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CALIFORNIA'S PUSH TO ELECTRIC VEHICLES

by Noah Swanson '25

California has long taken pride in leading the country in setting standards on environmental issues. Recent regulations will push the Golden State toward a future that bans the sale of new gasoline-powered cars and requires the state to get 90% of its electricity from clean sources by 2035. Regulations mandating zero emission truck fleets have also been unveiled and are currently under discussion. The electric vehicle mandates are likely to increase demand for electricity at a time when California's electrical grid is barely keeping up with demand. Moreover, the state of California's electric vehicle charging network is woefully inadequate. It will take a massive effort to meet rising demand.

The 2020 and 2022 summer heatwaves brought increases in electricity demand, mostly from residents trying to cool their homes, bringing the power grid to its knees. Heatwaves like that are only expected to get worse, further intensifying the demand on the grid. Researchers at the Georgia Institute of Technology found that California is particularly at risk of being unable to meet demand by 2050. The study suggests that an increase in demand in combination with rising temperatures reducing power

generation capabilities will be the primary causes of California's power grid woes. Their conclusion, that California will be unable to meet demand, is consistent with a 2021 report from the California Independent System Operator (CAISO). CAISO found that in 2020 and 2021, it was unable to fully meet the demands of its customers, particularly during high-load days.

Electric vehicles currently account for 1% of power used during peak hours. The California Energy Commission (CEC) projects that to increase to 5% in 2030 and 10% in 2035. The CEC predicts that the state will have to triple its power generation capacity by 2045. It is confident that the state will meet future demand, but observers note that its projections rely on uncertain and best-case assumptions. Writing for CalMatters, Nadia Lopez observes that California will have to do the following to meet expected demand for electricity:

- Convince drivers to charge their cars during off-peak hours, which may not be feasible for many people with restricted access to chargers.

- Build solar and wind facilities at an unprecedented pace.
- Develop an entire new industry: offshore wind farms.
- Increase the number of public chargers from the current 70,000 to 1.2 million by 2030.
- Expand vehicle-to-grid technology to allow electric cars to send energy back to the grid at times of high demand. This technology is new and still untested.
- Increase electrical production by up to 42% in 2035 and by as much as 85% in 2045.

In the past decade, fossil fuel usage has received increasing attention from politicians, who have pushed for a shift towards a power grid based on renewable energy. To that end, in 2018 California passed S.B 100, requiring that California get 100% of its power from renewable sources by 2045. This requires the build-out of clean energy generation to occur at a “record-breaking rate” for the next 25 years. The CEC estimates that the transition will cost over \$4.5 billion by 2045.

The CEC defines renewable energy to include solar, wind, geothermal, or small (under 30 MW). Solar and wind have both increased substantially in the past ten years, with solar going from a negligible portion in 2011 to

14% in 2021 and wind from 5% to 11% of all electric power in California. Geothermal stayed constant at 5%. All hydro sources dropped from 15% in 2011 to 10% in 2021 due to the prolonged drought. California has consistently been importing around 30% of its electricity.

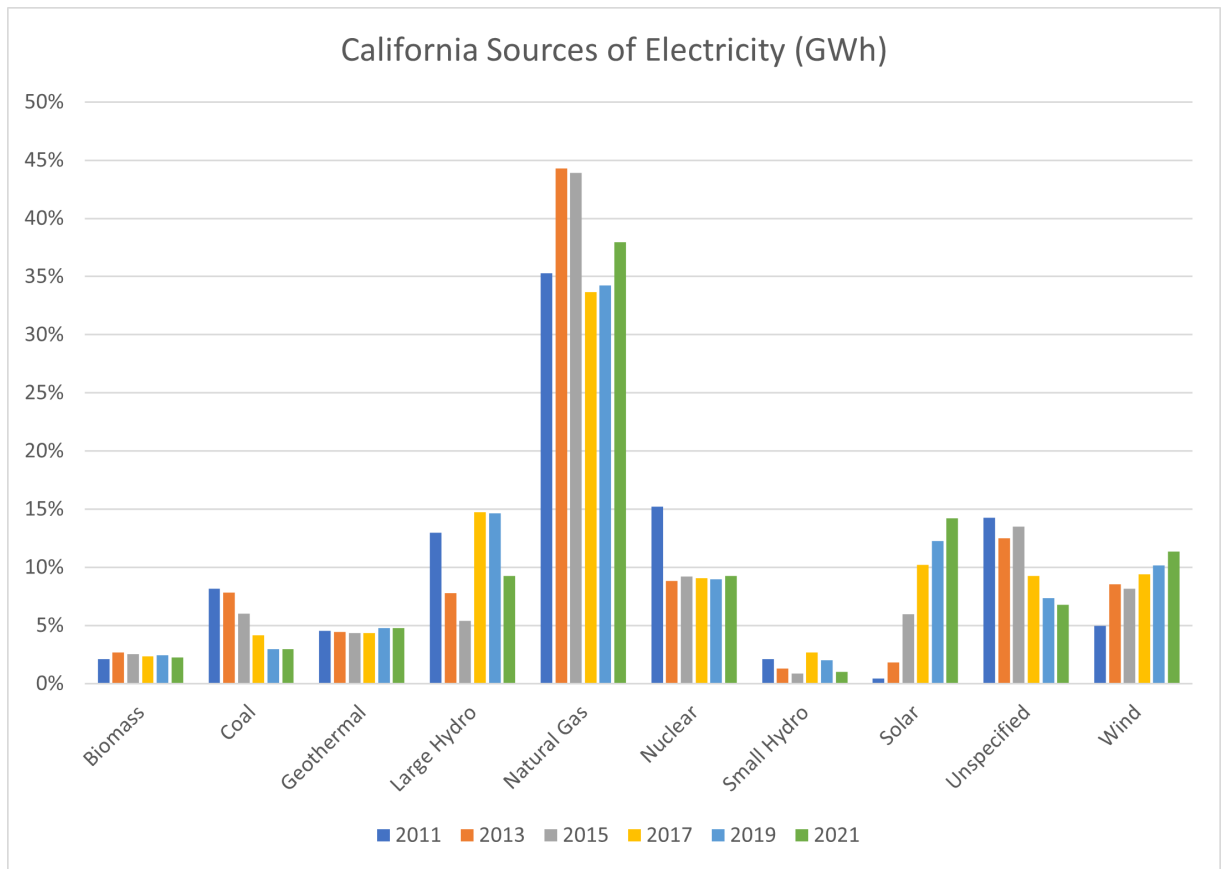
According to the Environmental Protection Agency, the transportation sector is the largest contributor to greenhouse gas emissions in the United States with passenger vehicles being the largest component. This suggests that if California is able to utilize zero-emission vehicles and power them with clean energy, their total greenhouse gas emissions would be significantly reduced. It is for this reason that Governor Newsom signed an executive order requiring that all new vehicles sold in California be zero-emission by 2035. The California Air Resources Board (CARB) adopted regulations codifying that order on August 25, 2022. However, electric vehicles need chargers. Researchers from the National Renewable Energy Laboratory released a study showing that infrastructure investments, specifically in charging stations, are the most effective policy to both incentivize EV adoption and lower greenhouse gas emissions.

California thus has three specific priorities for its Electric Vehicle infrastructure policy: the expansion of electricity generation, the transition of this generation to clean sources, and the move from fossil fuel-powered cars to electric vehicles.

Sum of Electric Generation (GWh) - California + Imports

Fuel Type	2011	2013	2015	2017	2019	2021
Biomass	6,226	7,929	7,547	6,874	6,787	6,271
Coal	23,970	23,193	17,735	12,075	8,232	8,272
Geothermal	13,259	13,192	12,883	12,705	13,260	13,214
Large Hydro	38,087	23,009	15,948	42,987	40,603	25,656
Natural Gas	103,577	131,423	129,750	98,315	95,057	105,356
Nuclear	44,697	26,217	27,251	26,519	24,945	25,758
Oil	36	38	54	33	36	37
Other (Waste Heat/Petroleum Coke)	13	14	14	409	422	465
Small Hydro	6,154	3,813	2,616	7,867	5,645	2,835
Solar	1,234	5,389	17,629	29,796	34,090	39,458
Unspecified	41,825	37,055	39,873	27,017	20,376	18,887
Wind	14,575	25,356	24,017	27,442	28,249	31,555
TOTAL	293,653	296,628	295,407	292,039	277,702	277,764

Source: California Energy Commission, 2009-2021, Total System Electric Generation Spreadsheet, <https://www.energy.ca.gov/media/7311>.



Source: California Energy Commission, 2009-2021, Total System Electric Generation Spreadsheet, <https://www.energy.ca.gov/media/7311>.

The Expansion of EV Infrastructure

California will have to invest heavily in electric charging stations to meet its lofty goals. The state plans to have over 250,000 charging stations by 2025. There are currently only 80,027 total chargers and over half of them (43,528) are “shared private,” meaning that they are only available to employees of specific businesses or residents of specific buildings. There are only 36,489 chargers available to the general public. Additionally, the benchmark of 250,000 was made before Governor Newsom’s EV mandate. The California Energy Commission estimates that 1.2 million chargers will be needed for passenger vehicles by 2030, and 157,000 chargers will be needed for medium to heavy vehicles. To reach this goal California will have to double the number of chargers in the state every two years until 2030.

California plans to use funding from the Infrastructure Investment and Jobs Act (IIJA) of 2021 to address this charger deficit. The IIJA is a \$1.2 trillion spending bill with about \$550 billion going toward nationwide infrastructure improvements. California is expected to receive about \$41.9 billion in funding for new projects and improvements over five years. Out of California’s share, only \$384 million is to be spent on Electric Vehicle infra-

structure improvements, but there are an additional \$2.5 billion in other grants that California can apply for. Almost none of this money is being spent on improving California’s power grid. California plans to connect the entire state via a modern network of electric vehicle charging stations.

The California Department of Transportation and the California Energy Commission began developing California’s deployment plan for the allocated IIJA funds in February 2022. So far most of these plans have focused on improving the infrastructure for electric cars. Based on the timeline given in the “California’s Deployment Plan for the National Electric Vehicle Infrastructure Program,” the final proposal will not be completed until the first quarter of 2023. The first two years of IIJA funding (about \$134 million) will be used mainly to increase the number of passenger vehicle charging stations. It complements subsidy bills such as H.R. 1271, The Electric CARS Act of 2021, and H.R. 4817, The Affordable EVs for Working Families Act, which seek to directly subsidize EVs, and encourage their adoption.

The hope is that this massive infrastructure build-out will permit not only current electric vehicles to travel across the state more easily, but will also boost the rate

How Much Electricity Does California Import (GWh)?

	2011	2013	2015	2017	2019	2021
California	200,986	199,783	196,195	206,336	200,475	194,127
Northwest Imports	35,220	35,086	35,800	39,873	23,930	32,572
Southwest Imports	57,447	61,759	63,412	45,830	53,297	51,064
	293,653	296,628	295,407	292,039	277,702	277,764
Import Percent	32%	33%	34%	29%	28%	30%

Source: California Energy Commission, 2009-2021 Total System Electric Generation Spreadsheet, <https://www.energy.ca.gov/media/7311>.

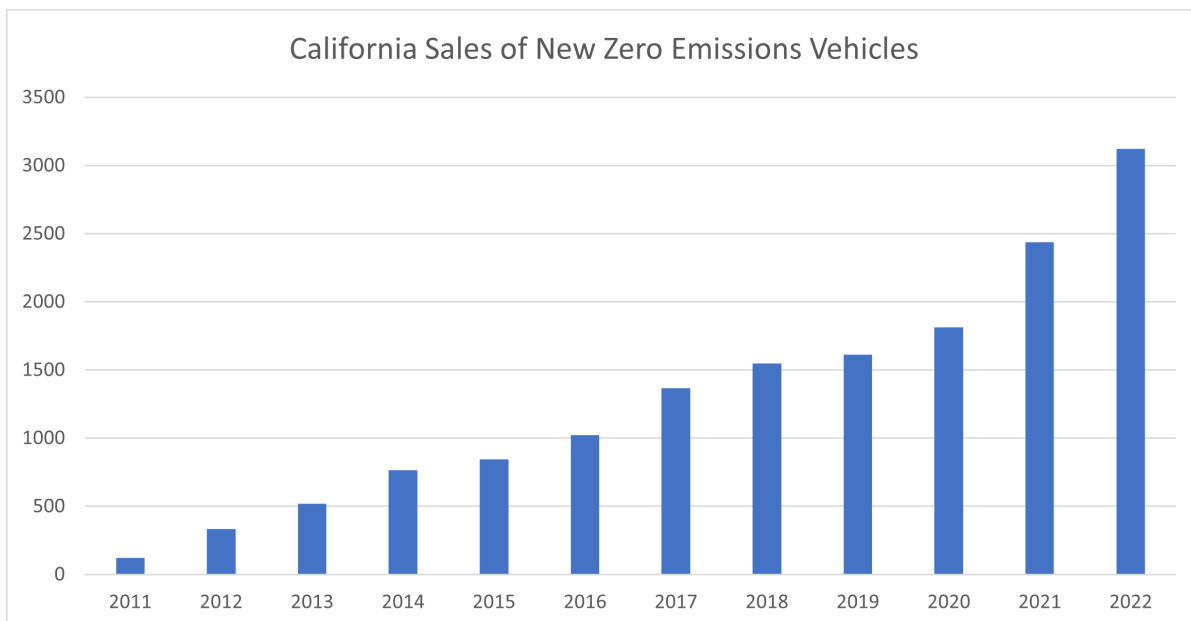
at which electric vehicles are purchased. A substantial body of research shows charging investment to be one of the best ways to incentivize electric vehicles purchases. This is largely by addressing one of the primary reasons people are hesitant to buy EVs: range anxiety, the fear that an electric vehicle will run out of power before reaching its destination.

The plan to invest directly into infrastructure is not unique to California. Other states are also using IIJA funding to invest primarily in charging infrastructure. Texas, for instance, is planning to spend over \$400 million dollars to expand its charging network, while New York has appropriated over \$175 million dollars.

These new chargers require energy to power them. In both the five-year infrastructure plan from the Office of Governor Newsom and the Draft Zero-Emission Vehicle Infrastructure Plan from the California Energy Com-

mission, there is little mention of any grid improvements. While discussing the potential impact electric vehicles will have on the grid, the Infrastructure Plan states, “there is work to be done, and the state’s planners are working to ensure the grid will be capable of supporting increased transportation electrification.” It goes on to discuss how options are being explored and there is more research to be done. From 2009 to 2021, California electricity production decreased from 298,313 GWh to 277,764 GWh while consumption increased from 278,986 to 280,738 GWh. At its peak in 2014, California consumed 197,434 GWh more than it produced.

California is not unique in its power grid woes. The 2021 winter storm power crisis in Texas showed that grid infrastructure needs to be improved nationwide. However, out of the \$550 billion Infrastructure Investment and Jobs Act of 2021, only about \$75 billion is going towards energy and power. None of that money appears to



Source: California Energy Commission (2023). California Energy Commission Zero Emission Vehicle and Infrastructure Statistics. Data last updated December 30, 2022. Retrieved March 20, 2023. from <http://www.energy.ca.gov/zevstats>.

be used to increase total electricity generation. Instead, it will fund projects such as making the grid more resilient against natural disasters, investing in research & development, and transitioning the grid towards clean energy.

In August, 2022, President Biden signed the Inflation Reduction Act (IRA). It allocates nearly \$370 billion for a range of tax credits to stimulate adoption of green energy technologies, including extending an existing tax

credit for the purchase of new EVs and a new credit for used EVs, credits to companies building new sources of emissions-free electricity, and subsidies for clean energy manufacturing. It does not contain specific provisions for California or allocations for infrastructure funding. The California Chamber of Commerce notes that much of the spending in California either supplements similar state programs, or would offset some costs of California mandates.

Planned Alternative Fuel Corridors for Electric Vehicles



Source: Fauble, Brian, Tiffany Hoang, and Madison Jarvis. California's Deployment Plan for the National Electric Vehicle Infrastructure Program. California Energy Commission and California Department of Transportation, 2022. <https://dot.ca.gov/-/media/dot-media/programs/sustainability/documents/nevi/2022-ca-nevi-deployment-plan-a11y.pdf>.

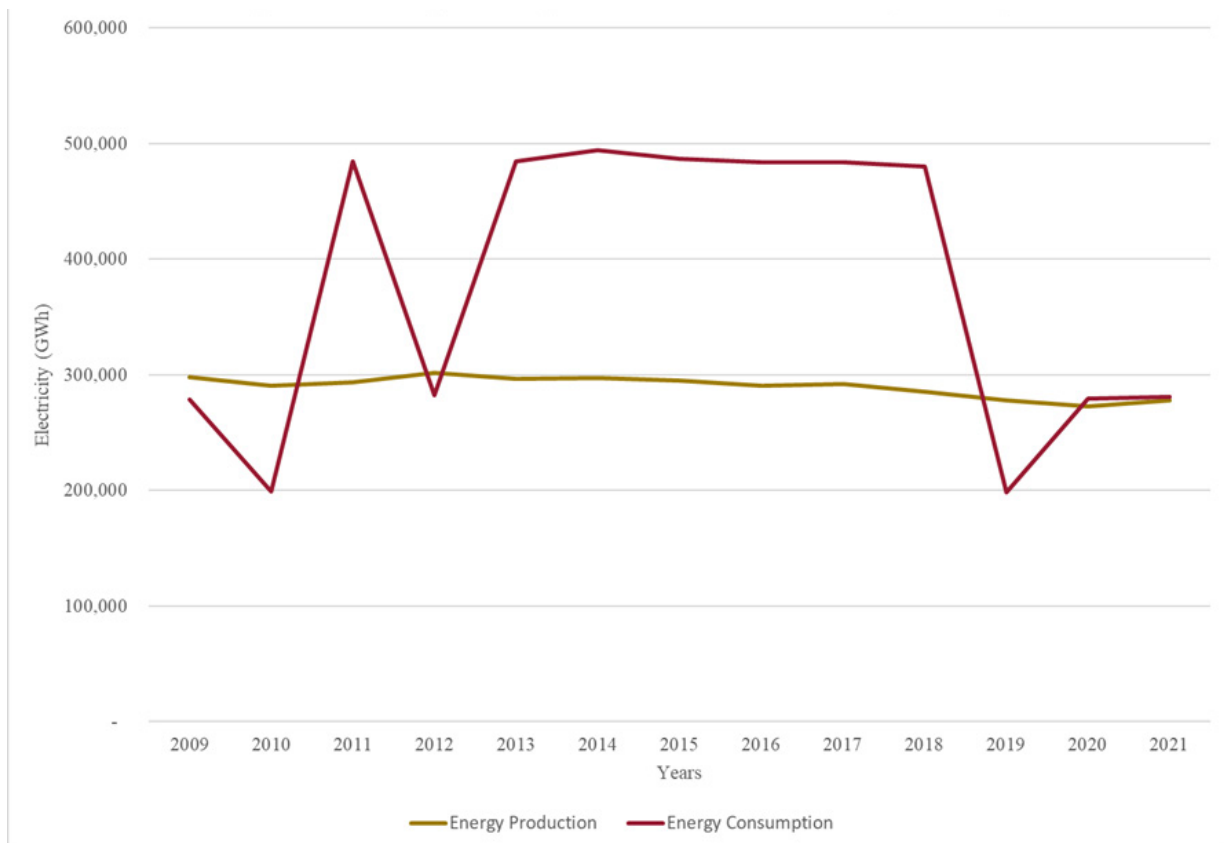
Inland Empire

The Inland Empire is especially likely to be affected by ZEV policies as it is now an important hub for the logistics industry. From 2014 to 2019, the Warehouse and Storage sector has been the fastest growing industry for the region, with employment growing 131% over the period. When the Covid-19 pandemic hit in early 2020, growth accelerated as more and more people began to shop online. In 2022 alone, 24,400 new jobs were created in the industry. With new jobs come new warehouses and more trucks. According to CalMatters, the Inland Empire is now home to over 4,000 warehouses, covering about one billion square feet of land and generating over 600,000 daily truck trips. This growth continues in the coming year. Amazon's new Ontario Fulfillment Center, when completed in 2024, will add an additional four million square feet of warehouse space along with 1,500 new jobs.

With the increase in shipping and logistics comes, of course, an increase in emissions. The vast majority of commercial trucks in the United States, around 76%, run on diesel fuel. Among Class 8 trucks, over 97% are diesel powered. In California, medium-heavy duty vehicles

make up only about 7% of the total on-road vehicles, but are responsible for 62% of all NOx emissions and 56% of particulate matter emissions. Like many other industrial emissions, diesel exhaust has been linked to a heightened chance of developing a multitude of health problems. Most notably, diesel has been linked with increased rates of asthma, pulmonary inflammation, thrombosis, raised blood pressure, and many other cardiopulmonary diseases. As the number of warehouses and goods being shipped through the Inland Empire rises, the number of diesel vehicle miles traveled rises with it. The end result being more diesel pollution in Inland Empire air. According to the American Lung Association, both San Bernardino and Riverside counties have some of the worst air not just in California, but the country. The effects of these emissions have led some journalists and community leaders to refer to the area as a "diesel death zone." It should be noted, however, that these issues are not new. A 2008 study by researchers at Portland State University predicted that "the estimated excess mortality associated [with diesel exhaust] is 32–64 cases per year, with a combined excess mortality and morbidity value of \$247–\$455 million per year." Although the researchers also recognized that industrial expansion would coincide with job growth,

Total Energy Consumption vs Production in California (2009-2021)



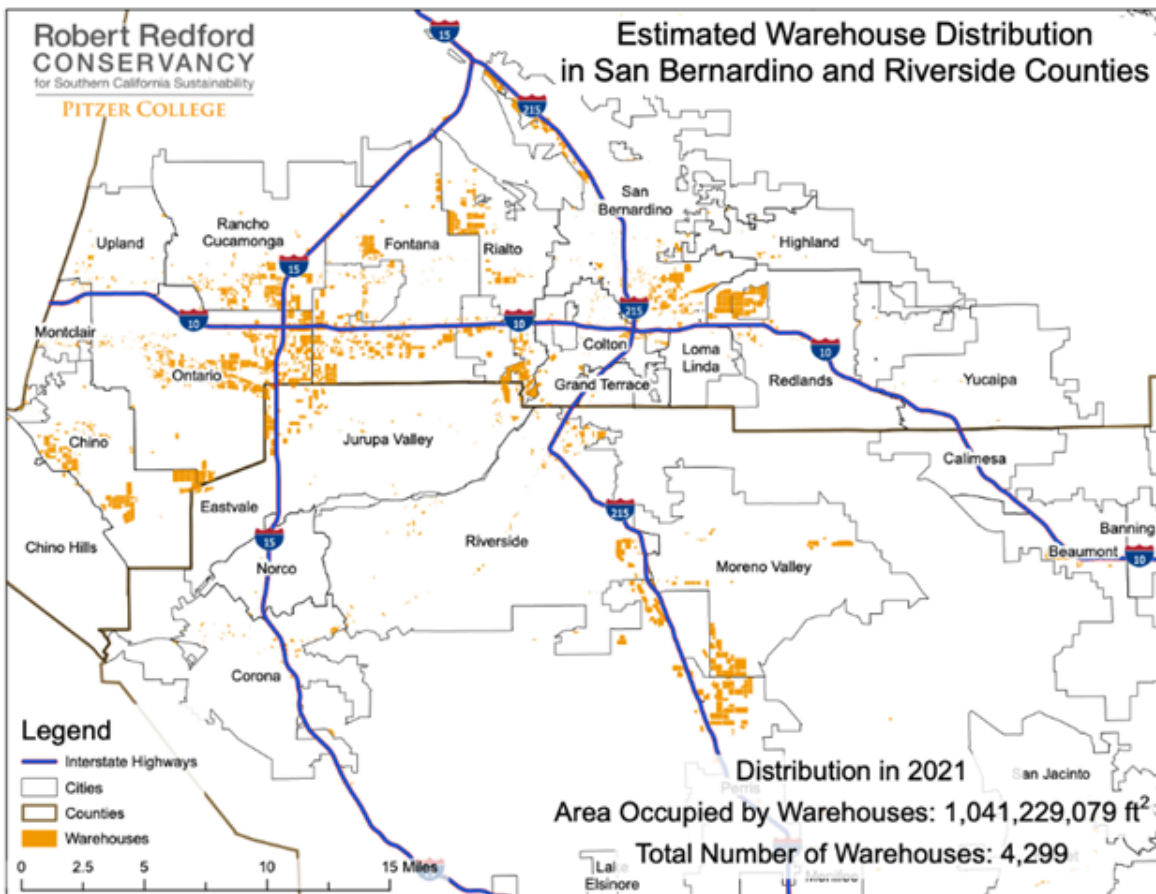
Sources: California Energy Commission. Electricity Consumption by County. 2021. <http://www.ecdms.energy.ca.gov/elecbycounty.aspx> and California Energy Commission. Electricity Consumption by County. 2021. <http://www.ecdms.energy.ca.gov/elecbycounty.aspx>

they predicted that “44%–81% of the estimated wages generated by industry growth” would go towards health costs.

These health issues have driven some in the Inland Empire to call for government regulation to curb the growing rate of emissions. Organizations such as The People’s Collective for Environmental Justice have been petitioning local and state governments to enact policies that address their concerns, and are starting to make some headway. On May 7, 2021 the South Coast Air Quality Management District adopted Rule 2305 or the “Warehouse Indirect Source Rule.” It requires warehouses larger than 100,000 square feet to earn a certain amount of points each year or face a fee. The points will be earned by completing specified actions that are aimed at reducing the levels of emissions emanating from these warehouses. The South Coast AQMD expects this to reduce emissions by 10-15%. However, change is coming not only at the local level. The state has passed several measures to reduce transportation-related emissions

such as the California Air Resource Board’s Advanced Clean Trucks Regulation in January 2021. Advanced Clean Trucks sets requirements for truck manufacturers to sell ZEV as an increasing percentage of their total sales from 2024 to 2035. The purpose of this regulation is to not only decrease total emissions but to create an incentive for the supply side of the industry. The strictest of these measures is one still being debated - Advanced Clean Fleets. Advanced Clean Fleets serves as an excellent medium to analyze the current debates surrounding the transition towards ZEV freight infrastructure. Before doing so, we need to examine the current landscape of ZEV medium and heavy-duty trucks.

Renewable energy shipping is still in its infancy. In 2023 it is estimated that the heavy-duty truck market will offer 152 different diesel-powered models and only 10 EVs. When it comes to trucks on the road, things are not much different. According to the CEC, as of Q2 of 2022, there are 1,943 ZEV medium-heavy duty vehicles on California roads. However, when you look at only trucks



Source: Warehouse CITY, Redford Conservancy at Pitzer College and Radical Research LLC, <https://www.pitzer.edu/redfordconservancy/mapping-data-visualization/>.

and vans, that number drops down to 574, with 52 in San Bernardino and only 13 in Riverside, an abysmal number when compared to the over 1.8 million gasoline powered medium-heavy duty vehicles operating in the state.

Traveling east from Los Angeles into the Inland Empire, there is a steep drop-off of available charging stations. Currently there are about 3,108 total chargers in the area, servicing a population of about 4.6 million. Additionally, not all chargers are suitable for medium and heavy-duty vehicles. Level 2 chargers, which make up 72% of all chargers in the area, need 80-100 hours to fully charge a heavy-duty truck. For this reason, medium-heavy duty trucks require DC Fast chargers, which are able to charge in a shorter time. For a region that is the seat of California warehousing and shipping, DC Fast chargers are sadly few and far between.

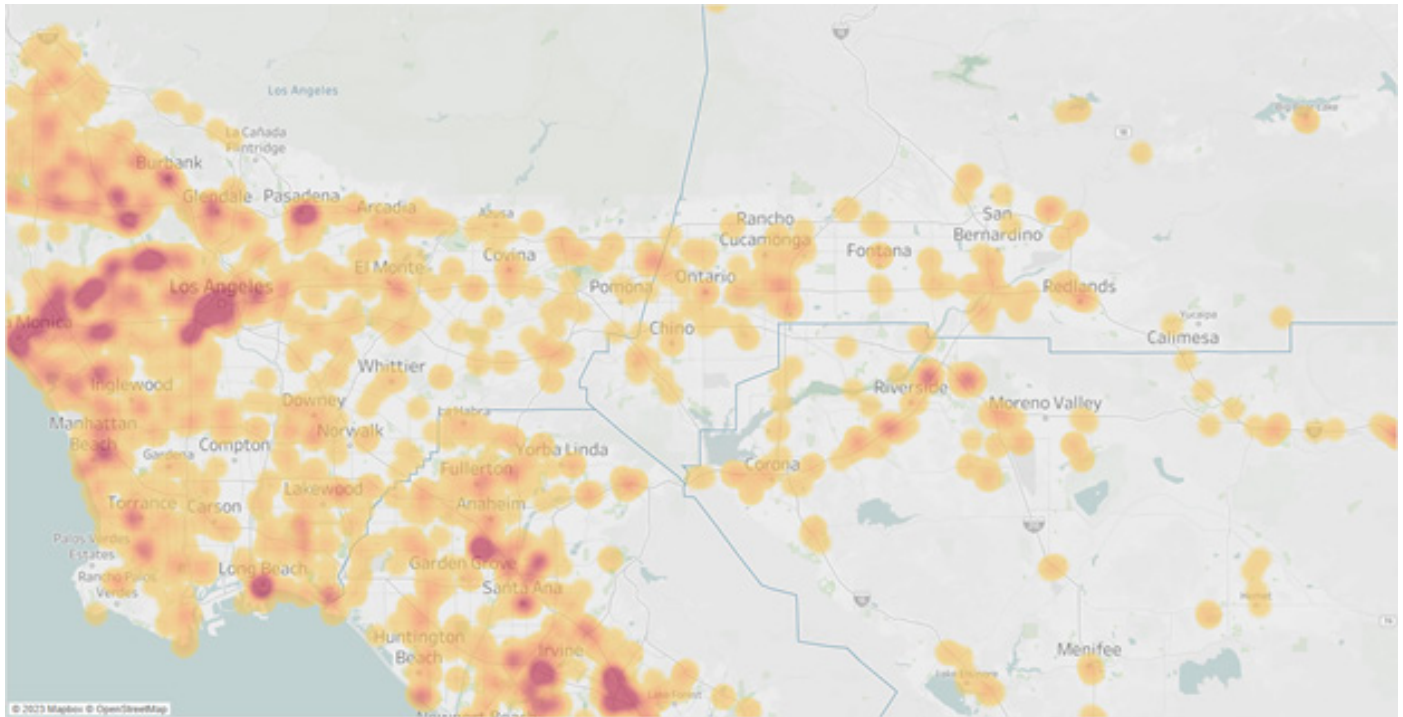
Where Advanced Clean Trucks was meant to stimulate supply of zero-emission trucks, Advanced Clean Fleets is designed to stimulate demand. In addition to a general requirement for all new class 2b-8 trucks to be ZEV by 2040, there are specific requirements for both private and public fleets.

If adopted, the regulation requires significant changes to the medium-heavy duty trucking ecosystem.

CARB predicts that by 2035, ACF in conjunction with ACT will result in there being 510,000 ZEVs by 2035. Based on the current number of 1,943, this would represent a 262,481% increase over the next 12 years. Even if some portion of this extraordinary growth comes to pass, all of these vehicles will need to be charged. Currently, there are 8,528 DC Fast chargers in California, of which, only 874 are located within the Inland Empire. In 2021, before ACF was proposed, the CEC estimated that by 2030 there would be “an additional 157,000 chargers...needed to support 180,000 medium- and heavy-duty vehicles anticipated for 2030.” Just as in the case of light-duty vehicles, the charging infrastructure is simply not there. As to what the state is doing to meet charger demand, CARB cites a task force formed to “create a common solution for high-power charging of fully commercial heavy-duty EVs and is working out the requirements for connectors, EVSEs, vehicles, communications, safety and related hardware.”

Replacing trucks is not a cheap proposition. CARB estimates that the cost of buying a new ZEV box truck will be upwards of \$100,000, and a new Class 8 Sleeper Cab costing north of \$250,000. While it is true that there will likely be some economies of scale, the transition will still result in businesses being forced to spend millions on new trucks. Some may argue that this is a cost that would have occurred anyway due to normal depreciation

Shared Charging Stations, Public and Private. Density Map of Los Angeles-San Bernardino-Riverside



Source: “Alternative Fueling Station Locator.” Alternative Fuels Data Center: Alternative Fueling Station Locator, March, 2023. https://afdc.energy.gov/stations/#/find/nearest?fuel=ELEC&ev_levels=all. Map: Noah Swanson '25.

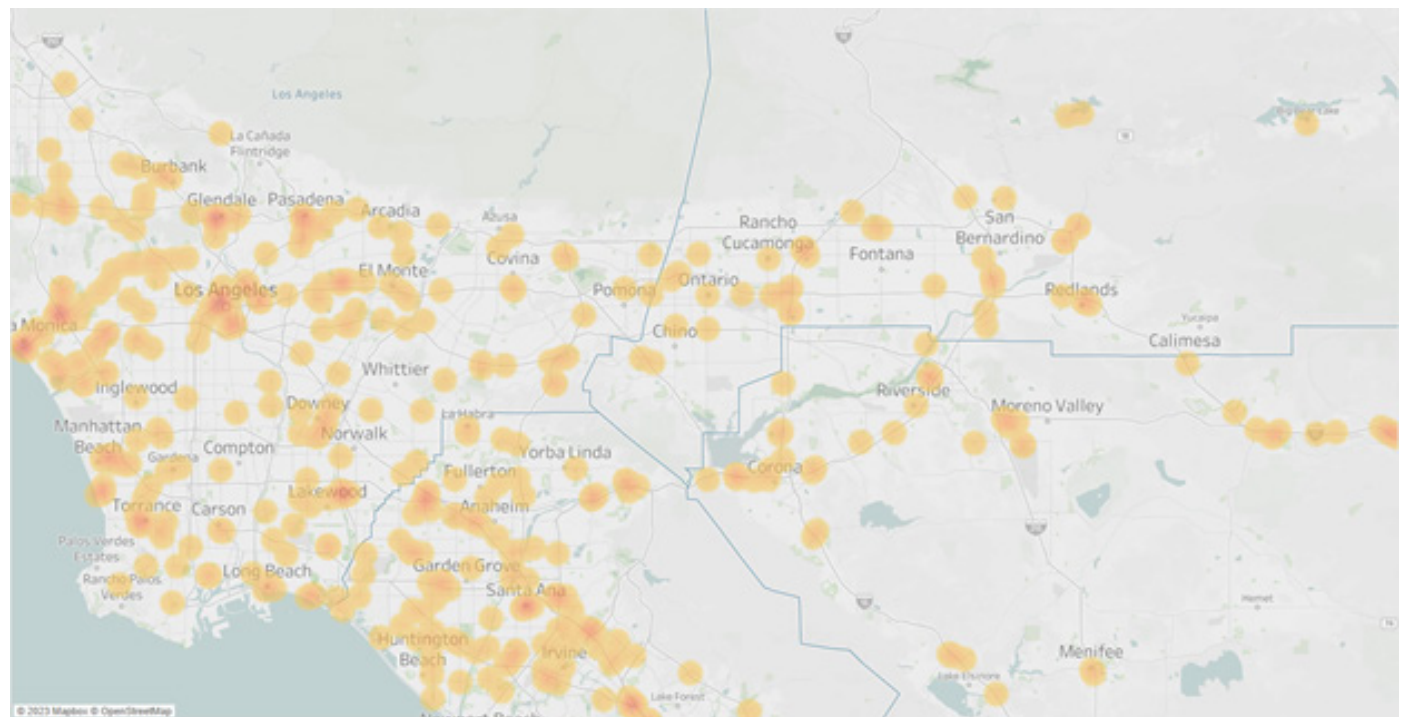
of internal combustion engine (ICE) trucks. It must be remembered that new trucks will have to be purchased when a truck reaches its minimum useful life, not its true useful life. New trucks are not the only source of expenditure. CARB recognizes that, at least in the near future, much of the charging infrastructure investment will have to be done by the private sector. This means businesses will have to spend additional millions of dollars simply so their trucks can fuel up. Thus, in the end, the cost of these investments will be primarily borne by consumers, that is, the people of California. CARB acknowledges that upfront costs will be steep, but claims that in the long run there will be \$22 billion in net savings as operating ZEVs will be significantly cheaper. However, the short run is not something to just be tossed aside. As Keynes said, "in the long run we're all dead."

Many California tax payers argue that they are already overburdened by the transportation industry through hospital bills and lives lost. This debate was at the center of an October 27th, 2022 public hearing held by CARB to consider ACF. Over the span of five hours, stakeholders from both sides voiced their commendations and concerns about ACF. The most salient worries from the opposition were the lack of a definition of commercially

available trucks, the inability for ZEVs to meet the needs of many industries, the cost of transitioning, and the lack of necessary infrastructure. Those opposed consisted not only of businesses and trucking associations, but also utility companies from across the state. They fear that because of the nature of their work, only ICE vehicles will be suitable to carry out both daily and emergency events. Utility representatives warned that if this regulation was put into place without stronger exemptions, the state's infrastructure will be put at serious risk. The opposition also warned that due to many truckers being employed as independent contractors, they - not companies - will primarily bear the cost of transitioning to ZEVs.

There were just as many in attendance who strongly supported the regulation. The "Clean Air Caravan," as they called themselves, consisted of several community and environmental organizations from the Inland Empire who drove up to Sacramento to voice their support. Their comments on the regulation can be summed up in two numbers: 2036 and 10. Instead of the current plan to require all truck sales to be ZEV by 2040, they urged CARB to accelerate the timeline to 2036. They argued that any additional costs are well worth the lives and pain saved by reducing harmful emissions. Their second

Shared DC Fast Charging Stations, Public and Private. Density Map of Los Angeles-San Bernardino-Riverside



Source: "Alternative Fueling Station Locator." Alternative Fuels Data Center: Alternative Fueling Station Locator, March, 2023. https://afdc.energy.gov/stations/#/find/nearest?fuel=ELEC&ev_levels=all. Map: Noah Swanson '25.

point was to reduce the fleet threshold from 50 trucks to 10. This decrease will bring more companies under the umbrella of ACF, and thus further decrease emissions. They stressed the importance to first “make it easier for our communities to breathe and soothe industry anxieties next.”

As with all other ZEV regulations, ACF has raised fears of the grid’s capacity to adapt to increased demand. In its report, CARB identifies some strategies that can be implemented to increase electricity production, but states no plans as to what is being done. When asked by a member of the board how utility companies plan to meet demand, Yulia Schmidt (California Public Utilities Commission) stated that “CARB is already undertaking some mapping efforts that we hope to incorporate into utility planning to help us forecast where fleets are going to need electricity. Uh, but it is a process that will be undertaken for the next several years.” Many stakehold-

ers, including those in the Inland Empire, experienced the blackouts of this previous summer, and are skeptical of an electric future. The California electricity grid is already in a precarious position.

Over the next 13 years, the state will attempt to increase the number of ZEV trucks from about 2,000 to 510,000 and the number of stations from almost 80,000 to over 1.2 million. All of these plans are still in their early stages, but a project of this scale is bound to have a massive impact on the state. If successful, it will combine with other initiatives to see a massive increase in the number of electric vehicles on the road and a significant decrease in harmful emissions. There are many questions that still need to be answered about this project, but one thing is certain: California will require a massive boost in electricity generation to meet these goals. ♦

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