public commitment to the company or technology. Furthermore, this funding (like the workforce training and development funding) will help ensure that California’s transition to cleaner vehicles will also lead to expanded economic opportunities and revenues within California.

“For Proterra, there are multiple benefits to our Clean Transportation Program Project. Number one is job creation right in the community where we are manufacturing our all-electric transit buses. As we continue to grow this market, we will keep adding jobs to build more zero-emission buses. It is not just Proterra and our buses. It is also all of the other manufacturers of zero-emission vehicles and their suppliers within California, up and down the state that create jobs.”

Quote from Kent Leacock, Proterra, Inc., July 18, 2019, staff workshop on Clean Transportation Program Benefits Report and Success for 2019 IEPR, Sacramento, CA. Proterra, Inc., has received two awards for a total of nearly \$5 million and provided over \$11 million in match funding.

Quantifying Benefits From Clean Transportation Program Projects

Section 44273 of the Health and Safety Code requires the Energy Commission to evaluate the following types of benefits for projects funded under the Clean Transportation Program:

- Petroleum Use Reduction
- Air quality
- GHG emissions reduction
- Benefit-cost assessment
- Technology advancement

The CEC partnered with the National Renewable Energy Laboratory (NREL) to develop quantifiable estimates of petroleum use reduction, air quality benefits, and GHG emissions reductions associated with Clean Transportation Program projects. NREL had similarly helped develop Clean Transportation Program benefits analysis in the 2013 IEPR, 2014 IEPR Update, 2015 IEPR, and 2017 IEPR.

On the Attribution of Benefits to the Clean Transportation Program

The Clean Transportation Program is one tool among a broader suite of incentives and regulations designed to achieve the state’s goals for GHG reduction and cleaner air.

As such, projects funded by the program also benefit (directly or indirectly) from other incentives or regulations, such as the LCFS, CARB’s low carbon transportation investments (and other GHG Reduction Fund investments), and the ZEV regulation, among others.

Moreover, the roughly \$829.4 million invested under the program has been contractually matched by more than \$860 million in outside funding.

As such, the CEC does not intend to convey the sole responsibility for the benefits of the projects funded under the program, nor as an analysis of these benefits in excess of regulatory requirements.

For the 2019 IEPR, NREL used the same approach toward quantifying Clean Transportation Program project benefits as it did in previous years. This quantification includes analyzing two categories of benefits: expected benefits and market transformation benefits. These categories are discussed further in the respective sections.

On July 18, 2019, the CEC hosted an IEPR workshop on the Clean Transportation Program Benefits Report and Successes that included a presentation from NREL on the initial results and findings from its 2019 analysis.⁵⁶² A subsequent stand-alone report from NREL will be published in fall 2019, which will document the full method and revised results.

Inputs and Assumptions

CEC staff provided NREL a list of pending, active, and completed Clean Transportation Program projects through March 2019, along with relevant information about each.⁵⁶³ The list included projects totaling about \$663.6 million, or roughly 80 percent of all Clean Transportation Program project funding. Other projects were not included in this analysis, such as projects without direct petroleum displacement or emissions reduction benefits (including regional readiness planning grants, workforce training, or fueling standards and certification), projects that were canceled or otherwise not expected to be completed, and projects that had only recently been proposed for awards. Table 32 shows the amount and percentage of funding included in the NREL analysis by project type.

⁵⁶² NREL, "CEC ARFVTP Benefits and Market Transformation Update." Presented on July 18, 2019. [Presentation by NREL on CEC ARFVTP Benefits and Market Transformation Update](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229019&DocumentContentId=60398) https://efiling.energy.ca.gov/GetDocument.aspx?tn=229019&DocumentContentId=60398.

⁵⁶³ Projects that were canceled by the CEC, or pending cancellation, were not included.

Table 32: Funding Analyzed by NREL by Project Type Through March 2019

Category	Project Type	Funding Analyzed by NREL (in millions)	Percent of Funding Analyzed by NREL
Alternative Fuel Production	Biomethane	\$70.7	94
Alternative Fuel Production	Gasoline Substitutes	\$32.4	82
Alternative Fuel Production	Diesel Substitutes	\$57.0	81
Alternative Fuel Infrastructure	Electric Vehicle Charging	\$90.5	95
Alternative Fuel Infrastructure	Hydrogen Refueling	\$109.9	91
Alternative Fuel Infrastructure	E85 Fueling	\$6.3	100
Alternative Fuel Infrastructure	Upstream Biodiesel Infrastructure	\$3.9	97
Alternative Fuel Infrastructure	Natural Gas Fueling	\$25.0	100
Alternative Fuel and Advanced Technology Vehicles	Natural Gas Commercial Trucks	\$80.5	93
Alternative Fuel and Advanced Technology Vehicles	Light-duty BEVs and PHEVs	\$28.0	100
Alternative Fuel and Advanced Technology Vehicles	Electric Commercial Trucks	\$4.0	100
Alternative Fuel and Advanced Technology Vehicles	Medium- and Heavy-Duty Truck Demonstration	\$126.3	100
Alternative Fuel and Advanced Technology Vehicles	Manufacturing	\$29.1	66
	Other	\$0.0	0
	Total	\$663.6	80

Source: CEC staff

The CEC staff also provided NREL with project information from a variety of sources, including initial funding proposals, surveys of funding recipients, and (when available) final project reports.

The most critical information included:

- The amount of alternative fuel produced at program-funded production plants, dispensed at program-funded fueling stations, or consumed by program-funded vehicles. This amount is used to estimate petroleum displacement.
- The life-cycle carbon intensity of the alternative fuel of the project (if distinct from statewide averages). This information is used to estimate GHG emissions reduction.
- The type of conventional vehicle replaced by the Clean Transportation Program-funded vehicle or alternative fuel (if applicable). This information is used to estimate petroleum displacement, air quality pollutant reduction, and GHG emissions reduction.

In addition to project data from the CEC, NREL also relied on other established models. NREL incorporated carbon intensity values from the California LCFS and the California-adjusted Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model when possible. NREL also used the VISION and GREET models to estimate reductions of oxides of nitrogen (NO_x) as well as particulate matter of less than 2.5 micrometers (PM 2.5).

Results from this analysis are reported primarily per-year (for example, GHG emissions reduced in 2030) rather than a cumulative basis (such as GHG emissions reduced through 2030). NREL assumed lifespans for each project class, with fuel production and fueling infrastructure projects having a longer lifespan than vehicle projects. Only vehicle projects, with an estimated lifespan of 16 years, had a shorter lifespan than the analysis duration. Projects were assumed to begin accruing benefits at the time of completion of the Clean Transportation Program agreement. For vehicle projects, NREL applied a “vehicle miles traveled depreciation rate” to account for the fact that older vehicles typically drive fewer miles per year as they age. Conversely, fuel production projects were assigned a three-year “ramp up” period to reach anticipated capacity.

Within NREL’s analysis, the benefits of a project are assumed to include all alternative fuel produced, dispensed, or consumed by a Clean Transportation Program-funded project. This approach is the most straightforward to quantifying benefits but risks overstating the direct impacts of the investment of the Clean Transportation Program. In almost all cases, Clean Transportation Program funding for a project must be matched by private funding. To date, the Clean Transportation Program total investment of \$829 million has been contractually matched with more than \$800 million in outside funding.⁵⁶⁴ Furthermore, other public funding and regulatory programs help ensure the success of Clean Transportation Program projects, including the LCFS, the Renewable Fuel Standard, the ZEV mandate, the Air Quality Improvement Program, and the GHG Reduction Fund. For similar reasons, benefits from this

⁵⁶⁴ Not including the match funding associated with as-yet-unsigned grant agreements.

analysis should not be viewed as independent of (or in addition to) the estimated benefits of related programs.

Expected Benefits

In NREL's analysis, "expected benefits" represent the direct outcomes of projects funded by Clean Transportation Program funding. These benefits assume a one-to-one substitution of conventional petroleum-derived fuels with an alternative fuel or improved vehicle efficiency or both. The amount of gasoline or diesel displaced, multiplied by the carbon intensity ratio of the new alternative fuel against gasoline or diesel, results in an estimate of GHG reductions.

Table 33 highlights the expected benefits from program-funded projects in terms of annual petroleum fuel reductions and GHG reductions. Based on NREL's analysis, projects supported by the Clean Transportation Program are expected to contribute to the reduction of 261 million gallons of petroleum fuel consumption and 1,423 thousand tonnes of carbon dioxide-equivalent (CO₂e) GHG emissions per year by 2030.

The ratio between petroleum fuel reductions and GHG reductions in Table 33 also illustrates the relative carbon reduction benefits of various alternative fuels. For example, in 2030, the biomethane fuel production projects reduce GHG emissions by about 1,900 tonnes of CO₂e per million gallons of displaced petroleum (22.6/11.8), while the natural gas commercial trucks reduce GHG emissions by just 2,700 tonnes per million gallons (9.7/3.6).

Table 33: Annual Petroleum Fuel and GHG Reductions (Expected Benefits)

Project Type	Petroleum Fuel Reductions (in million gallons)	Petroleum Fuel Reductions (in million gallons)	GHG Reductions (in thousand tonnes CO ₂ e)	GHG Reductions (in thousand tonnes CO ₂ e)
	2020	2030	2020	2030
Fuel Production	60.1	135.5	529.1	684.4
Biomethane	1.6	11.8	20.8	22.6
Diesel Substitutes	51.5	85.7	483.7	643
Gasoline Substitute	7	38	24.6	18.8
Fueling Infrastructure	62.6	70.9	227.9	275.4
Biodiesel	5.8	5.8	21.6	21.6
E85	13.8	13.9	41.8	42.1
Electric Charging	3.9	4.9	29.6	37.2
Hydrogen	8.8	12.6	62.1	89
Natural/Renewable Gas	30.3	33.7	72.8	85.5
Vehicles	1.8	0.9	14.5	6.7
CVRP and HVIP Support	1.8	0.9	14.3	6.5
Light-duty BEVs and PHEVs	0.0	0.0	0.2	0.2
Manufacturing	18.5	48.9	158.9	437.6
Medium- and Heavy-duty Truck Demonstration	1.1	1.3	8.4	9.3
Natural Gas Commercial Trucks	5.5	3.6	15.1	9.7
Total	150	261.1	953.9	1,423.1

Source: NREL. Note: subtotals and totals may not match due to rounding. *Does not include pre-2020 benefits from projects funded under the California Ethanol Producers Incentive Program.

In its expected benefits analysis, NREL also included tailpipe reductions of certain key criteria pollutants: NO_x and PM 2.5. However, for this analysis, NREL focused specifically on fuel and vehicle types with emission reductions recognized under the VISION and GREET models. This

focus narrows the analysis to projects using electricity and hydrogen as the alternative fuel.⁵⁶⁵ Table 34 summarizes the annual NO_x and PM2.5 reductions anticipated from the expected benefits approach.

Table 34: Annual Air Pollutant Reductions (Expected Benefits)

	Project Type	No_x Reductions (Tonnes/year)	No_x Reductions (Tonnes/year)	PM2.5 Reductions (Tonnes/year)	PM2.5 Reductions (Tonnes/year)
Year		2020	2030	2020	2030
Fuel Infrastructure	Electric Chargers	2.7	2.9	0.3	0.1
Fuel Infrastructure	Hydrogen	6	7.5	0.6	0.4
Fuel Infrastructure	Natural Gas	N/A	N/A	N/A	N/A
Vehicles	Clean Vehicle Rebate Project/Hybrid and Zero-emission Truck and Bus Voucher Incentive Project Support	7.0	1.8	0.1	0.0
Vehicles	Light-duty BEVs and PHEVs	0.0	0.0	0.0	0.0

⁵⁶⁵ Discussions are underway with CEC staff and NREL as to how natural gas can be included as well.

	Project Type	No _x Reductions (Tonnes/year)	No _x Reductions (Tonnes/year)	PM2.5 Reductions (Tonnes/year)	PM2.5 Reductions (Tonnes/year)
Vehicles	Natural Gas Commercial Trucks	55.3	53.5	0.0	0.0
Vehicles	Medium- and Heavy-duty Demonstration	9.2	15.9	0.2	0.2
Vehicles	Manufacturing	157.7	515.5	5.5	25.9
	Total	237.9	597.1	6.7	26.6

Source: NREL

Market Transformation Benefits

Unlike expected benefits, market transformation benefits represent estimates of how Clean Transportation Program funding might indirectly influence the expansion of alternative fuel production and use in the future. A simple example might be the impact of seeing additional charging stations in the vicinity makes a prospective vehicle buyer more willing to consider buying a PEV or the impact of a successful demonstration of an advanced technology truck increases the likelihood of that technology achieving future commercial success. The latter example is one way of evaluating program-funded “technological advancement” as required by the statutes of the program.

NREL has identified four potential ways Clean Transportation Program projects can influence market transformation. Table 35 describes these potential influences. There may be other ways that Clean Transportation Program projects influence the future market growth of clean fuels and vehicles; however, these are the examples NREL found to be the most readily quantifiable. The methods used to quantify these influences were established in the 2014

Table 35: Market Transformation Benefits Description

Market Transformation Influence	Applicable Project Types	Description of Influence Outcomes
Perceived Vehicle Price Reduction	Electric charging Hydrogen stations Light-duty BEVs and PHEV incentives	Increased consumer awareness Removal of consumer choice barriers via increased refueling access
Vehicle Cost Reduction	Manufacturing	Reduced cost to produce or supply a technology “Learn by doing” Economies of scale
Next-Generation Trucks	Medium-Duty/Heavy-Duty truck demonstration Medium-duty BEV incentives	Additional trucks deployed as a result of successful demonstration projects
Next-Generation Fuels	Biofuel production (all fuel types)	Additional or expanded biofuel production facilities in response to successful projects

Source: NREL

Because the market transformation benefits analysis relies on future market conditions and decisions in a way that the expected benefits analysis does not, NREL includes two sets of assumptions to generate a “low case” and “high case.”⁵⁶⁷ In general, the *low case* reflects more conservative assumptions about demand elasticity for ZEVs, savings from economies of scale, and the ability of successful demonstration projects to leverage private interest for larger commercial-scale projects. The “high case” reflects the opposite.

Table 36 summarizes the total market transformation benefits under consideration for petroleum displacement, GHG emission reduction, and air pollutant reduction. Because market transformation benefits lag behind the initial expected benefits of a project, this table focuses on benefits in 2030. As with the expected benefits, NREL did not attempt to quantify air pollutant reductions associated with the market transformation benefits of biofuel production

566 NREL. 2014. *Program Benefits Guidance: Analysis of Benefits Associated With Projects and Technologies Supported by the ARFVTP*, draft project report. [Link to Program Benefits Guidance report on the CEC's website](http://www.energy.ca.gov/2014publications/CEC-600-2014-005/CEC-600-2014-005-D.pdf) http://www.energy.ca.gov/2014publications/CEC-600-2014-005/CEC-600-2014-005-D.pdf.

567 These are unrelated to the demand cases used in the IEPR’s energy demand forecasts in Chapter 7.

projects (under “Next-Generation Fuels”). Moreover, air quality improvements for “Next-Generation Trucks” could not be reliably calculated because of significant uncertainties about what varieties of baseline vehicles would be displaced and their respective emissions profiles.

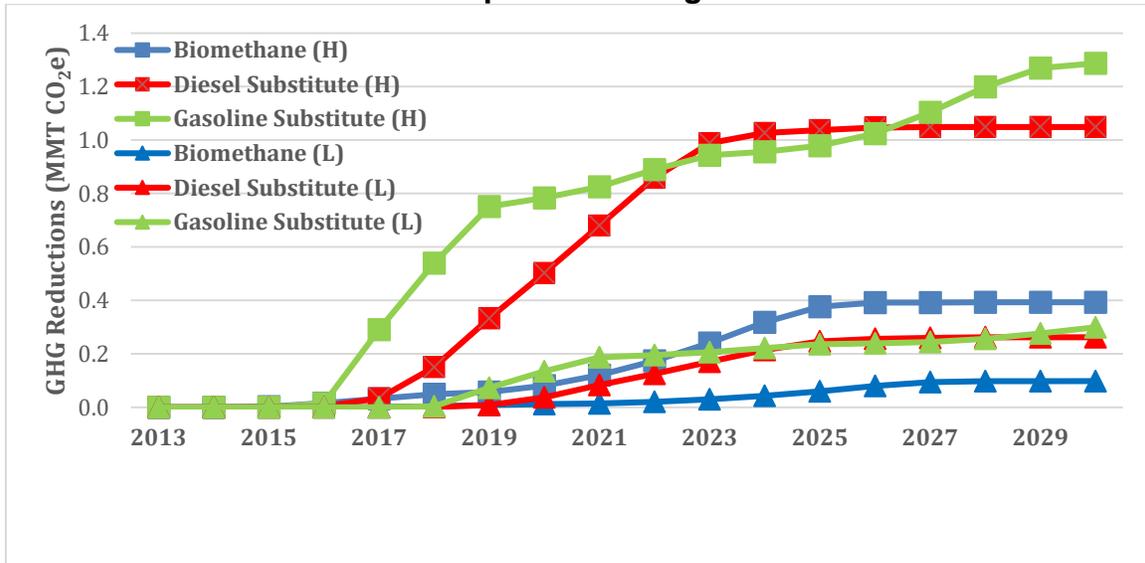
Table 36: Annual Market Transformation Benefits in 2030

Market Transformation Influence	Case	Petroleum Displacement (million gallons)	GHG Reduction (thousand tonnes CO ₂ e)	Nox Reduction (tonnes)	PM2.5 Reduction (tonnes)
Year		2030	2030	2030	2030
Perceived Vehicle Price Reductions	High	141	820	56.8	52.4
Perceived Vehicle Price Reductions	Low	55.4	326	14.4	13.3
ZEV Industry Experience	High	9.4	51	3.7	2.8
ZEV Industry Experience	Low	9.1	56	3.5	2.7
Next-generation Trucks	High	329	1,867	3,995	28.7
Next-generation Trucks	Low	17	150	206.6	1.5
Next-generation Fuels	High	323	2,730	N/A	N/A
Next-generation Fuels	Low	79	660	N/A	N/A
Total	High	802.4	5,468	4,055.5	83.9
Total	Low	160.5	1,192	224.5	17.5

Source: NREL

As an example of how market transformation benefits can change over time, Figure 60 shows the low case and high case for GHG reductions per year from the market transformation benefits assigned to “next-generation fuels.”

Figure 60: Annual GHG Reduction From Fuel Production Projects Funded by the Clean Transportation Program



Source: NREL

Benefit-Cost Assessment

As part of the biennial evaluation of the program, Health and Safety Code Section 44273 also requires the CEC to include a “benefit-cost assessment” for program-funded projects. While “benefit-cost” is not specifically defined within the section, the term “benefit-cost score” is defined elsewhere in the Clean Transportation Program’s statute as the “expected or potential GHG emissions reduction per dollar awarded by the commission to the project.”⁵⁶⁸

Unlike the previously discussed estimates of benefits, this evaluation requires assessing GHG emission reductions on a cumulative basis, not annually. A simple yet conservative assumption is to include the cumulative GHG emission reductions of program-funded projects through 2030. Based on this approach, the cumulative GHG emission reductions of expected benefits and market transformation benefits by 2030 range from roughly 29.9 million metric tons (using the low case for market transformation benefits) to 73.9 million metric tons (using the high case).

The CEC has awarded \$663.6 million toward Clean Transportation Program projects (not including canceled and defunded projects) with GHG emission reductions that are measurable using NREL’s method. When including projects that do not readily lend themselves to measurable GHG emissions (such as regional fuel readiness grants, workforce training

⁵⁶⁸ Health and Safety Code Section 44270.3.

agreements, and fuel standards and certification agreements), this amount increases to nearly \$830 million. Table 37 shows the resulting benefit-cost ratios, depending on which funding amount is used as the cost and whether the low case or the high case for market transformation benefits is applied. The values in Table 37 represent the approximate amount of carbon dioxide-equivalent metric tons reduced for every dollar invested by the Clean Transportation Program.

Table 37: Kilograms CO_{2e} Reduced Through 2030 per Program Dollar

	Cost Basis: Analyzed Projects Only	Cost Basis: All Projects
Expected Benefits + Market Transformation (Low Case)	45 kg/\$	36 kg/\$
Expected Benefits + Market Transformation (High Case)	111 kg/\$	89 kg/\$

Source: CEC

APPENDIX C: Transportation Energy Demand Forecast Historical Market Trends and Forecast Method

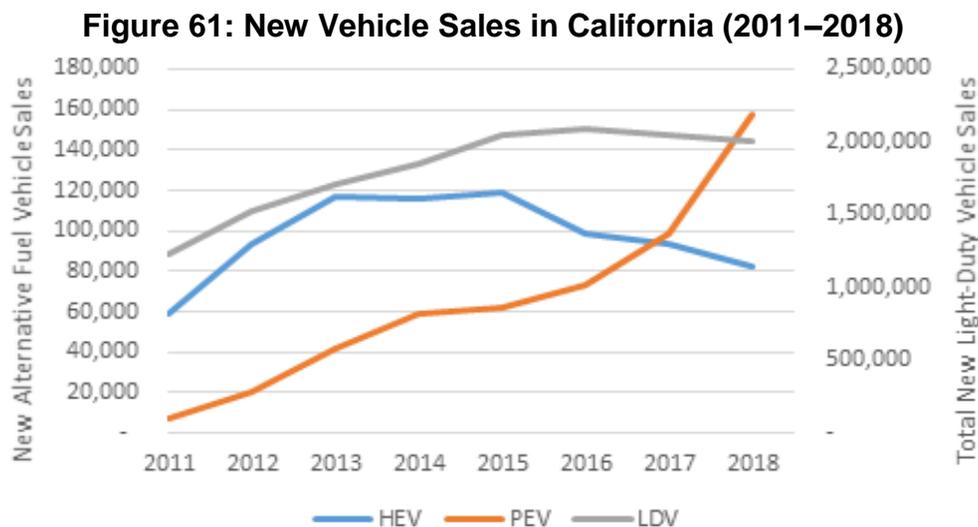
This appendix presents historical vehicle sales trends, energy consumption and price trends, as well as the method and assumptions supporting the transportation energy demand forecast.

Vehicle Sales and Fuel Consumption Trends

Total transportation fuel consumption increases with the growth in vehicle population, when fuel economy is relatively stable. The distribution among different fuels will change over time, depending on the changes in vehicle sales trends.

Vehicle Sales Trends

The economic recovery since the great recession of 2008 has led to growth in new vehicle sales. Light-duty vehicle (LDV) sales peaked in 2016, and Figure 61 shows a slight decline since then. Gasoline vehicles are the predominant share of the new LDV sales, but the share of new plug-in electric vehicles (PEV) sales in California has been steadily growing since 2009. The growth in PEV sales, however, seems to have come mostly at the expense of the hybrid electric vehicles (HEV), through 2017, and have surpassed hybrid sales. Meanwhile, fuel cell electric vehicle (FCEV) sales (not shown) have increased exponentially since 2015, when only 68 new vehicles were sold statewide, to nearly 2,500 in 2018.



Source: IHS Markit, via California New Car Dealers Association

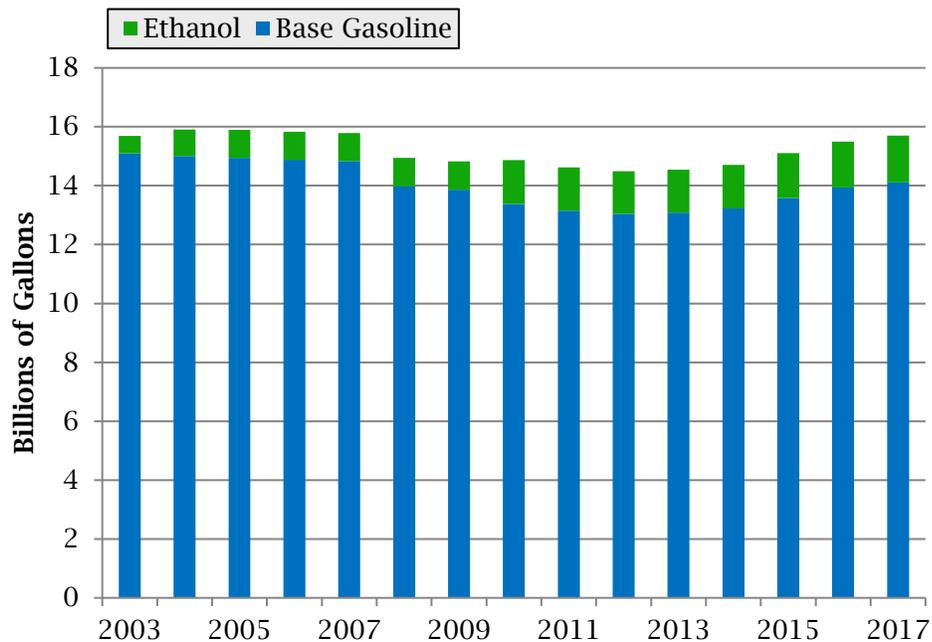
Energy Consumption Trends

Gasoline is the dominant fuel within the transportation sector, with diesel and aviation fuels following. Figures 62, 63, and 64 present trends for these fuels from 2003 through 2017. Diesel and aviation fuels reached peak consumption in 2007, while gasoline peaked in 2005.

The economic recession caused consumption of these fuels to dip in 2008 and 2009. Since then, aviation fuel consumption surpassed the previous peak in 2015, but diesel and gasoline consumption have recovered more slowly and have not yet surpassed the prerecession peaks.

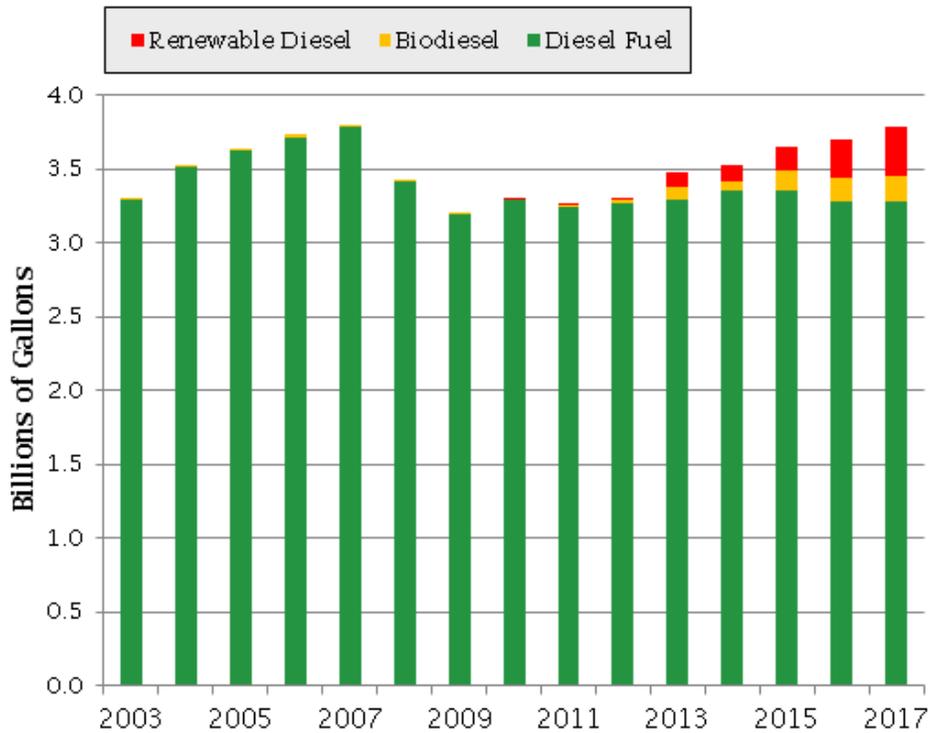
Since 2003, the ethanol blend in gasoline has increased from about 3.75 percent by volume to 10.1 percent in 2017. While the regulatory limit on blending ethanol into gasoline in California is 10 percent, sale of E85, which is a fuel blend of 85 percent ethanol and 15 percent gasoline, adds to ethanol consumption. Biodiesel and renewable diesel consumption have been spurred by obligations under the Low Carbon Fuel Standard (LCFS), representing more than 13 percent of diesel and diesel substitute consumption.

Figure 62: California Gasoline and Ethanol Consumption (2003–2017)



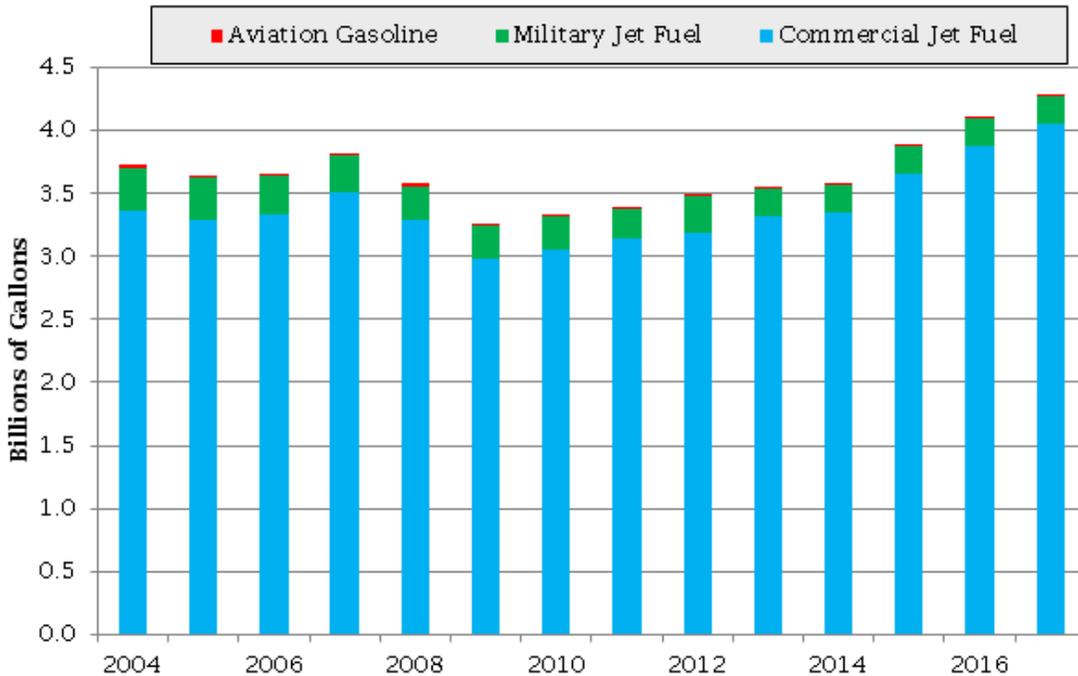
Source: CEC analysis

Figure 63: California Diesel Fuel, Biodiesel, and Renewable Diesel Consumption (2003–2017)



Source: CEC analysis

Figure 64: California Jet Fuels and Aviation Gasoline Consumption (2004–2017)



Source: CEC analysis

Table 38 presents the consumption trends for alternative gaseous fuels including propane (liquefied petroleum gas (LPG)), liquefied natural gas (LNG), compressed natural gas (CNG), and hydrogen.

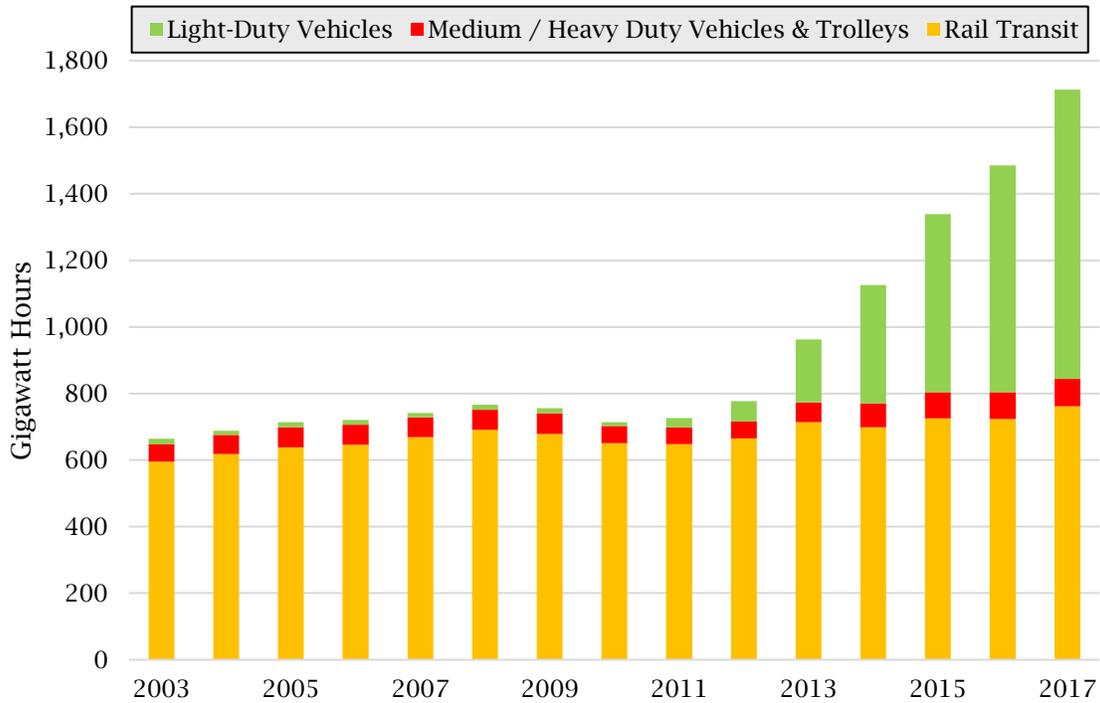
Table 38: California Gaseous Fuel Consumption (2003–2017)

Year	LPG ¹ (Propane) Consumption (Gallons)	LNG ² Consumption (Gallons)	CNG ³ Consumption (Therms)	Total Natural Gas ⁴ Consumption (Therms)	Total Natural Gas ⁴ Consumption (Diesel-gallon- equivalent)	Hydrogen ⁵ Consumption (Kilograms)
2003	18,455,500	27,970,031	64,686,479	98,033,540	75,605,656	728
2004	23,317,500	28,307,916	64,686,479	98,291,858	75,804,877	15,555
2005	22,999,500	28,645,800	77,007,713	113,150,176	87,263,944	9,275
2006	19,983,500	28,983,685	80,088,022	117,058,495	90,278,127	17,454
2007	18,316,000	22,400,000	86,248,639	119,325,161	92,026,231	19,987
2008	18,391,000	18,900,000	95,489,564	127,599,355	98,407,474	23,971
2009	22,861,067	29,635,453	98,569,873	139,456,782	107,552,186	38,292
2010	26,632,877	32,356,377	101,650,181	145,186,972	111,971,437	34,096
2011	29,139,991	35,487,647	104,730,490	151,230,879	116,632,633	52,179
2012	33,028,638	30,492,564	110,891,107	160,369,476	123,680,523	73,443
2013	34,755,459	31,868,353	113,971,416	165,759,354	127,837,318	66,276
2014	31,834,779	33,082,102	124,752,495	179,462,285	138,405,324	64,499
2015	25,806,328	34,000,572	126,292,650	181,989,469	140,354,345	62,708
2016	6,048,158	31,605,833	141,694,192	198,408,653	153,017,186	110,575
2017	9,320,651	37,320,039	187,252,522	217,261,208	167,556,698	574,747
2018	-	-	193,606,113	-	-	890,000

Source: 1) California State Board of Equalization Annual Report Table 25A- Taxable Distributions of Diesel Fuel and Alternative Fuels, 1937–1938 to 2009–2010 fiscal year data averaged over two years to estimates calendar year values for years 2003 through 2008. 2) LNG data from verbal reports to CEC reporting unit by suppliers. 3) CNG data obtained from the annual California Gas Reports. 1998–2016 reports online. [Link to California Gas Report Index on PG&E's website](https://www.pge.com/pipeline/library/regulatory/cgr/index.page) <https://www.pge.com/pipeline/library/regulatory/cgr/index.page>. CNG reported values for 2017–2018 obtained from the LCFS Quarterly Data Spreadsheet. 4) Total natural gas is the sum of LNG and CNG. 5) National Transit Authority annual reports and California Department of Motor Vehicles fuel cell vehicle registrations. Fuel cell vehicles assumed driven 9,600 miles/vehicle/year and U.S. Environmental Protection Agency Adjusted Combined Cycle fuel economy National Transit Authority Reports, Data Tables, Table 17, Energy Consumption, Other, or Hydrogen Fuels. The year 2018 reported hydrogen consumption exclusive to light-duty vehicles. The year 2018 represents hydrogen consumption sourced from CEC staff.

Finally, use of electricity as a transportation fuel is increasing, as depicted in Figure 65. The growth since 2010 is chiefly due to increased market penetration of light-duty PEVs.

Figure 65: California Transportation Electricity Consumption (2003–2017)



Sources: Federal Transit Administration and CEC analysis of California Department of Motor Vehicle data (2017 Light and heavy-duty vehicle electricity consumption is an estimate.)

Forecasting Approach

Due to fundamental differences among transportations sectors, the CEC uses 11 models to forecast energy demand in each sector. While these models often share inputs, these inputs are applied differently based on their known effect on the sector.

Suite of Models

Table 39 describes the CEC’s transportation forecasting models, highlighting the methodology and inputs used to run each model.

Table 39: CEC Transportation Forecasting Models

Model Category	Model	Description	Key Inputs
Vehicle Demand Models	Personal Vehicle Choice (LDV)	Generates forecast of household demand for LDVs by 15 size classes and 9 fuel types, in 3 market segments, based on consumer preferences and behavior.	Fuel cost, vehicle attributes and incentives, household population and income
Vehicle Demand Models	Commercial Vehicle Choice (LDV)	Generates forecast of commercial demand for LDVs by 15 size classes and 10 fuel types, based on consumer preferences and behavior.	Fuel cost, vehicle attributes and incentives, gross state product
Vehicle Demand Models	Government (LDV)	Uses rules to grow government LDVs by fuel/technology types, from the base-year stock	Gross state product, fuel economy
Vehicle Demand Models	Rental (LDV)	Uses rules to grow rental vehicles from the base-year stock	Gross state product, fuel economy
Vehicle Demand Models	Neighborhood Electric Vehicles (NEV)	Grows vehicles from the base-year stock	Gross state product
Vehicle Demand Models	Truck Choice Model (Medium-/Heavy-duty)	Uses Argonne TRUCK 5.1 model to project different truck fuel types and technology market penetration	Fuel cost, fuel economy, vehicle prices and incentives
Travel Demand Models	Urban Travel	Predicts choices among travel modes (including auto, bus, rail, and others) and forecasts short-distance personal travel and fuel demand for all travel modes	Fuel cost, travel cost, in-and-out of vehicle travel time, population, personal income
Travel Demand Models	Intercity Travel	Composed of two models: one predicts volume of travel, and the other predicts choices among long-distance travel modes (auto, rail, airplane)	Fuel cost, travel cost, departure frequency, personal income
Travel Demand Models	Air Travel	Composed of two models: one predicts passenger aviation, and another predicts freight aviation	Travel cost, personal income, population
Travel Demand Models	Freight Energy Demand (Freight Movement)	Composed of two models: one forecasts vehicle movement and fuel demand for goods movement and modal choice for truck vs. rail; the other forecasts local and regional movement and fuel demand for medium- and heavy-duty delivery, services, recreation, and other economic activities	Fuel cost, shipment size, travel time, gross state product
Travel Demand Models	Other Bus Travel	Model predicts bus miles and fuel demand based on projections of bus fleets such as school buses, demand response (paratransit), shuttle buses etc. and ridership trends	Population, grants (federal, state, local)

Source: CEC

Key Inputs and Assumptions

CEC staff use a variety of inputs and assumptions to generate the forecast results. Staff use different combinations of inputs and assumptions to create the low, mid, and high electricity demand cases.

California Department of Motor Vehicles Data

The 2017 vehicle registration data from the California Department of Motor Vehicles (DMV) serves as base-year data for forecasting the growth of various vehicle types within the state. The CEC periodically receives raw vehicle registration data from the DMV and processes the data to classify into LDV and medium-duty (MD)/heavy-duty (HD) vehicles. The LDV data are then broken down into 15 vehicle classes, nine fuel and vehicle technology types, model-year vintages, and four market segments (residential, commercial, rental, and government). Buses are classified by function, as identified in the CARB Emission Factors model (EMFAC), into urban transit, school, intercity motor coaches, and “other” buses such as institutional use or shuttles at airports. Medium-duty trucks include Classes 3, 4 and 5, and 6. Heavy-duty trucks include Classes 7 and 8, including straight trucks such as beverage delivery and garbage trucks operating within regions, and articulated tractor-trailers operating at ports, in regional service, and in interstate service. The interstate tractor-trailers are characterized in CARB’s EMFAC.

Fuel Price Forecast

Within the forecast, fuel prices affect the types of vehicles purchased, as well as the total number of miles traveled per year. Specifically, higher prices for a particular fuel make a consumer less likely to buy a vehicle using that fuel, less likely to use that fuel in a vehicle that can use multiple fuels, less likely to use that vehicle for travel, and more likely to buy a vehicle with greater fuel economy.

All forecast fuel price cases are developed by CEC staff (with the exception of the hydrogen prices) and are based on broader price trends.⁵⁶⁹ Gasoline and diesel fuel price cases are based on the United States Energy Information Administration’s (U.S. EIA’s) nationwide forecasts in its 2019 Annual Energy Outlook.⁵⁷⁰

⁵⁶⁹ A number of refineries and related facilities have had significant outages in 2019, however, the impact of these outages on future fuel prices is unclear at this time and is not accounted for in the fuel price forecast. The most recent outage, on October 15, 2019, was caused by a fire and explosion of ethanol storage tanks at the NuStar tank farm, which is adjacent to the Phillips 66 Rodeo refinery in Contra Costa County. As of October 25, gasoline prices have not been impacted due to the NuStar outage, and it remains unclear what impact this will have on ethanol distribution logistics.

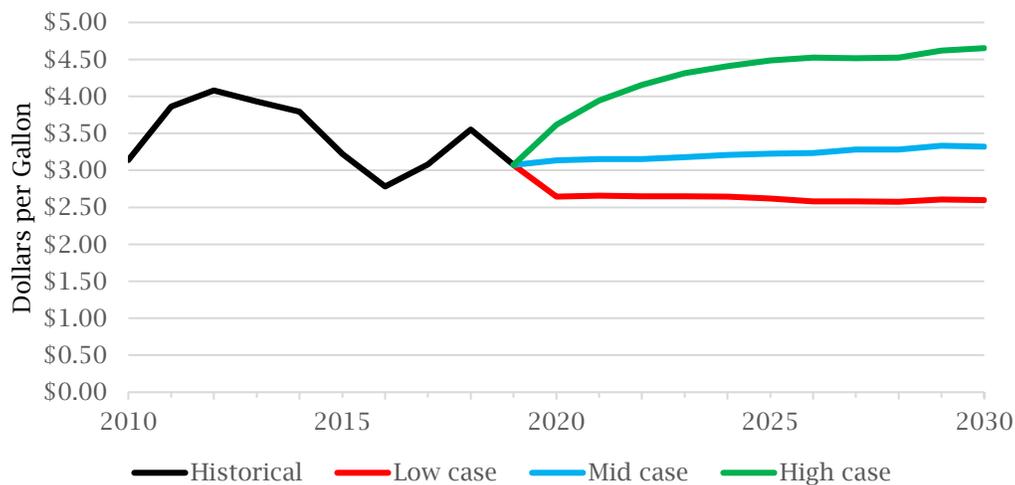
⁵⁷⁰ [Link to Annual Energy Outlook 2019 on the U.S. EIA's website](https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf) <https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf>.

To translate national fuel price forecasts into California fuel price forecasts, CEC staff considered the historical influences of several factors on California retail prices. These include:

- U.S. gasoline prices.
- Crude oil prices paid by both California and U.S. refiners (on average).
- California taxes.
- Predicted LCFS credit prices and carbon prices.
- A dummy variable to account for the large influence of the Torrance outage on the price of gasoline in California.⁵⁷¹

The resulting gasoline price cases proposed for the low, mid, and high energy demand cases are shown in Figure 66.

Figure 66: California Gasoline Price Cases (2018 Dollars per Gallon)



Source: CEC

Alternative fuel price forecasts are based on a variety of sources but are usually tied to broader market prices for the fuel outside the transportation sector. For instance, the price cases for electricity in the transportation forecast match the average residential electricity rate used in the electricity demand forecast. Similarly, the transportation price cases for CNG reflect the residential, commercial, and industrial price scenarios developed by CEC staff for the

⁵⁷¹ Producing a dummy variable is done by means of an ordinary least squares regression analysis with historical data (1995-2018): California retail (gasoline) price as the dependent variable and the following independent variables: U.S. (gasoline) price, California (gasoline) sales tax, California (gasoline) excise tax, underground storage tank fee, LCFS credit price, carbon price, and a dummy for the outage at the Torrance refinery. The coefficients from this regression are then used to predict future California prices with predicted future values of all the independent variables.

natural gas demand forecast. These transportation CNG price cases reflect the relationship among the residential, commercial, industrial, and transportation nationwide forecasts generated by the U.S. EIA.

The National Renewable Energy Laboratory (NREL) developed a hydrogen price forecast for the Energy Commission. These prices also inform the 2019 version of an annual hydrogen station assessment by the CEC and CARB as required by Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013).⁵⁷² This hydrogen price incorporates the utility-level preliminary price forecasts for natural gas and electricity developed for the 2019 IEPR. The price also incorporates the requirement by Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006) to dispense a minimum of one-third renewable hydrogen from publicly funded hydrogen refueling stations.

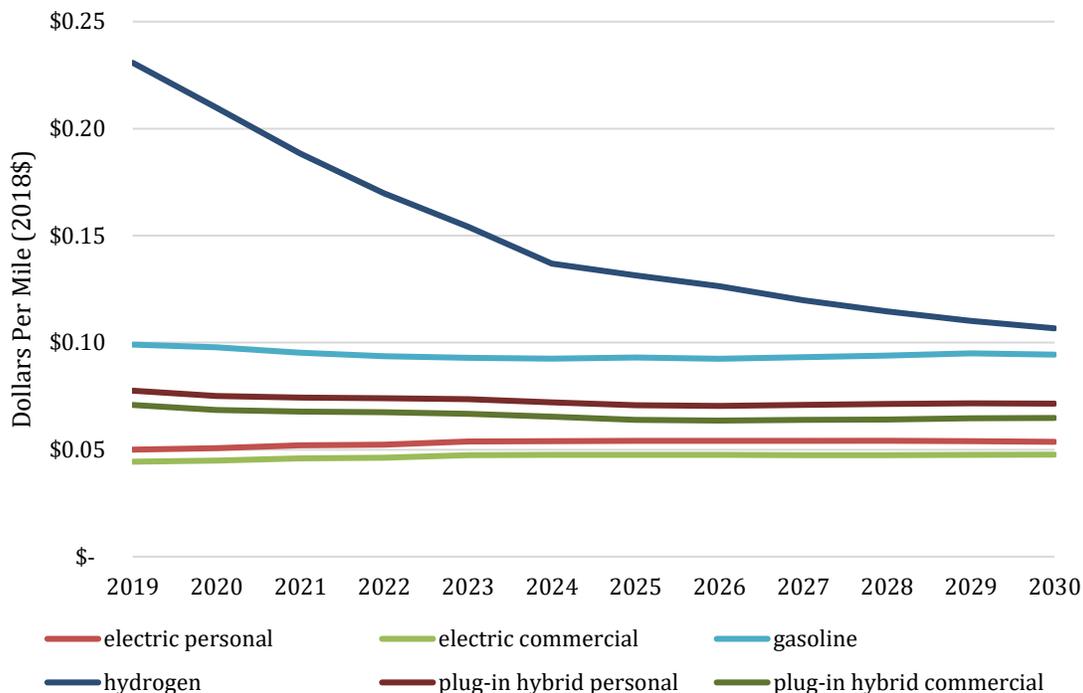
Conventional and alternative fuel prices can be converted into common energy units, such as megajoules,⁵⁷³ British thermal units, or gasoline-gallon equivalents. However, comparing these efficiencies without respect to fuel price does not capture the operating cost of different vehicle technologies. For example, a battery-electric vehicle (BEV) will travel farther than a comparably sized car with a gasoline combustion engine on the same number of megajoules. For this reason, the transportation energy demand forecast uses cost per mile (not just cost per energy unit) in gauging consumer and fleet preferences across the different fuel options.

Figure 67 compares the approximate cost per mile of gasoline and several alternative fuels among midsize cars in the LDV sector for the mid case fuel price forecast. While fuel prices are forecast to increase, fuel economy is forecast to see a similar rise, so cost per mile is not expected to see a significant change for gasoline, plug-in hybrid electric vehicles (PHEVs), or BEVs. As shown, the cost per mile of electricity remains significantly lower than gasoline for both residential and commercial consumers. Based on input from NREL, the cost per mile of hydrogen for FCEVs is expected to decline over time in response to increasing economies of scale for new hydrogen refueling stations. (However, most light-duty FCEVs are leased with special "free fuel" conditions for a period of several years, and a similar business arrangement is anticipated for heavy-duty FCEVs, although no such vehicle is available.)

572 Baronas, Jean, Gerhard Achtelik, et al. 2017. *Joint Agency Staff Report on Assembly Bill 8: 2017 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California*. CEC and CARB. Publication Number: CEC-600-2017-011. [Link to AB 8: 2017 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California report](http://www.energy.ca.gov/2017publications/CEC-600-2017-011/CEC-600-2017-011.pdf)
<http://www.energy.ca.gov/2017publications/CEC-600-2017-011/CEC-600-2017-011.pdf>.

573 A "megajoule" is one million joules. It is the standard unit of work or energy in the International System of Units, equal to the work done by a force of one newton when the point of application moves through a distance of one meter in the direction of the force.

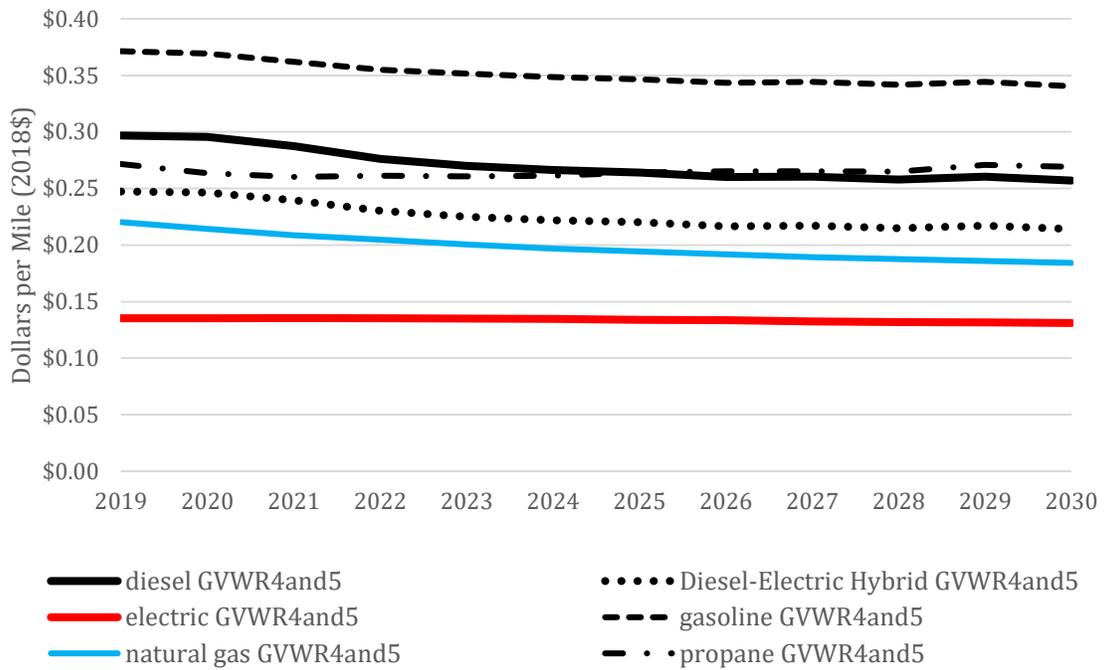
Figure 67: Fuel Cost per Mile Forecast for LDVs (Midsize Cars), Mid Case



Source: CEC, NREL

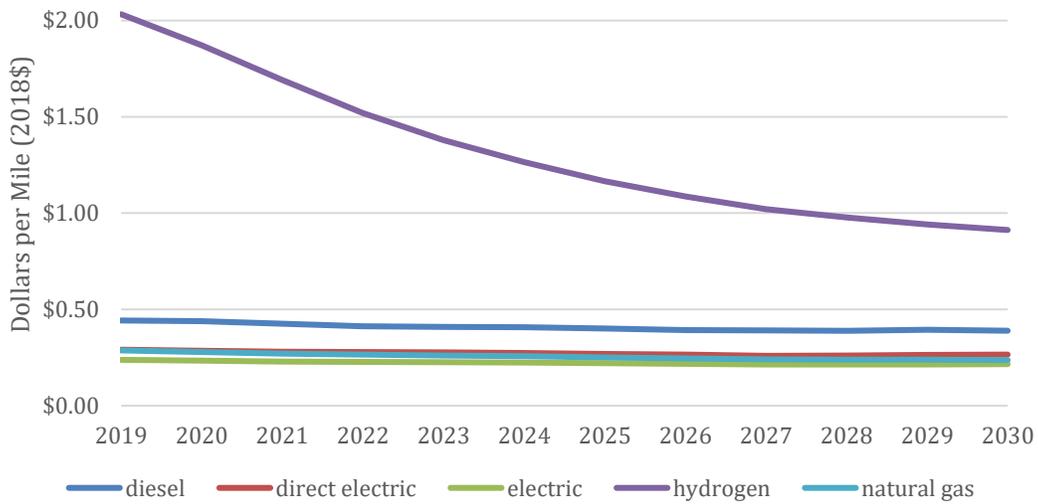
Figure 68 shows the cost per mile of various fuels for MD trucks, Classes 4 and 5. The relative ranking of gasoline, diesel, and electricity cost per mile for MD trucks are the same as for LDV, shown in Figure 67. However, the MD costs per mile are higher than LDV because of additional weight and typically more urban drive cycles of MD trucks, as compared to average-drive cycles for LDVs. Figure 69 shows the cost per mile of various fuels in Class 8 in-state tractor-trailers in regional service. Electric is the lowest cost per mile, followed by natural gas, diesel-electric hybrid, and the other fuels, with hydrogen being the highest cost per mile.

Figure 68: Fuel Cost per Mile Forecast for MD Trucks (Classes 4 and 5), Mid Case



Source: CEC

Figure 69: Fuel Cost per Mile Forecast for In-State HD Tractor-Trailers (Class 8), Mid Case



Source: CEC

Consumer Preferences (LDVs)

Consumer preferences are a key component in developing the CEC’s forecasts of size and composition of the LDV population. To gauge consumer preferences, the CEC periodically surveys residential and commercial LDV owners to capture the historically distinct preferences between the two groups. The survey provides participants with a series of hypothetical vehicles with different attributes and government incentives and then asks them to choose one

for purchase. Their choices help the CEC assess consumer preferences for different vehicle attributes, fuel types, and vehicle classes.

The CEC is completing the 2019 survey. The 2019 IEPR forecast relies on the last survey conducted in 2017 by Resource Systems Group.⁵⁷⁴

Vehicle Attributes (LDVs)

Once the survey measures consumers' preferences for different attributes, fuel types, and vehicle classes, those preferences can be matched against a forecast of vehicle attributes by vehicle class and fuel type that are anticipated to be offered in the market.

Key vehicle and infrastructure attributes include:

- Range.
- Vehicle price.
- Fuel economy.
- Fuel cost per mile.
- Acceleration.
- Number of makes and models.
- Time to fuel station.
- Refueling time.
- Maintenance costs.
- Cargo capacity.

Given the heightened focus on vehicle electrification and compliance with CARB regulations for ZEVs, CEC staff generated different scenarios for ZEV price and range, presented in Chapter 8.

MD and HD Truck Alternative Fuel Penetration Rates

To determine the penetration rates of alternative fuels and advanced vehicle technologies for MD and HD trucks, the forecast relies on Argonne National Laboratory's TRUCK 5.1, a truck choice model. As constructed, the model is limited to one conventional "base" fuel (such as gasoline or diesel) and up to three alternative fuel trucks for each class. In response to this limitation, CEC staff assigned alternative fuels and technologies in classes already commercialized. Trial runs of possible fuels in each class were used to arrive at a set of competing fuel types with significant market penetration. For example, hydraulic hybrid trucks and hydrogen fuel cell trucks were dropped from consideration because they showed zero

⁵⁷⁴ [Link to information on the California Vehicle Survey on the CEC's website](https://www.energy.ca.gov/data-reports/surveys/california-vehicle-survey) <https://www.energy.ca.gov/data-reports/surveys/california-vehicle-survey>.

market penetration in trial runs. Staff also applied California-specific annual vehicle miles traveled population-weighted across many ranges,⁵⁷⁵ alongside California-specific fuel prices and Hybrid and Zero-Emission Voucher Incentive Project (HVIP) incentives for alternative fuels.

H-D Systems provided truck price and fuel economy forecasts. Prices for alternative fuel trucks were based on an assumption that production reaches high volume by the end of the forecast period, achieving a lower price than the low volume typical during early commercialization. H-D Systems assigned fuel efficiency by truck duty cycle most common for each truck class.⁵⁷⁶

Policies, Regulations, and Incentives

California has implemented a range of regulations and incentives to advance its clean transportation goals. Several of these regulations and incentives are incorporated into the transportation forecast and vary between LDVs and MD and HD vehicles.

California's ZEV regulation and the federal Corporate Average Fuel Economy standards apply to LDVs. Several government incentives included in the LDV choice analysis include the state rebates from the Clean Vehicle Rebate Project administered by CARB, the federal income tax credit, and access to the state's high-occupancy vehicle lanes.

Among MD and HD vehicles, staff incorporated several regulatory requirements into the forecast. CARB's truck and bus regulations, for instance, require diesel particulate filters and updates to 2010 or newer engines, with a provision for alternative compliance by fleets. The preliminary forecast also accounts for fleet requirements in the South Coast Air Quality Management District area, which require the procurement of lower-emission and alternative fuel vehicles for transit buses, refuse trucks, and certain other fleets.

For transit buses, the forecast also assumes a significant expansion of zero-emission buses within the forecast period. This expansion is in line with CARB's proposed Innovative Clean Transit goal of transitioning all transit buses to zero-emission technologies by 2040. This assumption is based on CARB staff analysis that shows that, without grants, battery-electric buses are cost-competitive with conventional buses due to the reduced costs of fuel and maintenance. The initial incremental capital costs for transit agencies can be reduced with a combination of state grants, programs to support transportation electrification, or leasing options.

575 2017 California Vehicle Inventory and Use Survey, Caltrans Division of Planning.

576 The CEC contracted with *H-D Systems* to forecast the medium and heavy-duty vehicle attributes used for the 2017 and 2019 IEPR. "Duty cycle" is the pattern of operation, such as refuse trucks that stop at each residence and use energy to process each curbside container are assigned lower fuel efficiency than would be typical for freeway driving.

APPENDIX D:

Summary of Publicly Owned Utilities' Integrated Resource Plan Resource Mix

This table presents the portfolio of electricity resources for each publicly owned utility (POU) required to submit an integrated resource plan (IRP) to the California Energy Commission (CEC) for review, as described in Chapter 1. Senate Bill 350 (De León, Chapter 547, Statutes of 2015) required POUs to adopt an IRP by January 1, 2019, for review by the CEC. The CEC reviewed the IRPs to determine if they met certain requirements, including achieving Renewables Portfolio Standard procurement requirements set in SB 350 and greenhouse gas emissions reduction targets established by the California Air Resources Board. SB 350 also identified a number of planning goals and procurement requirements that the IRPs must meet or address. The table shows each POU's generation resources by resource type, and the percentage of total energy by resource type for the years 2018, 2019, 2025, and 2030. The table reflects the resource mix identified in each POU's IRP.

POU Name	Generation by POU and Resource Type (GWhs)	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU			
Anaheim	2018	2019	2025	2030	2018	2019	2025	2030
Solar	7	7	123	122	0%	0%	5%	5%
Other Renewables	366	370	372	759	16%	16%	16%	33%
Wind	169	169	56	131	7%	7%	2%	6%
Large Hydro	38	38	38	38	2%	2%	2%	2%
Coal	1,086	1,141	1,097	0	47%	50%	48%	0%
Natural Gas	873	866	746	794	38%	38%	33%	35%
Net Market Purchases	-247	-297	-157	427	-11%	-13%	-7%	19%
Anaheim Total	2,292	2,294	2,275	2,272	100%	100%	100%	100%
Burbank								
Solar	98	91	268	264	8%	8%	22%	22%
Other Renewables	48	60	60	60	4%	5%	5%	5%
Wind	54	76	465	404	4%	6%	39%	33%
Energy Storage	0	0	0	106	0%	0%	0%	9%
Large Hydro	19	21	21	22	2%	2%	2%	2%
Nuclear	81	86	86	86	6%	7%	7%	7%
Coal	444	455	180	0	35%	38%	15%	0%
Natural Gas	472	586	507	466	37%	49%	43%	38%
Net Market Purchases	43	-171	-393	-194	3%	-14%	-33%	-16%
Burbank Total	1,260	1,204	1,194	1,215	100%	100%	100%	100%

POU Name	Generation by POU and Resource Type (GWhs)	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU			
Power Enterprise of the San Francisco Public Utilities Commission (CCSF)								
Solar	8	8	10	12	1%	0%	1%	1%
Other Renewables	420	567	568	493	28%	29%	28%	26%
Large Hydro	1,064	1,375	1,421	1,376	71%	70%	71%	73%
Natural Gas	10	10	10	10	1%	1%	1%	1%
CCSF Total	1,503	1,961	2,009	1,892	100%	100%	100%	100%
Imperial Irrigation District (IID)								
Solar	385	466	449	435	10%	12%	11%	10%
Other Renewables	624	1,186	821	1,642	17%	32%	20%	38%
Large Hydro	166	180	169	150	4%	5%	4%	3%
Nuclear	119	114	114	114	3%	3%	3%	3%
Natural Gas	1,088	1,313	1,203	1,155	29%	35%	30%	27%
Net Market Purchases	1,381	505	1,279	847	37%	13%	32%	20%
IID Total	3,764	3,764	4,035	4,343	100%	100%	100%	100%
Los Angeles Department of Water and Power (LADWP)								
Solar	3,502	3,915	7,076	7,906	13%	14%	24%	26%
Other Renewables	1,834	2,444	3,368	3,751	7%	9%	12%	12%
Wind	2,447	2,446	2,469	3,033	9%	9%	8%	10%
Energy Storage	14	133	883	885	0%	0%	3%	3%
Large Hydro	1,103	1,164	1,585	1,839	4%	4%	5%	6%
Nuclear	3,176	3,177	3,177	3,176	12%	12%	11%	10%
Coal	4,652	4,558	1,635	0	18%	17%	6%	0%
Natural Gas	9,249	8,899	8,509	9,711	35%	33%	29%	32%
Net Market Purchases	409	409	409	409	2%	2%	1%	1%
LADWP Total	26,386	27,144	29,111	30,710	100%	100%	100%	100%
Modesto Irrigation District (MID)								
Solar	67	67	397	818	2%	2%	13%	22%
Other Renewables	10	21	10	141	0%	1%	0%	4%
Wind	477	493	493	367	18%	18%	16%	10%
Large Hydro	13	13	13	13	1%	0%	0%	0%
Natural Gas	780	733	659	724	29%	26%	21%	20%
Net Market Purchases	1,332	1,451	1,600	1,648	50%	52%	50%	44%
MID Total	2,680	2,779	3,174	3,712	100%	100%	100%	100%

POU Name	Generation by POU and Resource Type (GWhs)	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU			
Palo Alto								
Solar	345	322	386	377	38%	34%	42%	41%
Other Renewables	118	113	113	47	13%	12%	12%	5%
Wind	107	100	43	0	12%	11%	5%	0%
Energy Storage	0	0	0	0	0%	0%	0%	0%
Large Hydro	355	560	481	481	39%	59%	52%	53%
Nuclear	0	0	0	0	0%	0%	0%	0%
Coal	0	0	0	0	0%	0%	0%	0%
Natural Gas	0	0	0	0	0%	0%	0%	0%
Net Market Purchases	-19	-152	-92	7	-2%	-16%	-10%	1%
Palo Alto Total	906	942	930	912	100%	100%	100%	100%
Pasadena								
Solar	106	103	312	452	8%	8%	25%	36%
Other Renewables	388	397	251	205	30%	29%	20%	16%
Wind	24	28	10	0	2%	2%	1%	0%
Large Hydro	44	44	44	44	3%	3%	4%	4%
Nuclear	79	75	74	72	6%	6%	6%	6%
Coal	484	413	205	0	38%	30%	16%	0%
Natural Gas	156	77	96	78	12%	6%	8%	6%
Net Market Purchases	0	219	271	394	0%	16%	21%	32%
Pasadena Total	1,280	1,357	1,264	1,244	100%	100%	100%	100%
Redding								
Solar	0	0	24	174	0%	0%	4%	31%
Other Renewables	26	32	32	32	3%	5%	6%	6%
Wind	175	180	180	180	23%	29%	34%	32%
Large Hydro	183	242	237	237	24%	38%	45%	43%
Natural Gas	245	4	15	16	32%	1%	3%	3%
Net Market Purchases	127	170	39	-82	17%	27%	7%	-15%
Redding Total	756	628	527	557	100%	100%	100%	100%
Roseville								
Solar	91	1	179	254	8%	0%	15%	22%
Other Renewables	190	189	128	48	16%	15%	11%	4%
Wind	175	138	179	255	15%	11%	15%	22%
Large Hydro	159	215	215	215	13%	17%	18%	19%
Natural Gas	259	274	249	249	22%	22%	21%	22%
Net Market Purchases	326	419	251	125	27%	34%	21%	11%

POU Name	Generation by POU and Resource Type (GWhs)	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU			
Roseville Total	1,200	1,235	1,200	1,147	100%	100%	100%	100%
Riverside								
Solar	259	258	394	383	11%	11%	17%	15%
Other Renewables	384	650	648	944	17%	28%	27%	37%
Wind	97	93	93	93	4%	4%	4%	4%
Large Hydro	30	30	30	30	1%	1%	1%	1%
Nuclear	92	93	93	95	4%	4%	4%	4%
Coal	634	617	295	0	28%	27%	12%	0%
Natural Gas	49	99	273	150	2%	4%	11%	6%
Net Market Purchases	745	474	556	861	33%	20%	23%	34%
Riverside Total	2,291	2,315	2,382	2,557	100%	100%	100%	100%
Sacramento Municipal Utility District (SMUD)								
Solar	0	552	1,293	1,742	0%	5%	11%	15%
Other Renewables	0	1,371	1,537	1,519	0%	12%	13%	13%
Wind	0	1,636	1,823	2,899	0%	14%	16%	24%
Large Hydro	0	719	704	704	0%	6%	6%	6%
Natural Gas	0	5,503	5,599	4,628	0%	48%	48%	39%
Net Market Purchases	0	1,624	682	455	0%	14%	6%	4%
SMUD Total	0	11,405	11,638	11,948	0%	100%	100%	100%
Silicon Valley Power (SVP)								
Solar	61	61	155	521	2%	2%	3%	11%
Other Renewables	850	966	881	838	23%	25%	19%	18%
Wind	449	453	1,416	1,767	12%	12%	31%	37%
Large Hydro	487	814	1,083	814	13%	21%	23%	17%
Natural Gas	1,282	1,285	1,140	981	35%	33%	25%	21%
Net Market Purchases	564	308	-55	-164	15%	8%	-1%	-3%
SVP Total	3,694	3,888	4,621	4,758	100%	100%	100%	100%
Turlock Irrigation District (TID)								
Solar	159	158	451	743	5%	5%	13%	19%
Other Renewables	138	141	125	123	4%	4%	4%	3%
Wind	370	370	370	370	11%	11%	10%	10%
Large Hydro	244	336	330	372	7%	10%	9%	10%
Coal	308	0	0	0	9%	0%	0%	0%
Natural Gas	1,516	1,333	1,111	886	46%	40%	31%	23%

POU Name	Generation by POU and Resource Type (GWhs)	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU	Percentage of Total Energy, by Year and POU			
Net Market Purchases	527	968	1,158	1,384	16%	29%	33%	36%
TID Total	3,261	3,306	3,544	3,878	100%	100%	100%	100%
Vernon								
Solar	124	124	419	476	11%	10%	33%	36%
Other Renewables	61	61	47	184	5%	5%	4%	14%
Wind	0	0	79	79	0%	0%	6%	6%
Large Hydro	21	21	21	21	2%	2%	2%	2%
Nuclear	94	94	94	94	8%	8%	7%	7%
Natural Gas	719	753	689	0	64%	61%	54%	0%
Net Market Purchases	103	173	-67	451	9%	14%	-5%	35%
Vernon Total	1,123	1,226	1,281	1,304	100%	100%	100%	100%
Glendale Water and Power (GWP)								
Solar	0	0	131	257	0%	0%	12%	20%
Other Renewables	0	51	51	51	0%	6%	5%	4%
Wind	0	97	314	445	0%	11%	30%	34%
Energy Storage	0	0	-10	-14	0%	0%	-1%	-1%
Large Hydro	0	53	53	53	0%	6%	5%	4%
Nuclear	0	86	86	86	0%	10%	8%	7%
Natural Gas	0	166	379	384	0%	20%	36%	30%
Net Market Purchases	0	388	44	33	0%	46%	4%	3%
GWP Total	0	841	1,048	1,294	0%	100%	100%	100%

APPENDIX E:

Report on the Implementation Status of the Recommendations in the Senate Bill 350 Low-Income Barriers Study Part A and Part B

Status of Recommendations in Barriers Study Part A

On July 30, 2019, the California Energy Commission (CEC), the California Public Utilities Commission (CPUC), and the California Air Resources Board (CARB) held a joint agency workshop on Advancing Energy Equity to review progress towards implementing the recommendations in the Barriers Studies, Part A⁵⁷⁷ and B⁵⁷⁸ and to explore next steps and key actions to advance energy equity throughout California. At the workshop, state agencies discussed the actions they have already taken and the actions they plan to complete to fulfill the recommendations of the Barriers Studies. This appendix provides a summary of the implementation status of each recommendation in Barriers Study Part A and Part B.

California's state agencies have made significant progress towards accomplishing the recommendations in the Barriers Studies. The programs created to implement the recommendations are making a real contribution and benefiting low-income Californians and those living in disadvantaged communities. Moreover, these programs have laid a solid foundation upon which California can construct an equitable energy future.

Recommendation 1: Establish a Multiagency Taskforce to Facilitate Coordination Across State-Administered Programs

Status: Completed

In May 2017, the Governor's Office established an interagency task force to implement priority recommendations from both the CEC's Barriers Study Part A and CARB's Final Guidance Document. The task force was comprised of over 15 state agencies implementing clean energy

577 CEC, Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities. [Link to workshop information, notices, and documents regarding SB 350 Barriers Study on the CEC's website](https://www2.energy.ca.gov/sb350/barriers_report/) https://www2.energy.ca.gov/sb350/barriers_report/.

578 CARB, Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents, [Link to CARB Barriers Report on the CARB website](https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document) <https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document>.

and transportation programs, as well as related disciplines including but not limited to public health, water, and housing. The task force met through the end of 2018 to ensure continued coordination across agencies. State agencies continue to collaborate through workshops and other informal activities.

The CEC, in coordination with partner agencies, developed the Clean Energy in Low-Income Multifamily Buildings Action Plan (CLIMB Action Plan) which identifies actions to improve existing programs in the multifamily sector and lays the foundation to develop long-term solutions.⁵⁷⁹ The CLIMB Action Plan identifies programs and policies, remaining challenges, and concrete actions the state can take to accelerate the implementation of distributed energy resources (such as demand response, onsite renewable energy, electric vehicle infrastructure, energy storage, and energy and water efficiency) strategies within California's multifamily housing stock. With a significant number of Californians living in multifamily buildings, these buildings offer an opportunity and a challenge to accelerating the state's clean energy progress. The final Climb Action Plan was adopted in November 2018. In June 2019, the CEC launched the multifamily component of the Building Energy Benchmarking Program, which was identified in the CLIMB Action Plan as information needed to better understand multifamily buildings.⁵⁸⁰

Next Steps

The CEC continues to engage with state partners on current multifamily-related program activities (CLIMB Strategy 4.3.1). As recommended in CLIMB Strategy 2.1.3, the CEC will implement multifamily building energy benchmarking activities, including outreach and education to multifamily building owners. For example, the CEC is funding a grant to Energy Council (a joint powers agency) to launch a project that will accelerate multifamily building upgrades in the San Francisco Bay Area.⁵⁸¹ In addition, as recommended in CLIMB Strategy

579 [CEC's Clean Energy in Low-Income Multifamily Buildings Action Plan](https://ww2.energy.ca.gov/business_meetings/2018_packets/2018-11-07/Item_06.pdf) https://ww2.energy.ca.gov/business_meetings/2018_packets/2018-11-07/Item_06.pdf

580 The Building Energy Benchmarking Program is the state's program to publicly disclose the energy use of buildings in California. It requires owners of large commercial and multifamily buildings to report energy use to the California Energy Commission by June 1 annually. Data to better understand energy use in commercial properties and multifamily buildings will be released fall 2020.

581 [Transcript for the November 7, 2018, CEC Business Meeting](https://efiling.energy.ca.gov/getdocument.aspx?tn=225914) <https://efiling.energy.ca.gov/getdocument.aspx?tn=225914>.

2.1.3,⁵⁸² the CEC will implement multifamily building energy benchmarking activities, including outreach and education to multifamily building owners.⁵⁸³

Recommendation 2: Enable the Economic Advantages of Community Solar to Low-income and Disadvantaged Populations

Status: Ongoing

The CPUC and California Department of Community Services and Development (CSD) have made significant progress establishing new programs and pilots to implement this recommendation. In 2018, the CPUC issued decision D.18-06-027, which adopted the Community Solar Green Tariff Program (CSGT). This program allows low-income customers in disadvantaged communities to benefit from the development of solar generation projects located in or near their communities. Eligible customers participating in this program are able to receive a 20 percent discount on their overall utility bill. The IOUs filed their implementation plans in August 2018 and the CPUC issued Resolution E-4999, which approved the IOUs implementation plans with modification in May 2019. The IOUs have updated their CSGT tariffs to comply with the direction provided in the resolution.

In August 2019, the IOUs submitted to the CPUC their marketing, education, and outreach plans, 2019–2020 program budgets, and project solicitation documents. Community Choice Aggregators (CCAs) who serve residential customers in disadvantaged communities are eligible to offer their own CSGT programs, as long as they are consistent with all program requirements.

In June 2019, CSD awarded \$4.43 million in funding for its Community Solar Pilot Program (CSPP) — two community solar projects that will provide benefits to low-income households and test prototype delivery models. The CSPP, part of California Climate Investments,⁵⁸⁴ aims to make the benefits of solar energy more available to eligible low-income households, lower residents' energy bills, and provide co-benefits to communities, including economic and workforce development. CSD selected the following two projects:

Santa Rosa Band of Cahuilla Indians Empowering Communities: CSD awarded approximately \$2 million to GRID Alternatives Inland Empire in Riverside to install a 994 kilowatt (kW) direct

582 CLIMB Strategy 2.1.3: Establish a repository of multifamily building data for program development, implementation, and evaluation, including data such as that from the Building Energy Benchmarking Program (Assembly Bill 802) and Tax Credit Allocation Committee affordable housing inventory.

583 [Barriers Study Recommendations Report](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229108&DocumentContentId=60513) <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229108&DocumentContentId=60513>. TN# 229108. p. 1.

584 California Climate Investments is funded by the Greenhouse Gas Reduction Fund.

current (DC) ground-mounted solar array in partnership with the Santa Rosa Band of Cahuilla Indians and the Anza Electric Cooperative, Inc. Anza Electric Cooperative, Inc. will assign credits to subscribers on their monthly bills that will reduce household usage costs by up to 50 percent. The system will be sited on Santa Rosa Tribal lands and will benefit approximately 38 homes on those lands and an additional 150 to 250 low-income households within the cooperative's boundaries.

Port of Richmond Community Solar Project: CSD awarded approximately \$2.38 million to GRID Alternatives Bay Area in Oakland to install a 989 kW DC solar array at the Port in Richmond. The project will benefit approximately 155 low-income households in Richmond's disadvantaged communities. The project will generate revenue from a feed-in-tariff offered by Marin Clean Energy and utilize an off-bill mechanism to distribute benefits.

Next Steps

The CPUC hosted a stakeholder workshop on September 16, 2019, to discuss CCA CSGT implementation issues. CSD's selected projects are estimated to be operational and delivering benefits by the first quarter of 2021.

Recommendation 3: Strategize and Track Progress of Workforce Development and Clean Energy Goals

Status: Ongoing

In 2018, the CWDB hosted nine consultations that addressed labor market strategies for achieving the state's climate targets in a way that benefits all Californians. Feedback gathered informed the development of a state draft plan for economic and workforce development in a carbon-neutral economy. The draft plan reviews job growth, job quality, job access, and training in the energy sector (for example, renewable energy and energy efficiency). The draft plan is currently under review at the Governor's Office.

In addition, the CWDB is developing an initiative for High Road Construction Careers with Senate Bill 1 (Beall, Chapter 5, Statutes of 2017) funds, and basing it on the successful model of multi-craft pre-apprenticeship developed with Proposition 39 funds (2014–2018).

Lastly, the CWDB and CPUC are collaborating to explore ways to integrate economic and workforce development in clean energy programs.

Next Steps

Following the public release of the draft plan, CWDB will pursue an interagency strategy to implement key recommendations. CWDB will also begin making investments in workforce partnerships that will advance an equity agenda across climate-impacted industries, including accessible apprenticeship pathways in energy and transportation sectors. This includes \$30 million from the Greenhouse Gas Reduction Fund (GGRF) in fiscal year 2019–2020 for CWDB's two main initiatives under its Equity, Climate, and Jobs agenda: High Road Construction Careers and High Road Training Partnerships.

Recommendation 4: Develop New Financing Pilot Programs to Encourage Investment for Low-income Customers

Status: Ongoing

CAEATFA is implementing financing pilots for energy efficiency retrofits in the investor-owned utility territories at the request of the CPUC. These pilots are designed to lower the cost and expand access of private capital financing across the residential, affordable multifamily, and small business/commercial markets to help remove the upfront barrier of capital.

In 2017, CAEATFA streamlined the California Hub for Energy Efficiency Financing pilot programs to remove structural barriers and address challenges. The Residential Energy Efficiency Loan (REEL) Assistance Program was the first of the pilot programs to launch in 2016. The REEL Program helps homeowners and renters access lower cost financing for energy efficiency projects by reducing risk to participating lenders. The program has seven active lenders and more than \$20 million available in loan loss reserve funds to help participating lenders mitigate energy efficiency loan risk. The program has leveraged nearly \$7 million in private capital, with 52 percent of borrowers located in low-moderate income census tracts.⁵⁸⁵

In September 2019, CAEATFA launched the Small Business Financing (SBF) pilot. The goal of the program is to help small businesses access better financing terms for energy efficient retrofits. Eligible customers include for-profits and nonprofits meeting one of the following requirements: fewer than 100 employees, annual revenues of less than \$15 million, or adherence to Small Business Administration size limitations. Three finance companies have enrolled, and contractor enrollment has begun. Products supported include loans, leases, equipment financing agreements, service agreements, and savings-based payment agreements. CAEATFA plans to add an on-bill repayment option to the program in 2020.⁵⁸⁶

In May 2019, CAEATFA launched the third pilot program—the Affordable Multifamily Energy Efficiency Financing pilot. The program is designed to leverage and complement existing efforts to finance affordable multifamily energy efficiency retrofits and to encourage growth in private-market energy efficiency lending. The establishment of on-bill repayment functionality is also under design.

⁵⁸⁵ [Residential Energy Efficiency Loan Assistance Program https://www.treasurer.ca.gov/caeatfa/cheef/reel/index.asp](https://www.treasurer.ca.gov/caeatfa/cheef/reel/index.asp)

⁵⁸⁶ Ibid.

Next Steps

CAEATFA is working to identify a funding source to expand the pilots statewide, to provide a more comprehensive (solar and zero-emission vehicle charging) and streamlined financing program for energy projects across the state. CAEATFA is incorporating lessons learned to develop other effective financing solutions to leverage private capital.

Recommendation 5: Establish Common Metrics and Encourage Data Sharing Across Agencies and Programs

Status: Ongoing

In June 2018, the CEC released the *2018 Tracking Progress Report for Energy Equity Indicators*, which helps identify opportunities to improve access to clean energy, to increase clean energy investment in low-income and disadvantaged communities, and to improve local energy resilience. The report includes geospatial indicators related to the local economy, geography, demography, social engagement, public health, and environmental quality that can identify low-income and disadvantaged communities with the most need, as well as performance indicators to inform a baseline and evaluate progress on energy equity efforts across California.

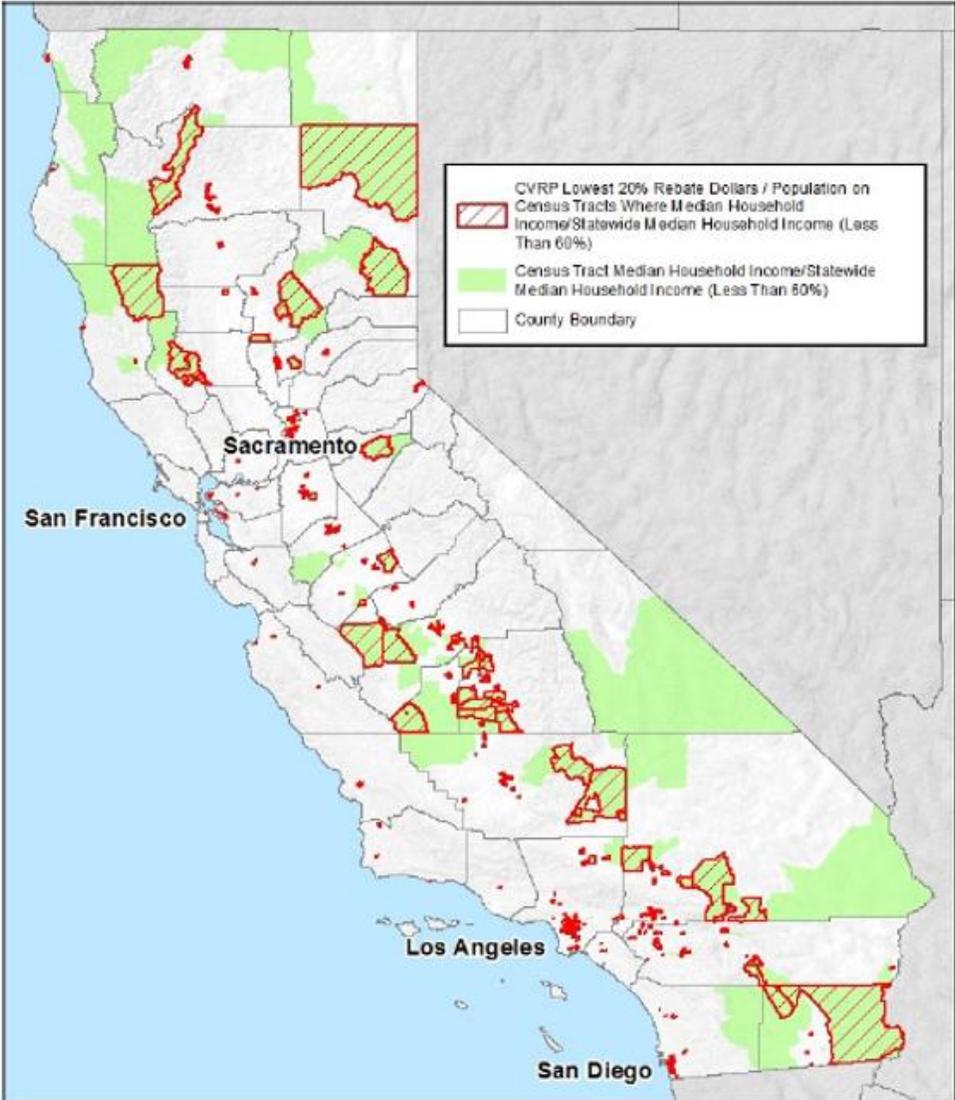
The energy equity tracking progress report will serve as a mechanism to monitor performance of state-administered clean energy programs in low-income and disadvantaged communities across the state. The CEC also developed an accompanying interactive internet-based map that will allow for various data viewing options. CARB is working with the CEC, other state agencies, communities, and the public to develop a similar set of indicators related to clean transportation access for low-income residents.

Next Steps

The interactive web map continues to be refined. Additional data and improvements to the online data visualization tool are expected in the fall of 2019 and an updated Energy Equity Indicator report is expected in 2020.

Examples of information provided in the 2018 tracking progress report for energy equity indicators are shown below.

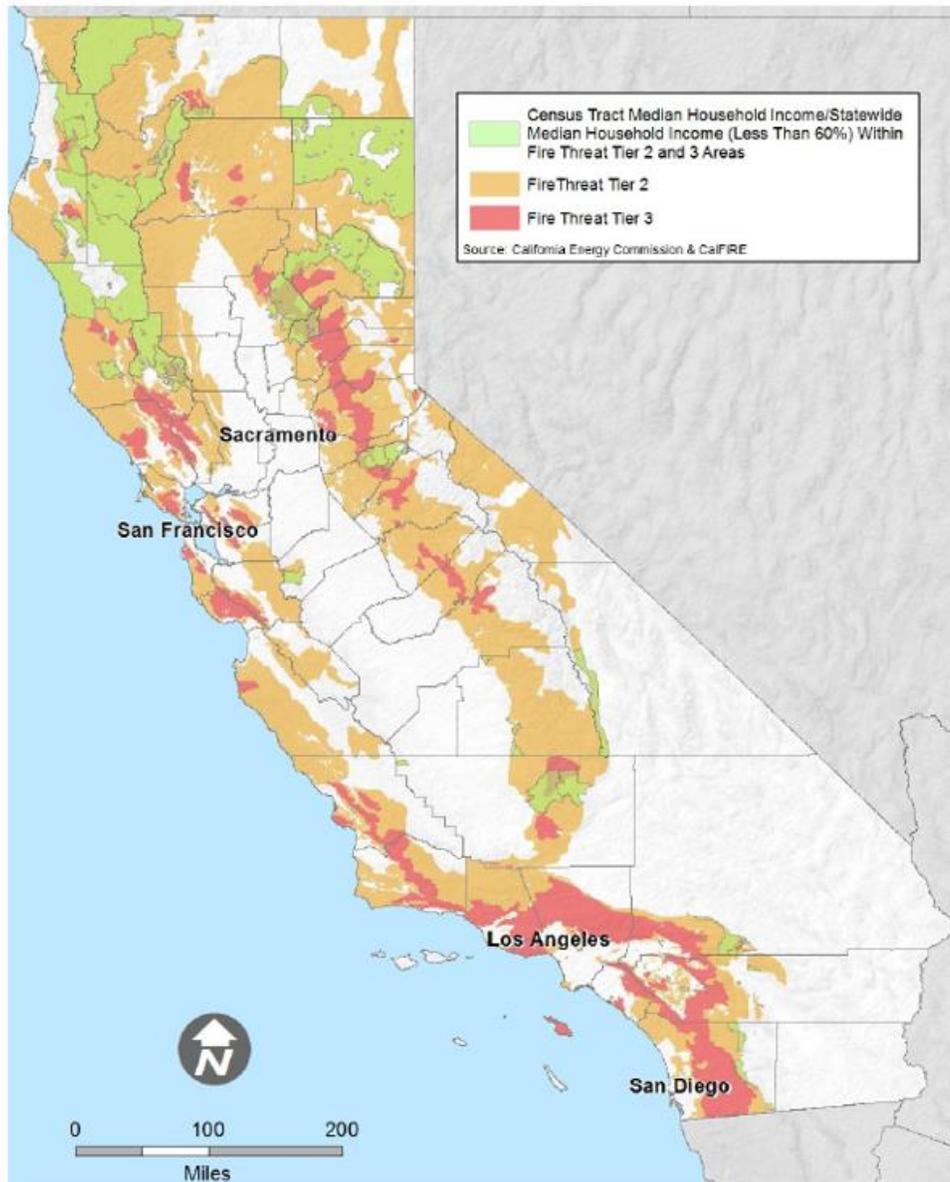
Figure 70: Clean Vehicle Rebate Program Incentive Opportunities in Low-Income Areas



Source: California Clean Vehicle Rebate Project, U.S. Census Bureau 2010 census tract boundaries, 2011–2015 American Community Survey five-year estimates.⁵⁸⁷

587 [California Clean Vehicle Rebate Project](https://cleanvehiderebate.org/eng) <https://cleanvehiderebate.org/eng>.

Figure 71: Low-Income Areas That Intersect With Tier 2 and Tier 3 Fire-Threat Areas



Source: CPUC fire-threat map, U.S. Census Bureau 2010 census tract boundaries, 2011–2015 American Community Survey five-year estimates⁵⁸⁸

588 [CPUC fire-threat maps](https://www.cpuc.ca.gov/firethreatmaps/) <https://www.cpuc.ca.gov/firethreatmaps/>.

Recommendation 6: Expand Opportunities for Low-income and Disadvantaged Communities to Use Photovoltaic and Solar Thermal Technologies

Status: Ongoing

In D.18-06-027, the CPUC adopted two additional programs to promote solar services in disadvantaged communities: the Disadvantaged Communities Single-Family Affordable Solar Homes Program (DAC-SASH) and the Disadvantaged Communities Green Tariff Program (DAC-GT).

The DAC-SASH program provides upfront incentives for solar installations by low-income residents and owners of single-family homes in disadvantaged communities. In January 2019, the CPUC selected GRID Alternatives as the DAC-SASH program administrator through a competitive solicitation process. GRID Alternatives and Southern California Edison (SCE) executed a purchase order for administration of the DAC-SASH program in April 2019. After a stakeholder engagement process, GRID Alternatives submitted a DAC-SASH program handbook and program implementation plan in May 2019. The CPUC approved the handbook and program implementation plan on September 12, 2019.⁵⁸⁹

The DAC-GT program allows disadvantaged community residents to subscribe to receive electricity generated from a solar facility in California and receive a 20 percent discount on their overall bill. The IOUs filed tariffs for the DAC-GT program in August 2018. A number of parties raised issues with the IOUs' proposed implementation plans and suggested improvements. In May 2019, the CPUC adjudicated these issues and approved the implementation plans for the DAC-GT program with modification in Resolution E-4999.

In addition to the DAC-SASH and the DAC-GT programs, the CPUC is implementing other programs that are expanding funding for photovoltaic and solar thermal offerings for low-income customers. For instance, in December 2017, the CPUC created the Solar on Multifamily Affordable Housing (SOMAH) program, which provides funding to incentivize the installation of solar on existing multifamily affordable housing. In March 2019, the CPUC issued Resolution E-4987 to approve modifications to the SOMAH Program Handbook Program Implementation Plan. In April 2019, the CPUC issued D.19-03-015 to provide more flexibility in IOU administrative expenditures, outlining options for future actions regarding the auditing or review of the SOMAH program, and establishing deadlines for the execution of the necessary co-funding and incentive agreements to launch the program.

589 CPUC. [Resolution E-5020](http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M313/K697/313697139.PDF) <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M313/K697/313697139.PDF>.

The SOMAH program formally launched and began accepting incentive applications on July 1, 2019. By close of business that same day, the entirety of SCE's, San Diego Gas & Electric's (SDG&E's), and Pacific Gas and Electric's (PG&E's) 2019 incentive budgets were fully reserved by a total of 226 applications. These applications represent roughly 70 MW of installed capacity, or nearly a quarter of the SOMAH Program's total goal of developing at least 300 MW of installed solar generating capacity by December 31, 2030.

The CPUC also established a program to provide cleaner energy offerings to disadvantaged communities in the San Joaquin Valley. In December 2018, the CPUC issued decision D.18-12-015, which approved pilot projects in 11 San Joaquin Valley disadvantaged communities. The pilots will provide either natural gas or electric appliances to households that currently rely on wood and propane appliances. Electrification pilots allow for electrical panel upgrades and leverage energy efficiency, solar thermal, and energy storage options. There are also bill protection and split incentive provisions to protect the participants from any potential increases in energy costs or displacement of renters due to the home upgrades. The primary goals of the pilots are to provide cleaner and more affordable energy options to households in disadvantaged communities and to collect data to help inform the feasibility of scaling the program to other disadvantaged communities.

CSD also administers programs that are helping implement this recommendation. CSD's Low-Income Weatherization Program (LIWP) provides low-income households with solar photovoltaic (PV) systems and energy efficiency upgrades at no cost to residents. LIWP currently operates three program components: community solar pilots (discussed under Recommendation 2), multifamily energy efficiency and renewables, and farmworker housing energy efficiency and solar PV.

The LIWP multifamily program provides technical assistance and financial incentives for installing energy efficiency and solar PV systems in low-income multi-family dwellings. Due to strong market demand, the program is currently oversubscribed and lack of program funding has forced the scale-down of marketing, outreach, and new project enrollment activities. To date, CSD has allocated \$54.4 million to this program and current funding will support the completion of pending projects by June 2021. Across the portfolio of properties served to date, the LIWP multifamily program has realized an impressive 40 percent energy usage reduction on average. At some projects, where deep energy efficiency retrofits have been paired with electrification measures (for example, switching to heat pump water heaters) and solar PV energy systems, the result has been near net-zero projects.

The farmworker program provides energy efficiency upgrades and solar PV systems to low-income farmworker households. On January 22, 2019, CSD released a request for proposals seeking to award approximately \$10.5 million (\$5.25 million per region) to farmworker housing administrators in two defined 6-county regions. On April 9, 2019, CSD selected La Cooperativa Campesina de California to be the administrator of the two regions.

Next Steps

The CPUC will host a stakeholder workshop in fall 2019 to discuss CCA implementation issues with programs similar to the DAC-SASH program.⁵⁹⁰

IOUs have updated their DAC-GT tariffs to comply with the direction provided in Resolution E-4999. IOUs will submit marketing, education, and outreach plans, 2019–2020 program budgets, and solicitation documents in early August for CPUC review.

SOMAH incentive funding (sourced from the IOUs' 2019 Cap-and-Trade Program proceeds) will be considered for replenishment once the CPUC approves the IOUs' 2020 Energy Resource Recovery Account forecast updates or energy cost adjustment Clause applications. This is expected in the first or second quarter of 2020.

For San Joaquin Valley disadvantaged communities, a request for proposals for a third party program administrator and "community energy navigator" are in process. IOUs have begun community outreach and education efforts. Other details of the electrification and natural gas extension pilots are under review. The goal is to finish the planning process and begin implementation of the pilots in 2020.

For CSD's multifamily program, the 2019–2020 budget act appropriated \$10 million from the GGRF to CSD to continue LIWP low-income solar and multifamily weatherization services. CSD is developing an allocation plan for the 2019–2020 LIWP appropriation and anticipates the plan will dedicate some newly appropriated funding to the LIWP multifamily component.

CSD's farmworker program implementation will begin 90 days following contract execution and conclude by December 31, 2020.

Recommendation 7: Enhance Affordable Housing Tax Credits for Housing Rehabilitation Projects to Include Energy Efficiency and Renewable Energy Upgrades

Status: Completed

Under the California Tax Credit Allocation Committee's (TCAC) 9 percent and 4 percent credit programs, a point system has been incorporated which allows projects to get additional points by committing to environmental certification programs (such as LEED, GreenPoint Rated, or Passive House) or incorporating renewable energy and energy efficiency measures.

Additionally, TCAC uses the California Utility Allowance Calculator in these credit programs to

⁵⁹⁰ [Transcript of the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229742&DocumentContentId=61170)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=229742&DocumentContentId=61170>, TN 229742, p. 38. 20-23.

set project-specific utility allowances that recognize energy efficiency and solar improvements. This allows project owners to keep a larger portion of their gross rent allocation, which can then be used to finance energy efficiency and solar improvements, or other project financing gaps.

In January 2019, the CEC informed the CPUC and the IOUs implementing the Energy Savings Assistance Common Area Measures Program about tax credit properties and how these deed-restricted low-income multifamily buildings may benefit from the program.⁵⁹¹ The CEC noted how these buildings could be improved by deep energy retrofits beyond the common areas at times of ownership and financing change.

Next Steps

The TCAC is conducting rulemaking proceedings in 2019 that will affect the funding and competitiveness of low-income multifamily housing applying for low-income housing tax credits. The CEC will continue collaborate with the CPUC and IOUs and monitor regulatory changes affecting the funding and incentivizing of energy efficiency measures in low-income multifamily housing.

Recommendation 8: Establish Regional Outreach and Technical Assistance One-stop Shop Pilots

Status: Ongoing

The CEC and CPUC have explored options for developing a one-stop shop; however, given the complexity and broad crosscutting nature of a comprehensive one-stop shop, additional resources need to be identified for implementation.

Senate Bill 1072 (Leyva, Chapter 377, Statutes of 2018) requires the establishment of a regional climate collaborative program to provide capacity building for under-resourced communities to access climate mitigation funding. This law directs the Strategic Growth Council (SGC) to adopt guidelines for the regional climate collaborative program by October 2019. The law also requires the SGC to develop technical assistance guidelines that a state agency would be authorized to use in delivering its technical assistance resources or in developing additional technical assistance policies, standards, or guidelines by July 1, 2020. If this law is implemented, it could serve as a platform for implementing one-stop shop pilots. For the status of one-stop-shops for transportation programs, please see "Status of Recommendations in *Barriers Study Part B*", recommendation 3, below.

⁵⁹¹ This conversation took place during the CPUC's monthly Energy Savings Assistance Common Area Measures conference call.

Next Steps

The CEC, CPUC, and CARB will continue to explore options for ongoing development of regional one-stop-shops, however, additional resources likely need to be identified for implementation.

Recommendation 9: Investigate Consumer Protection Issues for Low-Income Customers and Small Businesses in Disadvantaged Communities Seeking Access to Clean Energy

Status: Ongoing

Several agencies have been working to address consumer protection in the growing clean energy economy. In March 2019, the CPUC, the Contractors State License Board, and the Department of Business Oversight entered into a joint enforcement agreement and formed a taskforce with working groups to provide relief for customers harmed by solar companies' unfair business and lending practices, and collaborate on future policy solutions that enhance consumer protections for solar customers, particularly in vulnerable communities.

The taskforce is working to improve coordination on complaint tracking and response, enforcement and preventative outreach and education.

In October 2018, the CPUC issued the Net Energy Metering (NEM) Consumer Protection decision D.18-09-044. The decision establishes a process for creating a solar information packet for consumers and directs utilities to require valid Contractors State License Board licenses from solar providers to interconnect residential single-family solar systems to the grid, along with solar disclosure documents.⁵⁹²

Next Steps

The CPUC is continuing to consider ways to enhance NEM consumer protections, such as a consumer complaint mediation, a restitution fund, enhanced enforcement, citations, or an administrative penalty mechanism under CPUC authority. As required by Assembly Bill 1070 (Gonzalez Fletcher, Chapter 662, Statutes of 2017), the CPUC is developing standardized inputs and assumptions for the calculation of electric bill savings for solar customers. The CPUC is also monitoring the alternative energy provider complaints filed with the CPUC's Consumer Affairs Branch, as well as complaints filed with the Contractors State License Board and California Department of Business Oversight, to determine if existing consumer protections are deterring bad actors or whether further action is needed. The CPUC continues to reach out to stakeholders.

⁵⁹² CPUC. [Solar Consumer Guide](https://www.cpuc.ca.gov/solarguide/) <https://www.cpuc.ca.gov/solarguide/>.

Recommendation 10: Direct Funding to Collaborate with Community-Based Organizations for Community-Centric Delivery of Clean Energy Programs

Status: Ongoing

CARB, the CEC, the CPUC, and other supporting agencies continue to work on identifying opportunities where additional funding is needed to support collaboration and increased access to clean energy and transportation for low-income residents.

Next Steps

The agencies will continue working together to identify opportunities where additional funding could support further collaboration and increased access. The agencies will also continue working to ensure that existing programs are benefiting low-income and disadvantaged communities.

Recommendation 11: Direct Research, Development, Demonstration, and Market Facilitation Programs to Include Targeted Benefits for Low-income Customers and Disadvantaged Communities

Status: Complete

The CEC has taken several actions to implement this recommendation.

Targeted Investments

Assembly Bill 523 (Reyes, Chapter 551, Statutes of 2017) requires at least 25 percent of the Electric Program Investment Charge's (EPIC) technology demonstration and deployment (T&D) funds collected from investor-owned utility ratepayers be allocated to projects located in and benefiting low-income or disadvantaged communities. As of July 2019, the CEC's EPIC program has invested approximately 31 percent of T&D funds to 104 project sites located in disadvantaged communities, and an additional 34 percent to 74 project sites located in communities that are low-income but not considered disadvantaged. Project locations are shown in Figure 72.

Figure 72: EPIC Projects Located in Low-Income and Disadvantaged Communities



Source: Joint presentation by CEC, CPUC, CSD, CAEATFA, and CWDB at the July 30, 2019, joint agency workshop on Advancing Energy Equity, slide 12, <https://efiling.energy.ca.gov/GetDocument.aspx?tn=229158&DocumentContentId=60578>.

Changes to Proposal Scoring Criteria

The CEC will implement new scoring criteria in upcoming TD&D solicitations to ensure that: 1) T&D projects located in disadvantaged and low-income areas are providing direct benefits to the community, and 2) scorers can evaluate the projected localized health impacts, if any. Additionally, the criteria requires community support and ongoing community engagement. The CEC will continue to provide funding set-asides for low-income and disadvantaged communities, where applicable.

Expanding Opportunities

The CEC directed Navigant Consulting to evaluate market strategies that have been piloted to overcome barriers to mass deployment of distributed energy resources in existing buildings in low-income/disadvantaged communities. The evaluation focused on renters, multifamily buildings, and small businesses and identified barriers and key drivers for adoption. The final report provided 13 recommendations from successes and lessons learned in programs throughout the United States and grouped them into three critical areas for success:

Outreach barriers: lack of awareness, lack of customer trust, and lack of education channels.

Outreach recommendations:

- Develop partnerships with community-based organizations to build trust and awareness.
- Conduct tailored marketing, education, and outreach that considers culture, language, and geography and is targeted at contractors, building owners, and tenants.
- Educate target community about program benefits.
- Use customer engagement from one program to co-enroll customers in other programs.

Funding barriers: split incentives, code compliance issues, and insufficient funding.

Funding recommendations:

- Establish long-term policy signals on programs and funding levels to improve program planning and align with stakeholder infrastructure investment cycles.
- Develop program funding mechanisms that deliver cash flow-positive projects from day one to encourage low-income and disadvantaged community stakeholders to act.
- Develop a program to manage and fund the code compliance repairs required to implement DER.
- Determine a methodology to calculate non-energy benefits to improve the cost-effectiveness of distributed energy resource programs.
- Consider bundling existing funding sources to finance low-income and disadvantaged community initiatives.

Execution barriers: inadequate customer and contractor support, slow program response times, and excess/complex paperwork.

Execution recommendations:

- Create a low-income and disadvantaged community program “Czar” role to streamline and combine programs and an online portal that serves as a single resource for potential applicants.
- Streamline and simplify eligibility application criteria.
- Develop program offerings that provide direct value for all stakeholders.

Design programs that provide adequate technical assistance and deliver cost savings.

These recommendations were incorporated into the various goals and strategies provided in the CLIMB report (discussed in Recommendation 1).

EPIC Challenges

The CEC created two-phase competitions, known as *EPIC Challenges*, where the first phase centers around the design and planning to create advanced energy communities, and the second phase awards winners with funding for the buildout of their design. Phase 1 for the first EPIC Challenge was issued in 2016 for the design and planning of advanced energy communities. Both Phase I (planning and design) and Phase II (build) included funding set

asides for disadvantaged communities. The CEC has selected two of the Phase I projects to move to the build phase and plans to select two additional projects, both located in disadvantaged communities, to move to the build phase. For the two projects selected for the build phase, one will build two new affordable housing developments in Lancaster (Los Angeles County) that will be all-electric zero-net-energy microgrids. The second project will retrofit a mixed-income neighborhood block in Oakland (Alameda County) to be a zero-net-energy microgrid.

EPIC Symposiums

The 2018 and 2019 EPIC Symposiums included panels highlighting projects located in various underserved communities. In 2019, the CEC awarded a 3-year contract to Gladstein, Neandross and Associates (GNA) to ramp up the CEC technical transfer and knowledge dissemination activities for the EPIC Program. As part of this work, GNA will conduct forums to ensure project results and lessons learned from technology demonstration projects—especially those located in and benefitting disadvantaged and low-income communities—are shared with the relevant stakeholders.

Next Steps

The CEC will make Navigant’s final report publicly available on the CEC website so other stakeholders can read the analysis and utilize the findings. In addition, the CEC plans to launch its next design-build competition titled “Reimagining Affordable Mixed-Use Development in a Carbon-Constrained Future,” which will be released in late 2019. For this upcoming design-build competition, all projects sites are required to be located in disadvantaged and low-income communities.

Recommendation 12: Conduct a Follow-up Study for Increasing Contracting Opportunities for Small Businesses Located in Disadvantaged Communities

Status: Ongoing

In 2018–2019, GO-Biz was allocated \$23 million from the General Fund to support three grant programs for small business technical assistance centers throughout California. The Small Business Technical Assistance Expansion Program provides \$17 million each year through 2022–2023 to expand small business services, such as free or low-cost one-on-one consulting and low-cost training. The program’s funding is focused on services to underserved business groups, including women, people of color, veterans, and low-wealth, rural, and disaster impacted communities.

The 2018–2019 budget also included the continuation of \$3 million in annual funding through 2022–2023 for the Capital Infusion Program, which supports one-on-one business consulting provided by the Small Business Development Network to assist small businesses in accessing capital. The 2018-2019 budget also allocated \$3 million in one-time local cash match grants for the Technical Assistance Program, which supports other federal small business technical assistance centers. This one-time local cash match grant sunsets on September 30, 2019.

Next Steps

GO-Biz will make grant awards for the 2019–2020 Small Business Technical Assistance Expansion Program.

Status of Recommendations in *Barriers Study Part B*

At the July 30, 2019, joint agency workshop on Advancing Energy Equity, CARB described the status of the six priority recommendations from their *Barriers Study Part B* report.⁵⁹³ Table 40 contains a summary of the recommendations, followed by a description of the status and actions taken to date.

The Barriers Study Part B continues to be a key driver as CARB develops clean mobility access and transportation equity policy and solution building. SB 350 has helped shape how CARB moves ahead with program implementation and identification of funding and other needs that address barriers to clean transportation access for low-income residents. CARB will continue to apply lessons learned, evaluate priorities to ensure that efforts promote community-level achievements in transportation equity, and support capacity to both transition to and identify projects that are sustainable and applicable in other communities.

⁵⁹³ [SB 350 Barriers Study Part B CARB Implementation Progress presentation by CARB](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229101&DocumentContentId=60505)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=229101&DocumentContentId=60505>.

Table 40: Barriers Study Part B Priority Recommendations and Lead and Supporting Agencies

	Recommendation	Lead and Supporting Agencies
1	Expand assessments of low-income resident clean transportation and mobility needs to ensure feedback is incorporated in transportation planning and for guiding investments.	Lead: California Department of Transportation (Caltrans), CARB, California Transportation Commission (CTC) Supporting: Local transportation authorities, metropolitan planning organizations (MPOs), councils of government (COGs), transit agencies, CEC, CPUC, SGC, CDPH
2	Develop an outreach plan targeting low-income residents across California to increase residents' awareness of clean transportation and mobility options.	Lead: CARB, CEC, CPUC, SGC Supporting: CDPH, CTC, Caltrans, Department of Motor Vehicles, Go-Biz, air districts, investor-owned utilities, publicly owned utilities
3	Develop regional one-stop shops to increase consumer awareness and technical assistance.	Lead: CARB, CEC, SGC Supporting: CPUC, CSD, California Natural Resources Agency, California Department of Housing and Community Development, California Department of Water Resources
4	Develop guiding principles for grant and incentive solicitations to increase access to programs and maximize low-income resident participation.	Lead: CARB, CEC, CPUC, SGC Supporting: CTC, Caltrans, California Department of General Services, CDPH
5	Maximize economic opportunities and benefits for low-income residents from investments in clean transportation and mobility options by expanding workforce training and development.	Lead: California Labor and Workforce Development Agency, CWDB, CARB Supporting: CEC, CPUC, CSD, CDPH, California Employment Development Department
6	Expand funding and financing for clean transportation and mobility projects, including infrastructure, to meet the accessibility needs of low-income and disadvantaged communities.	Lead: CARB, CEC, CPUC, CTC, Caltrans Supporting: SGC, air districts

Source: CARB, [Barriers Study Part B](https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document), <https://ww2.arb.ca.gov/resources/documents/carb-barriers-report-final-guidance-document>.

Recommendation 1: Expand Assessments of Low-income Resident Clean Transportation and Mobility Needs to Ensure Feedback is Incorporated in Transportation Planning and for Guiding Investments

Status: Ongoing

The California Department of Transportation (Caltrans) is coordinating with regional and local governments to promote expanding assessments of low-income community transportation needs. Additionally, CARB has integrated community transportation needs assessments into its clean mobility projects and has created a voucher program to provide resources in support of these efforts.

Next Steps

Caltrans plans to develop best practices that highlight successful local and regional engagement efforts and provide recommendations for objectives that can be achieved through

needs assessments.⁵⁹⁴ CARB is designing a complementary approach for working with communities to assess their transportation needs and resources. The process has been integrated into new and existing CARB incentive programs to ensure funds are prioritized toward projects that meet transportation needs and have community support.

Recommendation 2: Develop an Outreach Plan Targeting Low-income Residents Across California to Increase Residents' Awareness of Clean Transportation and Mobility Options

Status: Ongoing

CARB is leading implementation of an outreach roadmap that identifies strategies for effectively coordinating, streamlining, and delivering tailored clean transportation outreach. The roadmap highlights the importance of a robust community engagement process that values community knowledge and includes community-based organizations and residents in developing solutions and strategies.

Next Steps

A public draft of the outreach plan is expected in fall 2019.

Recommendation 3: Develop Regional One-stop Shops to Increase Consumer Awareness and Technical Assistance

Status: Ongoing

CARB, using \$5 million of Volkswagen Settlement funds and a recent addition of \$5 million in Low Carbon Transportation Investment funds, is developing regional one-stop shops for low-income customers. The aim is to increase awareness of transportation rebates and incentive programs, and provide reliable information about available technologies and clean transportation options. In October 2018, CARB selected GRID Alternatives to advance this concept. The initial pilot focuses on the development and maintenance of a streamlined, single application for low-income consumers to apply and qualify for CARB's low-carbon transportation equity projects, such as Clean Cars 4 All, the Clean Vehicle Rebate Project, financing assistance programs, and clean mobility options for disadvantaged communities.

The pilot will focus on providing coordinated community-based outreach and education to maximize program participation and promote advanced technology vehicle adoption among low-income residents.

⁵⁹⁴ [Transcript for the July 30, 2019, IEPR workshop on Advancing Energy Equity](https://efiling.energy.ca.gov/getdocument.aspx?tn=229742) https://efiling.energy.ca.gov/getdocument.aspx?tn=229742. p. 82.

Next Steps

The streamlined, single application is in the testing phase and the first public version is expected to launch in 2020.⁵⁹⁵

Recommendation 4: Develop Guiding Principles for Grant and Incentive Solicitations to Increase Access to Programs and Maximize Low-income Resident Participation

Status: Ongoing

With the goal of increasing the ability of low-income residents and disadvantaged communities to access grant funding, CARB is developing guiding principles for state and local agencies to incorporate into designing competitive solicitations. CARB has also consulted with other agencies, program administrators, and applicants to develop solutions that streamline and simplify the grant and incentive application process.⁵⁹⁶

Next Steps

CARB intends to release the public guidance document in 2020 to promote the best practices identified through collaboration and begin incorporating the feedback into the development of grants and solicitations.

Recommendation 5: Maximize Economic Opportunities and Benefits for Low-income Residents From Investments in Clean Transportation and Mobility Options by Expanding Workforce Training and Development

Status: Ongoing

With funds from Senate Bill 1 and the GGRF, the CWDB has three investment projects related to the transportation sector.⁵⁹⁷ CARB is also integrating workforce development into program implementation, which can provide direct employment benefits in addition to the CWDB's efforts. Strategies include investment in projects that contain targeted hiring and job training, as well as exploring workforce development and fellowship opportunities as part of project outreach and capacity-building.

⁵⁹⁵ Ibid., p. 84.

⁵⁹⁶ Ibid., p. 85.

⁵⁹⁷ Ibid., p. 79.

Next Steps

The CWDB plans to invest in 12 new partnerships with strong connections to the industries and occupations critical to reaching the state’s 2030 climate change targets.⁵⁹⁸

Recommendation 6: Expand Funding and Financing for Clean Transportation and Mobility Projects, Including Infrastructure, to Meet the Accessibility Needs of Low-income and Disadvantaged Communities

Status: Ongoing

Over the past six budget cycles (Fiscal Year 2013/2014 to Fiscal Year 2018/2019), the Legislature has appropriated approximately \$1.7 billion to CARB for low-carbon transportation projects to support the transformation of California’s fleet—supporting clean vehicle ownership, clean mobility, streamlined access to funding and financing opportunities, increasing community education, and exposure to clean technologies.⁵⁹⁹

The CPUC has also authorized funding of electric vehicle charging infrastructure in the territories of all of its jurisdictional utilities, and the majority of these authorizations have required significant portions of this infrastructure be built in disadvantaged communities and/or targeted to low-income customers.

Next Steps

CARB will continue funding transformative transportation projects, including plans to provide \$22 million for the Sustainable Transportation Equity Project through a community-based approach to identify and address the unique mobility needs of a given community. Through facilitated collaboration and capacity building, the pilot intends to work with communities to develop context-specific solutions for a cleaner, more accessible, and integrated transportation system that benefits the community resident that need it most. CARB will also, through its Clean Mobility Options Voucher Pilot, provide over \$20 million to low-income and disadvantaged communities for carsharing, bikesharing, and other clean mobility projects. In addition, CARB plans to provide up to \$7 million for outreach and education coordination, expand community transportation needs assessments, and provide technical assistance and the one-stop shop.⁶⁰⁰

⁵⁹⁸ Ibid., p. 79.

⁵⁹⁹ Ibid., p. 85.

⁶⁰⁰ [SB 350 Barriers Study Part B CARB Implementation Progress presentation by CARB](https://efiling.energy.ca.gov/GetDocument.aspx?tn=229101&DocumentContentId=60505)
<https://efiling.energy.ca.gov/GetDocument.aspx?tn=229101&DocumentContentId=60505>. TN# 229101. p. 8.