Zero-Emission Vehicles and Infrastructure

Key Updates Since 2017 Tracking Progress

- In January 2018, Governor Edmund G. Brown Jr. issued Executive Order B-48-18 calling for 5 million zero-emission vehicles (ZEVs) by 2030 and the installation of 250,000 electric vehicle chargers and 200 hydrogen refueling stations by 2025.

- The California Budget for 2018-19 provides the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) up to $122.7 million to accelerate the development of ZEV infrastructure. The amount represents a substantial increase from previous years.

- The Energy Commission and Center for Sustainable Energy launched the California Electric Vehicle Infrastructure Project (CALeVIP) project, which provides a streamlined incentive process for installing electric vehicle charging infrastructure.

- The Energy Commission launched the School Bus Replacement Program as directed under Senate Bill 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017).

- The California Public Utilities Commission (CPUC) continues approving investor-owned utility (IOU) investments in electric vehicle infrastructure. In January 2018, the CPUC approved 15 priority review projects totaling $42 million, and in May 2018 CPUC approved four standard review projects totaling about $738 million.


- Under Senate Bill 350, the California Air Resources Board (CARB) finalized the *Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low-Income Residents* in February 2018, which identifies barriers faced by low-income customers in adopting zero-emission and near-zero emission transportation options.

- In September 2018, the Governor’s Office released the *2018 ZEV Action Plan: Priorities Update*, which updates and refines the top priority actions from the 2016 ZEV Action Plan.

- There are almost 18,000 public chargers (level 2 and direct current (DC) “fast” chargers) installed in California as of December 2018, of which 15 percent are DC “fast” chargers.
Accelerating the Deployment of Zero-Emission Vehicles and Infrastructure

On March 23, 2012, Governor Brown issued Executive Order B-16-2012, which set a long-term goal of having the necessary infrastructure to support 1 million ZEVs by 2020 and 1.5 million ZEVs on California’s roadways by 2025. In January 2018, Governor Brown reaffirmed California’s commitment to ZEVs with Executive Order B-48-18. This executive order directs all state entities to work with the private sector and appropriate levels of government to:

- Put at least 5 million ZEVs in California by 2030.
- Spur the installation and construction of 250,000 ZEV chargers, including 10,000 direct current fast chargers, and 200 hydrogen refueling stations by 2025.
- Partner with regional and local governments to streamline ZEV infrastructure installation processes wherever possible.
- Collaborate with stakeholders to implement this order, including, but not limited to, updating the 2016 ZEV Action Plan (especially to expand private investments in low-income and disadvantaged communities), recommending related actions for California’s economy and jobs, making it easier to install chargers in homes and businesses, and making charging and hydrogen fueling more affordable and accessible.

To support these goals, the Governor’s Enacted Budget for FY 2018-19 provides the ARFVTP up to $122.7 million to accelerate development of a statewide network of hydrogen refueling and electric vehicle charging stations, manufacturing, and workforce training and development.

Continuing Advancement

Plug-in electric vehicles (PEVs)¹ and fuel cell electric vehicles (FCEVs) are considered ZEVs and continue to need investments in “front-loading” the charging and refueling infrastructure to support new vehicle rollouts, technological advancements in battery capacity and vehicle range, increased power capacities of fast chargers, and advancements in producing and dispensing hydrogen fuel. The following provide guidance for collaborative statewide efforts in the advancement of ZEVs and supporting infrastructure:

- Governor’s ZEV Action Plan²
  
  In October 2016 the Governor’s Office released the 2016 ZEV Action Plan, which outlines more than 200 specific actions state agencies will take to continue advancing the ZEV market in California. The Energy Commission has been tasked in numerous lead and supporting roles within the 2016 ZEV Action Plan.

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¹ Includes battery electric vehicles (BEVs) and plug-in hybrid electric (PHEVs).
In September 2018 the Governor’s Office released the 2018 ZEV Action Plan: Priorities Update, which refines the top priority actions to realize the Governor’s vision for ZEVs, as outlined in the two executive orders. While the 2018 Priorities Update focuses on the most important actions to be executed in 2018, the 2016 ZEV Action Plan remains active as state agencies continue to implement the various actions.

- **California Sustainable Freight Action Plan (CSFAP)**

  The Sustainable Freight Action Plan, released in July 2016, establishes targets to improve freight efficiency, transition to zero-emission technologies, and increase competitiveness of California’s freight system.

  The CSFAP identifies the Energy Commission as a lead/colead agency for numerous tasks, including funding medium- and heavy-duty ZEV infrastructure, standardizing medium- and heavy-duty vehicles and equipment charging protocols, investing in advanced vehicles and equipment technology demonstrations and deployment, and renewable fuel production and other freight technologies. The Energy Commission has released two solicitations for the demonstration of advanced freight vehicles and equipment in support of the CSFAP that are discussed in the “Medium- and Heavy-Duty Vehicles” and “Infrastructure” sections of this update.

  The Energy Commission is also participating in workgroups established by the California seaports and Society of Automotive Engineers to establish formal standards for medium- and heavy-duty charging.

- **Senate Bill 350 (De León, Chapter 547, Statutes of 2015) – Clean Energy and Pollution Reduction Act**

  Integrated Resource Plans (IRPs) - SB 350 requires California’s publicly owned utilities (POUs) with annual electricity demand exceeding 700 gigawatt-hours to develop and adopt IRPs by January 1, 2019. In addition to discussing plans for meeting greenhouse gas reduction targets and procurement plans for renewable energy, the IRPs must also address plans for transportation electrification. The Energy Commission adopted guidelines for the POUs’ submission of IRPs and will review IRPs for consistency with legislative requirements.5

  Low-Income Barriers Study - SB 350 requires CARB, in consultation with the Energy Commission, to develop a study on the barriers faced by low-income customers in adopting zero-emission and near-zero-emission transportation options. In February 2018, CARB released the Low-Income Barriers Study, Part B: Overcoming Barriers to

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5 [http://www.energy.ca.gov/sb350/IRPs/](http://www.energy.ca.gov/sb350/IRPs/).
Clean Transportation Access for Low-Income Residents.\(^6\) The report cited affordability, awareness, and a lack of permanent, long-term funding sources as primary barriers to increasing access to clean transportation and mobility options in underserved and disadvantaged communities. Energy Commission staff will take these barriers and the recommendations to overcome them into account when developing future funding opportunities.

- CARB’s proposed regulations in support of the 2016 Mobile Source Strategy
  - The Innovative Clean Transit draft proposed regulation seeks mechanisms for transit agencies to develop plans to transition to a fleet of zero-emission buses by 2040.\(^7\)
  - A regulatory concept for Advanced Clean Trucks would require truck and chassis manufacturers to sell a portion of Class 2B or larger vehicle sales as zero emissions, among other alternatives.\(^8\)
  - Proposed requirements implementing the Electric Vehicle Charging Stations Open Access Act aim to standardize the initiation of the charging experience for customers and promote nonmember access to equipment, and provide a single source of station location information.\(^9\)
  - Modifications to the Low Carbon Fuel Standard, under the B-48-18 order to expand ZEV infrastructure, include provisions to encourage smart charging of electric vehicles based on electricity carbon intensities that are time-differentiated.

The aforementioned provided additional strategic framework for the Energy Commission’s ARFVTP investments.

**Alternative and Renewable Fuel and Vehicle Technology Program**

The California Legislature passed Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) that created the ARFVTP, administered by the Energy Commission. With funds collected from vehicle and vessel registration, vehicle identification plates, and smog-abatement fees, the ARFVTP funds projects that "transform California’s fuel and vehicle types to help attain the state’s climate change policies." Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) subsequently extended the program through January 1, 2024.

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\(^6\) [https://www.arb.ca.gov/msprog/transoptions/sb350_final_guidance_document_022118.pdf](https://www.arb.ca.gov/msprog/transoptions/sb350_final_guidance_document_022118.pdf)

\(^7\) [https://www.arb.ca.gov/msprog/ict/meeting/mt180611/180611ictregsummary.pdf](https://www.arb.ca.gov/msprog/ict/meeting/mt180611/180611ictregsummary.pdf).

\(^8\) [https://www.arb.ca.gov/msprog/actruck/mtg/180531presentation.pdf](https://www.arb.ca.gov/msprog/actruck/mtg/180531presentation.pdf).

Cumulative program allocations for ZEVs as of September 2018\(^\text{10}\) include:

- **$94.9 million** for electric vehicle (EV) charging infrastructure, which consists of:
  - $6.1 million for private access including single-family, fleet and workplace.
  - $30.6 million for corridor fast charger installations.
  - $16.2 million for commercial installations.
  - $38.8 million to provide EV charger incentives.
  - $1.3 million for multiunit family installations.
  - $1.9 million for loan loss reserve program with California Pollution Control Financing Authority for EV charger installation loans.

- **$110.9 million** for 64 retail hydrogen refueling stations and $10.7 million for ongoing operation and maintenance of 34 hydrogen refueling stations.

- **$10.0 million** to support hydrogen refueling for public infrastructure, including testing and temporary refueling.

- **$7.0 million** to California Department of Food and Agriculture/Division of Measurement Standards (CDFA/DMS) for the development of hydrogen purity and dispensing standards for hydrogen and electricity. Also, $500,000 was provided to CDFA/DMS to operate the United States Department of Energy (U.S. DOE) Hydrogen Station Equipment Performance (HyStEP) device.

- **$8.0 million** for hydrogen infrastructure to support the deployment of 10 fuel cell electric trucks at the Port of Long Beach featuring 100 percent renewable hydrogen produced on-site by a Tri-Generation fuel cell power plant.

- **$3.97 million** for a 5,000-kilogram-per-day electrolysis plant in Moreno Valley (Riverside County). The facility will produce and supply 100 percent renewable hydrogen fuel to California’s network of public hydrogen refueling stations.

- **$76.7 million** to help California companies demonstrate zero-emission medium- and heavy-duty advanced technologies for trucks, buses, and freight movement. These projects, which are located in and provide benefits to disadvantaged communities, are critical to bringing these technologies to market.

- **$43.6 million** in funding for start-ups and small manufacturers of advanced technology vehicles, components, and batteries to expand their plants and assembly lines.

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$11.4 million for ZEV regional readiness planning.

$49.1 million to fund incentives for all-electric and plug-in hybrid electric vehicles via the CARB Clean Vehicle Rebate Project (CVRP).

In January 2018, Governor Brown released a proposed 2018 plan for California’s Climate Investments, which includes a $1.25 billion Cap-and-Trade Expenditure Plan and a new eight-year initiative to accelerate sales of zero-emission vehicles through vehicle rebates and infrastructure investments. The 2018-19 Enacted Budget includes up to $122.7 million for the Energy Commission to support zero-emission vehicle infrastructure, manufacturing, and workforce development and training. This budget provides ARFVTP with an increase in funding for electric vehicle charging stations, which is discussed in more detail in the ARFVTP 2018-2019 Investment Plan Update.\(^{11}\)

**ZEV Infrastructure**

To accelerate ZEV adoption, robust and reliable electric vehicle charging station and hydrogen refueling networks must be available. The following sections provide information on the installation of public electric vehicle chargers and hydrogen refueling stations that the Energy Commission has been able to track. Moving forward, the Energy Commission plans to start tracking private installations (not publicly accessible), such as those at hospitals, businesses, technology companies such as Google and Yahoo, and computer industries. These additional data will provide a more comprehensive data set to support electric vehicle infrastructure planning.

In 2018, California averaged about 225 public level 2 charger installations per month and about 90 public direct current (DC) “fast” chargers per month.\(^ {12}\) There are almost 18,000 public chargers (level 2 and DC “fast” chargers) installed in California as of December 2018, of which 15 percent are DC “fast” chargers. California is a quarter of the way to meeting its goal of 10,000 DC “fast” chargers by 2025.

**PEV Charging Infrastructure**

To help track PEV charging station availability and locations, the Energy Commission accesses the U.S. DOE’s Alternative Fuels Data Center.\(^ {13}\) The Alternative Fuels Data Center includes publicly available charging stations that have been verified by the National Renewable Energy Laboratory (NREL) through collaboration with infrastructure equipment and fuel providers, original equipment manufacturers (OEMs), and industry groups. The Alternative Fuels Data Center is an important tool for tracking the availability of PEV charging stations in California.

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11 [https://www.energy.ca.gov/altfuels/2017-ALT-01/documents/](https://www.energy.ca.gov/altfuels/2017-ALT-01/documents/).

12 Level 2 charging uses alternating current at 240 volts to charge at about 10-20 miles of range per hour. Fast chargers use DC electricity at 480 volts to recharge a BEV in about 30 minutes. (Level 1 charging uses alternating current electricity at 120 volts to provide about 5 miles of range per hour of charging. ) Source: Orenberg, Jacob. 2017. 2017-2018 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2016-007-CMF.

Center information is downloaded regularly by the Energy Commission and combined with data on new charger installations funded through ARFVTP to allow staff to analyze potential siting needs.

As of September 2018, the ARFVTP has awarded $94.9 million for more than 8,800 charging outlets at over 5,400 public and private sites throughout California (Table 1).

<table>
<thead>
<tr>
<th>Charging Outlets</th>
<th>Private</th>
<th>Public</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed</td>
<td>4,385</td>
<td>3,470</td>
<td>7,855</td>
</tr>
<tr>
<td>Planned</td>
<td>100</td>
<td>8,77</td>
<td>977</td>
</tr>
<tr>
<td>Total</td>
<td>4,485</td>
<td>4,347</td>
<td>8,832</td>
</tr>
</tbody>
</table>

Source: California Energy Commission staff

**Direct Current Fast Charging (DCFC) Corridor Chargers**

In October 2013, the governments of California, Washington, Oregon, and British Columbia signed an agreement called the “Pacific Coast Action Plan on Climate and Energy” that includes a commitment to transition the West Coast to clean modes of transportation. In support, Washington and Oregon installed the Pacific Northwest portion of the West Coast Electric Highway, a network of DCFC stations located every 25 to 50 miles along Interstate 5 and other major roadways in the Pacific Northwest.

California is supporting the installation of DCFC on highway corridors that will complete the California portion of the West Coast Electric Highway allowing travel from Oregon to the Mexico border. The Energy Commission has awarded $22.7 million in grant funding to install 194 dual-standard DCFCs at 119 sites across the state (represented by the yellow dots in Figure 1). These DCFC installations are anticipated to be completed in 2019.

Going forward, highway corridors will be analyzed for placement of additional higher-powered DCFCs (125 kilowatts [kW] and greater) to expedite charging for next-generation PEVs with higher-capacity batteries.

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14 “West Coast Electric Highway” is a trademarked name under the jurisdiction of the Washington Department of Transportation and has specific requirements for adoption and use of the name.
Figure 1: California Electric Vehicle Fast Charging Locations as of August 2018

Source: California Energy Commission staff, U.S. DOE’s Alternative Fuels Data Center, Caltrans
Other DCFC Corridor Efforts

California Department of Transportation (Caltrans) is working on the installation of publicly accessible DCFCs within Caltrans’ right-of-way. The goal of Caltrans initiative is to fill gaps within California’s DCFC network along key routes of the California highway system where sufficient commercial ZEV fueling opportunities do not exist. Caltrans worked with the Energy Commission and California Governor’s Office of Business and Economic Development (GO-Biz) to identify high-priority corridors and sites for public DCFCs. Thirty-seven public DCFC sites will be located within the state highway right-of-way and other Caltrans-owned locations. Caltrans anticipates 34 DCFC sites will be ready for public use in 2019 (Figure 1).

Electrify America, the subsidiary managing Volkswagen’s $2 billion U.S. electric vehicle charging infrastructure plan (of which $800 million must be spent in California), is launching a network of electric vehicle charging stations along highly traveled highways (Figure 2). Highway stations will be equipped with chargers capable of delivering maximum power levels from 150 kW to 350 kW.

Filling in Charging Infrastructure Gaps Using Block Grants, Regional Modeling, and Data Collection

To provide more focused PEV infrastructure projects that will target gaps in charging availability, ARFVTP awarded funding to the Center for Sustainable Energy (CSE) to implement the California Electric Vehicle Infrastructure Project (CALeVIP). CALeVIP offers incentives for the
purchase and installation of electric vehicle charging infrastructure at publicly accessible sites throughout California. The goal of CALeVIP is to implement targeted incentive projects throughout California that address a specific region’s EV charging needs with a mechanism that speeds the installation, reporting, and funding through a streamlined process.

In December 2017, CALeVIP’s first regional project, the Fresno County Incentive Project, was launched offering rebates of up $7,000 for Level 2 chargers. In August 2018, the Southern California Incentive Project was launched, offering up to $80,000 for the installation of DCFC in Los Angeles, Orange, Riverside and San Bernardino Counties. The Southern California Incentive Project also includes a requirement in which 25 percent of total project funds must go to projects in disadvantaged communities.

CALeVIP incentive project design is driven by the Electric Vehicle Infrastructure Projection (EVI-Pro) modeling tool developed in coordination with the Energy Commission and the National Renewable Energy Laboratory. The EVI-Pro model analyzes regional demand and quantifies the types, locations, and quantities of chargers needed to support the goals of California’s electric vehicle objectives. A staff report was published in March 2018 titled California Plug-in Electric Vehicle Infrastructure Projections: 2017-2025, Future Infrastructure Needs for Reaching the State’s Zero-Emission Vehicle Deployment Goals,15 and a stakeholder workshop discussing means to improve infrastructure modeling and siting modeling was held in May 2018.16

Energy Commission staff is establishing a streamlined method for collecting data from public networked electric vehicle chargers to better understand the use of deployed and future chargers. The usage data will provide insight on how public stations are used by PEV drivers, including peak charging timing, energy dispensed, and dwell time. These data will enhance the EVI-Pro model by enabling better understanding of charger usage and PEV driver behavior.

**Hydrogen Refueling Station Infrastructure**

In comparison to plug-in electric vehicles (battery-electric and plug-in hybrid electric vehicles) that use all battery-electric power or battery-electric power with a small gasoline engine, FCEVs use an electric motor and an electric drivetrain and are powered by hydrogen gas stored in onboard tanks.

The anticipated deployment of hydrogen refueling stations is shown in Figure 3. As of September 2018, there are 35 open-retail hydrogen refueling stations in California capable of supporting up to 9,550 FCEVs. With the exception of the Newport Beach station, all the publicly available hydrogen refueling stations have been funded through ARFVTP. The Newport Beach station represents a significant milestone as it is the first hydrogen refueling station to be upgraded to open-retail using nonstate funds.

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Through ARFVTP, the Energy Commission has invested $110.9 million to support the construction of 64 hydrogen refueling stations (Figure 4). Once completed, these stations will have a daily refueling capacity of 16,795 kilograms (kg)/day, enough to support 23,990 FCEVs.

As of April 2018, 4,411 FCEVs were registered with the Department of Motor Vehicles (DMV), and the most recent industry estimates indicate a total of 5,179 vehicles deployed through August 2018. The CARB’s 2018 Annual Evaluation of Hydrogen FCEV Deployment and Hydrogen Fuel Station Network Development17 projects more than 23,000 FCEVs by 2021 and 47,000 by 2024.

Hydrogen refueling stations funded by the Energy Commission are required to dispense at least 33 percent renewable hydrogen on a per-kilogram basis. After all 64 ARFVTP-funded stations become open retail in the 2019–2020 time frame, the maximum daily fueling capacity will reach 16,795 kilograms per day (kg/day), requiring more than 5,542 kg/day of 100 percent renewable hydrogen to meet the 33 percent requirement.

In June 2018, the Energy Commission approved a $3.97 million award to construct a 100 percent renewable hydrogen production plant in Moreno Valley. StratosFuel, the project developer, will use the award to add 2,000 kg per day to the production capacity of a 3,000 kg per day facility already under development. When completed, the facility will produce 5,000 kg of renewable hydrogen daily to supply California's network of public hydrogen refueling stations.

In October 2018, the Energy Commission posted a notice of proposed award for two additional 100 percent renewable hydrogen production plants in unincorporated Kings County and Bay Point, California. Each proposed award consists of $3.97 million to construct facilities each with
the capacity to produce 1,000 kg per day of 100 percent renewable hydrogen for use by California’s network of public hydrogen refueling stations.

The Energy Commission annually analyzes the remaining cost and timing to establish the initial network of 200 hydrogen refueling stations and publishes the Joint Agency Staff Report on Assembly Bill 8 each December.\(^\text{18}\)

The 2017 Joint Report projected that with the continued business-as-usual allocation of $20.0 million annually, funding eight 300 kg/day stations per year, may allow the supply of hydrogen dispensing capacity to keep pace with demand until 2021, after which a shortfall in capacity is expected.

As of July 2018, the Energy Commission’s ARFVTP has provided $121.6 million in funding for capital expense and operation and maintenance support for 64 hydrogen refueling stations, of which 35 are open retail and 29 are under development.

In September 2018, CARB adopted Resolution 18-34 that modifies the Low Carbon Fuel Standard to allow hydrogen refueling stations to earn hydrogen refueling infrastructure credits based on the capacity of the hydrogen station, in addition to credits earned for the fuel dispensed. These credits will provide a subsidy to hydrogen refueling station owners that can supplant Energy Commission O&M funding, thereby increasing the amount of ARFVTP funding available for new station construction. The expected value of these proposed hydrogen refueling infrastructure credits and the duration of the incentive exceed what can be offered through the ARFVTP, and these should reduce investment risk and provide a stable source of operating capital. The Energy Commission will continue discussions with CARB and stakeholders to ensure that all available funding for hydrogen refueling is used in the most effective manner for encouraging early FCEV adoption.

Medium- and Heavy-Duty Vehicles and Infrastructure


In October 2016, the California Fuel Cell Partnership (CaFCP) released an action plan for the deployment of fuel cell trucks in California that have the potential to significantly reduce the negative impacts associated with freight transport. The CaFCP led a team of original equipment manufacturers (OEMs), industry stakeholders, and state agencies, including the Energy Commission, to develop a focused strategy for FCET development. Two near-term vocational categories were selected: Vehicle Classes 4-6 urban “last-mile delivery” trucks\(^\text{19}\) and Classes 7-8 short-haul/drayage trucks. The action plan identified priority recommendations including, but not limited to, technology transfer from buses, data collection, technology demonstrations, increased funding, and focus on hydrogen infrastructure.

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\(^{18}\) [https://www.energy.ca.gov/transportation/report_ab8.html](https://www.energy.ca.gov/transportation/report_ab8.html).

\(^{19}\) “Last-mile trucks” are trucks that complete the final stage of delivery when shipments reach the destination. These vehicles travel from regional distribution centers to customers in local communities and return to a distribution hub at the end of the day.
ZEVs in the Freight Sector

In July 2015, Governor Brown issued Executive Order B-32-15, which provides a vision for California’s transition to a more efficient, more economically competitive, and less polluting freight transport system that resulted in the development of the California Sustainable Freight Action Plan (CSFAP).

Under the ARFVTP, the Energy Commission released two solicitations for demonstrating advanced freight vehicles and equipment in support of the CSFAP. The first solicitation, released in November 2016, awarded funding for five demonstration projects for medium- and heavy-duty vehicle technologies at California seaports. A summary of those demonstrations is in Table 2 below.

Table 2: Medium- and Heavy-Duty ZEV Demonstrations at Seaports

<table>
<thead>
<tr>
<th>Port of Los Angeles (#1)</th>
<th>Port of Los Angeles (#2)</th>
<th>San Diego Port Tenants Association</th>
<th>Port of Long Beach</th>
<th>South Coast Air Quality Management District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>$5,833,000</td>
<td>$4,524,000</td>
<td>$5,903,652</td>
<td>$9,755,000</td>
</tr>
<tr>
<td>Total Vehicles/Equipment</td>
<td>25 Yard Tractors</td>
<td>3 Yard Tractors, 2 Top Handlers</td>
<td>10 Drayage Trucks, ITS</td>
<td>9 Gantry Cranes 16 Drayage Trucks</td>
</tr>
<tr>
<td>Project Completion (Estimate)</td>
<td>2021</td>
<td>2020</td>
<td>2021</td>
<td>2021</td>
</tr>
</tbody>
</table>

In December 2017, the Energy Commission released a second solicitation for advanced freight vehicle infrastructure deployment that was open to all California seaports, regional warehouses, and distribution centers that directly support freight movement. Funds were used to support electric vehicle and hydrogen infrastructure deployment for advanced freight vehicles in classes 3 through 8. Two projects have been awarded and one proposed summarized below.

1) Equilon Enterprises LLC will develop a high-capacity hydrogen refueling station servicing and promoting the expansion of zero-emission fuel cell electric Class 8 drayage trucks for the Port of Long Beach (pending approval).

2) Port of Long Beach’s Port Advanced Vehicle Electrification (PAVE) Project will upgrade critical electrical infrastructure, install an innovative energy storage
system, and deploy the a heavy-duty off-road direct current fast-charging solution on the grounds of Total Terminals International’s (TTI) marine terminal to support TTI's imminent deployment of six new zero-emission, battery-electric yard hostlers (utility tractor rigs).

3) Port of Los Angeles’ Zero-Emission Freight Vehicle Advanced Infrastructure Demonstration project will design and demonstrate inductive, or wireless, charging technology to support each of the 10 yard tractors at West Basin Container Terminal's equipment corral, as well as two opportunity charging stations at the central break location where yard tractors can obtain a quick top-off midshift. The project will also include a battery storage system designed by BYD Motors, Inc. to receive and store energy from the electrical grid when grid power is more available and costs are low, and provide it to the yard tractors when costs are higher.

**School Bus Replacement Program**

Senate Bill 110 provides the Energy Commission up to $75 million from the California Clean Energy Jobs Act (Proposition 39, 2012) to retrofit or replace old school buses throughout California with preferences for targeting buses serving disadvantaged communities and school districts with most students receiving free and reduced-price meals. In May 2018, the Energy Commission released a grant funding opportunity for school bus replacement for California public school districts, county offices of education, and joint powers authorities. The funds will provide new electric school buses, and the Energy Commission plans to provide up to $60,000 per awarded bus for electric vehicle charging infrastructure. The solicitation closed in September 2018, and applications are under review.

**Regional Readiness Planning**

Infrastructure planning for ZEV deployment requires coordination at the local and regional levels. The Energy Commission has conducted six grant solicitations for regional readiness planning, providing $11.4 million for 52 agreements to prepare for and expedite the deployment of alternative fuel infrastructure and vehicles. These grants aim to streamline the permitting process for future ZEV infrastructure, promote regional coordination through the establishment of ombudsman positions, analyze sites, establish best practices for “ZEV-ready” building and public works guidelines, and provide public ZEV education and outreach.

**Electric Vehicle-Ready Communities Challenge**

In December 2017, the Energy Commission released a grant funding opportunity for a competition that challenged project teams to accelerate the deployment of electrified transportation within the local and regional levels with a holistic and futuristic view of regional transportation planning. The funding opportunity was for Phase 1 of an expected two-phase effort for electric vehicle-ready communities. Phase 1 is for developing the planning blueprints to identify the actions and milestones needed to proceed toward implementing the electric vehicle-
ready community. Nine agreements were awarded in May and June 2018, and the project regions are highlighted in Figure 5. The blueprints for all nine regions are anticipated to be completed by July 2019.

**Figure 5: Electric Vehicle-Ready Community Challenge Phase I Regions**

![Electric Vehicle-Ready Community Challenge Phase I Regions](image)

Source: California Energy Commission staff

### ZEVs in Disadvantaged Communities and Innovative Mobility Services

The Energy Commission has committed to ensuring that all Californians have an opportunity to participate in and benefit from the ARFVTP. ARFVTP grant solicitations have scoring criteria to encourage projects in disadvantaged communities, which include those with disproportionate environmental pollution or a concentration of low-income households. As of September 2018, the Energy Commission has funded 927 Level 1 and Level 2 charging connectors, 98 DCFC connectors, and 12 hydrogen refueling station within disadvantaged communities scoring in the top 25 percent under CalEnviroScreen Version 3.0. ARFVTP funding opportunities for

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20 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.

21 As determined by the Office of Environmental Health Hazard Assessment California Communities Environmental Health Screening (CalEnviroScreen) tool.
charging infrastructure will include charger installations that will serve workplaces and multiunit housing within these communities.

Funding opportunities included projects for innovative mobility services, such as EV sharing, ride sharing, and alternative transit services that can promote innovative mobility service demonstrations in disadvantaged communities. These types of charging venues have the potential to broaden the market of BEV and PHEV purchases for those that do not have a dedicated parking space for charging. The Energy Commission awarded four projects in late 2017 to demonstrate innovative electric vehicle mobility services in four specified areas in California.

- Two projects with Envoy Technologies, Inc. will demonstrate an all battery-electric vehicle car-sharing program at 30 affordable housing developments throughout the Bay Area, Sacramento Metro, and northern San Joaquin area. The project aims to serve low-income persons and families by providing access to vehicles for those who typically struggle to afford owning their own mode of transportation.

- CALSTART, Inc. will demonstrate a ride-sharing program using six Chevrolet Bolts for students attending Fresno City College from rural Fresno County area. The project aims to demonstrate how existing transit services in rural areas can be leveraged and enhanced through the addition of advanced battery-electric vehicles and innovative ride-matching services.

- StratosFuel, Inc. will demonstrate a fuel cell electric vehicle car-sharing platform in Riverside and Ontario. The project will use mobile applications to reserve and rent fuel cell electric vehicles

**Smart Charging and Vehicle-Grid Integration**

Vehicle-grid integration can help improve the integration of renewable energy resources, reduce charging infrastructure and vehicle operating costs, and reduce utilities’ distribution maintenance requirements. The Energy Commission is collaborating with other state agencies to update the *California Vehicle-Grid Integration (VGI) Roadmap: Enabling Vehicle-Based Grid Services* to ensure that future investments in charging consider the system needs necessary for vehicle-grid integration and associated benefits.

Energy Commission staff’s *California Plug-In Electric Vehicle Infrastructure Projections: 2017-2025* analysis found that unmanaged light-duty electric vehicle charging may contribute nearly 1,000 megawatts of new demand during the peak hours. Staff also found that networking technologies that enable shared use of infrastructure could be leveraged to automate demand

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22 [http://www.energy.ca.gov/contracts/GFO-16-605/](http://www.energy.ca.gov/contracts/GFO-16-605/)


24 [http://www.energy.ca.gov/altfuels/2017-ALT-01/documents/](http://www.energy.ca.gov/altfuels/2017-ALT-01/documents/)
responsive charging. In line with Energy Commission staff’s analysis, Lawrence Berkeley National Laboratory found that managing charging and enabling the use of electric vehicle batteries as dischargeable capacity could serve as the equivalent to roughly 5 gigawatts of stationary storage, with capital savings enabling greater investment in vehicle electrification in California. These findings are supported by recommendations of the 2017 Integrated Energy Policy Report (IEPR) to standardize electric vehicle charging equipment to enable resource dispatch and to update the Vehicle-Grid Integration Roadmap.

**Other Activities**

**Fixing America’s Surface Transportation Act**

California (Governor’s Office, Energy Commission, Caltrans, CARB, CPUC, and the California State Transportation Agency [CalSTA]) submitted a joint proposal under the Fixing America’s Surface Transportation Act, nominating 43 essential corridors for zero-emission and alternative fuel designation under a nationwide designation to improve public access to alternative fuels, improve air quality, and reduce GHG emissions. Of the 43 corridors submitted, the Federal Highway Administration nominated 28 corridors for designation in California (Figures 6 and 7). One of two designations were then assigned to each nominated highway segment: “Signage Ready,” meaning that there are a sufficient number of facilities on the corridor to warrant signage alerting drivers of the availability of alternative fueling stations, or “Signage Pending,” meaning that the corridor does not yet have sufficient alternative fuel facilities to warrant highway signage.

**Table 3: California Designated Alternative Fuel Corridors for Electric Vehicles and Hydrogen**

<table>
<thead>
<tr>
<th>Electric Vehicle</th>
<th>Hydrogen</th>
</tr>
</thead>
</table>

Source: California Energy Commission staff

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Figure 6: Electric Vehicle Alternative Fuel Corridors

2017 California Alternative Fuel Corridors
Electric Vehicle

Source: Caltrans

While the data on this map has been examined for accuracy, Caltrans disclaims any responsibility for the accuracy or correctness of the data. In no event shall Caltrans become liable to users of this map, or to any other party, for any loss or damages, compensatory or otherwise, including but not limited to time, money, or goodwill, arising from the use of this map product.

Source: Caltrans
Figure 7: Hydrogen Alternative Fuel Corridors

2017 California Alternative Fuel Corridors
Hydrogen

Source: Caltrans
CPUC Transportation Electrification Activities

In 2014 the CPUC adopted Decision 14-12-079 in Rulemaking 13-11-007, which allows for the consideration of utility ownership of EV charging stations and infrastructure on a case-specific basis. Subsequently, in 2016 the CPUC approved light-duty infrastructure pilot programs for Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison (SCE) to install charging stations summarized in Table 4.

<table>
<thead>
<tr>
<th>Program Name</th>
<th>SDG&amp;E</th>
<th>SCE</th>
<th>PG&amp;E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
<td>3,500 charging stations</td>
<td>1,500 charging stations</td>
<td>7,500 charging stations</td>
</tr>
<tr>
<td><strong>Budget</strong></td>
<td>$45M</td>
<td>$22M</td>
<td>$130M</td>
</tr>
<tr>
<td><strong>Markets</strong></td>
<td>Multifamily and workplaces</td>
<td>Multifamily, workplaces, and public</td>
<td>Multifamily and workplaces</td>
</tr>
<tr>
<td><strong>Disadvantaged Communities</strong></td>
<td>≥ 10% charging stations in disadvantaged communities</td>
<td>≥ 10% charging stations in disadvantaged communities</td>
<td>≥ 15% charging stations in disadvantaged communities</td>
</tr>
<tr>
<td><strong>Program Start Date</strong></td>
<td>Mid 2017</td>
<td>May 2016</td>
<td>January 2018</td>
</tr>
</tbody>
</table>

Table 4: IOU Light-Duty PEV Charging Infrastructure Programs

The CPUC is working to implement the transportation electrification provisions of SB 350 by directing the six IOUs to propose portfolios of transportation electrification programs and investments that can be implemented over the next two to five years. PG&E, SCE, and SDG&E filed applications containing proposed transportation electrification projects on January 20, 2017. Together, the three utilities submitted proposals to invest $1 billion in transportation electrification over an approximate five-year period for CPUC consideration.

In January 2018, the CPUC approved, with modifications, the first priority review transportation electrification applications under SB 350. The decision approves 15 projects (four PG&E projects, five SCE projects, and six SDG&E projects) with combined budgets of $42 million. The projects include electrification of school buses, delivery trucks, airport/seaport equipment, truck

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26 Bear Valley Electric, Liberty Utilities, Pacific Corp, PG&E, SCE, and SDG&E.
stops, and commuter locations. Other projects include the installation of fast charging for urban locations and incentives for car dealerships.\textsuperscript{27}

In May 2018 the CPUC approved, with modifications, four standard review transportation electrification projects and two rate designs proposed by PG&E, SCE, and SDG&E with combined budgets of about $738 million, with a further set aside of $29.5 million for evaluation of the projects.\textsuperscript{28} A summary table of the programs that have been approved under SB 350 is provided in Table 5.

| Source: CPUC |
| PacificCorp, Liberty Utilities, and Bear Valley Electric Service also filed applications with the CPUC in June 2017 totaling $7.4 million to support transportation electrification through charging infrastructure installation and rebates, as well as outreach and education. |

In addition to the applications above, SDG&E filed an application for medium- and heavy-duty electric vehicle charging infrastructure program and a vehicle-to-grid electric school bus pilot in January 2018. SCE filed an application to expand a second phase of its Charge Ready Program.

\textsuperscript{27} CPUC Decision 18-01-024: \url{http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M204/K670/204670548.PDF}.

\textsuperscript{28} CPUC Decision 18-05-040: \url{www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442457637}. 

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for 48,000 charging stations and market education in June 2018. These programs are pending before the CPUC.

It July 2018, PG&E, SCE, and SDG&E, and Liberty Utilities (CalPeco Electric) LLC submitted proposals to CPUC that pilot the installation of charging infrastructure in schools under Assembly Bill 1082 (Burke, Chapter 637, Statutes of 2007) and state parks and beaches under Assembly Bill 1083 (Burke, Chapter 638, Statutes of 2007). A decision is required for these applications by December 2018.

Publicly Owned Utilities (POUs)

Consistent with SB 350, utilities in California must achieve widespread transportation electrification as a principal goal of their investment and resource planning. POUs, together with air districts, transportation planning agencies, and municipal governments, play an important coordinating role in reducing GHG from transportation 40 percent below 1990 levels by 2030 and improving air quality. POUs will be developing strategies to address procurement of transportation electrification in their integrated resource plans to be submitted in January 2019.

The Los Angeles Department of Water and Power (LADWP) is expanding its support of electric transportation with Charge Up LA! Offering rebates of up to $500 for residential charger installations and up to $5,000 to commercial customers to help deploy EV charging infrastructure at businesses, including workplaces, multi-unit dwellings, and public parking lots. The program includes the new Used EV Rebate Program that provides rebates of up to $450 to buy qualifying used EVs or plug-in hybrid electric vehicles. LADWP is actively promoting the awareness of EVs, plug-in hybrid electric vehicles and motorcycles, as well as the benefits they provide. LADWP’s goal is to have 10,000 chargers in the City of Los Angeles by 2022.

The Sacramento Municipal Utility District (SMUD) also offers a variety of incentive programs to support electric transportation in the Sacramento region. SMUD offers a $1,500 incentive for each Level 2 hardwired wall or pedestal mounted electric vehicle charger port (up to 20 incentives per property) at multi-family and workplaces. The program also offers an incentive of up to $120,000 for each DC fast charging project in the region (up to 6 projects per year). Residents who purchase or lease a new plug-in electric vehicle are eligible for a $599 incentive to charge free for two years or a Level 2 charger.

Air District Grant Funding

California air districts are also implementing programs to advance ZEVs. The three major programs monitored by Energy Commission staff are implemented by the Bay Area Air Quality Management District (BAAQMD), San Joaquin Valley Air Pollution Control District, and the South Coast Air Quality Management District (SCAQMD).

The BAAQMD’s “Charge!” program offers grant funding to help offset a portion of the cost of purchasing, installing, and operating new publicly available charging stations at workplaces, multiunit homes, and public locations. The program has allocated $5.0 million and is scheduled to reopen late October 2018.
Through the Carl Moyer Program, BAAQMD also offers funding to help vehicle fleet owners replace, repower, or convert their trucks or buses with newer, lower-emission equipment. As part of this program, applicants can request funding to install, covert, or expand battery-charging, hydrogen, or natural gas-fueling stations.

San Joaquin Valley Air Pollution Control District’s Charge Up! EV Charger Incentive Program provides funding for public agencies and businesses in the valley to purchase and install new publicly available Level 2 chargers.

SCAQMD and the Mobile Source Air Pollution Reduction Review Committee offer a Residential EV Charging Incentive Pilot Program that offers up to $250 for the cost of hardware for Level 2 residential chargers. An additional incentive of up to $250 is available for low-income residents.

Through the Carl Moyer Program, SCAQMD also offers funding for infrastructure projects that enable the deployment of alternative, advanced, and cleaner technologies to support the state’s air quality goals. Eligible projects include infrastructure for on-road heavy-duty vehicles, off-road nonrecreational equipment and vehicles, agricultural equipment, and marine vessels.

**Increasing Role of Private Investments**

NRG Energy’s settlement\(^{29}\) with the CPUC provided the first major installations with private investments, eventually providing 200 public fast charging station sites and the infrastructure for 10,000 plug-in units at 1,000 diverse locations (to “make ready” the sites) statewide. In February 2017, NRG and the CPUC entered into a second amendment to the agreement that extended the operating period commitment for the fast charging stations to December 2020, extended the make-ready stubs installation period through December 2018, and allocated up to $12.5 million of the make-readies amount for NRG to build at least 10 fast charging plazas (consisting of at least three fast chargers). As of December 2017, there were 196 completed fast charging sites and 5,721 make-ready stubs installed at 657 sites.

The New Energy and Industrial Technology Development Organization (NEDO), in a joint agreement between NEDO and GO-Biz in partnership with Nissan Motor Co., Nissan North America, Kanematsu, and EVgo,\(^{30}\) are conducting a demonstration project called “DRIVE THE ARC.”\(^{31}\) The project has completed the installation of fast chargers at 25 locations from Monterey to Tahoe (Figure 8). The project aims to encourage EV uptake and use through efficient public charging station deployment that connects major points of interest in Northern California.

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\(^{30}\) Originally part of NRG.

\(^{31}\) [https://www.drivethearc.com](https://www.drivethearc.com).
Volkswagen, through its subsidiary Electrify America, will invest $800 million over a 10-year period for ZEV infrastructure, education, and access in California as part of a settlement with CARB. Volkswagen will submit four ZEV investment plans, each of which will cover 30 months and total $200 million, to CARB for approval. The first of these plans was approved in July 2017. Electrify America has been focused on securing real estate and preparing for construction of electric vehicle charging stations. The first planned network in California will consist of more than 600 DCFC at about 160 sites. In addition, Electrify America will also build roughly 1,500 charging stations at workplaces and multiunit dwellings in six target markets (Sacramento, San Francisco, San Jose, Fresno, Los Angeles, and San Diego). In June 2018, Electrify America and the City of Sacramento announced Green City Initiative Projects including zero-emissions car-sharing programs, zero-emissions shuttle bus routes, and deployment of EV charging infrastructure. The Energy Commission will continue to monitor the development and implementation of the Volkswagen settlement investment plans to ensure that Energy Commission infrastructure projects are conducted cooperatively with the investments.

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32 Between 2009 and 2015, Volkswagen sold 2.0-liter diesel vehicles in California that used devices to defeat emission tests. To remedy the environmental harm, Volkswagen provided a settlement to California.
Additional References:

2018-2019 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program:
https://efiling.energy.ca.gov/getdocument.aspx?tn=223420

Grant Funding Opportunity for School Bus Replacement for California Public School Districts and County Offices of Education
http://energy.ca.gov/contracts/transportation.html#GFO-17-607

2018 Awards for Advanced Freight Vehicle Infrastructure Deployment
http://energy.ca.gov/contracts/GFO-17-603_NOPA.pdf

2018 Awards for Electric Vehicle Ready Communities Challenge Phase I:
http://www.energy.ca.gov/contracts/GFO-17-604_NOPA_revised.pdf

2017 Awards for Innovative Mobility Service Demonstrations With Zero-Emission Vehicles:
http://www.energy.ca.gov/contracts/GFO-16-605_NOPA.pdf

2017 Awards for Light-Duty Vehicle Hydrogen Refueling Infrastructure:

Energy Commission’s Joint Agency Staff Report on Assembly Bill 8: 2017 Annual Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California:

California Plug-in Electric Vehicle Infrastructure Projections: 2017-2025
https://efiling.energy.ca.gov/getdocument.aspx?tn=222986

California Electric Vehicle Infrastructure Project (CALeVIP)
https://calevip.org/

http://www.energy.ca.gov/2017_energypolicy/index.html

Sustainable Freight
www.casustainablefreight.org

Clean Vehicle Rebate Project
http://energycenter.org/clean-vehicle-rebate-project/cvrp-project-statistics

2016 ZEV Action Plan
Effective December 18, 2018

2018 ZEV Action Plan

Department of Energy’s Alternative Fuels Data Center:
http://www.afdc.energy.gov

For information on clean and efficient vehicles available in California, see the California Air Resources Board buying guide for clean and efficient vehicles:
https://www.driveclean.ca.gov/

California Pollution Control Financing Authority’s EV Charging Station Financing Program:
http://www.treasurer.ca.gov/cpcfa/calcap/evcs/

Pacific Coast Collaborative and West Coast Electric Highway
http://www.pacificcoastcollaborative.org/Pages/Welcome.aspx
http://www.westcoastgreenhighway.com/

Bay Area Air Quality Management District’s Charge! Program
http://www.baaqmd.gov/grant-funding/public-agencies

San Joaquin Valley Air Pollution Control District Charge Up! EV Charger Incentive Program
http://www.valleyair.org/grants/chargeup.htm

South Coast Air Quality Management District’s Residential EV Charging Incentive Pilot Program

For more information on the New Energy and Industrial Technology Development Organization’s (NEDO) DRIVEtheARC collaboration:
https://drivethearc.com

CPUC/NRG Settlement Agreement
http://www.cpuc.ca.gov/General.aspx?id=5936

Volkswagen Decree
https://www.arb.ca.gov/msprog/vw_info/vw-diesel-info/vw-diesel-info.htm

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