

Transportation Electrification

Reducing Emissions, Driving Innovation



SOUTHERN CALIFORNIA
EDISON[®]

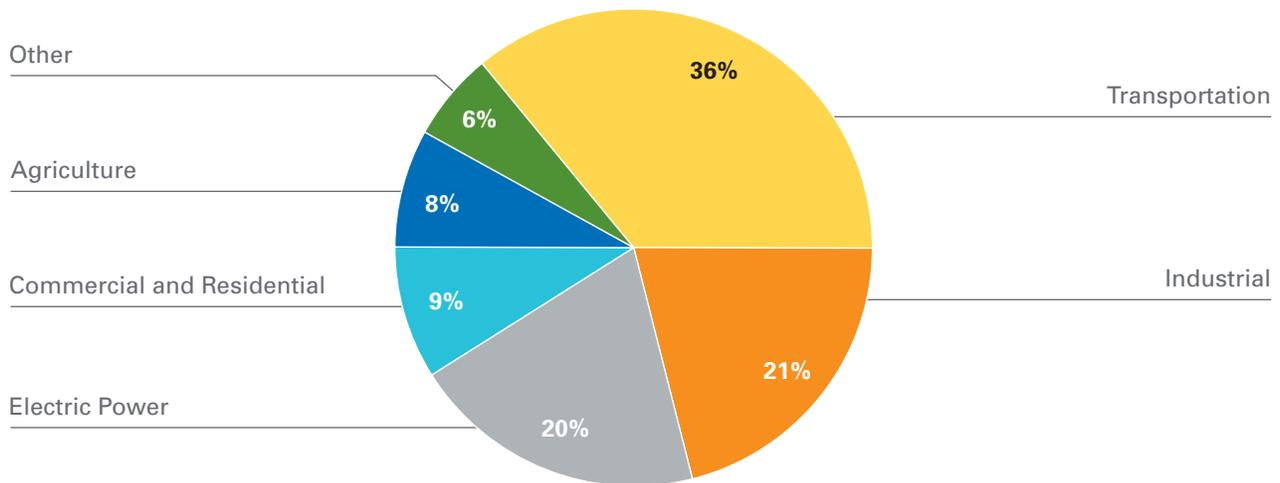
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Long a leader in environmental policy and action, California is raising the bar—requiring 40 percent reductions in greenhouse gas (GHG) emissions by 2030—along with complementary policies, such as a 50 percent renewables portfolio standard and doubling of energy efficiency by 2030. The State is also seeking solutions to curb nitrogen oxides (NOx) and particulate emissions, contributors to poor air quality. Despite major progress over many decades, Southern California, in particular, still has some of the worst local air quality in the nation. With just over a decade to achieve its ambitious GHG reduction goals and the immediate need to make dramatic

improvements in air quality, California needs bold, innovative solutions.

The transportation sector is responsible for 36 percent of California's GHG emissions¹—about half when you add fossil fuel refinement—and more than 80 percent of NOx and particulate emissions.² One of the most promising opportunities to meet California's complex environmental challenges and air quality standards is transportation electrification—powering passenger cars, delivery trucks, semi-trucks, and other people and goods movement with clean electric power instead of fossil fuels.

California GHG Emissions by Sector in 2014³



“Southern California Edison is taking a leading role to ensure that transportation electrification plays a major part in reducing of GHG and criteria pollutant emissions in California.”

Consumers are starting to gravitate towards a growing selection of passenger electric vehicles (EV) that deliver clean, quiet, powerful rides. As battery costs decline, EV ranges extend, and charging infrastructure expands, more people will drive EVs. While passenger EVs are available and adoption is slowly increasing, it is not nearly fast enough to achieve the substantial increase in electric transportation necessary to meet the state’s environmental challenges. And electrification of delivery and freight transportation is even further behind.

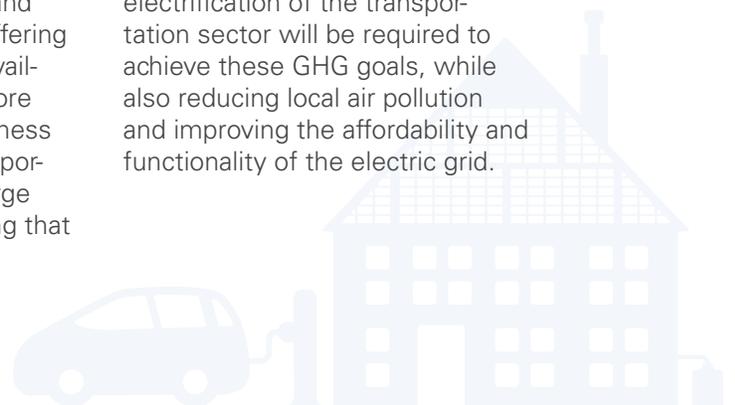
The natural role for electric utilities in electric transportation is delivering clean electricity to customers to fuel their EVs. California’s electric sector is quickly decarbonizing with the growth of renewable energy resources. New electricity infrastructure and a modernized grid will support the growth and integration of EVs.⁴ Electric transportation load can increase grid flexibility to integrate clean energy resources and spread the increasing cost of a clean modern grid over more customers. However, we must extend the grid and support more chargers that deliver clean and reliable electric fuel to EVs.

Southern California Edison (SCE) is taking a leading role to ensure that transportation electrification plays a major part in reducing of GHG and criteria pollutant emissions in California. In addition to cleaning and modernizing the grid, SCE is offering programs to support charger availability, make electric fueling more affordable, and increase awareness of the benefits of electric transportation. Through its current Charge Ready program, SCE is ensuring that

there are more places for passenger EVs to charge away from home. SCE is now proposing to extend this approach to commercial and heavy-duty vehicles—promoting electrification of freight transportation and people movement in Southern California. Also, SCE is proposing new rates for EV charging in order to lower the cost of entry for early adopters and promote use of chargers in a way that supports the operation of the electric grid.

Electric utilities like SCE cannot accelerate transportation electrification alone. State and local governments, environmental agencies, vehicle manufacturers and charging infrastructure providers all have important roles to play. Vehicle and battery technologies must continue to improve and become more affordable. New solutions that lower the cost and increase the availability of EV charging options need to be developed. And incentives like high occupancy vehicle lane (HOV) access and vehicle rebates should be in place to attract new users until transportation electrification matures.

We have just 13 years until 2030—the date when California has committed to meet the next phase of its GHG reduction goals. If the state, utilities, and other stakeholders do not act now, time will quickly run out to achieve these laudable GHG reduction goals. Significant electrification of the transportation sector will be required to achieve these GHG goals, while also reducing local air pollution and improving the affordability and functionality of the electric grid.



California's environmental challenges and the role of transportation

Climate Change

California has long been recognized for its forward thinking to implement real solutions to address climate change. The state encourages less use of electricity and greater reliance on renewable energy as ways to provide cleaner air and protect the environment.

California's goals to reduce total greenhouse gas emissions by 40 percent from 1990 levels by 2030 and 80 percent by 2050 are some of the most ambitious environmental goals in the world, and they will be difficult to meet. California has reduced

GHG emissions 9 percent from their peak in 2004,⁵ but meeting the 2030 goal will require reductions more than three times the annual rate achieved between 2004 and 2014.

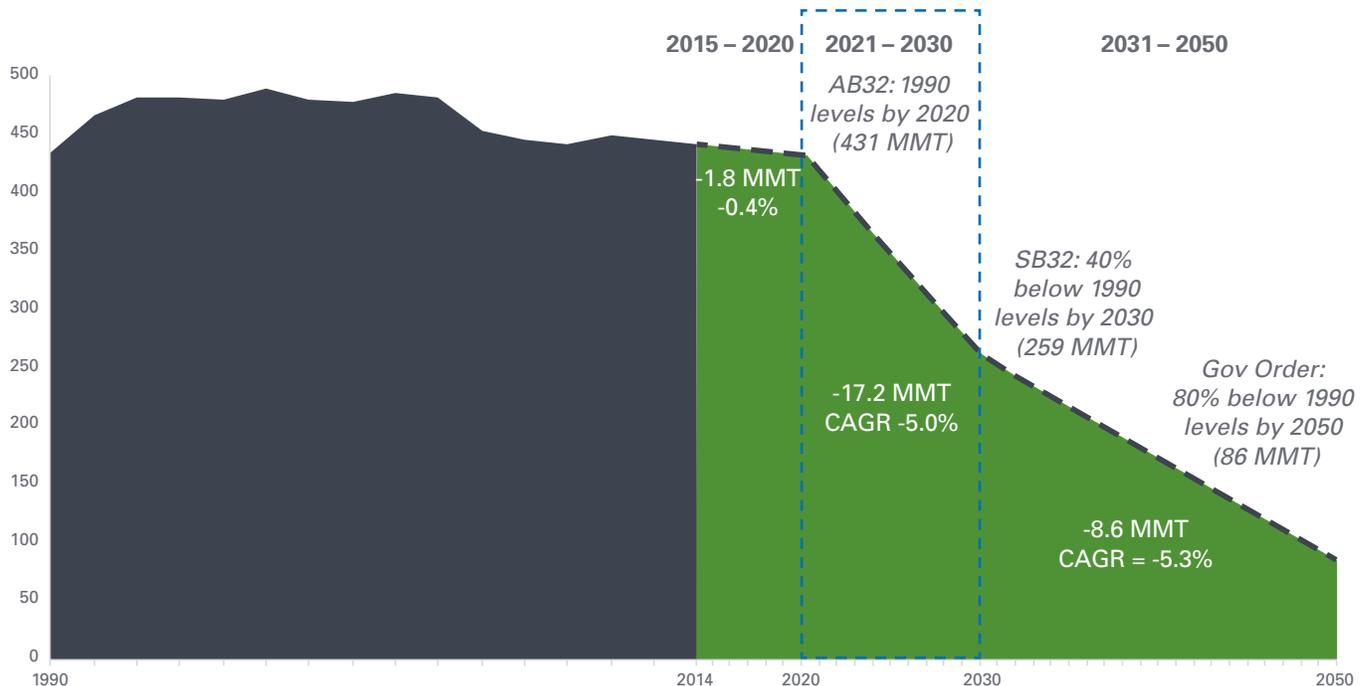
The transportation sector, including refineries, creates 50 percent of the GHG emissions in California. Nearly three quarters of the transportation sector emissions come from passenger vehicles, with the rest coming from medium- and heavy-duty trucks and non-road vehicles (e.g., forklifts). The California Air Resources Board's (CARB) draft plan to achieve the 2030 target calls for the transportation sector to reduce its GHG emissions nearly 40 percent by 2030.⁷ This is equivalent to moving all vehicles in the state from an average of 25 miles per gallon⁸ to 42 miles per gallon—without adding any more vehicles to the road.

"The transportation sector, including refineries, creates 50 percent of the GHG emissions in California. Nearly three quarters of the transportation sector emissions come from passenger vehicles."

Pace of GHG Emission Reductions Must Accelerate⁶

CA Statewide "Included" GHG Emissions
(million tonnes CO₂ equivalent)

CA Greenhouse Gas Trajectory
(million tonnes of CO₂ per yr. equivalent)



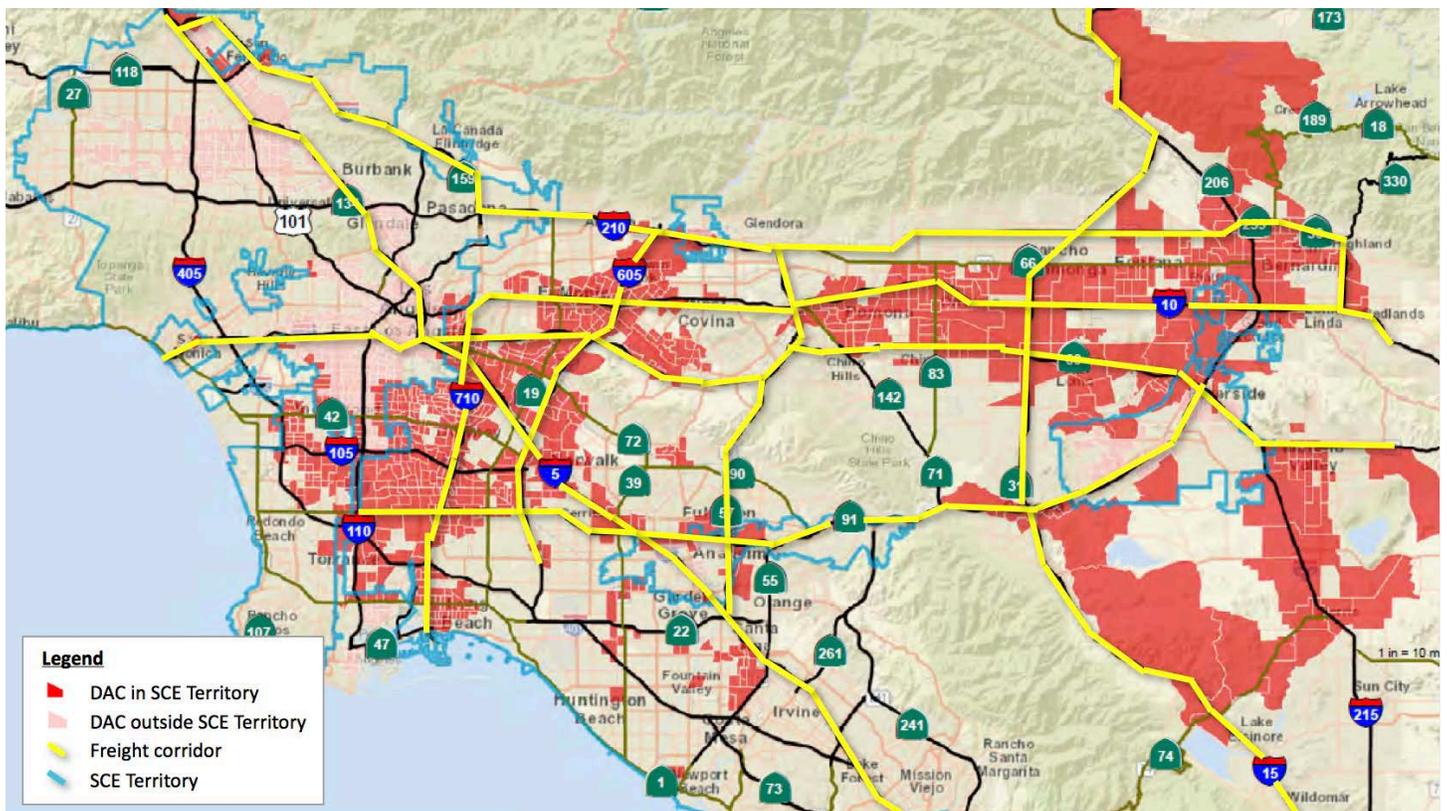
“Transportation has an even greater impact on air quality than on GHG emissions in California. It accounts for 80 percent of NOx and 95 percent of particulate emissions in the state.”

Air Pollution

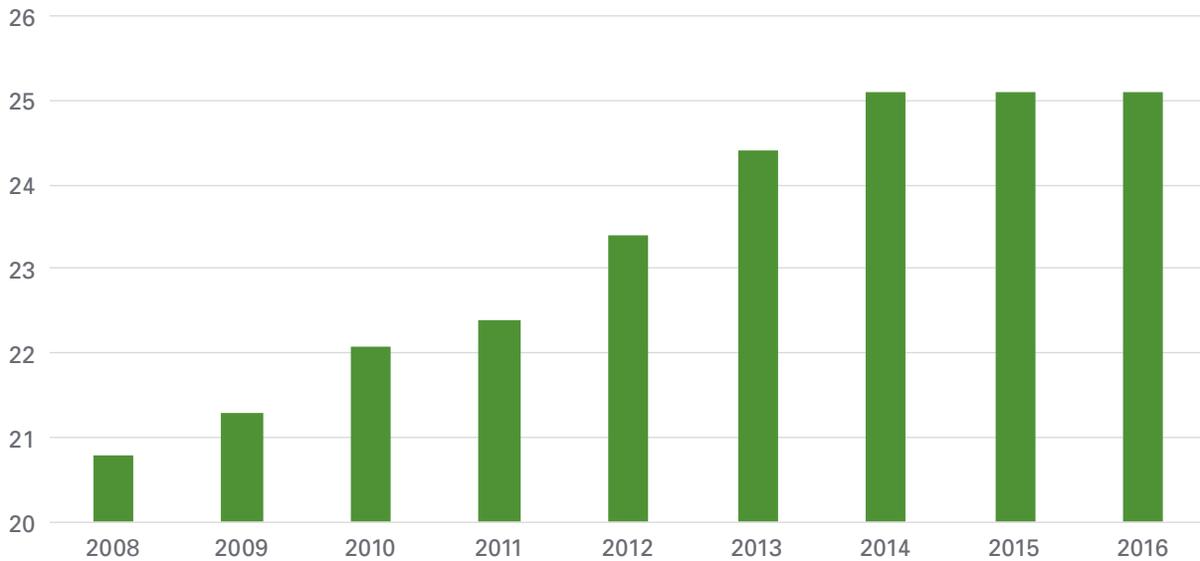
In addition to taking a leading role in addressing global climate change, California is focused on addressing a number of local air quality issues. NOx and particulate matter contribute to smog formation, which aggravates heart problems, bronchitis, asthma, and other lung problems. The only two air basins in the nation that are in extreme non-attainment of federal ozone requirements are the South Coast Air Basin and the San Joaquin Valley Air Basin—both served by SCE. While SCE has already taken significant action to address these issues by increasing the amount of clean energy supplied to customers, the transportation sector needs attention now.

Transportation has an even greater impact on air quality than on GHG emissions in California. It accounts for 80 percent of NOx and 95 percent of particulate emissions in the state. In SCE’s service territory, the communities most heavily impacted by the associated air pollution from transportation are disadvantaged communities. These communities are disproportionately impacted by the pollution caused by transportation both to and from warehouses and factories, and along major freight corridors.

Disadvantaged Communities are Heavily Impacted by Air Pollution from Freight Corridors¹⁰



Average U.S. Fuel Economy by Model Year (in miles per gallon)¹⁴



Transportation electrification as a solution

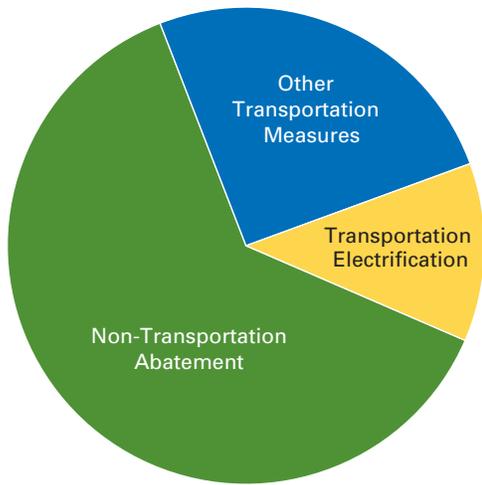
“Relying solely on improved efficiency of fossil fueled combustion engines for transportation sector improvements will not be enough for California to meet all of its environmental objectives.”

With transportation contributing to half of California’s GHG emissions and more than 80 percent of smog-forming pollution, reducing these emissions must be part of the solution to meet the state’s environmental challenges. Most vehicles in the state run on gasoline and diesel. While new vehicle fuel efficiency (in miles per gallon) in the United States increased by nearly 30 percent from 2000 to 2014,¹¹ it has not improved for three years straight.¹² Average passenger vehicle fuel efficiency has not changed from 2007 to 2014 due to consumer preferences for SUVs and trucks.¹³ Relying solely on improved efficiency of fossil fueled combustion engines for transportation sector improvements will not be enough for California to meet all of its environmental objectives.

Using clean electric power as a transportation fuel is an effective way to accelerate attainment of California’s environmental goals. For example, switching to electric fueling can reduce the GHG emissions when compared to fueling a vehicle with gasoline or diesel by at least 70 percent.¹⁴ By 2030, when 50 percent of California’s electricity will come from renewable energy, electric fuel will be even cleaner and more effective at reducing GHG and pollution than it is today.

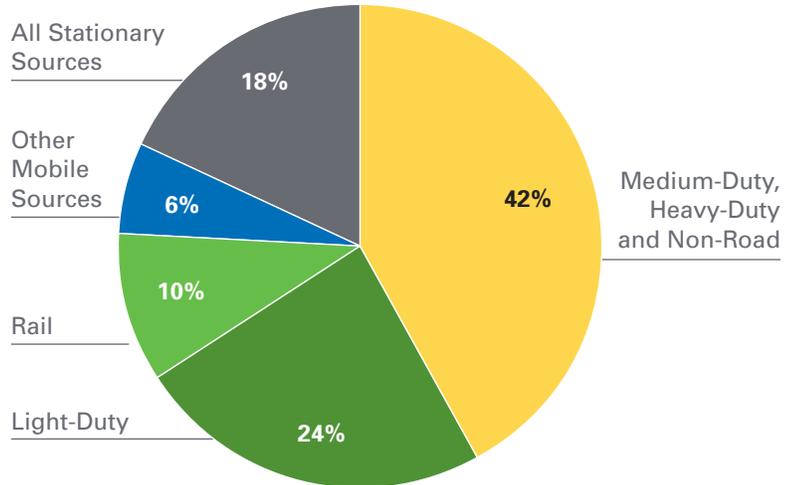
CARB’s draft analysis indicates that about one-third of the GHG reductions in the transportation sector will be due to zero-emission vehicles.¹⁵ Based on today’s availability and the current trajectory, these are likely to be EVs—with more than 4 million of them in California by 2030.¹⁶ If other GHG reduction approaches do not work, we will need even more.

Transportation Electrification’s Contribution to GHG Abatement—CARB Adapted View¹⁸



2030 GHG Abatement = 182 MMT

Medium- and Heavy-Duty Trucks and Non-Road Vehicles Contribute Significantly to NOx Emissions¹⁹



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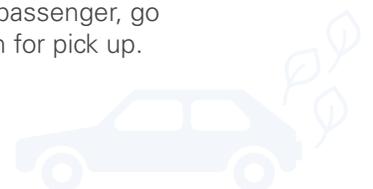
Similarly, transportation electrification can significantly reduce smog-forming emissions and particulates to meet federal air quality standards. Vehicle electrification would eliminate much of these emissions from the region, with the electricity for fueling these vehicles increasingly coming from emission-free resources like solar and wind. Non-road and larger vehicles like forklifts, delivery and semi-trucks play a major role in these emissions.

Transportation electrification has begun, but uptake is slow

After more than five years of commercial availability, passenger EVs represent only three percent of total annual vehicle sales in California. Despite the slow progress, some trends support growth potential:

- **More models in more classes**—EVs are now available in every class of passenger vehicle from small to large sedans, SUVs, and mini-vans. Virtually every major car manufacturer makes an EV.

- **Increased electric range at a lower price**—Early EV models had a range of less than 100 miles, but some new EVs travel more than 200 miles on a single charge. Vehicle costs are decreasing as a direct result of dramatic declines in battery cost.
- **Faster charging**—More EV models are now available with a quick charge port, allowing for faster refueling (about 80 percent of battery in 30 minutes) where DC fast charging stations are available. New standards could reduce this to about 10 minutes.
- **Ride-sharing/taxis and autonomous operations**—Ride-sharing services and taxis may rely heavily on EVs—short trips at slow speeds with lots of stops and starts are ideal for electrification. Autonomous EVs will push these trends even further by making recharging easy—drop off the passenger, go recharge, and return for pick up.



\$1.3/gallon
(EV gasoline equivalent)
VS.
\$2.8/gallon
(gasoline)

20+
models
available

12,000
chargers in
California today

260,000+
EVs in California today
4,000,000+
zero emission vehicles
in California by 2030

“To achieve meaningful transportation electrification, we have to start dramatically increasing the rate at which EVs are added in place of fossil-fuel vehicles.”

Beyond passenger vehicles, the degree of EV usage in commercial and industrial applications is more mixed. Electric forklifts are readily available and used. Electric delivery trucks are commercially available, although they are not widely used. And a number of California transit agencies have purchased electric buses and made commitments to purchase additional buses in the near future. However, most medium- and heavy-duty vehicle segments have seen limited deployment and many technologies are limited to demonstration pilots.

Changing the mix of fossil fuel and electric vehicles is a significant challenge. California is expected to have more vehicles on the road by 2030, and each new vehicle typically stays on the road for 10 to 20 years.²¹ To achieve meaningful transportation electrification, we have to start dramatically increasing the rate at which EVs are added in place of fossil-fuel vehicles. Electric vehicle charging infrastructure must be in place now to fuel the growing number of clean EVs.

Electric utilities’ role: fueling transportation electrification

Southern California Edison and other electric utilities must proactively create the foundation for clean electric transportation fuel. The grid must be ready to deliver clean electricity to EVs. Drivers need access to charging at the right locations and at reasonable costs. Utilities must help to promote a broader understanding of the need for and benefit of transportation electrification.

A clean, modern grid and transportation electrification go hand-in-hand

A clean electric supply is necessary for transportation electrification to support environmental objectives. California’s electric power sector has already reduced GHG emissions by 20 percent from 1990 levels.²² In 2015, 24 percent of the electricity SCE delivered to customers was renewable and more than 36 percent was emission free.²³ This will expand to more than 50 percent renewable power by 2030, making EVs “cleaner” the longer they are in use.



“With a robust, modernized grid, transportation electrification can benefit the grid and its customers.”

The electric grid is ubiquitous, reliable, and always available. SCE is planning major strengthening and modernizing of its grid to improve reliability and to quickly and easily integrate the technologies that customers are adopting. Distributed solar and electric transportation can create new localized strains on the distribution grid that require increased visibility and operational flexibility.

With a robust, modernized grid, transportation electrification can benefit the grid and its customers. By charging when the grid has excess capacity from renewable generation, EVs can improve grid utilization and integrate more clean energy. Alternatively, at times of local supply shortages, an EV could stop charging to

alleviate constraints. Utilities can encourage this behavior through time-of-use rates and load control programs. Operational savings and the fixed costs of the grid can be shared across more load and more customers, creating affordable fueling for electric vehicle owners and lowering rates for other electric customers.

Removing barriers: availability, affordability, and customer awareness

In addition to providing a clean energy system that supports transportation electrification, electric utilities are well suited to address barriers to EV adoption through charging infrastructure deployment, rate design, and collaboration among key stakeholders. The most

Barrier Addressed			
SCE Role	Availability: Infrastructure necessary to fuel EVs	Affordability: Low cost in comparison to traditional vehicles	Awareness: Customer understanding of benefits of EVs
Infrastructure	<ul style="list-style-type: none"> • Charge Ready program to fund passenger vehicle charging infrastructure • Funding for medium- and heavy-duty truck charging infrastructure • Building vehicle charging infrastructure for electric transit buses • Building urban DC Fast Charger (DCFC) Clusters 	<ul style="list-style-type: none"> • Charge Ready rebate for away from home charging stations • Rebate for at home “make-ready” for residential customers • Rebate for charging stations for medium- & heavy-duty truck customers 	<ul style="list-style-type: none"> • Market education and outreach program to target potential car buyers in SCE’s service territory to expand awareness about EVs and the benefits of fueling from the electric grid
Rate design		Rates designed to encourage EV adoption	
Innovative Collaborations	Port electrification projects, such as cargo-handling equipment		Bonus reward to rideshare and taxi drivers who use EVs

Existing Programs | Proposed Programs

“SCE has already begun addressing the key barriers of availability and affordability through its Charge Ready program.”

important barriers to focus on to increase EV adoption are: availability, affordability, and awareness.

While the electric grid is preparing to support transportation electrification, charging equipment is still needed to give EV drivers peace of mind that they will be able to charge when needed. Today, there are only 12,000 chargers in California and at least 124,000 are needed to accommodate EV growth over the next four years.²⁴ In addition to availability of chargers, the cost of upgrading the electrical infrastructure from the grid to the chargers can be a barrier for many customers.

SCE has already begun addressing the key barriers of availability and affordability through its Charge Ready program. Charge Ready supports EV charging stations in parking lots where passenger vehicles are parked for extended periods such as workplaces and multi-unit dwellings. SCE installs electrical infrastructure at a customer’s site to support charging stations and provides a rebate toward the purchase of those charging stations. SCE is proposing to expand this model to new vehicle segments, including trucks, electric buses, cargo-handling port equipment and forklifts.

Pilots and programs are important steps to facilitate transportation electrification. SCE expects to propose additional programs and pilots in the future to further reduce these barriers. For example, SCE intends to expand its Charge Ready program to grow from 1,500 chargers to nearly 30,000 chargers.²³ Additionally, SCE sees opportunities to bring multiple market participants together to:

- Create EV salesforce training materials;

- Create software applications to provide better information on charging station availability;
- Explore avenues to enable other parties to participate in fueling infrastructure deployment.

Dynamic stakeholder collaboration: the key to success

While utilities have a crucial role to play in accelerating EV adoption, many other participants need to support this market transformation as well.

Vehicle manufacturers and charging station providers will be instrumental in increasing consumer awareness, providing innovative financing, continuing to lower vehicle costs, deploying infrastructure, and adopting charging standards.

State and local policymakers can eliminate barriers to EV adoption as well. The state should continue providing incentives to ensure that EVs are cost competitive with traditional vehicles. Other incentives like HOV lane access and parking privileges are high value, low cost means of encouraging adoption. Local jurisdictions need to play a role too, ensuring that local siting and permitting for new EV service is completed quickly.

Major public works efforts, such as electrifying the Interstate 710 freeway, will need multi-party collaboration. The Interstate 710 freeway is a major north-south interstate freeway that serves as the principal transportation connection for goods movement between the Ports of Long Beach and Los Angeles and regional rail yards and warehouses, but this freight corridor creates health risks for local communities. Electrification

“Transportation electrification is an essential part of what needs to be done to significantly reduce GHG emissions and clean up criteria pollutants that disproportionately impact disadvantaged communities.”

solutions have been considered for this corridor for many years, but a complex mix of commercial, industrial, community, and governmental entities involved in the process make it difficult to gain traction.

These parties cannot work alone. They must be willing to collaborate and share lessons learned, while developing programs to encourage the adoption of EVs. Given the real world timing constraints of bringing millions of new EVs on the road to meet the state’s environmental objectives, there must be a willingness to try to new methods, fail fast, and move on.

Charging forward

California has set some of the most ambitious climate change and environmental goals in the world. Transportation electrification is an essential part of what needs to be done to significantly reduce GHG emissions and clean up criteria pollutants that disproportionately impact disadvantaged communities. Other states face these same issues—transportation electrification can expand faster and more affordably with the scale of national deployment.

SCE will use its reliable and clean electric grid to accelerate transportation electrification. Its current and proposed programs support accelerated adoption of EVs across all transportation segments through the provision of increasingly clean power coupled with infrastructure improvements, thoughtful rate design, and innovative collaborations that directly address the barriers to greater transportation electrification.

Early adoption of utility pilots and programs and action from policymakers are critical to meeting California’s 2030 and 2050 climate goals and federal air quality standards, while improving the well-being of communities, driving innovation, and improving cost efficiency for electric customers.

Addressing global climate change will require discussion, refinement, and adaptation—along with a willingness to make adjustments based on feedback from all stakeholders. A state like California holds great potential to serve as a living laboratory for transportation electrification—a place to explore coordinated solutions, showcase innovations, and establish models for others to follow.



References:

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"Other" includes Recycling and Waste & High Global Warming Potential
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<https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf>; <http://www.pevcollaborative.org>
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- ²² Emission free electricity includes wind, solar, biomass, geothermal, small hydro, large hydro, and customer solar energy.
- ²³ Existing locations: http://www.afdc.energy.gov/data_download; locations needed: <http://www.nrel.gov/docs/fy15osti/60729.pdf>
- ²⁴ Subject to CPUC approval of moving beyond initial phase of 1,500 chargers.

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