2020

Integrated Energy Policy Report Update

Volume I: Blue Skies, Clean Transportation
Executive Summary

Introduction

The year 2020 brought many challenges but also hopes for a better future. The 2020 Integrated Energy Policy Report (IEPR) Update identifies actions the state and others can take to ensure a clean, affordable, and reliable energy system. California's innovative energy policies strengthen energy resiliency, reduce greenhouse gas (GHG) emissions that cause climate change, improve air quality, and contribute to a more equitable future.

The 2020 IEPR Update is divided into three parts:

1. **Volume I focuses on California's transportation future and the transition to zero-emission vehicles (ZEVs).**
2. **Volume II examines microgrids, lessons learned from a decade of state-supported research, and stakeholder feedback on the potential of microgrids to contribute to a clean and resilient energy system.**
3. **Volume III reports on California's energy demand outlook, updated to reflect the global pandemic and help plan for a growth in zero-emission plug in electric vehicles.**

Other Key Energy Planning Efforts

The California Energy Commission (CEC), California Public Utilities Commission (CPUC), and the California Independent System Operator are working to ensure grid reliability in response to increasingly severe events related to climate change, such as the extended heat wave experienced in August 2020 that led to rotating power outages. Grid reliability will be further discussed in the 2021 IEPR. (For more information on corrective actions the agencies are taking to address the August rolling outages, see the Final Root Cause Analysis, Mid-August 2020 Heat Storm. http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf.) For the longer term, the CEC is working with the CPUC and the California Air Resources Board (CARB) to plan for transforming the state's electric system to 100 percent renewable and zero-carbon by 2045, as directed by Senate Bill 100 (de León, Chapter 312, Statutes of 2018).

(For information, see the CEC's SB 100 web page. https://www.energy.ca.gov/sb100.)

Blue Skies, Clean Transportation

While Californians will remember 2020 for the devastating impacts of COVID-19 and the worst season of destructive wildfires in recorded history, one of the few benefits of the shutdown was better air quality. As traffic dwindled because of the stay-at-home order in late March and early April, Los Angeles experienced blue skies and was ranked one of the cleanest cities in the world. But as traffic returned to normal and wildfires raged, the state's air quality plummeted. Transportation-related pollution is the state's number one source of harmful diesel particulates, smog-forming nitrogen oxides, and GHG emissions, and higher temperatures caused by transportation and other sources of GHGs are exacerbating the problem of wildfires.

To address these challenges, the state is doubling down to accelerate ZEV deployment. On September 23, 2020, Governor Gavin Newsom signed Executive Order N-79-20, setting a 100 percent ZEV target for new passenger vehicle sales by 2035 and 100 percent ZEV operations target for medium- and heavy-duty vehicles in the state by 2045. Global ZEV sales, especially battery-electric, are growing, and prices are falling as the market scales, accelerating the timeline for ZEVs to achieve cost-parity with internal combustion engine vehicles. Opportunities also exist for streamlining the charging and hydrogen refueling infrastructure for ZEVs, helping reduce costs for refueling.

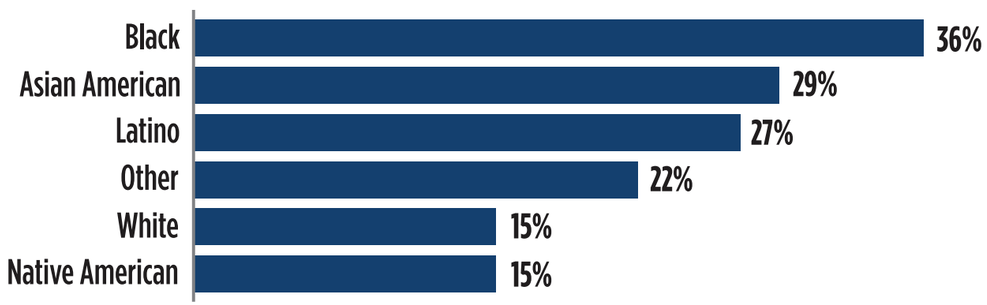
Transitioning to a ZEV future will improve public health, reduce transportation costs for Californians, expand economic development and create jobs, and, with the right planning, improve the reliability of the electric grid. At the same time, the state must ensure access to clean mobility options to ensure low-income and disadvantaged communities benefit from this transition.

Transportation Pollution and Disparate Impacts

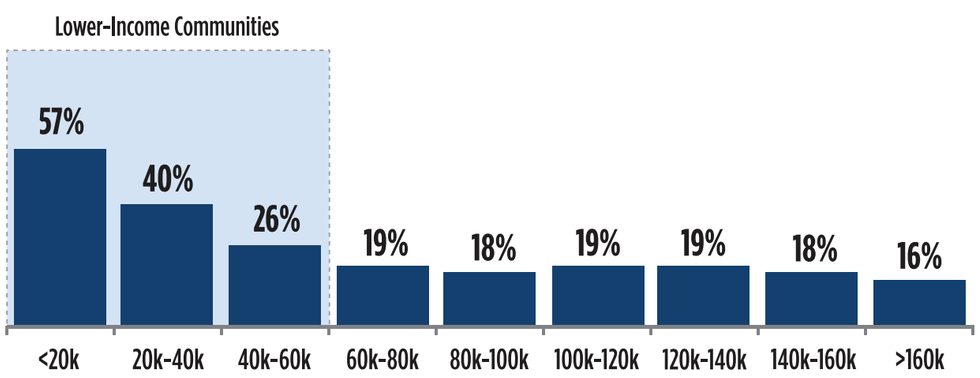
While all Californians will benefit from the transition to ZEVs, those who stand to benefit most are those disproportionately impacted by transportation-related pollution. For example, medium- and heavy-duty vehicles (which include vehicles such as school buses and garbage trucks) are the largest source of diesel particulate matter, the leading contributing factor to cancer caused by air pollution. Furthermore, residents living in low-income and disadvantaged communities are exposed to higher levels of transportation-related toxic diesel particulate matter (Figure ES-1). According to a November 2020 study by Harvard researchers, Californians exposed to the most air pollution are more than twice as likely to die from COVID-19 as those communities with clean air.

Figure ES-1: Disparities in Transportation-Related Pollution Exposure by Race and Income

Percent of Residents Living in High Diesel PM Exposure Commununities, by Race



Percent of Residents Exposed to High Diesel PM by Census Tract Median Household Income



Credit: CEC analysis of census and CalEnviroScreen data (Note: "High Diesel PM Exposure" communities are census tracts that score in the highest 75th percentile of census tracts for diesel particulate matter. The vast majority [90 percent] of diesel PM emissions come from vehicles.)

Transportation remains a key focus in the state's efforts to address climate change. The state is making important reductions in GHG emissions, largely from the electricity sector, as electricity generated from renewable energy resources like solar and wind increases and displaces fossil fuel-based electricity generation. By contrast, emissions from vehicles and fuel production have risen since 2012 (although there was a slight drop in emissions in 2018) and comprise more than half of the state's GHG emissions. (See Figures ES-2 and ES-3.)

Figure ES-2: Transportation-Related Emissions Account for More Than Half of the State's GHG Emissions

California 2018 GHG Emissions 425 Million Metric Tons (MMT) CO2e

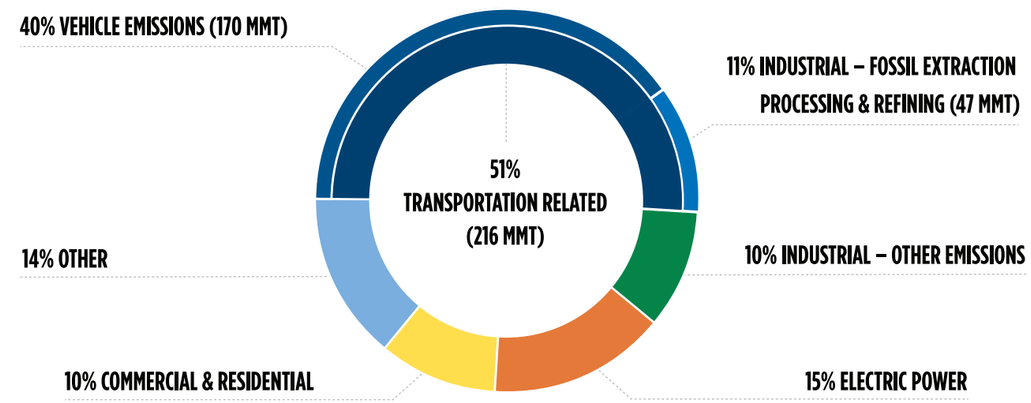
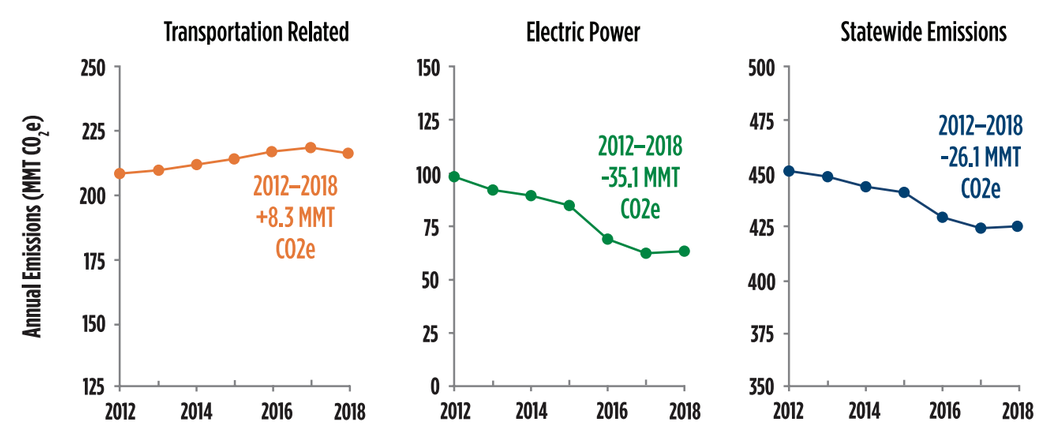


Figure ES-3: GHG Emissions From Transportation Have Increased in Recent Years, Despite Declines in Electric Power and Overall Statewide Emissions



Credit: CARB 2018 GHG Inventory

While specific solutions to reduce air pollution and GHG emissions from vehicles will likely evolve as the economy responds to the pandemic-induced recession and as technologies improve, several overarching recommendations are clear:

- **A zero-emission transportation system, including battery-electric and hydrogen fuel cell electric vehicles, is necessary for the health of the state's residents and environment.**
- **Building out a standardized ZEV charging infrastructure and hydrogen fueling infrastructure will be critical to market growth and achieving statewide vehicle and climate goals.**
- **Continued state support for infrastructure buildout, coupled with leveraging private investment, is needed until the market can achieve self-sufficiency.**
- **The state must expand access and prioritize clean transportation benefits in the most impacted communities to address disparate impacts of transportation pollution.**
- **Battery-electric vehicle charging must be aligned with grid needs to help integrate renewables and add resiliency to the grid.**

Disruptive Changes to Mobility and Economic Growth

A new series of technologies have begun to emerge in recent years to alter radically the transportation landscape: electrified transportation, autonomous vehicles, and shared mobility services. These have been termed the "Three Revolutions" in transportation. While these exciting changes present a tremendous opportunity, they also come with potential drawbacks.

In a "Blue Skies" scenario, transportation accessibility increases for all communities, renewably powered electric transportation reduces pollution, and integration with other transit modes reduces congestion. Done right, this type of scenario can be the basis of additional economic growth of up to $134 billion per year, as estimated in an economic forecast by NEXT 10. However, in a "Dirty Skies" scenario, technologies grow without a broad electrified energy vision and leadership, leading to additional congestion, more fossil fuel-powered vehicles, pollution from dirty electricity sources, and more car dependence due to disorganized transportation services.

In addition to hosting the largest ZEV market in the country, California is the epicenter of the three revolutions. The state is in a unique position to make clean transportation a significant portion of its economy. A 2021 CALSTART survey of the electric vehicle and equipment supply chain in California showed at least 70,000 direct jobs. The same study identified more than 360 unique companies involved in the ZEV supply chain in California. With this initial advantage, there is a substantial opportunity for California to support this industry and become a leader in the export of its products, knowledge, and services, all while ensuring growth of well-paying jobs for residents. Care must be taken to ensure that low-income and disadvantaged communities share in these potential benefits of the three revolutions.

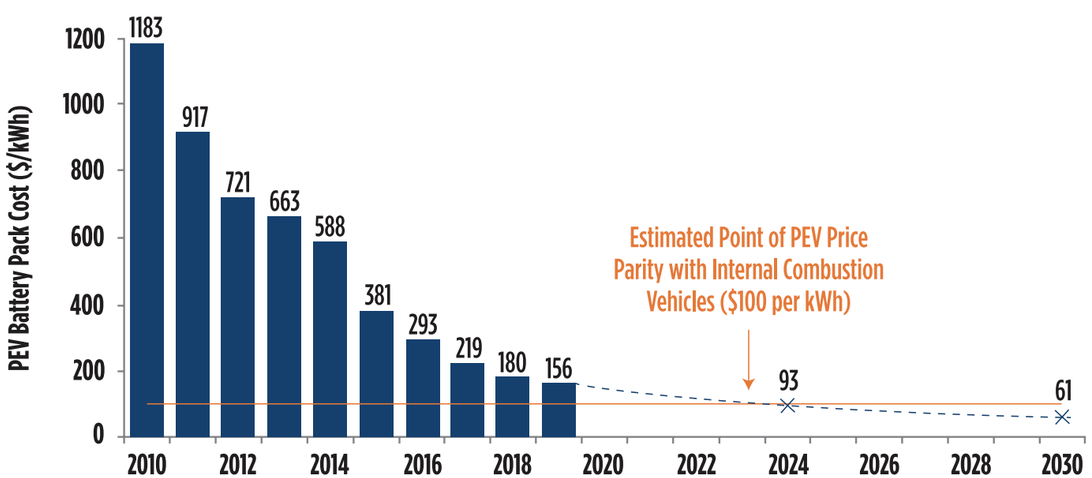
Plug-In Electric Vehicles (PEVs):

Innovation, Decreasing Costs, and Market Growth

The light-duty plug-in electric vehicle (PEV) market has surpassed expectations of analysts from even just a few years prior. In China and in Europe, PEV sales doubled between 2017 and 2019. This remarkable growth is primarily the result of strong government policies and rapidly decreasing costs for components, especially batteries. Since 2010, prices for lithium-ion battery packs have decreased by nearly 90 percent, with an additional 40 percent decline expected from 2019 to 2024. (See Figure ES-4.) With these continued price declines on the horizon, expert analysts from multiple organizations expect price parity with conventional vehicles within the next five years or sooner, making PEVs a competitive option for many looking to purchase new vehicles. Reduced initial cost, coupled with lower fueling and maintenance costs, will mean more money in Californians' pockets, more than $1,000 per year due to fueling and maintenance savings alone.

Figure ES-4: Battery Prices Experiencing Rapid Declines, With Continued Declines Expected Through 2030

Bloomberg New Energy Finance PEV Battery Pack Prices, Historical and Projected



Credit: Bloomberg New Energy Finance

Success in the light-duty PEV market has set the stage for transitioning medium- and heavy-duty vehicles. This sector is poised for rapid growth, in part due to strong state policies and programs. The CEC's bulk purchases of battery-electric school buses have bolstered higher levels of production, contributing to a nearly 50 percent price reduction in the last four years. Prices for PEVs used for freight and buses are also declining, making the total cost of ownership (including maintenance and fuel) cost-competitive with fossil-fueled vehicles in several use cases now, and potentially all by 2030. Continued cost declines will make them the preferred option for many fleet operators.

Meeting the goals in Executive Order N-79-20 will require continued programs and policies supporting the deployment of ZEV infrastructure and vehicles (passenger, medium- and heavy-duty, and off-road), supportive electric utility rates, and additional investment in fueling infrastructure. State and private sector investments are necessary to support a rapid scale-up of vehicle electrification. Investments need to be responsive to the rapidly evolving market conditions and increase equitable access of benefits. The goal is to foster a self-sustaining market that does not rely on public funding for ZEVs.

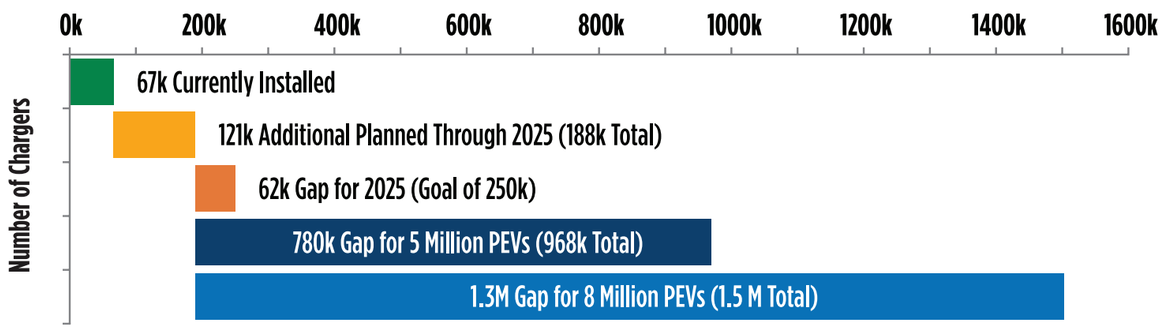
Charging Infrastructure:

Key to PEV Market Growth and an Opportunity for the Grid

One of the leading challenges to address for accelerated market penetration of all PEVs is to ensure a widespread, reliable, and easy-to-use network of charging infrastructure. Statewide goals for PEVs will require many more public and shared chargers. Figure ES-5 shows the current and planned charger infrastructure through 2025 and highlights the gap between the 2025 goal and the gap for a 5 million ZEV scenario in 2030. Meeting Executive Order N-79-20 will require scaling up sales through 2035, resulting in up to 8 million ZEVs on the road by 2030, making the charging infrastructure need even greater.

Figure ES-5: Gaps in the Chargers Necessary for Additional PEVs on the Road

Significant Charger Needs for 2025 and 2030

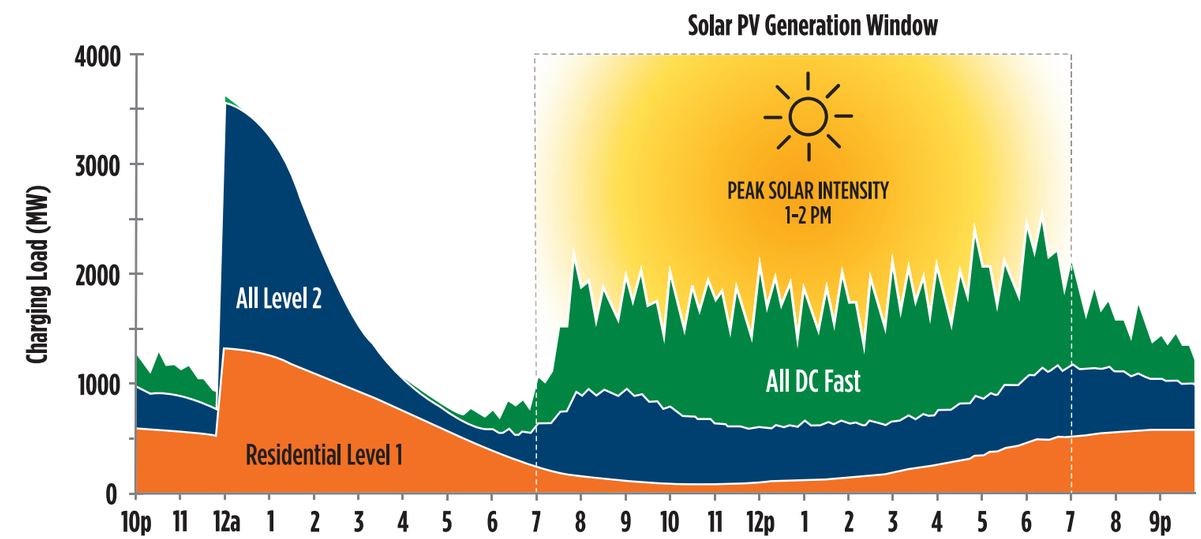


Uniform charger standards will be key to accelerating station deployment and making charging simple for drivers. Furthermore, incentives and policies will be necessary to help manage charging patterns to benefit the grid, including vehicle-grid integration (VGI, which enables electric vehicles to be responsive to grid needs while meeting consumer charging needs). (See Figure ES-6.) Early research suggests that vehicle-grid integration may enhance grid reliability and reduce the cost of supplying electricity to all consumers. Large-scale charging, however, may compound problems if consumers charge their vehicles when grid operators have less renewable energy available to meet demand or if there is a large amount of demand for other electricity services. Finally, while at-home charging is convenient, it is not accessible for all, especially residents of multiunit dwellings. Programs and policies directed to these challenges and opportunities should be a state priority.

Credit: California Energy Commission

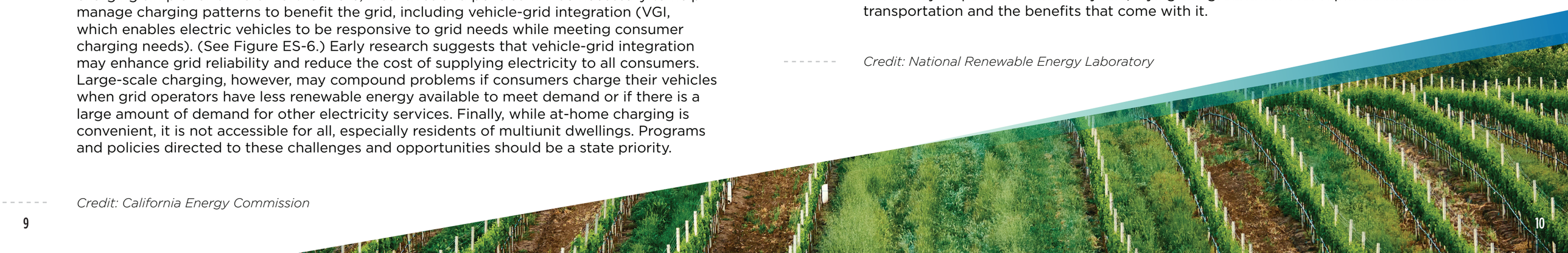
Figure ES-6: Managing Charging Impacts on the Grid for Maximizing Renewable Energy Use Will Be Important as the PEV Market Grows

Load Profile for a Typical Weekday for EVI-Pro 2 with 5 Million PEVs



New regulatory and funding mechanisms should be examined to encourage private-sector investments in charging infrastructure, especially those in disadvantaged or low-income communities. Disadvantaged communities are defined by the California Environmental Protection Agency as the top 25 percent of census tracts most impacted by pollution. Low-income communities are defined by the California Department of Housing and Community Development as those communities at or below 80 percent of the statewide median income. Public investment across communities is critical but on its own will not be sufficient to meet the infrastructure build out requirements needed to support California's goals, especially the 2035 goal of 100 percent ZEV sales. Exploration of new business models and programs will be key steps in the next few years, laying the groundwork for rapid electrification of transportation and the benefits that come with it.

Credit: National Renewable Energy Laboratory



Fuel Cells and Hydrogen:

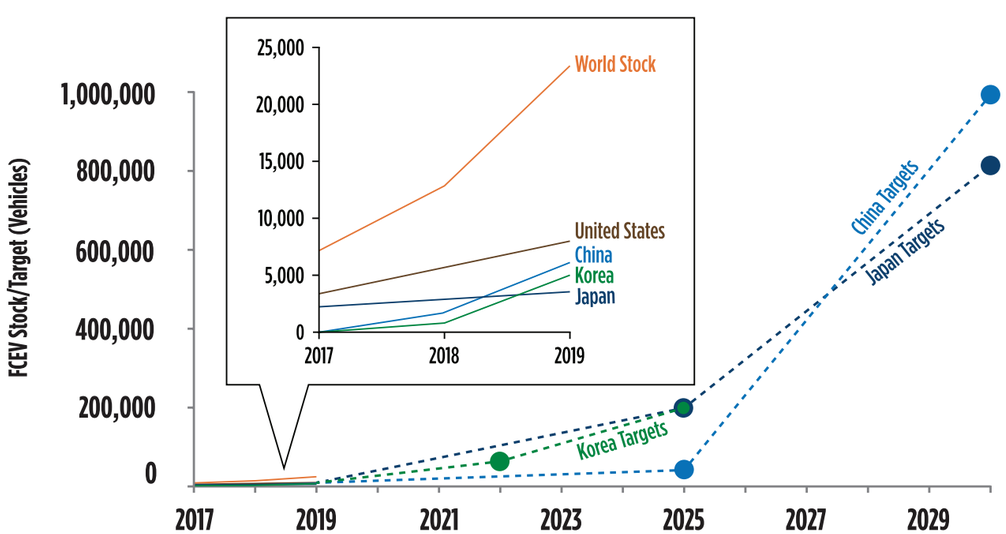
Global Investment, Decreasing Costs

Fuel cell electric vehicles (FCEVs) are at a more nascent stage than battery-electric vehicles, but there are growing investments in hydrogen fueling and vehicle deployment. Given the fast refueling and longer ranges, FCEVs offer advantages over battery-electric vehicles that could be particularly important for medium- and heavy-duty applications, including long-distance freight and transit buses. California continues to make progress in building out hydrogen refueling infrastructure. As of December 2020, 179 stations were either in operation or planned for operation. Achieving the goal of 200 stations established by Executive Order B-48-18 will allow the state to satisfy the fueling needs of more than 100,000 light-duty FCEVs. Another potential market growth opportunity is the stacking benefit of fuel cells, which allows production of similar fuel cell stacks across vehicle sizes. For example, Toyota's Class 8 semitruck uses two fuel cell stacks from its light-duty Mirai. Production of the same fuel cell stacks across all vehicle sizes allows economies of scale that may contribute to faster price declines than would otherwise be expected.

Global investment in hydrogen and national FCEV goals in Japan, China, and Korea also bolster the case for fuel cells. Leading economies have made investments that will contribute to a broader hydrogen energy ecosystem, opening the door for economies of scale that could drive down costs and allow FCEVs to play a key role in the ZEV transition. Because hydrogen can be generated with renewable energy and electrolyzers, FCEVs are well-positioned to use renewable hydrogen rather than fossil-derived hydrogen. (See Figure ES-7.)

Figure ES-7: Global Goals for FCEVs Show the Potential for High Market Growth in FCEVs

Fuel Cell Electric Vehicle Current Stock and Targets, by Country -- *Credit: International Energy Agency (IEA)*

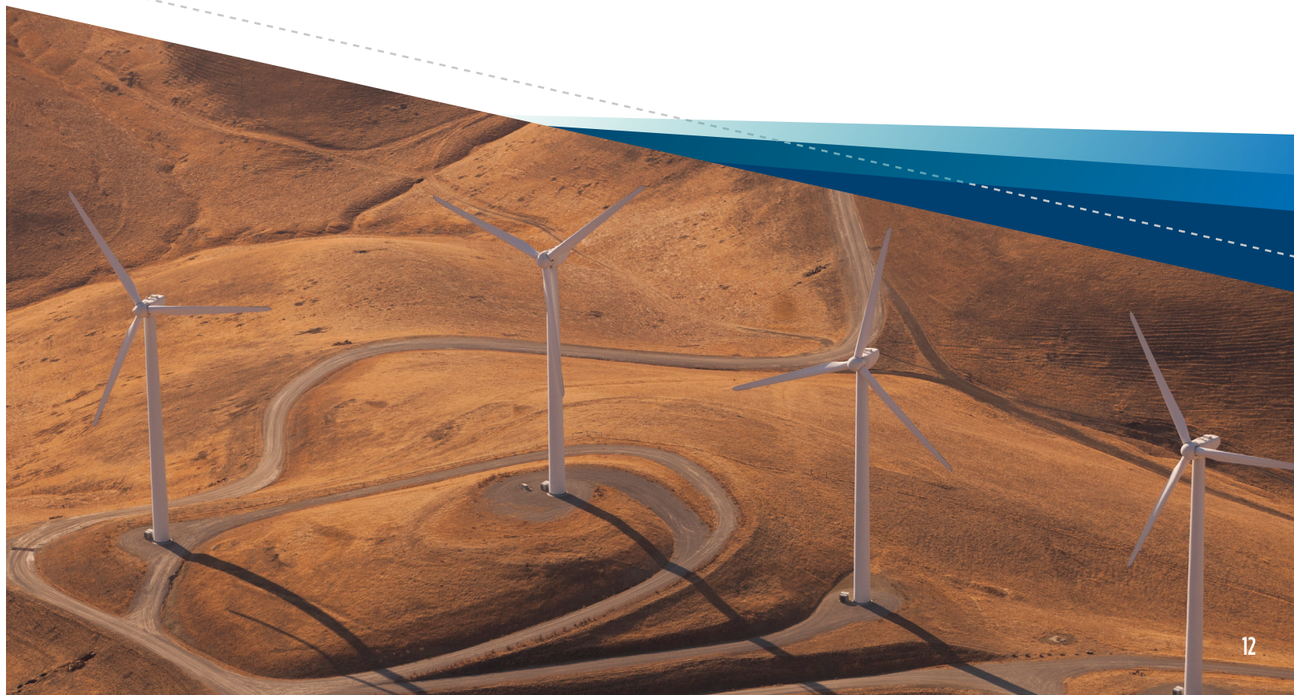


The state should continue to support FCEV commercialization and hydrogen infrastructure build-out to ensure there are ZEV options to meet different user needs. The medium-duty, heavy-duty, and off-road sectors should be priority focus areas, given the urgent need to reduce harmful emissions for these vehicles and the advantages that FCEVs may offer over battery-electric in certain applications.

ZEVs and Energy Resilience

The unprecedented number of wildfires across more than 4 million acres in Northern, Central, and Southern California is putting some grid infrastructure in a precarious position. As a result of public safety power shutoffs (PSPS) to reduce wildfire risk in some areas, many Californians are interested in purchasing generators and backup batteries for their homes or other buildings. ZEVS can help meet this need as they are fundamentally energy storage devices. A battery or fuel cell can provide power to the wheels of the vehicle or to a home or business. Community-scale solutions that take advantage of larger battery resources, such as school buses, are also worth exploring. The right equipment and grid safety precautions are necessary, but this energy resiliency opportunity is one that the state should embrace.

Of course, when the power is out, neither conventional combustion vehicles nor ZEVs can be refueled unless there is a backup source of energy to pump fuel or charge a battery. So, while ZEVs are a source of energy resiliency, they eventually need resilient refueling infrastructure. Fortunately, batteries and onsite renewable generation tied to charging infrastructure offer this resiliency potential. These technologies can also provide critical services to communities in the event of power outages as well as general beneficial energy services when the grid is functioning.



Low-Carbon Fuels and Near-Zero-Emission Vehicles May Be Useful in Some Contexts

Although ZEVs represent a revolutionary opportunity to transform transportation, it will take 15-25 years to transition most fleets, and some transportation modes may be more difficult to electrify. During this ZEV ramp up, low-carbon liquid fuels and other low-emission fuels can be blended with or substitute for petroleum. State policies and incentives should prioritize low-carbon liquid fuels for sectors that are the hardest to electrify, such as long-distance aviation. While air travel is generally the purview of the federal government, California's sustainable aviation fuel can earn credits from CARB's Low Carbon Fuels Standard. The state should, however, keep careful attention directed to carbon accounting and other sustainability metrics.

In the shorter term, renewable gas may also have a place in reducing air pollution, such as smog-forming nitrogen oxides. California has seen a rapid expansion of renewable gas facilities in the state, potentially comprising the energy potential for about 25 percent or more of the state's diesel fuel supply. However, renewable gas is primarily composed of methane, and because methane is a potent GHG with 25 times the warming potential of carbon dioxide, the state must balance the benefits of renewable gas against the impacts of methane leakage.

MOVING FORWARD

Putting the pieces in place to enable the rapid market expansion of ZEVs will be challenging but offers the potential of tremendous rewards. Careful attention to building and properly aligning infrastructure, incentives, equity, and the grid can help the state meet its energy and climate goals with benefits for all Californians. Zero-emission transportation is fundamental to a carbon-neutral economy and the health of all Californians. In planning to maximize the benefits of clean transportation for all residents, California can be a leader in developing a cleaner, healthier, and more equitable future.

IEPR Update

Every other year, the California Energy Commission prepares an Integrated Energy Policy Report to assess major energy trends and issues facing the state's electricity, gas, and transportation fuel sector. In alternate years (such as 2020), the CEC provides updates to these assessments. This volume of the 2020 IEPR Update focuses on transportation. Preparation of Integrated Energy Policy Reports involve close collaboration with federal, state, and local agencies, as well as a wide variety of stakeholders in an extensive public process to identify critical energy issues and develop strategies to address them.

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