



Zero Emission Freight Transition at the California-Baja California Border

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Preface

In January 2023, President Joseph R. Biden of the United States, President Andrés Manuel López Obrador of Mexico, and Prime Minister Justin Trudeau of Canada met at the 2023 North American Leaders' Summit to promote a common vision for North America. The U.S., Mexico, and Canada recognize the urgency for rapid, coordinated and ambitious measures to build clean energy economies and respond to the climate crisis. To combat the climate crisis, the three leaders committed to multiple measures including developing a plan for operating standards and the installation of electric vehicle (EV) chargers along international borders to ensure a seamless EV charging transition from country to country.

This EV plan also builds upon the shared strategic economic and commercial priorities that the U.S. and Mexico relaunched with the U.S.-Mexico High-Level Economic Dialogue (HLED) in 2021. The HLED provides a platform for the U.S. and Mexico to leverage their strong economic integration to foster regional prosperity, expand job creation, promote investment in our people, and reduce inequality and poverty.

Around the same time period in September 2022, the Commission of the Californias convened state officials from California and Baja California to discuss California's planned transition towards zero-emission vehicles (ZEVs) and the wide-ranging regional impacts it will have on our neighbors to the south, including Baja California and Baja California Sur, and how the three states can work together to promote the transition to ZEV technology.

In an effort to facilitate and contribute to this high-level international and interregional dialogue, this document explores the benefits, challenges, and considerations associated with the transition to zero emission (ZE) heavy and medium duty trucks in the California-Baja California (CA-BC) border region.

Executive Summary

The California-Baja California border region is both essential for trade and impacted by poor air quality. Some of the largest supply chains in the nation are connected through the border region, the core of California's freight economy, generating billions per year in international trade. In 2021, the region's land ports of entry (POEs) handled \$71.8 billion worth of goods. Mexico became the United States' top trade partner in 2019 and has remained in the top two positions since then. Meanwhile, residents who live near these trade routes face some of the worst air quality in the region. An important challenge is twofold: recognizing the importance of cross border trucking as the dominant mode of goods movement and backbone of California's freight economy while also recognizing the urgent need to reduce air pollution in impacted communities and reduce greenhouse gas emissions for future generations.

The International Border Community, which includes San Ysidro and Otay Mesa, is designated through Assembly Bill 617 and the California Air Resources Board's (CARB) Community Air Protection Program as an area disproportionately affected by exposure to air pollution from mobile and stationary sources. These communities have the highest traffic percentile in the state and its Particulate Matter (PM) 2.5 levels are in the 95+ percentile. At the binational land POEs, emissions are a concern due to commercial vehicle transport and idling waiting to cross the border.

To improve air quality statewide, California has established ambitious ZEV and ZEV infrastructure targets including the Innovative Clean Transit Rule (ICT), the Advanced Clean Truck Rule (ACT), and Governor Newsom's Executive Order N-79-20, which sets the target of 100% of Medium- and Heavy-Duty (MD-HD) fleets transitioning to ZEVs by 2045. The order also requires state agencies, in partnership with the private sector, to accelerate deployment of affordable fueling and charging options.

Several unique challenges and barriers to effective ZE freight transition include incongruencies in regulations across the nation and CA-BC border, limited performance and charging infrastructure for ZE trucks, and effective outreach to the region's diverse stakeholders. Economic impacts could go up and down the supply chain as transportation costs are likely to increase. Under any scenario in which the new ZE regulations cause higher shipping costs, there will be some decline in marginal economic activity, loss of jobs/economic output, and an accompanying rise in prices throughout the chain from producer to consumer. These losses may or may not be modest in comparison to benefits, but it is important to design policies in ways that minimize costs for the desired benefit.

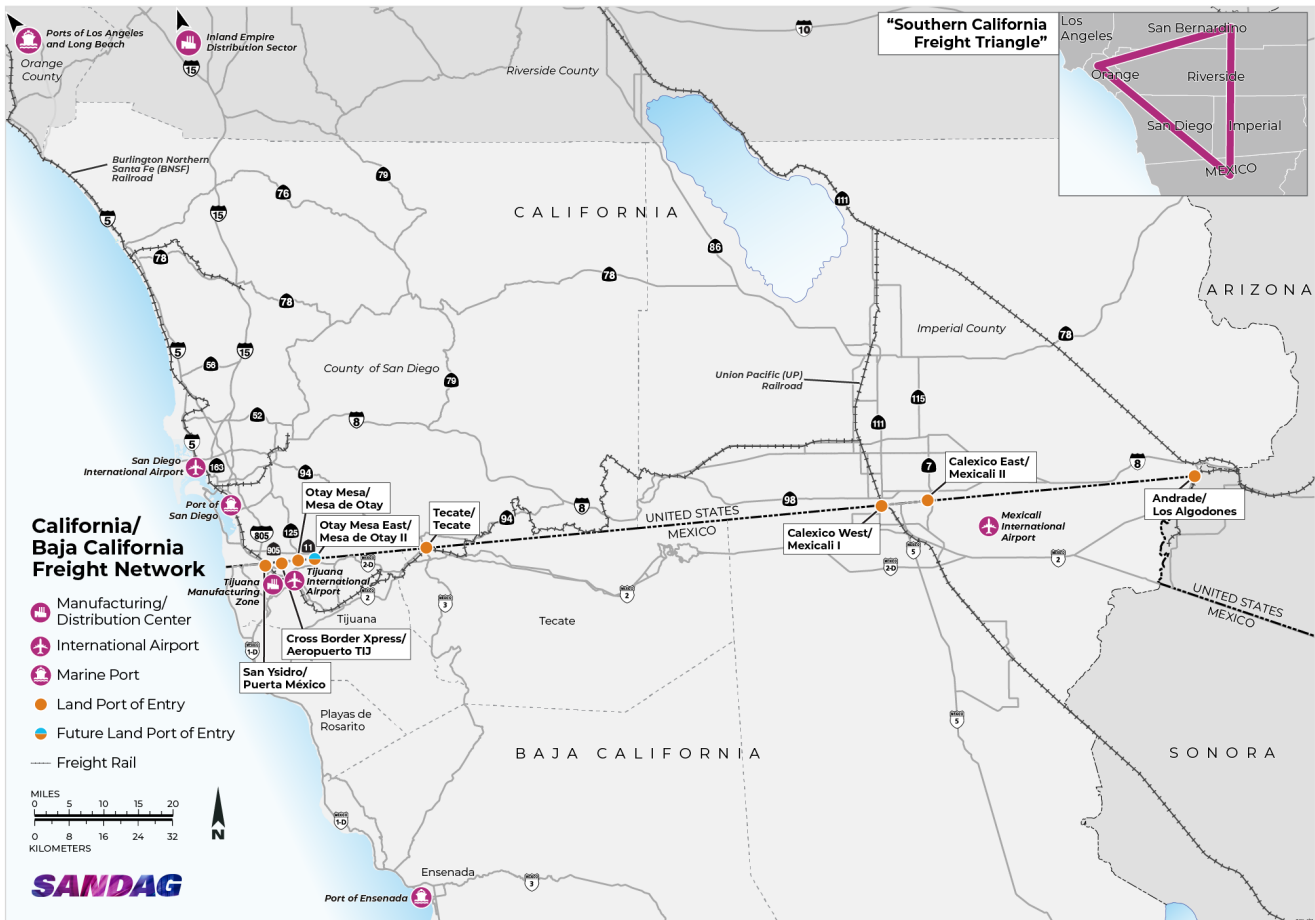
This paper identifies opportunities to facilitate the transition to ZE freight in the CA-BC border region, including infrastructure improvements, reducing border wait times, expanded incentives, pilot projects, consideration of hydrogen, workforce training, and other initiatives.

Border Region Freight Flows: The Core of California’s Freight Economy

The CA-BC border region connects some of the largest supply chains in the nation. Trade crossing the border in California contributes billions of dollars to the state and national economies annually. In 2019 this meant 23 billion in economic output for California and 48 billion for the rest of the U.S. with a combined 265,000 jobs nationwide and more than 3 million jobs in Mexico. In Southern California there is a **freight triangle** between the CA-BC border, the Ports of Los Angeles and Long Beach, and the Inland Empire that together are the core of California’s freight economy (Figure 1). The CA-BC freight triangle contains a freight network that accounts for the most significant trade in California.

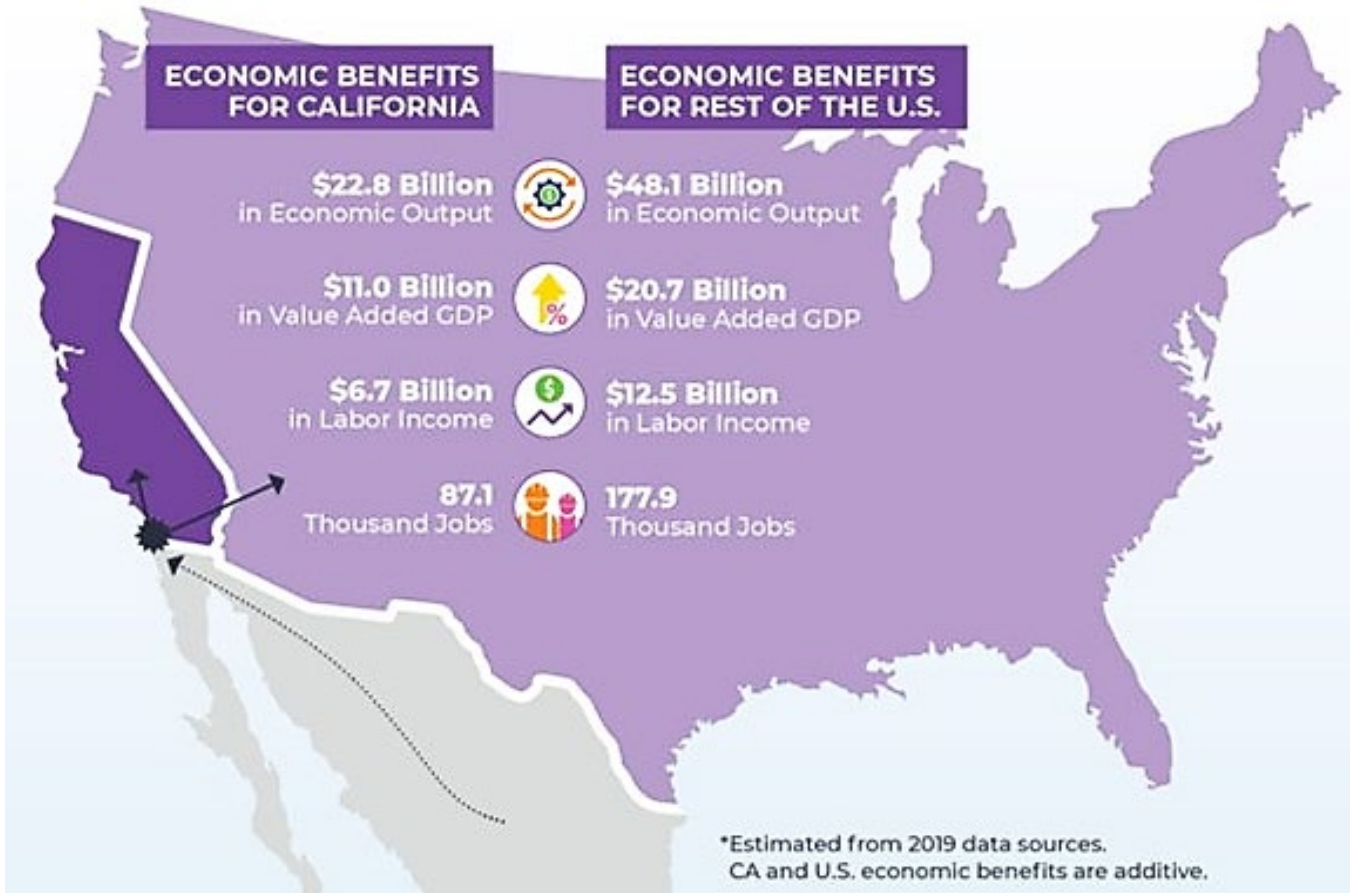
The CA-BC freight triangle contains a freight network that accounts for the most significant trade in California.

Figure 1
The CA-BC border region consists of San Diego and Imperial counties in the U.S. and the municipalities of Tijuana, Tecate, and Mexicali in Mexico.



The U.S. and Mexico have grown increasingly interdependent since the passage of the 1994 North American Free Trade Agreement (NAFTA) and the resulting integration of many North American supply chains. Between 1993 and 2022, the value of U.S.–Mexico trade increased by 856%.¹ Mexico became the top overall goods trade partner to the U.S. in 2019 and has remained in the top two positions since.² Mexico also continues to be California’s number one export market, purchasing 15.5% of all the state’s exports. Figures 2 and 3 help to illustrate the significance of the region’s POEs for the state and nation.

Figure 2
The CA-BC border region POEs contribute significantly to California and the nation.



¹ U.S. Census Bureau, as of February 2023 (calculated on a nominal basis), <https://www.census.gov/foreign-trade/balance/c2010.html>.

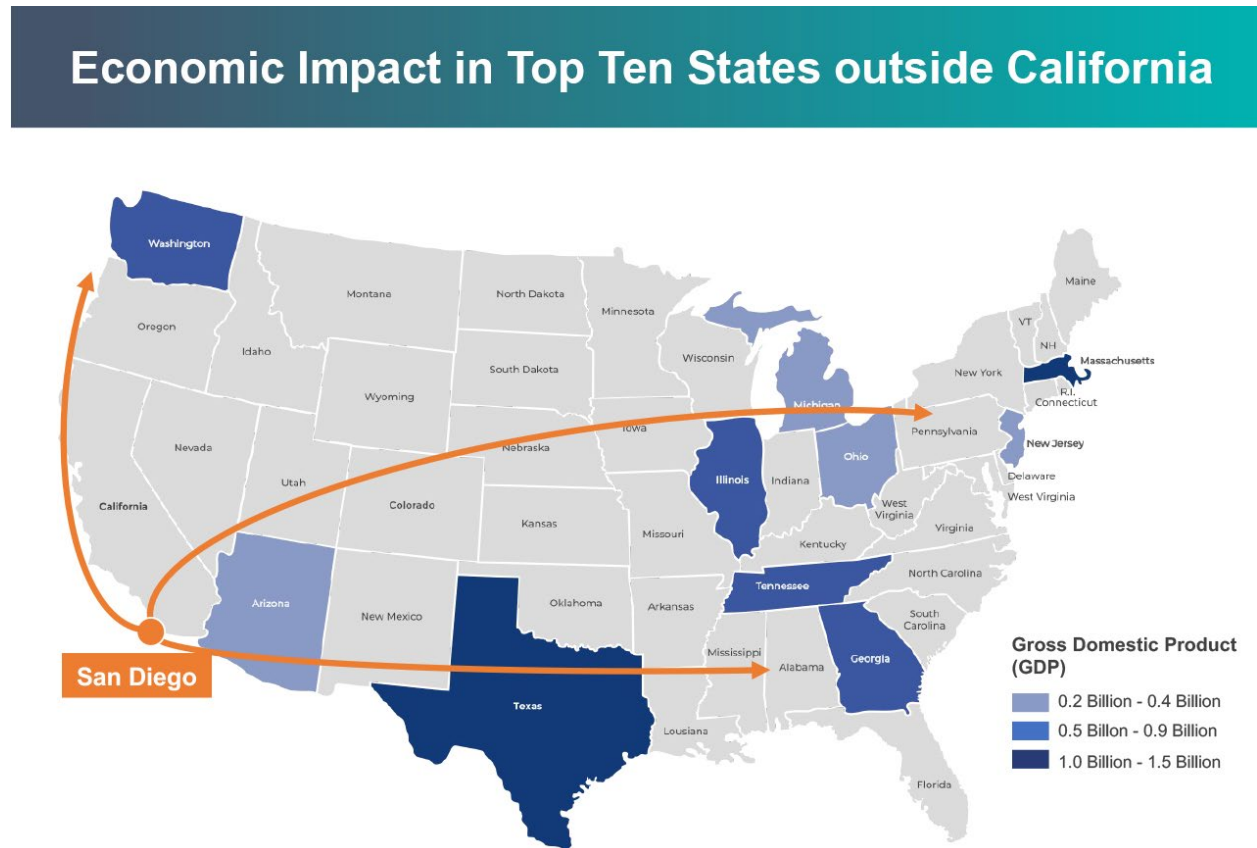
² U.S. Census Bureau, as of October 2022. <https://www.census.gov/foreign-trade/statistics/highlights/top/index.html>

In 2021, the region’s land POEs handled \$71.8 billion worth of goods (Figure 4), with the Otay Mesa POE being the second-busiest truck crossing along the U.S.–Mexico border. This annual two-way trade has more than tripled in value since reaching a low in 2009 after the Great Recession, and in 2021 was dominated by U.S. imports (\$46.4 billion) compared to U.S. exports (\$25.4 billion).

According to a 2010 research paper,³ 40% of the value of U.S. imports from Mexico is U.S.-made; for China that figure is 4%. This shows the interdependency of U.S-Mexico supply chains and reinforces the fact that strengthening manufacturing with Mexico strengthens U.S manufacturing as well. With recent COVID-related supply-chain disruptions and geopolitical tensions, more manufacturers are looking to nearshoring (and “friendshoring”)⁴ leading to a spike in manufacturing investment in Mexico.

Figure 3

Trade through the CA-BC POEs have economic impacts for nearly every state in the nation.

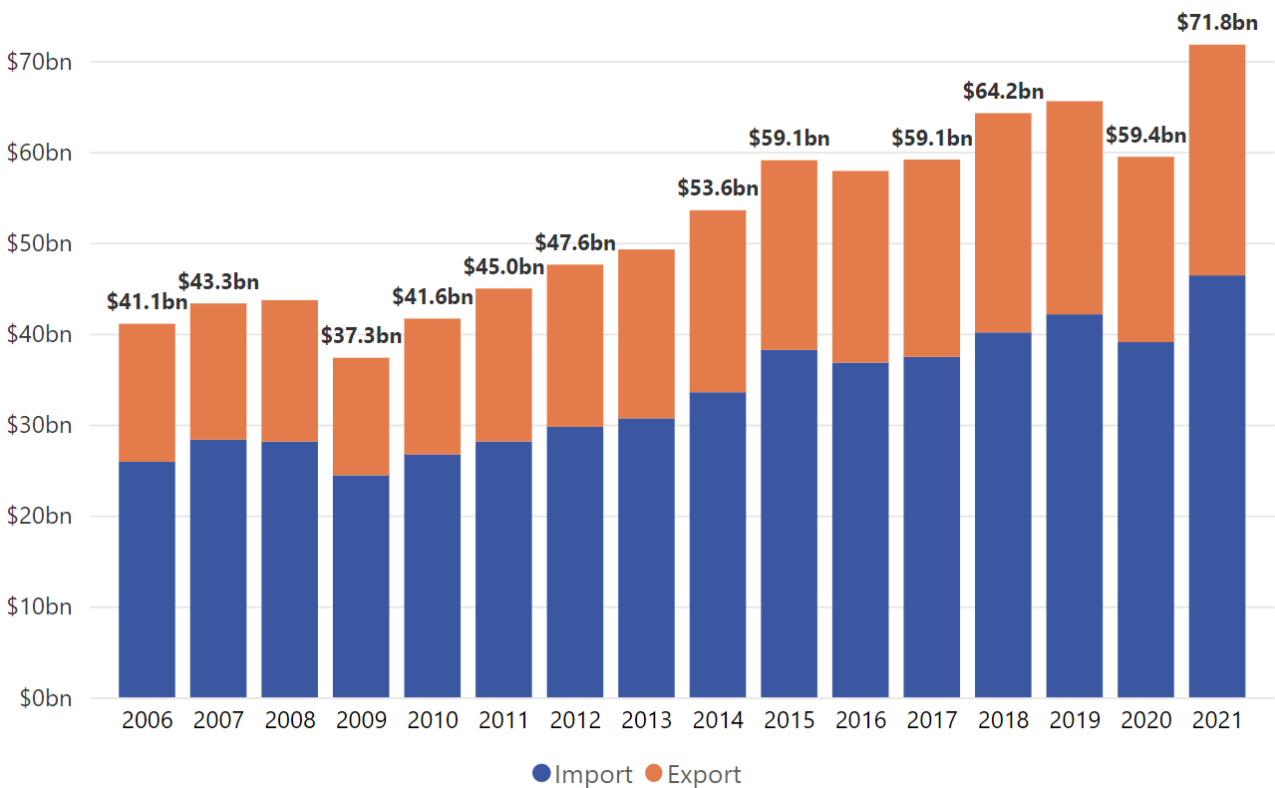


³ <http://www.nber.org/papers/w16426>

⁴ Nearshoring is the practice of transferring a business operation to a nearby country, especially in preference to a more distant one while friendshoring refers to manufacturing and sourcing from countries with shared values.

The United States-Mexico-Canada Agreement is a free trade agreement (USMCA) that replaced NAFTA in July 2020. It is anticipated to attract additional trade between the U.S. and Mexico, due to additional trade facilitation and incentives and will strengthen labor rules to be more consistent between the three countries. Among the many provisions of the USMCA, the agreement includes a higher “domestic content” requirement for the parts that are used to manufacture motor vehicles. This is anticipated to result in more trade between the U.S. and Mexico (e.g., the Toyota maquiladora, which produces Tacomas, is near Tecate, and the assembled Tacomas cross into the U.S. using the Otay Mesa POE to seaport, rail, and interregional/local roadways).

Figure 4
Bilateral Trade Value via Truck – California Commercial Land POEs, 2006–2021



Source: U.S. Department of Transportation (DOT) BTS

San Diego County Freight Network

Situated between major production, trade, and population centers, San Diego County depends on an integrated transportation network to move people and goods within and through the region to the rest of the nation and around the world. Due to the interdependent binational economy with Tijuana and Tecate, San Diego’s globally competitive business environment hosts a manufacturing sector that is one of the world’s strongest cross-border supply chains, with a combined gross domestic product of approximately \$268 billion for San Diego County alone in 2021, and \$10.9 billion for Imperial County.⁵

⁵ U.S. Bureau of Economic Analysis; Gross Domestic Product by County

Imperial County Freight Network

Imperial County relies on its freight highway network to handle over 90% of total commodity flows, its agriculture commodities surpass \$2 billion annually⁶. The Imperial County freight highway system facilitates the movement of goods from the international border with Mexico through two land POEs, Calexico West and Calexico East, and the Union Pacific Railroad. Freight movement in Imperial County includes agricultural, medical, and a variety of other products to Coachella Valley in Riverside County with connections west to the Los Angeles/Long Beach Seaports and other key distribution centers throughout California. Other high value commodities such as aerospace and aeronautical equipment and parts, as well as computer equipment also move through Imperial County POEs.

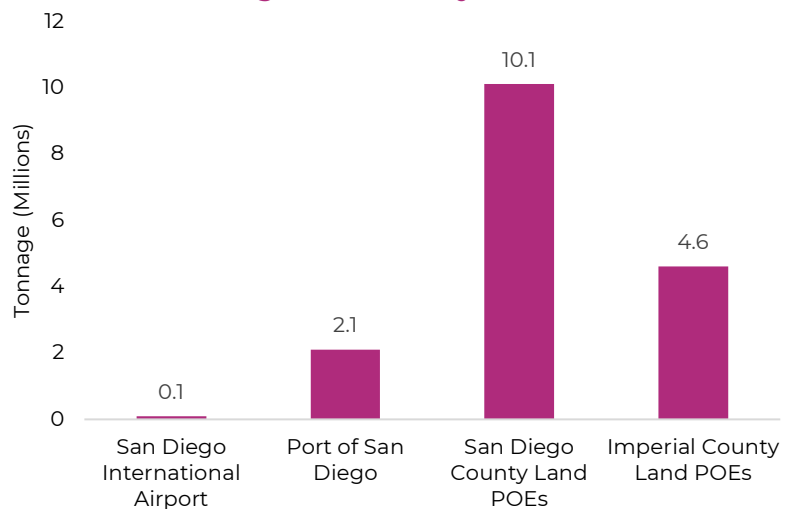
Trucking as Dominant Mode of Goods Movement

Trucking is the predominant mode of commercial transportation in the region. Freight by truck is critical in Tijuana, where maquiladoras⁷ are not served by rail. Over 1.4 million northbound trucks moved through the region's three commercial land POEs in 2021, with an assumed equal number of southbound trips.⁸ Otay Mesa, as the main commercial gateway for international trade between California and Baja California, ranked second in total volume of trucks and third in total trade value moved by truck among the southern border land ports.

San Diego and Imperial counties land POEs reflect the highest amount of combined import and export tonnage in the region (Figure 5). A substantial majority of total tonnage for these counties is moved through San Diego County (Otay Mesa and Tecate) with an estimated 60% and Imperial County (Calexico East) with 27%.

Over 1.4 million northbound trucks moved through the region's three commercial land POEs in 2021, with an assumed equal number of southbound trips.

Figure 5
2019 Freight Volume through Regional Gateways



Source: IHS Markit Transearch, Port of San Diego, and San Diego International Airport

⁶ 2021 Imperial County Agricultural Crop & Livestock Report: <https://agcom.imperialcounty.org/wp-content/uploads/2022/10/2021-CR-Draft-Final.pdf>

⁷ A maquiladora is a foreign-owned factory in Mexico that exports its products to the company's home country (the U.S. has many maquiladoras just south of the border in Mexico).

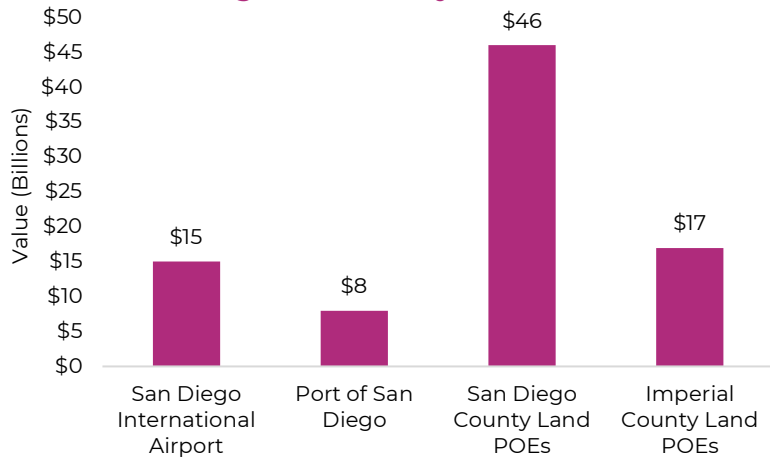
⁸ "California-Baja California Border Crossing and Trade Statistics," SANDAG, <https://opendata.sandag.org/stories/s/h8wt-5zns>

Similarly, as with tonnage, San Diego and Imperial Counties POEs overwhelmingly lead the region's gateways in combined import and export trade value (Figure 6). Among the top commodity categories **exported** across the CA-BC border are electrical machinery and equipment, manufactured goods, high tech equipment, motor vehicles, and agricultural and food products.⁹

This diversified mix of commodity categories reflects the integration of the Baja California economy with goods sourced from the U.S. and exported to Mexico through land POEs (Figure 7).

Goods of many types sourced from across the U.S. are exported to Mexico through the CA-BC POEs. Some of these exports to Mexico are then used as inputs to Mexican manufacturing, which become finished products then exported by Mexico back to the U.S.

Figure 6
2019 Freight Value through Regional Gateways



Source: IHS Markit Transearch, Port of San Diego, and San Diego International Airport

Goods of many types sourced from across the United States are exported to Mexico through the CA-BC POEs.

Figure 7

Top commodities exported from the U.S. and Mexico across the CA-BC border in 2019

Top U.S. Commodities by Output	Top Mexico Commodities by Output
1. Electrical Machinery and Equipment	1. Electrical Machinery and Equipment
2. Manufactured Goods	2. Motor Vehicles
3. High Tech (Computer-Related)	3. High Tech (Aircrafts and Measuring Instruments)
4. Plastics and Articles	4. Manufactured Goods
5. Other	5. Agricultural and Food Products
6. High Tech (Aircrafts and Measuring Instruments)	6. High Tech (Computer-Related)
7. Motor Vehicles	7. Other
8. Agricultural and Food Products	8. Plastics and Articles

Source: SANDAG. 2022. Otoy Mesa East Economic Value of Cross Border Freight Study.

⁹ Based on Freight Analysis Framework data from 2017

Cross Border Trucking

California-Mexico freight is almost exclusively carried across the CA-BC border by trucks through the region's international land POEs. The majority of these cross-border truck trips are undertaken by drivers that specialize in this route. A typical truck shipment between the U.S. and Mexico uses dedicated cross border tractors to pick up a trailer from a yard on one side of the border and then haul it over the border to another yard for transfer to a domestic carrier.

This pattern is sometimes referred to as a “drayage” operation, but it may be more accurately described as a “cross border shuttle” service. Whereas the CARB definition of drayage only applies to trucks serving marine ports and intermodal railyards, cross border shuttle carriers are specialized in international customs, can be certified by customs agencies with special permissions, and require a driver experienced in cross border routes between countries.

More than 90% of the cross border trucking business is performed by Mexican-domiciled motor carriers.¹⁰ Mexico-domiciled cross border shuttle trucks must have a DOT number, Federal Motor Carrier Safety Administration (FMCSA) assigned “MX” or Mexico docket number, and a valid FMCSA Certificate of Registration for operations within the commercial zone generally extending 30 miles into the U.S. from the border. Regardless of the type of authority the carrier obtains, no Mexico-domiciled carrier may conduct point-to-point operations within the U.S.¹¹ There is a lot of cross border freight truck activity that is centered within a 30-mile radius of the CA-BC border, and many of these trucks are from Mexico.

Trucking companies wanting to operate across a broader geographic area (further away from the border than 30 miles) on both sides of the border register trucks in both Mexico and California. This 'dual plating' operation incurs higher costs as motor carriers must pay for registration in two states at the same time and are subject to laws and regulations on both sides of the border.

This is where one of the challenges of implementing ZE freight at the CA-BC border exists. In order to do business in California, a Mexico based fleet may have dual plating on their trucks and the fleet is therefore subject to California regulations around zero-emissions while in Baja California neither the supply nor the regulations are in place.

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There is a lot of cross border freight truck activity that is centered within a 30-mile radius of the CA-BC border, and many of these trucks are from Mexico.

¹⁰ Appendix Y: Goods Movement Planning and 2021 San Diego and Imperial Counties Freight Gateway Study Update: <https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/goods-movement-planning/freight-gateway-study/goodsmovementplanningand2021sandiegoandimperialcountiesfreightgatewaystudyupdateappendixy20211201.pdf>

¹¹ Cross-Border Operating Requirements for Mexico-domiciled Motor Carriers. Federal Motor Carrier Safety Administration. <https://www.fmcsa.dot.gov/international-programs/cross-border-operating-requirements-mexico-domiciled-motor-carriers>.

Benefits of Zero Emission Freight at the Border

Poor air quality is a critical issue near the California-Baja California border. The San Diego International Border Community¹², which includes San Ysidro and Otay Mesa, is designated through Assembly Bill 617 and the CARB Community Air Protection Program as an area disproportionately affected by exposure to air pollution. California environmental screening tool CalEnviroScreen version 4.0 shows that the community has the highest traffic percentile in the state and its PM_{2.5} levels are in the 95+ percentile. Environmental Justice Neighborhoods in San Diego County and the El Centro-Heber-Calexico Corridor in Imperial County are also included in CARB's Community Air Protection Program¹³.

Socioeconomic indicators show San Ysidro residents are limited in overcoming the pollution exposure and environmental effects. Over 27,000 residents have Population Burdens, including an 86+ percentile for poverty, 79+ percentile for unemployment, 89+ percentile for education, and 85+ for linguistic isolation. With significant poverty levels and having much of their limited income going towards housing, their ability to protect themselves from pollution exposure is greatly limited. The International Border Community is also confronted with pollution, specifically from Tijuana, Mexico. The San Ysidro Community Air Quality Study¹⁴ showed elevated particulate levels in the community when it was downwind of Tijuana. Additional monitoring and cooperation are needed to reduce the elevated pollution levels and better protect the residents of San Ysidro.

Mobile sources and fossil fuels are currently responsible for 80% of nitrogen oxides (NO_x) emissions, 50% of greenhouse gas emissions from fuel production, and more than 95% of diesel particulate matter (DPM) emissions in California.¹⁵ The equipment used to move goods at both the large scale (e.g., trucks and trains) and the small scale (e.g., forklifts and onboard ship equipment) traditionally use fuels such as diesel which emit such air pollutants as carbon dioxide (CO₂), NO_x, sulfur oxides (SO_x), a variety of particulate matter (PM), and others that pose a risk to public health and environmental safety. Communities located near or adjacent to freight network gateways and corridors are disproportionately impacted by these effects. It is important to point out that there are stationary emissions sources within the border community. For example, there are two peaker power plants¹⁶ in Otay Mesa, which are powered by gas and create significant emissions within the community as well as other stationary sources. It is anticipated that if no changes are made to current trends, environmental conditions will worsen in the San Diego region by 2050.

¹² <https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/communities/international-border-community>

¹³ <https://www.icab617community.org/>

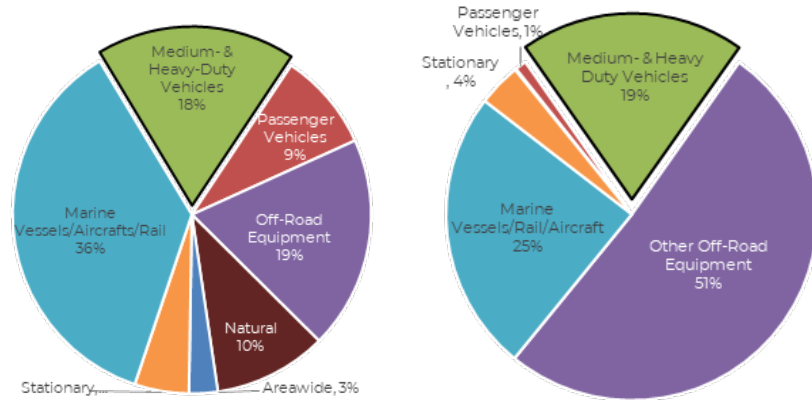
¹⁴ <https://oehha.ca.gov/calenviroscreen/general-info/san-ysidro-community-air-study>

¹⁵ "Advanced Clean Trucks Fact Sheet," CARB, August 20, 2021, arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet.

¹⁶ Peaker power plants are used when the electricity grid is near capacity (e.g. during summer months in Southern California).

Trucks account for the largest percentage of goods movement within the San Diego region. One study showed that HD diesel trucks in the San Diego region emit an average of 19.7 tons of NOx per day.¹⁷ Figure 8 illustrates the contribution of medium- and heavy-duty trucks and buses to NOx and DPM emissions in San Diego County in 2022¹⁸. While only one-fifth of DPM and NOx emissions in San Diego County are associated with operation of these vehicles, source of these emissions are localized near schools and residences, as those trucks operate within these areas.

Figure 8
2022 NOx (left) and Diesel PM (right) Emissions in San Diego County



Source: 2019 California Emissions Projection Analysis Model version 1.03

In 2016, trucks at the San Diego–Tijuana land POEs resulted in an average of approximately 182 metric tons of CO₂ emitted per day – equivalent to emissions from consumption of nearly 17,900 gallons of diesel fuel.¹⁹ The daily average when including truck delay at Imperial County POEs rises to 249 metric tons.

Zero Emission Policy in the Border Region

The CA-BC border region recognizes the need to transition to ZE freight. One way to minimize the greenhouse gas emissions and air pollution impacts from goods movement is by converting trucks to ZEVs, which produce zero tailpipe emissions and include plug-in battery EVs and hydrogen fuel cell vehicles (HFCV). Vehicle emissions are regulated at varying levels of geography in the U.S. and Mexico.

¹⁷ “Draft Community Emissions Reduction Plan,” SDAPCD, 2020, [sandiegocounty.gov/content/dam/sdc/apcd/PDF/AB_617/Portside%20Environmental%20Justice%20RAFT%20CERP%20Oct%202020.pdf](https://www.sandiegocounty.gov/content/dam/sdc/apcd/PDF/AB_617/Portside%20Environmental%20Justice%20RAFT%20CERP%20Oct%202020.pdf).

¹⁸ CARB’s 2019 California Emissions Projection Analysis Model v1.03. Link: <https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool>

¹⁹ “Impacts of Border Delays.” <https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/borders-and-interregional-collaboration/binational/volume-1-background-and-summary-findings-2021-02-09.pdf>

Freight transportation system operations are regulated by various government agencies. The Secretariat of Environment and Natural Resources is the sole agency responsible for emission standards for new vehicles in Mexico. In February 2018, the agency published NOM-044-SEMARNAT-2017, an update to HD emission standards. The regulation established a timeline for alignment between Mexican and then-U.S. standards for new HD vehicles beginning in 2022.²⁰ The Secretariat of Communications, Infrastructure, and Transportation regulates cross border transportation and trade while the Office of the Federal Prosecutor for Environmental Protection enforces federal emissions regulations, and the Baja California state government is responsible for administering vehicle registrations in compliance with those regulations.

In Mexico, ZE regulations are not as developed as they are in the U.S. The Mexican Federal Energy Commission has a ZE charging program that, according to one expert, has not been significantly promoted. Although policies for personal ZEVs are maturing, policies and programs related to commercial ZEVs do not yet exist.

The grid in Mexico is underequipped to reliably handle charging for freight.

One interviewee explained that for electrical supply and distribution, the highest priority is handling the summer loads; the state of the grid is such that medium tension circuits are severely congested, and there is a shortage of equipment. The grid in Mexico is underequipped to handle charging for freight.

In the U.S., freight operations are regulated by the U.S. DOT's FMCSA and National Highway Traffic Safety Administration as well as the U.S. Environmental Protection Agency (EPA). Although federal regulations on truck fuel efficiency and emissions have been tightened periodically over the previous decades, California has adopted fuel efficiency and emissions standards more stringent than those set at the U.S. federal level by EPA.²¹ CARB is the primary state agency responsible for regulating emissions of air pollutants and greenhouse gases from transportation (including light and MD-HD vehicles). As of 2023, all trucks operating in California must have model year 2010 or newer engines (based on the Emissions Control Label), and most heavy trucks must have a PM exhaust filter installed.

CARB prepares a Scoping Plan (climate change) at least once every five years, which demonstrates how the state will reduce greenhouse gas emissions. The 2022 CARB Scoping Plan identifies pathways for all sectors in California to achieve carbon neutrality by 2045 or sooner. As an agency, CARB has the authority to monitor the progress of the recommendations and strategies identified in the Scoping Plan to ensure the state is making advancements to reduce emissions, which includes moving the ZEV industry forward. CARB does this through regulation and incentives.

California has established ambitious ZEV targets including the ICT, the ACT, and Governor Newsom's Executive Order N-79-20, which sets the target of 100% of MD-HD fleets transitioning to ZEVs by 2045. The order also requires state agencies, in partnership with the private sector, to accelerate deployment of affordable fueling and charging options.

In June 2020, CARB adopted its first ZEV requirements for HD trucks. California's ACT—the first such policy globally—calls on truck manufacturers of Class 2b-8 trucks to sell increasing percentages of ZE trucks beginning in 2024.

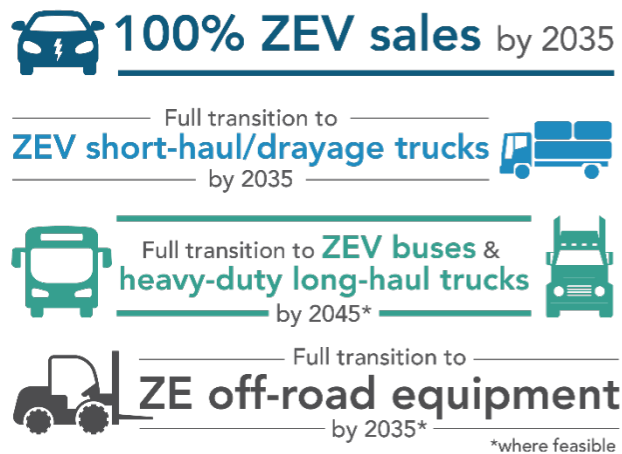
²⁰ [Mexico heavy-duty vehicle emission standards \(theicct.org\)](https://theicct.org)

²¹ [Vehicle Emissions California Waivers and Authorizations | US EPA](https://www.epa.gov/vehicle-emissions-california-waivers-and-authorizations)

To meet the goals established by Executive Order N-79-20, CARB is working on complementary regulations to accelerate the transition to ZE MD-HD vehicles in California. The proposed ACF regulation, planned for CARB board consideration in spring 2023, will focus on setting major ZEV fleet purchase requirements. If approved, a large fraction of HD vehicles operating in California would be subject to the following requirements:

- **State and Local Government Fleets:** From 2024 through 2026, at least 50% of new public vehicle additions must be ZEV, and 100% of new purchases must be ZEV starting in 2027.
- **Drayage Fleets:** Beginning in 2024, new drayage trucks added to port registries must be ZEV, and all drayage trucks must be ZEV by 2035. The proposed ACF regulation notes that legacy drayage trucks (i.e., diesel and natural gas drayage trucks) may enter the port registries prior to 2024 and operate to the extent of their useful life, but not past 2035. This definition of drayage applies to trucks serving marine ports and intermodal railyards. However, it does not apply to trucks serving land POEs unless the goods are destined to or from marine ports or intermodal railyards.
- **High Priority and Federal Fleets:** California HD truck fleets are high-priority if: (1) the fleet has 50 or more vehicles under common ownership or control; or (2) the entity or the combination of entities operating under common ownership or control have \$50 million or more in total gross annual revenue in the prior year—otherwise, the fleet is not subject to this regulation. Starting in 2024, high priority fleets can only add ZEVs to their fleets, and legacy internal combustion engine (ICE) vehicles have until the end of their useful life to transition to ZEV. The proposed ACF regulation also provides another compliance option in which fleets are not restricted from procuring ICE vehicles after 2024 but are required to reach pre-established ZEV milestones each year²²

According to CARB’s estimates, almost two-thirds of trucks operating in California are expected to be ZE by 2050. It is expected that the ACT and proposed ACF regulations will drastically change the mix of MD-HD vehicle technologies in the region. Specifically, this regulation will not only impact large fleets with more than 50 trucks or \$50 million in total gross annual revenue, but also it affects the vehicles that are under common ownership and control by these entities. This applies to vehicles operated using shared resources for day-to-day operations, such as a common motor carrier number, name, or logo, and it applies to vehicles subject to relationships that control work assignments and the sharing of operating expenses, including owner-operators working exclusively under larger entities.



²² CARB. [Heavy-Duty Zero-Emission Vehicle Information | TruckStop \(ca.gov\)](https://www.ca.gov)

The policy push in California to date has focused on ZE vehicles through the ACT manufacturer mandate and ACF fleet mandate. However, there is currently no mandate for public agencies or private business to supply ZE charging/refueling infrastructure, which will be necessary to support increasing numbers of ZE vehicles.

The California Energy Commission (CEC), California Public Utilities Commission (CPUC), and other agencies are involved in administering incentive programs and regulating the development of such infrastructure. Through Assembly Bill 2127 (AB 2127), the CEC is required to work with CARB and the CPUC to prepare and biennially update a statewide assessment of EV charging infrastructure needed to support state ZEV adoption goals and reduce greenhouse gas emissions to 40% below 1990 levels by 2030.

Border Region Policy and Industry Challenges

The following section details findings from research based on existing literature combined with qualitative interviews with freight stakeholders. Individual interviews were conducted over a three-week period and included shippers, carriers/truck drivers and companies, an energy policy expert, customs brokers, a media representative, and a large scale manufacturer. Interviewees were identified during community outreach workshops held in the border region and through contacts made by SANDAG and Caltrans staff. Appendix C provides a list of interviews and the interview guide. Additional insights from related efforts such as freight stakeholder workshops held for SANDAG's Sustainable Freight strategy also served as sources of qualitative data.

Interviews and policy analysis revealed several areas of regulatory and policy related challenges for the ZE transition in the border region. Generally, the new regulations are forcing carriers to re-think their entire supply chains. Timing of routes, number and type of drivers, locations of routes and stops, cost of operating, vehicle purchasing and maintenance, training, and safety are all subject to change with the new regulations. Companies face many unknowns with new ZE vehicles, citing the overall cost of driving as a main concern: Where will they refuel? How long will it take? What are the safety features compared to diesel? What is the resale value of a ZE truck? How will they cover the cost of reduced loads resulting from heavier batteries? How will they compete with unregulated smaller fleets? How will Mexican companies buy ZE trucks without incentives in Mexico? How will the cost of business increase and how much of that will affect consumers? What will the energy cost? These are some of the numerous questions brought up by freight stakeholders during interviews. This section identifies four main categories of challenges that emerged from this research:

- Inconsistency in California and Mexico Industry and Air Quality Regulations
- Range, Weight, and Cost Limitations of Battery Electric Trucks
- Charging and Fueling Infrastructure and Truck Parking
- Messaging and Outreach.

Inconsistency in California and Baja California, Mexico Air Quality Regulations

The border region is unique because many trucking companies operate functionally across the two countries, but the ZE rules are inconsistent across the border. Several interviewees suggested that northern Baja California and Southern California should share similar rules for air quality, noting that air moves freely across the border without the need to go through customs and immigration. If Mexico remains with less stringent ZE regulations, the “dirty” trucks will continue to operate and continue to pollute the air basin. While air quality regulations on the California side of the border act as an instigator for changes in infrastructure and business practices, there is not a corresponding regulatory driver on the Mexico side, businesses that operate on both sides have a lack of harmonization in regulations.

Adding to the complexity are inconsistent Gross Vehicle Weight regulations, with Mexico allowing heavier trucks on roads than the U.S. According to one source the powertrain for battery electric trucks is approximately 10,000 pounds heavier than diesel trucks, requiring the same amount of goods to be moved using more trucks in order for trucks to comply with Gross Vehicle Weight limits on the U.S. side of the border. When interviewed, industry representatives pointed out that adding more trucks to deliver the same amount of goods increases the cost of goods (and increase vehicle miles traveled) and suggested that weight regulations should be changed to allow heavier vehicles until battery electric technology can mature enough to allow for lighter trucks. This may require a complementary mechanism to address increased wear on the roads caused by heavier vehicles.

Another area of concern for interviewees is the uneven impact of regulations on medium to large companies versus those for smaller fleets. Interviewees stated this was “unfair” because some companies are faced with more restrictions. Conversely, a significant portion of truck operators in the freight industry are independent contractors who own their own vehicles and work for larger corporations. These operators could be left with vehicles they can no longer use in California, leading to potential unemployment.²³

A third area of inconsistency is varied regulations in U.S. states other than California. With less stringent regulations in Arizona and Texas, for example, operators may be inclined to shift back to diesel trucks when crossing into states that do not have the charging infrastructure to support ZE vehicles. Interviewees noted that drivers may shift their business to other states which could result in a loss of business in California.

Range, Weight, and Cost Limitations of Battery Electric Trucks

Interviewees expressed concern that battery electric trucks have many time constraints that do not currently exist with diesel trucks. A diesel truck is typically able to travel for over 1,000 miles without needing to stop and refuel, but charging a battery electric truck could take several hours for a current range of less than 300 miles. The need to find a place to charge could also impact the route and add time because of distance. If a company decides to transfer goods from one vehicle to another, that also adds time. The additional time it takes to deliver goods in a battery electric truck creates a number of challenges for companies.

²³ Appendix Y: Goods Movement Planning and 2021 San Diego and Imperial Counties Freight Gateway Study Update: <https://www.sandag.org/-/media/SANDAG/Documents/PDF/projects-and-programs/goods-movement-planning/freight-gateway-study/goodsmovementplanningand2021sandiegoandimperialcountiesfreightgatewaystudyupdateappendixy20211201.pdf>

For example, cross border trucks are often certified trusted travelers through the Customs Trade Partnership Against Terrorism (CTPAT) program, which does not allow the truck (or any aspect of the supply chain) to be left unattended for any length of time. If a driver were to spend all allowable driving hours combined with charging hours, there may be a need for a hotel which would compromise CTPAT regulations. It is not uncommon for the border economy to consist of consolidation facilities where customs brokers handle freight from CTPAT certified and non-CTPAT certified trucks. Additionally, drivers are currently paid by miles, not by hours. Having longer charging times would imply that drivers would need to be paid hourly, which would increase operation costs. Some truck drivers that work for Mexican companies are paid based on commission. Increasing delivery time will impact the pay of workers who rely on a commission that is based on how quickly goods are delivered.

Several interviewees noted that the ZE trucks, especially battery electric, cannot replace diesel trucks at a 1:1 ratio. The extra weight reduces their effective weight capacity, so additional ZE vehicles could be required to transport the same volume of goods.²⁴ Unlike a diesel truck, many electric trucks cannot cover 300+ miles before needing to re-fuel²⁵. Especially when carrying heavier loads, a battery electric truck has to stop to re-charge more frequently than a diesel truck would,²⁶ which impacts truck trips and routes. One company stated that its understanding of the battery electric truck capacity will not allow its drivers to complete their shortest route between the border and the San Pedro Bay ports, which is 275-300 miles. Currently this trip can be done in one day, but with the reduced range of battery electric trucks, the company would need to rethink how to make this common trip cost effective. According to interviewees, this re-thinking of supply chains also must consider other market challenges such as a truck driver shortage.

One final challenge noted by most interviewees is the increased cost of a battery electric truck and a hydrogen fuel cell truck. Although cost estimates vary widely between truck manufacturers and researchers, most agree that ZE trucks cost more, and this is a challenge for businesses. Business owners articulated through interviews that they are now faced with a choice between attempting to comply with California regulations or moving their business out of California as much as possible, for example to Arizona. One of their deciding factors appears to be if they believe it is worth it to purchase more expensive trucks. When you pair this information with the fact that Mexico is California's number one trading partner, it becomes clear that vehicle cost challenges have significant impacts.

This challenge, which affects numerous companies operating in the border region, exemplifies the re-thinking that will be required at all levels of the supply chain because of increased regulations. According to interviewees, this re-thinking of supply chains also must consider other market challenges such as a truck driver shortage.

²⁴ Caltrans. 2022. California's Deployment Plan for the National Electric Vehicle Infrastructure Program.

²⁵ [Evaluation of the Economics of Battery-Electric and Fuel Cell Trucks and Buses: Methods, Issues, and Results \(escholarship.org\)](https://escholarship.org)

²⁶ Caltrans. August 2022. California's Deployment Plan for the National Electric Vehicle Infrastructure Program.

Charging and Fueling Infrastructure and Truck Parking

Freight transportation is a highly competitive business, and the availability and reliability of charging and/or fueling infrastructure to support freight vehicles is crucial to the transition to ZE freight. Several interviewees stated that charging and fueling infrastructure should be implemented before mandating compliance. Gaps in charging and fueling infrastructure exist in Southern California and Mexico. There are currently over 7,000 direct current fast chargers at public charging stations in California; however, most or all of these chargers are at stations that were not built for trucks, many of them are likely in retail areas or other locations not suitable for truck charging and do not have space for trucks to charge.²⁷ There are currently three public hydrogen fuel truck stations²⁸ in California. When this existing infrastructure is compared to the 11,129 estimated class 4-8 ZE trucks that will be on the roads in 2025, and 134,831²⁹ class 4-8 ZE trucks that will be on the roads in 2030 as a result of CARB's Advanced Clean Trucks and proposed Advanced Clean Fleets (ACF) rules, it is apparent that there is a gap in the infrastructure needed to support ZE trucks.

Complicating the issue of infrastructure deficiencies is the concern among companies that the supply of hydrogen and electricity is inadequate to meet the demand. The CEC's AB 2127 report notes that, "In many cases, medium- and heavy-duty vehicles and equipment will need to charge as quickly as possible, which will create new multimegawatt loads. Charging infrastructure planning will be especially important and must address grid constraints, resilience, and compatibility with existing operating schedules."³⁰ The CEC and CPUC are working now to incorporate the potential additional energy demand into their planning process, but upgrading the grid to accommodate needed ZE freight infrastructure is likely to take years. Mexico is even further behind in terms of grid capacity. In addition to the regulatory differences noted previously, based on an interview of an expert from Mexico, the electric grid in Mexico is not currently able to handle significant additional electric load in most places.

In addition to energy supply challenges and a lack of infrastructure, a greater truck parking and charging footprint is required for ZE trucks. Companies have considered purchasing land for charging in strategic locations to help reduce disruption to their supply chain routes. On the border, international processing requirements (inspections, document checks, etc.) cause bottlenecks for vehicular traffic, and wait times can vary drastically and reach up to six hours. Trucks will often compensate for longer travel times by crossing at irregular hours and coordinating a rest period in the receiving country, thereby generating parking demand near international border crossings.³¹ A similar situation is anticipated with additional delays incurred from charging and will exacerbate an already challenging international supply chain.

²⁷ CEC: <https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/electric-vehicle>

²⁸ This information is based on a Hydrogen Fuel Cell Partnership station map. <https://h2fcp.org/stationmap>

²⁹ Vehicle numbers are from CARB.

³⁰ <https://efiling.energy.ca.gov/getdocument.aspx?tn=238853>

³¹ Caltrans. February 2022. California Statewide Truck Parking Study.

Messaging and Outreach

Interviewees suggested that more robust outreach on the new ZE regulations is needed. Two carriers said it does not feel like a collaborative process, because amid so much uncertainty carriers may go without clear answers to their many questions. Another interviewee cited communication as critical to outreach to the border community to help people see and understand “the why” behind the regulations. “You need to show them why clean air is important... not with numbers... but really show them.” The interviewee added that the Think Blue San Diego campaign, which taught the border community about the harm of dumping automotive oil in storm drains was successful because it effectively communicated the “why” through pictures. The interviewee also cited the campaign to get border communities COVID-19 vaccinated as a successful outreach campaign that worked because there was a clearly articulated advantage to complying with the recommended course of action.

Economic Implications

It is important to consider what impact air quality policy in California may have on the economy. The costs of the proposed ZEV regulations could be significant for operators of MD-HD trucks. While the market for personal EVs has expanded greatly in the past five years, the market for MD-HD EVs is two to five years further behind according to the SANDAG MD-HD ZEV Blueprint³², meaning that both price and performance of MD-HD EVs (and other ZEVs) are not close to those of internal combustion vehicles that they would replace. While reasonable to expect that EV technology will continue to advance to the point where MD-HD EVs are on par or superior in cost and performance to internal combustion vehicles, perhaps quite quickly, the current state of the market is such that the proposed regulations that begin to affect MD-HD purchasing for “high priority fleets” in 2024 could represent a significant cost and performance penalty in a regulatory and infrastructure context that is unsettled (“high priority fleets” are defined as an entity with \$50 million or more in gross annual revenue or a fleet who owns, operates, or controls 50 or more vehicles under common ownership and control).

If, as seems likely in the short term, firms that operate “high-priority fleets” are faced with additional costs that affect their operations, we could see a shift to smaller firms that are better able to control costs. These smaller firms would then likely raise rates as well responding to increased demand. The result being higher costs for all shippers, and an unearned advantage to smaller shipping firms.

In the longer term, it seems likely that costs would converge to the baseline, and perhaps even decline in comparison, if the ACF regulation encourages quicker adoption of ZE trucks that prove to have lower Total Cost of Operation (TCO) due to technological improvement.

Faced with higher shipping costs, companies will respond in different ways. It is hard to imagine firms abandoning manufacturing infrastructure due to potentially modest and likely short-to-medium-term increases in shipping costs (especially as shipping costs have proven volatile historically due to variations in fuel costs and driver shortages). But it could dampen future investments in the CA-BC border region if manufacturers see a difficult regulatory environment.

³² [SANDAG - Regional Medium-Duty & Heavy Duty ZEV Blueprint](#)

More likely, firms would also seek alternative shipping routes that bypass California. This could lessen both the costs and benefits of the rule, but would disadvantage business, including warehouse and distribution workers in California, resulting in economic losses. Under any scenario in which the rule causes higher shipping costs, there will be some decline in marginal economic activity, loss of jobs/economic output locally and nationally, and an accompanying rise in prices throughout the chain from producer to consumer. These losses may or may not be modest in comparison to benefits.

Questions with Assumptions of Economic Impacts in Existing Policy

Stakeholders have raised several questions with the economic assumptions included in CARB's proposed ACF rule. The [MD-HD ZEV Needs Assessment Report](#) included a TCO analysis which suggests that despite the higher upfront costs for EVs, even in the relatively near future the total costs of operation will be lower when reduced fuel/energy and maintenance costs are factored in over the life of the trucks. This analysis seems to assume that the operational capabilities (range, capacity, etc.) of available or to be available vehicles are comparable, although it stresses that the technology for long-haul tractors lags behind others. In addition, the report notes that the production of ZE MD-HD vehicles was affected by production delays caused by supply chain disruptions during the COVID-19 pandemic. This effectively limits the availability and options of vehicles and is consistent with observations of affected firms, who indicated that available battery EVs lack range/fueling/weight capabilities to meet existing needs. It is also important to note that many of the incentive programs to defray the cost of the ACF program in the TCO calculations are not available to Mexico-based firms.

Thus a complete assessment of the costs of the proposed regulations would need to include both the increased purchase and infrastructure cost of the ZEV vehicles, an assessment of the reduced fuel/energy and maintenance costs, but also an accounting of the increased operational costs which could include (at least in the short term) reduced range resulting in higher refueling time/costs or reduced ability to serve clients, reduced capacity requiring more trucks per firm, and increased training time. Such an analysis would also need to account for the bi-national context of ZEVs, infrastructure, available incentives, and energy costs. Since bi-national trucking is also a long-haul industry, the differences between state-level policies must be considered as well.

A broader benefit-cost analysis would likely need to include the costs of public fueling infrastructure along with the type and deployment of the infrastructure versus a baseline. This is challenging due to a variety of unknown factors related to the differences between battery electric and hydrogen technology, if one will prove to be the dominant technology, or if a mix of the two will develop. The timing of both costs and benefits also impacts results. For example, a regulation with high upfront measurable costs that produces benefits further in the future will perform worse than a regulation with the same costs that produces benefits immediately. This timing aspect is particularly confounding in this context, as the ZEV technology is changing so rapidly, making cost (and to a lesser extent, benefits) projections difficult. Additionally, although air quality benefits for communities that trucks travel through are immediate, emissions benefits are measured as the difference between the baseline and emissions under a new policy over time and then monetized.

An additional complicating factor expressed by stakeholders is that certain “high-priority fleets” will have to begin to comply with the regulations in 2024, while smaller firms have a longer window. There is a question of why the 50-truck threshold was chosen, and whether it represents an appropriate inflection point for differential treatment in an economic context; is the industry structured in such a way that 50+-truck firms are better able to handle increased costs on a per-truck basis? These uncertainties are heightened in a cross-border region, where the Mexican ZEV context is considerably different, both in terms of regulations and infrastructure. To accurately reflect this difference for both benefits and costs, it will be important to know the structure of the industry, and what percentage of the fleet will fall into the “high-priority fleets” category.

While benefit-cost analysis seeks simply to quantify the benefits and costs of a policy, economic impact analysis seeks to take a broader view. Economic impact analysis takes the results of benefit-cost analysis and translates the increased costs and benefits into changes in economic activity. In the context of ACF, economic impacts could go up and down the supply chain as transportation costs are likely to increase, at least in the short-term for high-priority fleets. Air quality and health benefits, while real and important are difficult to measure from an economic standpoint. Below is a table that summarizes some considerations when estimating the economic impacts of the proposed ACF rule.

	How Calculated	Considerations
Increased costs to trucking companies	<ul style="list-style-type: none"> • Difference between baseline and costs under new policy over time. • Must account for changes in capital, fuel, maintenance, operations, and residual value. <ul style="list-style-type: none"> ▪ Understand cost differences between “high priority” fleets and non-high priority. 	<ul style="list-style-type: none"> • Both policy and baseline costs are difficult to measure in a context of rapidly changing technology. • The policy itself could impact technological advancement.
Costs for public fueling infrastructure	<ul style="list-style-type: none"> • Difference between baseline costs and costs under new policy over time. <ul style="list-style-type: none"> ▪ Differential costs between battery EV and HFCV fueling 	<ul style="list-style-type: none"> • Policy and baseline costs are difficult to measure in a context of rapidly changing technology. • The policy itself could impact technological advancement.
Reduced Emissions	<ul style="list-style-type: none"> • Difference between baseline and emissions under new policy <i>over time</i>, then monetize. 	<ul style="list-style-type: none"> • Policy and baseline emissions are difficult to measure in a context of rapidly changing technology.

Considerations to Improve Zero Emission Transition

There are various projects and programs that governmental agencies can implement to ease the burden on border communities during the ZE freight transition. The suggestions that emerged from this research include infrastructure improvements, different types of incentives, pilot projects/programs and training. Considerations presented emerged from interviews with freight stakeholders and do not necessarily indicate policy positions of SANDAG or other agencies that co-authored this report.

Build ZE Infrastructure Near, at, and South of the Border

Refueling/charging infrastructure was cited repeatedly by interviewed trucking companies as critical to transitioning to ZE freight. Not only are there too few fueling stations, but companies point out that the region needs redundancy in the supply of stations in case any station goes offline reducing supply and unable to meet demand. Cooperation with Baja California could be expanded to ensure that by 2035 there is adequate EV charging infrastructure south of the U.S. border to support the charging requirements of battery electric trucks and other ZE inter-modal cargo transport. Here, financing could prove critical so co-financing opportunities should be explored through the North American Development Bank (NADBank).

New ZE infrastructure presents several opportunities, including creation of jobs and coordination with broader regional efforts to implement ZE infrastructure, such as SANDAG's work with the Port of San Diego and California Energy Commission to develop a regional Blueprint for MD-HD ZE vehicle ZE infrastructure and the San Diego and Imperial County Sustainable Freight Implementation Strategy currently under development.

Reduce Border Wait Times

San Ysidro is the busiest land POE in the Western Hemisphere and Otay Mesa is the busiest commercial land POE in California, ranking 2nd among all U.S.-Mexico border crossings in total truck volume (2019). At the San Ysidro POE, cars regularly wait 2-4 hours traveling northbound in general lanes and at Otay Mesa trucks in regular lanes experience 2-4 hour wait times. Long waits lead to excess idling that contributes to air pollution and strains vehicles with limited and costly fueling/charging requirements. There are opportunities to work with federal partners to prioritize reducing border wait times at existing border crossings and at the future Otay Mesa East, where congestion pricing is planned to achieve an average 20-30 minute wait time goal. Collaboration should continue with federal agencies to encourage efficient processing of trucks and cars across the border.

Streamline Permitting

Permit streamlining for charging/fueling infrastructure was suggested. This can include government fast-tracking station permits and/or exemptions from environmental permits (e.g., California Environmental Quality Act and National Environmental Protection Act) for station development or other fueling infrastructure.

Use Creative Tolling

There may be an opportunity to demonstrate truck-only toll lanes in the Otay Mesa area. Although many trucks crossing the border northbound are anticipated to have destinations in Otay Mesa, trucks destined for points further north could benefit from reliable through travel. A potentially significant truck route for the future is from Otay Mesa East POE to the Port of San Diego's marine terminals and adjacent rail yards via SR 11, SR 905, and I-5, and Harbor Drive. Safe and reliable travel achieved through truck-only toll lanes between these gateways could encourage greater use of the route.

Clean truck toll discounts could be piloted in areas most impacted by emissions, such as Assembly Bill 617-designated Portside, International Border, and Calexico-El Centro-Heber Communities. This strategy suggests air quality improvements, but the loss of revenue from commercial vehicles should be weighed carefully. Policymakers should consider that toll discounts may be preferable to exemptions since discounts can be changed over time according to the needs of the incentive program. For example, it could be acceptable to grant ZE trucks toll discounts in the near term, but those discounts could be reduced or eliminated as these vehicles become the focus of incentives and discounts.

Focus on Hydrogen Technology

Several interviewees suggested hydrogen technology as an alternative to electric trucks because of their longer range, reduced refueling time, and lighter weight. One company has invested in several hydrogen vehicles after their research revealed better performance compared to electric. It was suggested that hydrogen fueling stations are lacking in San Diego, but there are two stations that have allowed companies to shift to hydrogen with minimal disruption to their supply chains. One challenge with hydrogen technology is that hydrogen production facilities have a higher upfront cost having to be built "at scale" while charging can be built incrementally.

Explore Specific Exemptions

One business owner proposed exemptions for businesses based on what percent of their route was inside of California. This kind of exemption would recognize that for some trips originating in Mexico, California represents a very small portion of their trip. Another idea is to develop an exemption for companies based in Mexico that have no infrastructure on the Mexico side, and that may not have the grid capacity to put in electric charging stations for trucks. Finally, if a company is certified with CTPAT both governments may benefit from delaying or exempting CTPAT trucks and supply chains from regulations. These kinds of creative exceptions that recognize current challenges faced by the border region could be explored.

Provide Expanded Incentives

Discussions with shippers and carriers revealed the need for expanded incentives to help smooth the transition to ZE freight, especially along the border. Interviewees cited the lack of grants for trucks purchased in Mexico (despite the requirement that Mexican plated trucks must be purchased in Mexico). With the significantly higher cost of purchase for ZE vehicles, grants at the point of sale would reduce the negative impact on businesses. Incentives can be expanded to companies doing business in Mexico or for vehicles with significant North American content. Small businesses may have unique difficulties with purchasing ZE trucks and unable to take the time to seek out grants/incentives and to know the process of working with public agencies (applications, reporting, etc.) nor which agencies are responsible for which programs.

Consider Overweight Corridors

Another potential incentive would be to design and implement overweight corridors at the U.S. side of the border for incoming ZEV trucks from Mexico, where maximum weight limits are higher than in the U.S. These corridors can be temporary in the Otay Mesa area to accommodate heavier ZE trucks and be free of charge. The corridor could extend to the Port of San Diego Working Waterfront or to the Ports of Los Angeles/Long Beach. Another type of corridor could allow carriers to exceed weight restrictions via payment of a fee and funds collected could be used to maintain and operate the system. The corridor could be designed to allow trucks to travel to consolidation/transfer facilities where cargo can be redistributed to meet U.S. weight limits prior to continuing on to destinations beyond the corridor. Allowing heavier trucks will reduce the number of cross border trips (because fewer trucks are needed to carry the same amount of cargo). Weigh in motion equipment will be installed before trucks enter the U.S. to verify axle weight limits. Overweight corridors have been implemented at other land border crossings, such as Pharr-Reynosa POE and Progreso POE in Texas, and are operating successfully. Challenges include identifying the corridor and negotiating with federal and local jurisdictions on the corridor management and use of fees.³³

Implement Pilot Projects

The Greater Nogales Santa Cruz County Port Authority, the Arizona DOT, the NADBank, and the Secretariat of Infrastructure and Urban Development of Sonora have come together with various local, industry and technology partners, to design, implement and monitor a 9-12 month pilot program that will deploy four electric trucks that will be used as an alternative to traditional combustion engine trucks for cross-border trucking operations. The program will require the installation of electric charging stations at strategic locations on both sides of the border, with consideration that backup charging stations may be required in proximity to the international boundary. Exploratory pilot programs allow new technology to be tested out while also gaining trust of industry.

Continued and enhanced cooperation with federal agencies is critical to minimizing air pollution along the border. Processing of vehicles by Customs and Border Protection and facility management by the Department of Homeland Security are both areas of potential coordination to be able to reduce wait times, increase ZE vehicle use and infrastructure, and continue to enable trade and economic growth. Reduction in wait times at all POEs is critical to reduce idling and opportunities to work with the federal government to incentivize faster processing at existing and future POEs should be considered.

³³ Caltrans. February 2021. California-Baja California 2021 Border Master Plan.

Create Appointment System for the Border

Another pilot program in Imperial County is being proposed through a grant request and would implement an Appointment/Arrival Window System with predetermined time slots and predictable wait times for commercial vehicle and cargo shipment processing at POEs. A staging area near the POE could allow trucks to park and stop idling while waiting for their appointment. Information on the appointment status will be provided to drivers at the staging area and enroute. This would require the availability or conversion of a lane at the POE for shipments that have appointments and associated staging/inspection areas. An appointment system would also have to be procured for use at the POE, with adequate predictive processing times. A staging area near the POE needs to be adequate and provide electrified truck stops to reduce idling and driver facilities. This should be considered also at existing Otay Mesa and the future Otay Mesa East Port of Entry.

Strengthen Training for Drivers and Mechanics and Outreach

Interviewees emphasized the need for additional training for their drivers and mechanics. ZE trucks use new technology, require different handling on the road and have different maintenance needs. Another suggestion at a broader policy level is to consider formalizing a tri-state memorandum of understanding to encourage Spanish language courses to certify EV Technology Technicians in the Baja California Peninsula modeled after courses already developed by the California Community Colleges. One unique idea suggested is implementing a truck sharing program that would not only allow drivers to use clean air vehicles but will familiarize and educate drivers with the technology before requiring that they “invest their livelihoods.” Building trust with the technology can reduce anxiety and encourage adoption of ZEVs.

Finally, additional outreach and training with cross border shippers and carriers about the impacts of air pollution to the cross-border community can provide opportunities to facilitate the transition to ZE freight. Building partnerships with freight stakeholders in the border region will also contribute to more effective and meaningful regulatory initiatives.

Appendix A: Summary Factsheet

The CA-BC “Freight Triangle” connecting cross border trucking to the Ports of Los Angeles/Long Beach and Inland Empire distribution centers, generates billions in international trade each year. This economic sector faces unique challenges with transitioning to zero emissions. The table below presents a summary of barriers and challenges that emerged from this research and interviews.

Transition to Zero Emission Freight: Summary of Challenges and Opportunities

Policy Challenges	Economic Impacts	Supply Chain Issues
Rules impact medium companies while smaller ones remain unregulated, creating unfair distribution of benefits. (p. 16)	Significantly higher vehicle cost can have significant impacts for shippers, carriers, and consumers. (p. 19-21)	Economic impacts could go up and down the supply chain as transportation costs likely to increase. (p. 20-21)
Mexican trucks have little support for zero-emissions at their base of operations and the grid is not equipped to handle charging. (p. 13)	Higher shipping costs can result in decline in marginal economic activity, loss of jobs/economic output, and rise in prices from producer to consumer. (p. 19-21)	ZE trucks require more refueling time, complicating requirements for drive time, routes, and customs certifications. (p. 16-17)
Regulations have not felt collaborative and additional outreach and support for those affected is needed. (p. 19)	Businesses consider leaving California and crossing the border in Arizona where regulations are less stringent. (p. 17 and 20).	Weight restrictions would require displacing goods to make up for the excess weight of ZE trucks. (p. 17)
Inadequate charging/fueling stations in the border region and questionable energy supply for ZEVs. (p. 18)	Border delays for freight result in billions of forgone economic output each year. (p. 22).	Without ZE rules nationwide, trucks traveling to other states will have little support for charging. (p. 16)
ZE regulations are not yet aligning at the federal and state levels between the US and MX and CA-BC. (p. 16)	Uncertainty around ZE truck resale value, maneuverability, and technology; require driver/mechanic training. (p. 25)	Long border waits create supply chain bottlenecks exacerbated by ZE freight regulations. (p. 22)
Opportunities to Facilitate ZE Freight Transition (p. 22-25)		
<ul style="list-style-type: none"> • Build infrastructure near, at, and south of the border • Reduce border wait times • Streamline permitting • Use creative tolling • Focus on hydrogen technology • Implement pilot projects • Consider overweight corridors • Explore exemptions and incentives • Create border appointment system • Strengthen training for drivers and mechanics and outreach 		

Appendix C: Interviews and Interview Guide

Select Interviews Conducted (names are pseudonyms)

Javier Marcos, medium sized trucking company representative
Jessica Marcos, medium sized trucking company representative
Brandon Matias, medium sized trucking company representative
Tomas Rodeo, Customs Broker
Jack DeVaux, Medium sized trucking company representative
Ricardo Kamali, Mexico energy expert
Jeff Stars, large trucking manufacturer
David Tumms, large trucking company representative
Claudia Santos, media representative in the border region

Interview Guide

Truck owner/operators, drivers, brokers, warehouse

Operations/Logistics

- To start off can you describe your company for us?
- How do you fit into the industry (competitors, market share, who do you service)?
- Who are your customers?
- Fuel costs have gone up and seem quite volatile... how are you managing that? Are you able to pass on costs?
- Have your contracts been affected by the change in costs?
- Can you describe your company's trucking operations in terms of the number of trucks you own/operate/contract, where they are physically based (California/out-of-state/Mexico), and size of the company?
- Can you describe where your company's fleets are currently operating?
- What is the typical timeframe you have for turning over your trucks/ how often do you turn over your fleet? – would that change?
- What steps is your company with operations in Mexico and /or both sides of the border taking to adopt new ZEV regulations?
 - Have you heard of any incentives or grants for purchasing vehicles in the future? If so, how are you hearing about these programs?
 - How are you thinking about the total cost of ownership for ZE trucks, depending on whether they are operating primarily in the U.S. or Mexico?
- How do you expect your truck charging/parking needs to change with ZE regulations in place, in terms of physical space?
 - Is your company planning to develop charging/fueling infrastructure on privately owned land, or will you be relying on publicly available infrastructure? If operating on both sides of border, will your strategy vary on either side?
- How are these regulations affecting the operations now and in the future?
- What steps/actions are you taking to mitigate these issues, if any?

- What percentage are vehicle purchases as part of your business expenses? Will this increase with the new CA ZE rules?
- Do you anticipate there being a 1-to-1 replacement of your current trucks?
- how many ZE trucks are you likely to have to buy per year over next five years?
- Do you anticipate having any issues with timeline and delivery of trucks as a result of regs? What about issues with orders of legacy trucks to Mexico?
- Do you anticipate any mode shift from these regulations?
 - e.g. truck to rail/water
 - Are there certain products or commodities that are especially impacted (mode, routes, type of service) by regs.
- Has your company considered relocating any aspect of the supply chain due to changes in regulations?
- How will regulations determine whether your company uses separate fleets for California compared to Mexico or other U.S. states?
- How might ZE truck performance and charging/fueling needs change the routes or destinations that your company serves?
- Would your company have “fueling” needs other than the vehicle itself (e.g. power shoring, cold storage)?

Infrastructure and Government

- What actions should policymakers and/or public agencies in California and Baja California (and to a larger extent, U.S. and Mexico) take to assist in the transition to ZEV fleets?
 - How can customs agencies assist?
 - How can utilities assist?
 - How can other regulatory agencies assist (e.g. CARB, CPUC, CEC)? - How can these agencies better advertise/communicate their incentive/grant programs?
- With the ZE transition, which occupations in your company would be most impacted and do they need training?
- Are there any ideas you have to support the trucking industry to transition to ZE?

Clean Air Regulations

- What are some of the opportunities or ways in which your industry or company can gain from the new ZE regulations?

OEM (U.S./MEX)

- What challenges is your company facing in transitioning to a ZE truck fleet? e.g. technological, materials cost, uncertain market? What types of policies could improve your ability to deliver ZE trucks?

SDG&E/CRE (MX)

- Are there plans for the grid to handle the capacity of trucks being added to the system?

- Do current utility policies support development of on-site electricity generation and storage?
- What ideas do you have if any to assist with the transition to ZE?

Mexico Policy Expert

- What are the Mexican policies and regulations associated with ZE transition for freight?
 - e.g. mandates on ZE truck manufacturers/purchases
 - Any difference in weight limits for ZE trucks near POEs/marine ports
- Are Mexican policymakers taking into consideration California's regulations and availability of infrastructure when proposing policies and projects?

Appendix D: Research Team

This document was created jointly by an inter-agency and cross-departmental team organized into a Technical Working Group, Project Development Team, and support staff, including the following people at SANDAG and Caltrans (in alphabetical order):

Jose Alvarez, Aremy Barrera, Ryan Chung, Natasha Dulik, Susan Freedman, Tim Garrett, Zach Hernandez, Fernanda Herrera, Andrea Hoff, Jeff Hoyos, Danielle Kochman, Jose Marquez, Jim Miller, Brian Miller, Mario Orso, Keri Robinson, Mariela Rodriguez, Antoinette Meier, Maria Rodriguez Molina, Caridad Sanchez, Nikki Tiongco, Shelby Tucker, Hector Vanegas, and Naomi Young.

Alejandra Mier y Teran was an instrumental study advisor from the Otay Mesa Chamber of Commerce and interviewees from the freight industry and local community on both sides of the border were instrumental to this research and their participation is greatly appreciated.

Appendix E: Acronyms

Acronym	Definition
ACT	Advanced Clean Truck Rule
CA-BC	California-Baja California
CARB	California Air Resources Board
CO ₂	Carbon Dioxide
CPUC	California Public Utilities Commission
CTPAT	Customs Trade Partnership Against Terrorism
DOT	Department of Transportation
DPM	Diesel Particulate Matter
EPA	U.S. Environmental Protection Agency
EV	Electric Vehicle
FMCSA	Federal Motor Carrier Safety Administration
HFCV	Hydrogen Fuel Cell Vehicles
HLED	High-Level Economic Dialogue
ICE	Internal Combustion Engine
ICT	Innovative Clean Transit Rule
MD-HD	Medium Duty -Heavy Duty
NADBank	North American Development Bank
NAFTA	North American Free Trade Agreement
NO ₂	Nitrogen Oxides
PDT	Project Development Team
POEs	Ports of Entry
SO _x	Sulfur Oxides
USMCA	United States-Mexico-Canada Agreement
ZE	Zero Emission
ZEV	Zero Emission Vehicle