# DRAFT

# Economic Study for the Clean Truck Fund Rate

DECEMBER 2019

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## ES    EXECUTIVE SUMMARY

### Clean Truck Fund Rate

The Port of Los Angeles' and Port of Long Beach's (Ports or POLA/POLB) 2017 Clean Air Action Plan Update (2017 CAAP Update) committed to a strategy to update the Clean Truck Programs at both ports to build upon the existing, successful programs. The objective of the Ports' updated Clean Truck Programs, as stated in the 2017 CAAP Update, is to transition the current drayage truck fleet to near-zero technologies in the near-term and ultimately zero-emissions technologies by 2035.

A key component of the updated Clean Truck Programs is the implementation of a Clean Truck Fund (CTF) Rate. As proposed in the 2017 CAAP Update, beginning in 2020, a rate will be charged to the beneficial cargo owners for loaded heavy duty container trucks to enter or exit the ports' terminals, with rebates for trucks that have CARB-certified low NOx engines or better.  The added cost of this CTF Rate is expected to help incentivize the transition of drayage trucks operating at the Ports to cleaner equipment.  In order to support development of the CTF Rate, the Ports committed to conduct an Economic Study to evaluate the potential economic effects of the proposed rate on the Ports and their supply chain partners, as well as the effectiveness of the rate as a mechanism to achieve the emissions reduction goals laid out in the 2017 CAAP Update.

### Analytical Approach

Conducting an economic study of the potential effects of a CTF Rate on the movement of loaded containers by truck through the San Pedro Bay Port gateway is a very complicated endeavor. This study focuses on the impact of the rate on: 1) decisions for routing cargo and 2) truck turnover. The factors which go into these analyses are many and complex, making the exercise of accurately forecasting the potential effects of a CTF Rate difficult and prone to uncertainty.

To conduct this evaluation the Ports sought multiple sources of information:

- Previous evaluations that may be relevant to the current assessment were reviewed
- A consultant (Davies Transportation Consulting Inc.) was engaged to conduct an econometric analysis to evaluate how a range of potential rates could: (i) affect the Ports' economic competitiveness, including the potential for cargo diversion, (ii) impact the drayage industry, and (iii) generate revenue from the collection of the rate.
- The Ports evaluated the current port industry competitive environment to enhance and expand upon the technical work done by the consultant.
- Input from stakeholders in meetings and workshops

## Potential Cargo Diversion Resulting from CTF Rates

Since the Great Recession of 2007-2009, POLA/POLB have experienced growth in overall container volume but at the same time, have seen losses in market share to Canadian, Mexican, East Coast and Gulf Coast ports. Therefore, it is important that the Ports understand the potential for further cargo diversion and additional losses in market share that may follow from the implementation of the CTF Rate.

### *Diversion Conclusions from Previous Evaluations*

Previous evaluations of the diversionary impact of increased costs at the Ports have found a range of responses, depending on factors such as the cargo's destination, inland mode of transportation, total transportation costs, and cargo value. In general, these analyses agree that cargo moving intact via rail to distant destinations is more price sensitive and likely to divert than cargo destined for local markets or cargo that is handled at local transload and distribution center facilities. However, port demand elasticity estimation is made more complicated by the high variability of freight markets and rates. Professor Robert Leachman's 2010 "*Final Report: Port and Modal Elasticity Study, Phase II*", found that demand elasticity increased markedly compared to his Phase I study in 2005 due to increased rail and drayage costs at the Ports. "The fact that demand elasticity can change so much and so quickly means that even if a regulation or fee does not initially have significant consequences, it could cause diversion if other factors such as changes in intermodal rail costs and availability shift."[1]

### *Davies Study Diversion Analysis*

The technical analysis conducted by the Davies team modeled the elasticity of demand (i.e. Ports' market share) in response to changes in transit time and shipping costs, using the potential of these factors to cause diversion of cargo as a proxy for overall diversion potential.

The model estimated the price elasticity of total imports through POLA/POLB to be -0.29, meaning a one percent increase in the cost difference between gateways would result in a 0.29 percent decrease in the Port's market share. Over the range of rates evaluated, using the elasticity results, a moderate amount of diversion is expected with 17,000 TEU on the low end ($5/TEU) up to 241,000 TEU or 1.4 percent of total import TEUs diverted annually ($70/TEU).

### *Diversion Factors in Addition to Cost and Transit Time*

Regression and elasticity analysis can be very helpful in understanding how the Ports' market share has historically reacted to changes in competitive factors that impact the cost and velocity of cargo moving through this gateway. However, recent changes in the economy and/or competitive environment may influence current routing choices of cargo owners in unexpected ways. Examples include but are not limited to:

- In-port and regional development choices both in the San Pedro Bay and at competing gateways
- Vessel deployments by carriers and carrier alliances

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[1] Environmental Regulation Impacts on Freight Diversion; UC Davis Institute of Transportation Studies & Policy Institute for Energy, Environment and the Economy (November 2018)

- Supply chain reliability (e.g. truck service and rail service)
- Changes in the cargo origins and destinations for high volume cargo owners
- Geopolitics and global trade policies
- Local regulations and policies

While economic models may pick up some of these effects, many are difficult to incorporate directly into a simple quantitative analysis. In some cases data for these factors are unavailable or they are difficult to quantify. Given the potential impacts to the Ports' immediate supply chain partners and possible direct financial losses to the Ports, consideration of the potential effects of a CTF Rate should be undertaken with caution and careful deliberation.

*Export Cargo Diversion*

Due to data constraints, a quantitative estimate of the price elasticity of export (outbound) cargo was not conducted by the Ports. However, a CTP Rate could have an impact on outbound cargo since an estimated 54 percent of the export container traffic consists of commodities that are sourced locally within the Ports' natural hinterland and are delivered to the Ports by truck. Agricultural exporters in the Central Valley are generally trucked to POLA/POLB or the Port of Oakland, so their choice of port could be influenced by any change in drayage cost due to the CTF Rates. Further, commodities that are sourced away from the San Pedro Bay area that arrive by rail and are transloaded locally would also be exposed to the CTF Rate, and could be at risk for diversion.

*Stakeholder Input on Diversion Potential*

Initial input on diversion has come from cargo owners and trucking companies, who have urged that great care should be taken to avoid diversion of cargo due to increased fees. The Ports anticipate further input on this issue as additional stakeholder meetings occur.

## Impact of the CTF Rates on the Drayage Sector

*Historical Impacts of Clean Truck Rate on Drayage Operations in the San Pedro Bay*

The original Clean Trucks Program included a fee on trucks that did not meet the 2007 engine emissions standards established by the Environmental Protection Agency (EPA). To understand the success of the Ports' original Clean Trucks Programs, and the previous fee structure, it is important to consider the factors that existed at the time the programs were being implemented. An understanding of these factors can provide insights and inform updates to the programs being considered today. These factors include:

- Concurrent development and implementation of the California Air Resources Board's (CARB's) Drayage Truck Regulation, followed by CARB's Truck and Bus Regulation, which established in-use requirements for Heavy-Duty trucking activities throughout the state.
- Meeting the requirements of the previous Clean Trucks Programs did not require significant technological advancement.
- The cost differential for a truck meeting the new engine standard was not significantly greater

than typical new truck prices at the time, and an available used truck market developed over the span of time that the Ports' requirements were being implemented.

▪ Financing was available through Licensed Motor Carriers (LMCs).

▪ Many truck owners chose to replace their older trucks early under the Ports' programs because of a combination of factors including familiarity with the technology, lower cost differential, available financial assistance, desire to avoid the fee, and the upcoming state regulatory requirement to replace their truck in a very short period of time.

▪ Lastly, early in the implementation of the Ports' Clean Trucks Programs, several larger, well capitalized national trucking companies entered the drayage market with new trucks meeting the 2007 EPA engine standards, leading to significant early transition of the fleet. Within a year however, most of these new trucks had been removed from the local drayage service and redeployed elsewhere because they were uncompetitive from a cost perspective against new trucks entering the drayage service that had been purchased using incentive funds provided by the Ports and the air quality regulatory agencies.

### *Davies Study Assessment of the Impact of CTF Rates*

The Davies team used a model to estimate the potential impacts of the CTF Rate under various assumptions regarding CTF Rate levels and capital subsidies. This model assumed that rates would be borne by the truckers and not the BCOs.

The modelling results led to the following findings:

▪ Due to the significant cost difference between conventional diesel-powered trucks and the anticipated NZE and ZE alternatives, the analysis showed that a rate, within the range analyzed, applied to trucks at the Ports as part of the delivery/pick-up transaction would not be sufficient to induce a change to purchase NZE and ZE trucks. Instead, the addition of an incentive or financial subsidy to reduce the cost of clean truck alternatives is necessary to make NZE and ZE alternative competitive in the market.

▪ None of the scenarios modelled by the consultant result in a 100 percent ZE fleet by 2035. Scenario 3 achieves 53 percent ZE by 2035; Scenario 4 achieves 75 percent ZE by 2035; and Scenario 5 achieves 85 percent ZE by 2035.

▪ The model identified that the cost for the full subsidies would be in the range of $2.4 to $3.8 billion, and that a fund in that amount could potentially be generated by a CTF Rate in the range of $35 to $50 per TEU. It is critical to keep in mind however, that the model assumed high capital costs and high subsidy amounts. The resulting estimate of subsidies required, as indicated by the model, could therefore be double to triple the amount that may actually be needed, based upon the level of subsidies that have been made available today through other funding agency programs.

*Additional Economic Factors*

Starting in early-2018, the Trump administration began implementing a series of tariffs to apply additional duties on a variety of goods imported into the United States. More than 97 percent of imports from China through our ports – the top categories are furniture, apparel, electronics and footwear – are now subject to tariffs.  U.S. tariffs against China have triggered retaliatory tariffs on nearly 97 percent of all U.S. exports to China.  As a result of this national trade policy, the Ports have observed significant volatility in volumes of import and export cargo. Tariffs create uncertainty, and the economy does not respond well to uncertainty; furthermore, the longer the trade war goes on, the harder it will be to reverse the damage and regain the lost business.[2]

*Stakeholder Input on the Impact of CTF Rates*

Input on rates has come from many stakeholders. Some trucking companies have urged a higher rate to help pay for new trucks. Other stakeholders seek a higher rate as an incentive to push truckers into newer equipment. On the other side of the discussion, some stakeholders are worried about diversion, while still others argue that such a rate may not be lawful. We look forward to further input on this issue.

## Conclusions

The Davies analysis, consistent with previous diversion analyses, indicates that a CTF Rate between $5 and $70 per TEU would have diversionary impact of up to 1.4 percent of the total imported TEU volume through the Ports. The Davies analysis notes that at rates higher than $75 per TEU, drayage from the Port of Oakland becomes cost competitive with drayage from the Ports, which marks the boundary where local and transload to truck cargo is no longer inelastic and thus also subject to diversion.

The Davies analysis also concludes that due to the significant cost advantage that older trucks have over new trucks (whether diesel, NZE, or ZE), no CTF Rate within the range studied is high enough on its own to make newer vehicles economically competitive with the existing fleet. Newer trucks, especially NZE and ZE technology trucks will only be competitive with the incumbent fleet if their purchase is subsidized.

In addition to the competitive factors of time and cost in the 2012-2017 reference period studied by Davies, the Ports face even greater competitive threats driven by the further development of ports in the US Southeast, the accelerated shift of manufacturing in Asia from China to Southeastern Asia, and significant tariffs on trade with China that have put additional pressure on shippers' margins and have made them less able to absorb or pass on additional costs. The Ports' experience with cargo diversion during their 2014/2015 congestion event shows that once shippers have invested in moving their cargo through new gateways, it is extremely difficult to get that cargo back.

Given these economic considerations:

- charging a high CTF Rate has no more impact on turning over the truck fleet than charging a low CTF Rate;

- a high CTF rate results in more cargo diversion than a low CTF Rate;

- changes in costs elsewhere along the supply chain in the future could dramatically alter the demand elasticity for the Ports;

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[2] https://www.portoflosangeles.org/tariffshurt

- the majority of shippers using the Ports are facing unprecedented cost pressures; and

- lost cargo cannot easily be recaptured;

the most prudent course of action would be for the Ports to exercise caution in setting a CTF Rate, and follow a process whereby they start at a lower CTF Rate for the purpose of generating funds to support the subsidized purchase of NZE and ZE vehicles as the existing truck fleet is turned over, while monitoring the CTF Rate's impact on Port competitiveness. A low CTF Rate that is shown to have no competitive impact on the ports could safely be incrementally raised; conversely, it may be impossible to undo the damage of a CTF Rate that is initially set too high.

## 1.0    INTRODUCTION

### 1.1    Clean Truck Fund Rate

The Port of Los Angeles' and the Port of Long Beach's (Ports or POLA/POLB) 2017 Clean Air Action Plan Update (2017 CAAP Update) committed to a strategy to update the Clean Truck Programs at both ports to build upon the existing, successful programs. The objective of the Ports' updated Clean Truck Programs, as stated in the 2017 CAAP Update, is to transition the current drayage truck fleet to near-zero technologies in the near-term and ultimately zero-emissions technologies by 2035.

A key component of the updated Clean Truck Programs is the implementation of a Clean Truck Fund (CTF) Rate. As proposed in the 2017 CAAP Update, beginning in 2020, a rate will be charged to the beneficial cargo owners for loaded heavy duty container trucks to enter or exit the ports' terminals, with rebates for trucks that have CARB-certified low NOx engines or better. The added cost of this CTF Rate is expected to help incentivize the transition of drayage trucks operating at the Ports to cleaner equipment. The collected CTF revenues would be used to fund incentives to promote turnover to a cleaner drayage truck fleet at the Ports. In order to support development of the CTF Rate, the Ports committed to conduct an Economic Study to evaluate the potential economic effects of the proposed rate on the Ports and their supply chain partners, as well as the effectiveness of the rate as a mechanism to achieve the emissions reduction goals laid out in the 2017 CAAP Update.

### 1.2    Analytical Approach Overview

Conducting an economic study of the potential effects of a CTF Rate on the movement of loaded containers by truck through the San Pedro Bay Port gateway is a very complicated endeavor. This study focuses on the impact of the rate on: 1) decisions for routing cargo and 2) truck turnover.

These include calculations of cost and time to market, reliability and predictability, service and support, port and regional infrastructure, desire of cargo owners to diversify or consolidate their logistics network, geopolitics and global trade policies. Additionally, changes in regulatory requirements that can affect different elements of the supply chain, shipping line strategies and alliances, and changes in manufacturing centers, all enter into the decision making process. Given this complexity, the ability to accurately forecast the potential effect is difficult and prone to uncertainty.

To conduct this economic evaluation, the Ports sought multiple sources of information:

1.  First, it was important to review previous evaluations that may be relevant to the current assessment. The number of similar studies that have been conducted to predict the potential effect of an increase in cost on the potential for cargo diversion and effects on the trucking industry for the San Pedro Bay market is limited. However, the work that was available was taken into consideration. Chief among these were various studies prepared by Leachman, Corbett, and Moffatt & Nichol/BST Associates.

2. Second, for the variables of cost and transit time that could be quantitatively modelled through a statistical analysis to provide an estimate of the potential effect of the rate, the Ports engaged a consultant (Davies Transportation Consulting Inc.). Davies conducted an econometric analysis to evaluate how a range of potential rates, from $5/TEU to $70/TEU, charged to the beneficial cargo owners per loaded container move by truck if the truck is not near-zero or zero-emissions could: (i) affect the Ports' economic competitiveness, including the potential for cargo diversion, (ii) impact the drayage industry, and (iii) generate revenue from the collection of the rate.

3. Third, the Ports have extensive expertise in the factors affecting the supply chain, and well-established relationships with the cargo owners and trucking industry that will be directly affected by the proposed rate. Therefore, relying on our own resources, expertise and relationships to provide an understanding of the potential effect of the rate was also taken into account. As a part of this step, the Ports also valuated the current port industry competitive environment to enhance and expand upon the technical work done by the consultant pertaining to cargo diversion.

4. Fourth, Port staff carried out a qualitative evaluation of the geopolitical climate and its associated risks, recent shifts in domestic trade policy, and ongoing technological change in the transportation and distribution industries.

5. And finally, the Ports have conducted outreach to stakeholders to seek their input and expertise on these issues through conference calls, meetings and workshops. This input is very important and will be of particular interest to our Boards of Harbor Commissioners as they consider a potential Clean Truck Rate in the coming months.

## 1.3    Structure of the Report

This report considers a broader evaluation of trends affecting the Ports' market share, relying on knowledge of the industry combined with a technical econometric analysis. The remainder the report is structured as follows: Section 2 describes the San Pedro Bay ports' historical market shares and factors contributing to the decline in market share. The purpose is to provide context for a high level description of the issues related to cargo diversion.

The Davies assessment of potential cargo diversion is reviewed in Section 3 and is followed by a discussion of factors that, in addition to transit time and cost, affect shipper gateway choice (Section 4). Section 5 is a review of stakeholder input on diversion; the potential for export cargo diversion is considered in Section 6. Section 7 summarizes Davies' analysis of the impact of the CTF Rates on the drayage sector and discusses the truck turnover modeling. The report concludes with Section 8, which is a summary of the results of the analysis.

## 2.0    POTENTIAL IMPORT CARGO DIVERSION RESULTING FROM CTF RATES

### 2.1    Historical POLA/POLB Market Share

Since the Great Recession of 2007-2009, POLA/POLB have experienced growth in overall container volume but at the same time, have seen losses in market share to Canadian, East Coast and Gulf Coast ports. The figure below shows the POLA/POLB market share and those of other major U.S. container ports for this traffic from 2003 to 2018, based on data from the U.S. Census Bureau. The POLA/POLB market share has declined steadily since 2003, falling from 55.7 percent in 2003 to 44.3 percent in 2018. Therefore, it is important that the Ports understand the potential for further cargo diversion and additional losses in market share that may follow from the implementation of the CTF Rate.

**Figure 2.1 U.S. Ports' Share of Pacific Rim Containerized Imports 2003-2018**
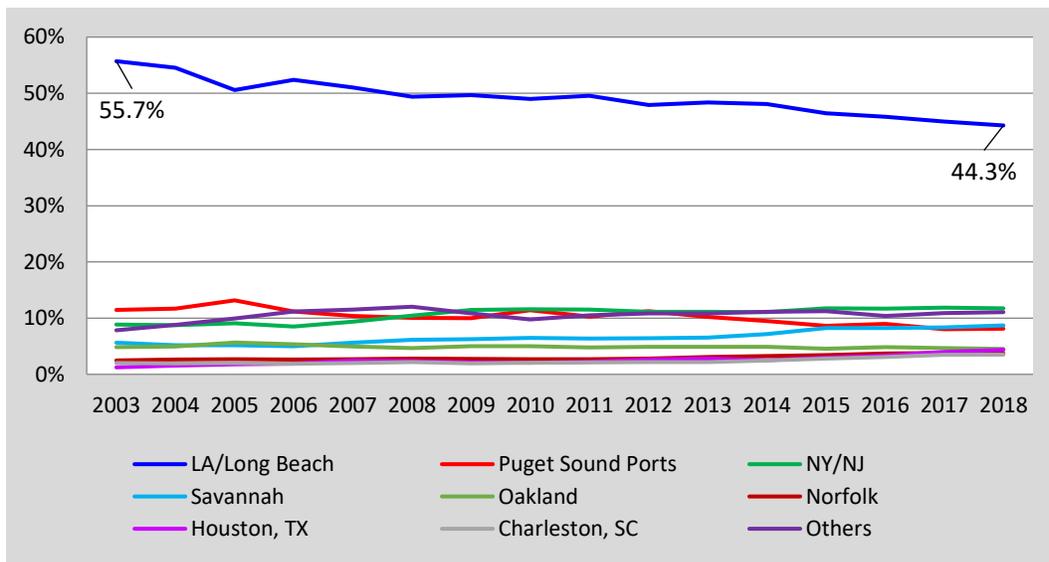


The competing U.S. ports that have experienced the largest increase in market share are the ports of Savannah, Norfolk, New York/New Jersey, Charleston and Houston. The largest increase in market share of U.S. containerized Pacific Rim imports has occurred outside of the U.S. at the Canadian West Coast ports of Vancouver and Prince Rupert.

### 2.2    POLA/POLB Import Traffic Categories

POLA/POLB import traffic is typically divided into categories based on the mode and/or destination of the cargo. The addition of a CTF Rate will impact each of these categories differently. The categories include:

- Inland Point Intermodal (IPI): cargo shipped intact in marine containers by rail to inland destinations. This traffic can be further divided into on-dock IPI which includes containers loaded

to rail at the Ports, and off-dock IPI which consists of containers transferred by truck to off-dock railyards including UP's Intermodal Container Transfer Facility (ICTF) and City of Commerce intermodal yard, and BNSF's terminal at Hobart.

- Transload to Rail: cargo unloaded from marine containers in the Los Angeles/Inland Empire region and reloaded to larger (53-foot) domestic containers and then delivered to the off-dock rail yards for rail shipment to inland destinations.

- Transload to Truck: cargo unloaded from marine containers in the Los Angeles region and reloaded to truck trailers and then delivered to inland destinations.

- Local: cargo trucked directly from the Port terminals to an inland destination.

The CTF Rate will be applied to movements of loaded containers in and out of the Ports by truck. Therefore, transloaded and local cargo will be directly affected by the proposed CTF Rate. And, while potentially not directly affected, IPI cargo may also be influenced by the CTF Rate over the long term.

**Figure 2.2 POLA/POLB Traffic Shares by Segment 2018**
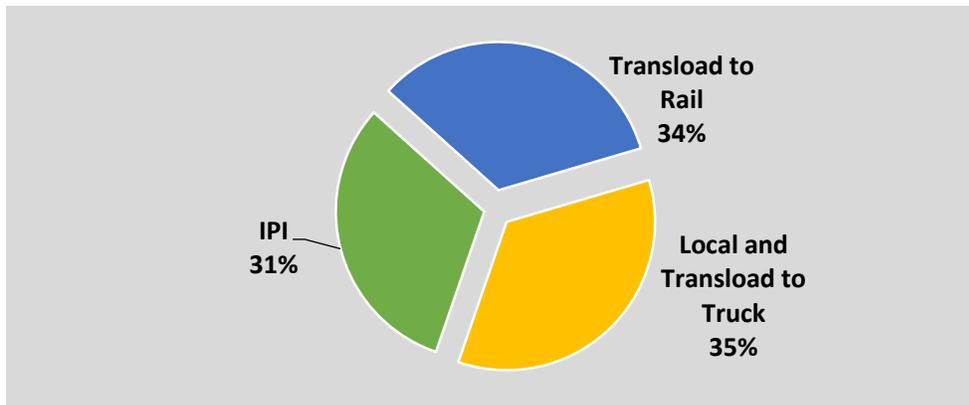


## 2.3    POLA/POLB Inland Point Intermodal (IPI) Market Share

In 2006, total IPI (inbound and outbound) containers through POLA/POLB peaked at 43 percent of total volume. By 2018, the share of IPI traffic had declined to just 31 percent.

- In absolute terms, although total POLA/POLB volumes have increased from 15.8 million TEU to 17.5 million TEU between 2006 and 2018, IPI volumes have actually decreased by 1.6 million TEU.
- This annual IPI loss from 2006 to 2018 equates to a loss of $969 million ($2019) in revenue to POLA/POLB (this does not include lost Alameda Corridor revenue).

There are a number of factors that have contributed to the decline in IPI traffic, many of which cannot be explicitly quantified but nonetheless contribute to an environment of cost uncertainty and the perception on the part of shippers of POLA/POLB unreliability. Additionally, there are a number of developments that have made other port gateways more competitive against POLA/POLB. For example, the events listed below have had a direct or indirect impact on the diversion of IPI cargo between 2006 and 2018.

- 2002: Alameda Corridor opens with fees paid by the BNSF Railway and Union Pacific Railroad (UPRR)
- 2002: West Coast labor lockout - complete shutdown of the ports for ten days. Many shippers changed their logistics system by shifting import containers to other ports throughout North America
- 2004: UPRR operational problems, causing delays to and from POLA/POLB
- 2005: PierPass fee initiated
- 2005: California Air Resources Board (CARB) Cargo Handling Equipment Regulation approved requiring phase in of cleaner equipment through 2017
- 2006: The original San Pedro Bay Ports Clean Air Action Plan (CAAP) was adopted by POLA/POLB, outlining the strategy for the Clean Truck Programs and associated fee which was in effect from 2008 to 2012
- 2007: Port of Prince Report expansion combined with favorable rail rates from the Canadian National Railway led to significant diversion of IPI containers from POLA/POLB
- 2007: CARB At-Berth Regulation approved requiring container, passenger and refrigerated-cargo ships to reduce emissions at-berth starting in 2014
- 2008: Affects of the Great Recession begin to result in cargo volume reduction (December 2007 to June 2009)
- 2008: CARB Drayage Trucks at Seaports and Railyards and Truck and Bus Regulations approved
- 2014/15: Terminal congestion related to arrival of larger vessels, chassis dislocation and equipment imbalance and labor contract negotiations
- 2016: Panama Canal Expansion completed
- 2018: SCAQMD Board direction to proceed with facility-based measures, including pursuit of a Memorandum of Understanding with the Ports, and Indirect Source Rules for railyards and warehouses/distribution centers
- 2018: Federal tariffs implemented on a variety of goods being imported into the United States primarily from China, POLA/POLB's largest trading partner, impacting 53 percent of POLA/POLB imports and 29 percent of POLA/POLB exports
- 2018: PierPass 2.0 implemented
- 2019: The Bayonne Bridge (NY) raised, which allows larger container ships to access terminals in NY/NJ.

## 2.4    Previous Diversion Assessments in the San Pedro Bay

In 2005, Professor Robert Leachman analyzed long-run demand elasticity at the Ports in his "*Final Report: Port and Modal Elasticity Study,*" determining what fee levels would induce diversion to other ports or transportation modes. He concluded that $60/FEU on inbound loaded containers at the Ports would cut both total import volume and transloaded import volume at the Ports by approximately 6 percent.

In 2006, James Corbett, James Winebrake, and Erin Green assessed whether freight diversion would be likely to occur if port user fees were assessed at California ports in their study "*Cargo on the Move through California: Evaluating Container Fee Impacts on Port Choice.*" They studied port user fees of about $30/TEU, and found that less than 1.5 percent of voyages to California ports would divert, and that a fee would have to be $40/TEU before any voyages to POLA or POLB would divert.

In 2007, Moffatt & Nichols and BST Associates assessed the effects of higher drayage costs at San Pedro Bay Ports related to the Ports' Clean Truck Program. This report found an elasticity of approximately -1.0 for discretionary cargo moving inland via intermodal rail or truck, with or without transloading, meaning a 1.0 percent in increase in relative transportation costs would result in -1.0 percent loss in port gateway market share. For containers trucked to or from the local region's warehouses, distribution centers and retailers, elasticity was estimated to be about -0.3, meaning each 1.0 percent increase in relative transportation costs would result in -0.3 percent decline in market share.

In 2010, Leachman updated many of the datasets and methods used in his 2005 work in his "*Final Report: Port and Modal Elasticity Study, Phase II*". He found that demand elasticity at the Ports increased compared to his Phase I analysis in 2005 because the costs of rail shipping and drayage in the Ports had increased significantly. His report emphasized that this change provides "a cautionary lesson that elasticity of imports can change markedly in the span of only several years, suggesting the need for continuing analysis to keep up with the dynamics of industry and global economics." Even if a fee or regulation does not initially have significant consequences, it could cause diversion if other factors later shift.

In 2018, Sam Fuller, Kelly Fleming, and Austin Brown of the UC Davis Institute of Transportation Studies and Policy Institute for Energy, Environment and the Economy published an issue paper on "*Environmental Regulation Impacts on Freight Diversion*". Policy Institute staff reviewed the Corbett and Leachman studies as part of their investigation into shipping cost and demand elasticity. Noting the instability of freight markets and rates that was also identified by Leachman, they reported that this instability means that port demand elasticity can change quickly and dramatically, and that caution should be used in applying older studies to current situations. In their conclusions, they state "[i]f demand elasticities for California ports are shown to be relatively stable over time, environmental polices resulting in higher cost increases for shipping companies may be tolerable. A more conservative approach may be warranted if elasticities are shown to be more volatile, lest future elasticity changes result in greater levels of diversion than would be expected today. High levels of diversion could become problematic from an environmental as well as an economic perspective. If an environmental regulation causes high levels of diversion, it is possible that impacts could be net negative if the environmental consequences of that diversion (e.g. increased fuel consumption) that the regulation triggers exceed the environmental benefits that the regulation achieves."

## 3.0     DAVIES ASSESSMENT OF POTENTIAL CARGO DIVERSION DUE TO THE CTF RATE

The technical analysis conducted by Davies used a linear regression model to estimate import cargo elasticity of demand (i.e. Ports' market share) in response to changes in transit time and shipping costs.

### 3.1     Import Cargo Elasticity

A regression model was used to estimate the elasticity of import cargo transiting the San Pedro Bay (SPB) ports. The purpose of this model was to estimate the potential for cargo diversion at various levels of a CTF Rate. The model used for the analysis was similar in functional form to models used in previous diversion studies conducted by both this consultant and others.

> **What is Regression Analysis?**
>
> *A regression equation is used to find out what relationship if any exists between sets of data. It is a way to mathematically model events that happen in the real world and all things equal, allows us to predict future events.*

The model analysed the relationship between transit time and cost (independent variables), and market share (dependent variable) to answer the question: how do changes in the independent variables affect Port market share, specifically changes in cost resulting from implementation of a CTF Rate? The regression output revealed that transit time and cost explained a meaningful amount, but *not all*, of the historical changes in SPB market share.

In economics, price elasticity of demand ($E_d$) is a measure that shows how demand responds to a change in the price of a product or service. When the quantity demanded for something changes considerably after a price change ($E_d > 1$), demand for the product or service is price elastic. If however, there is no change in demand, or very little change, demand is price inelastic ($E_d < 1$).

$E_d$ **=** percent change in quantity demanded **/** percent change in price

This type of analysis reveals the historical statistical-relationship of the variables being considered – meaning how changes in these variables (cost and transit time in this case) over time have affected the Ports' market share. Specifically, the factors analyzed in the Davies model were:

- The share of U.S. import container shipments handled by POLA/POLB
- The cost difference between routing cargo from Asia through POLA/POLB to Chicago and routing cargo from Asia through the Port of New York/New Jersey to Chicago
- The time difference between routing cargo from Asia through POLA/POLB to Chicago and routing cargo from Asia through the Port of New York/New Jersey to Chicago

Quarterly estimates of shipping costs and transit times were developed for the period between January 2012 and December 2017. A regression model was then used to estimate the impact of changes to the time and cost variables on the overall share of cargo handled by the Ports by cargo category. A summary of the modeling process follows below. The Technical Appendix includes a detailed explanation of the methodology and data sources used for the model.

1. Regression analysis was first undertaken to separately estimate the impacts of transit time and cost changes on the market share of IPI traffic and total containerized imports to the Ports of Los Angeles/Long Beach relative to competing ports (represented by Port of New York/New Jersey).

2. Key features of the analysis included:

   ▪ Market shares are based on port-level import data published by the U.S. Census Bureau.
   ▪ Changes in relative costs are based on beneficial cargo owner (BCO) costs. These are estimated using reported shipping line and railway revenues.
   ▪ Relative transit time and ocean freight costs are explicitly incorporated as an explanatory variable in the regression equation.

3. IPI cost estimates from POLA/POLB and New York/New Jersey (NYNJ) to Chicago are used as the benchmark for relative BCO costs because Chicago is the largest destination for POLA/POLB IPI traffic.

4. Regression output revealed that the variables tested were statistically significant (meaning extremely unlikely to be the result of random chance) and explained a meaningful amount of the historical changes in SPB market share.

5. The results of the regression analysis were then used to calculate elasticity estimates by cargo type as summarized in Figure 2.3.[3]

| Figure 2.3 Elasticity Estimates Summary | |
| --- | --- |
| **Traffic Type** | **Estimated Elasticity** |
| Total Imports | -0.29 |
| IPI Traffic | -0.77 |
| Transload to Rail | -0.20 |
| Local and Transload to Truck* | 0.00 |

*By assumption*

For the time period analyzed (2012-2017), the model estimated the price elasticity of total imports through POLA/POLB to be -0.29, meaning a one percent increase in the cost difference between gateways would result in a 0.29 percent decrease in the Ports' market share. Over the range of rates considered, using the elasticity results, a moderate amount of diversion is expected with 17,000 TEU on the low end ($5/TEU) up to 241,000 TEU or 1.4 percent of total import traffic diverted annually ($70/TEU).

Through this analysis it is possible to isolate the sensitivity of cargo volumes to the relative cost of moving cargo through this gateway compared with competing gateways. In general, the elasticity model concludes that import cargo destined for inland locations in Southern California and adjacent areas (i.e., transload and local cargo) is relatively price inelastic (though it assumes existing economic and port

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[3] Non-IPI cargo consists of cargo moving via truck, to be: transloaded to rail for non-local markets; transloaded into trucks for local and nearby markets; or directly delivered to the local market. Davies assumes that local and transload to truck cargo is inelastic, and estimates the elasticity of the transload to rail cargo from the amount of diversion of total non-local cargo not accounted for by the diversion of IPI cargo.

industry conditions are constant over time) due to lack of competition from other ports that could serve as an alternative gateway. Import cargo intended for destinations beyond Southern California and adjacent areas (i.e., IPI cargo) are predicted to have greater price elasticity because shippers have a wider choice of competitive gateways to move cargo at a competitive cost and time to market.

## 3.2    Uncertainties in the Regression Modelling

International supply chains are complicated. Shipper gateway choice is a function of more than just two variables, as described above. Therefore, the possibility of omitted-variable bias must be considered. This occurs when a statistical model leaves out one or more relevant variables. Variables may be omitted when data for a particular effect is unavailable or if the effect is not directly observable. This bias, if it exists, results in the model attributing the effect of the missing variables to the estimated effects of the included variable. Port staff identified a number of factors that may warrant consideration as omitted variables, as further discussed in Section 4.

Regression analysis can be very helpful in estimating the sensitivity of the Ports' market share to changes in competitive factors (e.g., cost and transit time), but the power of these factors to affect market share can change as market conditions evolve, thus making them less useful to predict future conditions. Over the past decade the transportation industry up and down the supply chain has experienced rapid technological change, intensifying competition, and more recently, shifting geopolitical risks and the effects of an unstable domestic trade policy. These changes in the economy and competitive environment may alter sensitivity to cost and transit time thereby rendering an estimate based on previous norms less accurate.

## 4.0   ADDITIONAL DIVERSION FACTORS

Regression and elasticity analysis can be very helpful in understanding how the Ports' market share has historically reacted to changes in competitive factors that impact the cost and velocity of cargo moving through this gateway. However, because the technical analysis used by Davies relied on past relationships (2012-2017),[4] it is backward looking. Therefore, projecting these relationships into the future may ignore industry and competitive developments that impact the sensitivity of market share to cost and transit time. More recent changes in the economy and/or competitive environment include but are not limited to:

- In-port and regional development choices both in the San Pedro Bay and at competing gateways
- Vessel deployments by carriers and carrier alliances
- Supply chain reliability (e.g. truck service and rail service)
- Changes in the cargo origins and destinations for high volume cargo owners
- Geopolitics and global trade policies
- Local regulations and policies

While the model may pick up some of these effects,[5] many are difficult to incorporate directly into the analysis. In some cases, data for these factors are unavailable or they are difficult to quantify. For example, if a shipper is subject to greater costs for local cargo, the shipper may choose to divert IPI or transload cargo to destinations with lower costs in order help offset increased costs for local goods. The economic model used for this study attempts to account for this potential by assuming a certain amount of diversion for IPI and transload to rail cargo in the event of increased costs for local and transload to truck cargo. However, there is no reliable source of data on of the magnitude of this effect.

Previous studies[6] have identified relatively faster transit time for shipments from Asia through POLA/POLB as a key competitive advantage but have implicitly assumed that this advantage is constant. The POLA/POLB transit time advantage was substantially affected by congestion due to a variety of factors including arrival of larger vessels, chassis dislocation and equipment imbalance, and a protracted labor contract negotiation from November 2014 to February 2015. The Ports' transit time advantage has recovered somewhat since early 2015 but has trended downward due to the decline in average transit time for East Coast shipments as carriers shifted services from the Suez to the Panama Canal.

In addition, while in the short term local and transload cargo may be less elastic due to existing investments by shippers in their current supply chain arrangements, in the long run shippers have more options to alter their supply chains to avoid increased costs. As a result, local and transload cargo could be more elastic over a longer time horizon. While the Davies analysis in the Technical Appendix assumes that local cargo is inelastic because it would in theory always be more expensive to route local cargo

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[4] The 2014 congestion event and the improvements of the Panama Canal were both important events in the analysis period and presumably had a significant impact on the share changes and possibly overwhelmed the cost component for the period.

[5] As noted is section 3.1, the independent variables, transit time and ocean freight costs, in the regression model explained a significant amount of the variability in market share but not all. An error term is included in regressions to incorporate the variability in the dependent variable (market share) that cannot be explained by the independent variables.

[6] Container Diversion and Economic Impact Study; Moffatt & Nichol and BST Associates (2007)

through a different port gateway, in practice the Ports currently service large shippers that do in fact send all of their imported cargo to logistics centers outside the region and then rail back the portion of cargo meant for local consumption. Since the Ports plan to charge the CTF Rate from 2020 until at least 2035, it is important consider the long-run when assessing the effects of cost increases on cargo diversion.

In addition to industry specific developments, the Ports are subject to geopolitical risks and changes in U.S. trade policy. Foremost among these are the challenges posed by the Trump administration's imposition of increased tariffs on Chinese goods imported into the United States. A recent report[7] released by the Port of Los Angeles showed that 56.1 percent of the value of containerized imports moving through the San Pedro Bay ports was affected by tariffs on Chinese goods. China also accounts for the largest share of waterborne exports moving through the San Pedro Bay. The share of export value that is subject to retaliatory tariffs was estimated to be 29.3 percent for containerized cargo.

Although China remains the dominant producer of goods sourced from Asia, U.S. importers have begun shifting production from China to other countries in Southeast Asia. The result is a diversion of import traffic from Transpacific shipping lanes to the West Coast in favor of routing through the Suez or Panama Canals to the East and Gulf Coast ports. The *Journal of Commerce* reported that, "U.S. East and Gulf coast ports grabbed an increasing share of rapidly slowing imports from Asia in the first 10 months of 2019, reflecting the geographic advantage in serving the Southeast Asian markets as production shifts from China during the United States-China trade war."[8] At present, lower value goods are most affected (to be fair this shift began some time ago but was accelerated by the trade war). It will take some time to move more sophisticated manufacturing processes out of China. However, looking beyond the near-term, the damage caused by current trade policy to container throughput at the SPB ports may be permanent. Trade policy also seems unlikely to change before the next presidential election, and even if there is a change in the administration, the outlook for trade is unclear.

In sum, there are a number of other market and structural conditions that affect sensitivity to cost and time that were not explicitly modeled in the regression. How these factors influence each other, and if they will reach a tipping point that cannot be predicted by looking at an individual variable in isolation is unknown. Therefore, the elasticity estimates in the previous section may well be understated. As a point of comparison, a 2007 Moffatt & Nichol and BST Associates study using a similar model estimated the elasticity of total traffic at -0.55, IPI at -1.00 and the elasticity of local traffic at -0.30.[9]

Given the potential impacts to the Ports' immediate supply chain partners and possible direct financial losses to the Ports, consideration of the potential effects of a CTF Rate should be undertaken with considerable deliberation and care.

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[7] By the Numbers: Jeopardizing the National Benefits of Trade Through America's Busiest Port Complex; BST Associates (November 2019)

[8] East, Gulf Coast Ports Gain Amid China Trade War; Mongelluzzo, Bill, JOC.com (November 21, 2019)

[9] The Moffatt & Nichol model used a log-log regression expression whereas the Davies model utilized a linear regression model. Although data sources differed, both used transit time and cost ratios as the dependent variables to estimate POLA/POLB market share. At the Ports' request, Davies ran a log—log version of their model and reported no material difference in their results.

## 5.0    STAKEHOLDER INPUT ON DIVERSION

Initial input on diversion has come from cargo owners and trucking companies, who have urged that great care should be taken to avoid diversion of cargo due to increased fees. During outreach for the proposed CTF Rate, cargo owners have expressed significant concerns with increasing costs for moving cargo. The addition of a new cost for the gateway, in the form of the CTF Rate, has been indicated to be a strong consideration when determining where to route their cargo.  The Ports anticipate further input on this issue as additional stakeholder meetings occur.

## 6.0    EXPORT CARGO DIVERSION

Due to data constraints, a quantitative estimate of export elasticity was not conducted for this evaluation. However, it is reasonable to assume a CTP Rate will have an impact on outbound cargo. The Ports handled 3.4 million TEUs of loaded export containers in 2018, approximately 38 percent of the quantity of loaded exports in the United States. In 2018, approximately 40 percent of loaded export containers were delivered to the Port terminals directly by rail (and thus would be exempt from the rate), 12 percent were delivered to near-dock or off-dock rail yards and trucked to the terminals, and 48 percent were trucked directly , some portion of which were transloaded cargo from rail.

Imports using the San Pedro Bay ports are often high value products. Higher value goods generally have less product substitution and therefore, would be expected to exhibit lower elasticity with respect to higher costs resulting from a CTF Rate. In contrast, many of the goods exported through the Ports are lower value commodities such as wastepaper and plastics, hay and animal feed, and raw cotton. In general, lower value commodities are likely to be more sensitive an increase in supply chain costs.

Additionally, some of the goods exported through POLA/POLB are then used by foreign manufacturers as inputs to products such as vehicles and vehicle parts, machinery, apparel, and electronics, which are then re-exported back to the U.S. Thus, any increased costs on exports could have a spillover impact on imports.

### 6.1    Export Logistics

Exporters choose among several types of commercial arrangements to engage in international trade. Two of the most frequently used methods include selling goods based on:

- Free On Board (FOB): Seller delivers goods, cleared for export, loaded on board the vessel at the named port.
- Cost Insurance and Freight (CIF): The seller is responsible for arranging carriage to the destination, and also for insuring the goods.

In both cases, the exporter will directly pay the local drayage costs. The ability of the exporter to pass these costs along to a customer will depend on the elasticity of the product market, i.e. for a product with few substitutes and few competing suppliers, customers will have few choices and will accommodate any increased costs due to the CTF Rate. For lower value commodities with many competing sources, cost increases will be borne by the exporter in the form of lower net prices for their commodities. When exporters experience increased transport costs through a specific gateway, they could try to divert their shipments to an alternative port or market, reduce their sales, or absorb the cost increase.

Due to the significant imbalance between import and export cargo at POLA/POLB, there is a surplus of empty containers available for exporters' use. Consequently, the export trade lanes departing from the California ports experience back-haul ocean shipping rates whereby the freight rate for the outbound export movement is significantly cheaper than for the import movement. In back-haul freight markets, transport carriers do not attempt to capture the fully allocated cost of providing the service. Rather,

carriers will seek to obtain sufficient revenue to at least cover their variable cost of providing the service. The net effect is that backhaul ocean freight rates are significantly less than import rates. The presence of relatively cheap backhaul ocean freight rates on the westbound trade lanes is a structural feature of the Southern Californian market. Exporters in other trade lanes and ports, particularly those with a more balanced ratio of exports to imports, often have to pay more. As a result, exporters moving through the Southern California gateway have a competitive advantage in some instances.

Since overall shipping costs for westbound export container traffic from POLA/POLB are less than for imports, the introduction of the CTF Rates will have a greater impact on their cost structure because a flat rate per container will represent a larger percentage of the total landed cost than for an importer. However, this does not necessarily mean that cargo moving through POLA/POLB gateway will be diverted to other ports. The propensity to divert cargo away from POLA/POLB to the Port of Oakland, for example, depends not only on the cost of local drayage but the ocean freight rate to the international destination of choice.

For exporters selling on a CIF (Cost, Insurance and Freight) basis, the lower ocean rates through POLA/POLB may compensate for higher drayage rates. Exporters selling on an FOB (Free On Board) basis may be more sensitive to drayage cost increases.

*Based on shipping line tariffs, rates for export shipments through POLA/POLB are lower than those through the Port of Oakland. The Hapag-Lloyd tariff structure indicates a $103 ocean freight rate price differential for the Port of Oakland compared to Los Angeles for a 40-foot container to be transported to Shanghai, China. The Hamburg Sud export tariff indicates that rates through POLA/POLB are $150 lower than those through Oakland.*

## 6.2    Key Findings of the Export Analysis

The key findings from this export container analysis are as follows:

- Total transport cost may represent a significant portion of total landed costs in a foreign market and is a very important factor in choosing an export port. Other supply chain requirements of the exported goods such as transit times, service offering, capacity and fluidity are also important.

- Transport costs are the major factor in determining a first likely alternative port choice if lack of capacity, congestion or other factors render the original port less competitive.

- The San Pedro Bay ports are the most competitive for westbound export trade with Asia serving markets in Southern California and certain inland locations because a surplus of export containers resulting from the import/export trade imbalance drives lower ocean shipping rates (i.e., "back-haul freight rates"). The scale of operations and diversity of service options at POLA/POLB makes the Southern California Gateway uniquely attractive for containerized export traffic.

- For locally sourced exports the first choice for an alternative port to POLA/POLB would be Oakland due to its proximity. For example, agricultural exporters in the Central Valley are generally located between POLA/POLB and the Port of Oakland, and so their choice of port is expected to be

influenced by any increase in POLA/POLB drayage cost due to the CTF Rates. The higher the CTR Rate, the more attractive the Port of Oakland becomes as an export gateway.

Exporters' sensitivity to any potential increase in drayage costs due to the CTF Rate transport costs may depend on the following:

- The product or commodity being exported is being sourced locally/regionally and is reliant on trucking to reach the ports or sourced from greater distance arriving by rail. An estimated 54 percent of the export container traffic consists of commodities that are sourced locally within the Ports' natural hinterland. Edible fruit and nuts are primarily sourced in the Central Valley and would incur a higher rate for drayage to the Ports. There is a possibility that at higher levels of the CTF Rate, the increased costs may make the Port of Oakland more attractive as an export gateway. The same logic would apply to cotton exports sourced in the Central Valley. Other cotton cargoes would arrive by rail from destinations such as Texas, New Mexico and Arizona. If cotton cargoes are source loaded and delivered on-dock to the marine terminal, they would not be subject to the CTF Rate.

- The commercial relationship underpinning how the goods are sold into international markets will effect the potential impact of the CTF Rate. Some export goods are sold on a FOB (Free On Board) basis and therefore, the producer absorbs the cost of local trucking. In other instances, such as exporters in the cotton trades who sell into international markets on a CIF (Costs, Insurance and Freight) basis may be able to mitigate the impact elsewhere in their supply chain.

- The export commodity may be of low value and not able to absorb cost increases. Often exporters in international commodity markets are price takers and full costs of exporting are borne by the producers. If the cost increase is so high that it eclipses the exporter's profit margin, it will need to find an alternative gateway for export, or if the cost for an alternative gateway is too high, the product will not be exported.

- Some products like wastepaper and other scrap commodities where the primary purpose of exporting is to avoid higher domestic costs for recycling or disposal are likely to be relatively insensitive to any increase in drayage costs due to the CTF Rate.

- If the exported goods are relatively high value, they may more readily absorb increased cost of transport in the final selling price. For example, a portion of locally sourced cargo consists of higher value goods for which service quality (reliability and transit times) are as important as costs. For these commodities, transportation costs represent a small portion of the final value of product and the CTF Rates are not likely to affect port choice.

As with imports, the impact of the CTF Rate on export traffic will depend on the mode of transport used to either deliver or transload containers and then move them to the container terminals. Loaded export containers delivered to the port via on-dock rail will not experience an increase in costs as a result of the CTF Rate. Commodities that arrive by rail and that are then transloaded or source loaded export containers delivered directly to the port terminals by truck will experience an increase in costs if the CTF Rate leads to an increase in drayage rates, and therefore would be at risk for diversion.

## 7.0    IMPACT OF THE CTF RATES ON THE DRAYAGE SECTOR

The Port also sought to understand the potential effect of the CTF Rate on the drayage sector, including the potential fleet projection and revenue generated by the CTF Rate that could be used to incentivize the transition to cleaner trucks.

### 7.1    General Considerations from the Previous Clean Truck Program Rate

Under the direction of the original 2006 San Pedro Bay Ports Clean Air Action Plan, both ports developed Clean Trucks Programs to reduce community health and air quality impacts from the aging Heavy-Duty trucks providing drayage services. Starting in 2008, the Ports helped the industry transition toward the State Drayage Truck Rule, which required the use of 2007 United States Environmental Protection Agency (EPA) engines by 2014, by advancing phased early adoption at the Ports by 2012. A $35 per loaded 20-foot equivalent unit (TEU) container fee was assessed in the interim (from 2009 to 2011) for moves by trucks with engines that did not meet the 2007 EPA engine standard, and the funding collected was used by both Ports to administer their respective Clean Trucks Programs and provide incentives for the purchase of trucks meeting the 2007 EPA engine standard. Most trucks transitioned to meeting the 2007 EPA engine standard by 2010, two years in advance of the deadline. Today, as shown in the 2018 annual Emission Inventory reports for both Ports, Heavy-Duty truck emissions have been reduced by 97 percent for Diesel Particulate Matter (DPM), 78 percent for Nitrogen Oxides (NOx), and 92 percent for Sulfur Oxides (SOx) compared to 2005. However, even with these tremendous improvements, Heavy-Duty trucks remain the Ports' largest source of greenhouse gas (GHG) emissions and second highest source of NOx.

To understand the success of the Ports' original Clean Trucks Programs, it is important to consider the factors that existed at the time the programs were being implemented. An understanding of these factors can provide insights and inform updates to the programs being considered today.

Of primary importance was the concurrent development and implementation of California Air Resources Board's (CARB's) Drayage Truck Regulation, followed by CARB's Truck and Bus Regulation, which established in-use requirements for Heavy-Duty trucking activities throughout the state. Under the state's requirements, trucks were required to meet the 2007 EPA engine standard by 2014. The Ports' programs essentially served to accelerate attainment of the state's established requirements.

In addition, meeting the requirements of the previous Clean Trucks Programs did not require significant technological advancement. Diesel-fueled trucks meeting the 2007 EPA engine standard were available, the transition could be made without any operational changes or significant specialized training for drivers or mechanics, and the trucks could be deployed using the existing regional diesel fueling infrastructure. Further, the cost differential for a truck meeting the new engine standard was not significantly greater than typical new truck prices at the time, and an available used truck market developed over the span of time that the Ports' requirements were being implemented.

Of note is the experience with the early generation natural gas-fueled trucks during the initial launch of the Clean Trucks Programs. In the interest of maximizing early emission reductions, both ports provided

incentives for the purchase and deployment of Heavy-Duty trucks fueled with natural gas. At the peak, more than 1,000 natural gas trucks were registered in the Ports' Drayage Truck Registry (PDTR). The natural gas-fueled engines that were available at that time however were undersized for the typical drayage truck duty cycle, and in many cases, significant mechanical issues arose, resulting in equipment down time, added expense, and grant-funded trucks that were abandoned. The new generation and larger-sized natural gas fueled engines available today have overcome these issues; however, this experience represents a cautionary tale for the Ports when implementing new technologies. Specifically, it underscores the need to balance the desire to accelerate emission reductions as quickly as possible with the proven readiness of the technology to do the work. It highlights the need to exercise caution and avoid moving forward with new technologies too quickly in unproven applications without fully confirming the equipment's capable performance in the challenging port duty cycle first. The lessons highlight the importance of the Truck Feasibility Assessment and the technology demonstration projects that both Ports and South Coast Air Quality Management District (AQMD) have been engaged in for many years.

Another significant factor that encouraged truck owners to replace their trucks was the availability of financing through Licensed Motor Carriers (LMCs). Many LMCs helped to purchase the replacement trucks for the Independent Owner Operators (IOOs) driving for their companies, under lease/loan arrangements that deducted payments from driver's paychecks for drayage work. In stakeholder comments, LMCs have indicated they will not be providing similar financing arrangements in the future due to the incidence of employee-misclassification litigation involving purported contractor drivers operating LMC-owned trucks financed in this manner.

It is believed that many truck owners chose to replace their older trucks early under the Ports' programs because of the combination of factors of familiar technology, lower cost differential, available financial assistance, interest in avoiding the fee, and the upcoming requirement to replace their truck anyway in a very short period of time under the state's regulation.

Lastly, early in the implementation of the Ports' Clean Trucks Programs, several larger, well capitalized national trucking companies entered the drayage market with new trucks meeting the 2007 EPA engine standards, leading to significant early transition of the fleet. Within a year however, most of these new trucks had been removed from the local drayage service and redeployed elsewhere because they were uncompetitive from a cost perspective against new trucks entering the drayage service that had been purchased using incentive funds provided by the Ports and the air quality regulatory agencies.

## 7.2    Davies Assessment

The Davies study also evaluated how a range of rates would affect (i) the total cost of moving cargo through the San Pedro Bay and (ii) the volume of container cargo by category: total imports, local cargo, IPI cargo, and transload cargo to predict the volume of cargo moved by truck and the number of trucks needed to move that cargo, and (iii) the potential revenue generation from the CTF Rate. Davies carried out the analysis using their Drayage Cost and Fleet Projections Model to estimate the potential impacts of the CTF Rate under various assumptions regarding CTF Rate levels and capital subsidies.

The model used by Davies was designed to estimate the potential impacts of the proposed CTF Rate on the Southern California drayage sector, focusing on fleet composition, program costs and revenues. Essentially the model identified a potential efficient fleet mix based on estimates of port traffic volumes, operational parameters of Southern California drayage operations, trip characteristics, truck costs for both Licensed Motor Carrier (LMC) fleets and Independent Owner Operator (IOO) options, and drayage rates. The model also estimated program revenues and capital requirements for fleet renewal based on the forecast fleet composition.

The model incorporates regulatory and CAAP requirements, and predicts that LMCs will minimize their costs by selecting trucks that are the least costly option. The forecasts are also shaped by institutional constraints related to the economics of the industry; for example, the limited capability of IOOs to obtain financing for new trucks. The fleet forecasts also consider the consultant's estimates regarding the timing of introduction and/or improvement of non-diesel propulsion systems, and the pace of adoption of new technologies which influence the balance between new and used vehicles in the drayage fleet.

A full description of the model, data sources, assumptions, and key parameters is included in the Technical Appendix.

### 7.2.1   Fleet Mix Calculations

The model employed an iterative process to calculate fleet mix (number of trucks by type and age for each year from 2019 to 2035), first looking at historical trends, gate move data, regulatory requirements, and estimates of when new technologies would be introduced into the fleet, then adjusting based upon anticipated demand, and finally combining revenues and costs to calculate the margins, which is the key variable for which type of truck is selected.

For new technology (near zero-emissions [NZE], hybrid electric, battery electric, and fuel cell electric trucks) there is no history on which to base future projections. The model assumed that battery and hydrogen fuel cell electric trucks will start to become available in small numbers by 2024 and gradually increase over time. In general, the fleet forecasts show a larger share of hydrogen fuel cell trucks relative to battery electric trucks in the zero-emissions (ZE) fleet. This is based on a judgement by Davies on the probable range of limitations of battery electric trucks that will reduce their ability to serve longer haul markets.

The fleet forecasts are then used to generate the following information:

- The number of new and used trucks acquired in each year, which is multiplied by the input cost assumptions for each type of acquisition to estimate capital investment;

- The number of trucks subject to CTP Rates is extracted from the tables for each year, and rate estimates are computed for each one of the subsidy levels identified in the study design;

- If the scenario being studied involves subsidies, subsidy costs are calculated as the number of trucks eligible for subsidies multiplied by the individual subsidy amounts;

- Summaries of costs, revenues and margins for each type of truck are also compiled.

### 7.2.2    Modelling the Impact of CTF Rates on Fleet Composition

The modelling approach is based on the assumptions by Davies that LMCs make decisions regarding fleet composition and beneficial cargo owners (BCOs) make decisions regarding the LMC they will hire to do their work. The assumption is that BCOs will choose the lowest cost alternative among LMCs. Similarly, the LMC is assumed to choose the cheapest alternative among the truck options available to them.

The POLA/POLB drayage fleet consists almost exclusively of older trucks that were purchased as used vehicles. In April 2018, trucks with model year earlier than 2014 accounted for 14,345 or almost 84 percent of the current fleet. This is due to the highly competitive nature of the industry, and the substantially lower purchase price of used trucks compared to new trucks. Due to their high capital costs, new trucks are not competitive in the local drayage market. For example, the cost today for a new 2019 model year diesel truck is about $125,000, while a 2011 model year truck is estimated to cost $21,850.[10]

The reliance of the drayage sector on the availability of used vehicles to minimize costs provides a challenge for modelling the impacts of the CTF Rates. Historically, the drayage sector could rely on the availability of used trucks for purchase from the long-haul sector. Even during the first Clean Trucks Program, diesel trucks that were compliant with the 2007 emissions standards could be purchased as used trucks prior to the deadline for compliance in 2012. Under the 2017 CAAP Update, the emissions performance requirements for entrance into the drayage registry will exceed those required for trucks in the long-haul sector. Consequently, the supply of used NZE and ZE trucks available for purchase was assumed to be limited to those that were purchased as new for use in the drayage sector. Therefore, the mix between new and used NZE and ZE trucks shown in the model in later years is assumed to be affected by the rate at which new trucks are purchased in earlier years, with resulting impacts on capital costs, CTF Rate revenues and subsidies.

The Drayage Cost and Fleet Projections Model has been used by Davies to estimate the potential impacts of the CTF Rate under various assumptions regarding CTF Rate levels and capital subsidies. The model focuses on fleet composition and program costs and revenues. The scenarios modelled included varying assumptions regarding the timing and application of CTF Rates by truck type, and the availability of capital subsidies. The impacts were estimated for each scenario for a range of potential CTF Rates from $5/TEU to $70/TEU to be charged for loaded containers picked up from or delivered to the port terminal. A subset of the scenarios included sensitivities to the impact of potential cargo diversion, making a total of ten possible outcomes.

### 7.2.3    Drayage Impact Model Scenarios

The modelled scenarios included a baseline projection of the truck fleet based on current regulatory requirements, and the addition of:

- a new registration requirement for new entries to the registry will be NZE/ZE trucks by 2023;
- the application of the Clean Truck Fund rate on all non-NZE/ZE trucks starting on January 1, 2021, extended to all non-ZE trucks on January 1, 2030;

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[10] J.D. Power Commercial Truck Guideline January 2019

- the availability of subsidies to NZE and/or ZE trucks over different timelines to cover the cost differential between either the new technology and a new or used diesel; and
- the potential effect of diversion due to the application of the CTF Rate.

The six scenarios modelled are summarized below:

**Scenario 0:** Baseline projection of truck fleet, taking into account existing requirements: a) the California Air Resources Board (CARB) regulation which will require all trucks to be 2010+ by 2023; b) the Port's October 2018 tariff change requiring new trucks entering the PDTR to be MY 2014 or newer. No Clean Truck Fund rate or subsidies included.

**Scenario 1:** Baseline projection of truck fleet. Building on Scenario 0, taking into account existing requirements, and adding a requirement: a) the CARB regulation which will require all trucks to be 2010+ by 2023, and b) the Ports' October 2018 tariff change requiring new trucks entering the PDTR to be MY 2014 or newer. The difference from Scenario 0 is that starting in 2023, all new entries to the registry will be NZE or ZE trucks. No Clean Truck Fund rate or subsidies included.

**Scenario 2:** Refines Scenario 1 by including the application of the Clean Truck Fund rate on all non-NZE or ZE trucks starting on January 1, 2021 and is extended to all non-ZE trucks on January 1, 2030. Revenues generated for each of the identified $/TEU rates included in the project scope ($5/TEU to $70/TEU) were estimated.

**Scenario 3:** Builds upon the existing requirements and the application of the Clean Truck Fund rate in Scenario 2 by incorporating subsidies to cover the cost differential between the new technology and a used diesel in two stages: (i) only NZE trucks starting January 1, 2021 through 2027 and, (ii) only ZE trucks from 2028 to 2035.

**Scenario 4**: Considers the existing requirements and the application of the Clean Truck Fund rate in Scenario 2 but incorporating subsidies to cover the cost differential between the new technology and a used diesel. It differs from Scenario 3 in that the subsidies are applied only to ZE trucks from rate initiation to 2035.

**Scenario 5:** Builds on the existing requirements and the application of the Clean Truck Fund rate in Scenario two by incorporating subsidies to cover the cost differential between new technology and a new diesel. Subsidies are applied in 2 stages: (i) only NZE trucks starting in 2021 through 2023 and (ii) only ZE trucks starting in 2024 through 2035.

### 7.2.4   Key Findings of the Truck Fleet Projection Analysis

The figure below shows forecasts of the impact of the combinations of engine emissions requirements, rates and subsidies on the percentage of non-NZE/ZE trucks in the fleet from 2019 to 2035.

**Figure 7.1 Non-NZE or ZE Trucks as a Percentage of the Drayage Fleet 2019 – 2035**
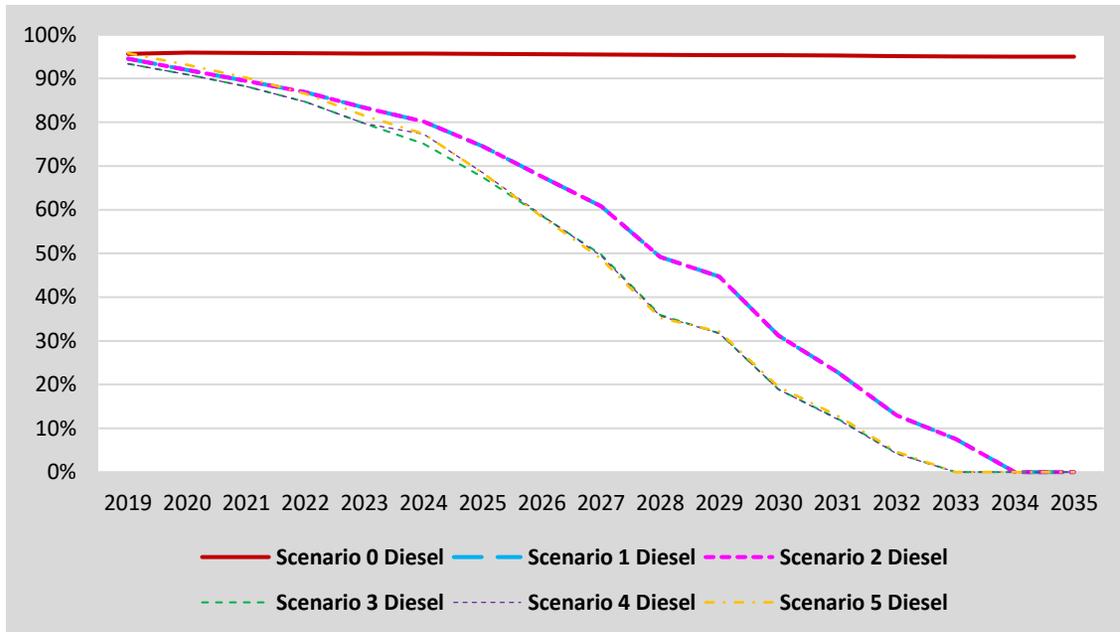


The modelling results lead to the following findings:

▪ In the absence of the restrictions on the entry of non-NZE or ZE trucks into the Ports' Drayage Truck Registry (PDTR), used non-NZE or ZE trucks will retain their predominant role in drayage operations throughout the period (Scenario 0).

▪ If the 2023 restriction on the new registration of NZE or better trucks is implemented as identified in the 2017 CAAP Update, the non-NZE or ZE fleet will decline as the trucks "age out" of the fleet (Scenario 1).

▪ The implementation of CTF Rates at the levels modelled, without the provision of a subsidy, will not modify the fleet composition from Scenario 1 because the rate levels are not sufficiently large to compensate for the increased costs of purchasing and operating NZE and ZE trucks (Scenario 2).

▪ The combinations of rates and subsidies modelled in Scenarios 3-5 accelerate the retirement of the non-NZE or ZE fleet and affect the NZE and ZE trucks' shares of the drayage fleet.

▪ None of the scenarios modelled result in a 100 percent ZE fleet by 2035. Scenario 3 achieves 53 percent ZE by 2035; Scenario 4 achieves 75 percent ZE by 2035; and Scenario 5 achieves 85 percent ZE by 2035.

## 7.3    Uncertainties in the Truck Fleet Projection Modelling

The present values of CTF Rate revenues, subsidies and capital requirements, given the specific scenarios

and the conservative set of assumptions used for the model, identified that the cost for the full subsidies would be in the range of $2.4 to $3.8 billion, and that a fund in that amount could potentially be generated by a CTF Rate in the range of $35 to $50 per TEU. It is critical to keep in mind however, that the model assumed high capital costs and high subsidy amounts, much higher than the level of subsidies that have been made available today through other funding agency programs. The model assumed subsidies would be needed to cover the full cost differential between a new technology truck and a new or used diesel truck. The model also did not identify other sources of the subsidy funds, which could come from a combination of CTF Rate revenue and funding from other grant sources, such as funding that is expected the be available from the Volkswagen Settlement funds, Greenhouse Gas Reduction Funds (GGRF), and other programs. The resulting estimate of subsidies required from the CTF Rate revenues, as indicated by the model, could therefore be double to triple the amount that may actually be needed.

The modelled scenarios provide a potential range of outcomes for illustrative purposes using a conservative set of assumptions related to a high estimate of capital costs for new trucks and a relatively high amount of subsidies provided. This results in an estimate on the top end of the range of the potential costs. For example, the model used a capital cost for a NZE truck of $250,000. While a low NOx or NZE standard has not yet been established by CARB, trucks with the 0.02g NOx/bhp-hr natural gas fueled engines are anticipated to meet the eventual standard. These trucks are currently selling for closer to $200,000 today. If a diesel-fueled NZE option becomes available, the anticipated cost is anticipated to be even less. Therefore, the capital costs and subsidies are likely to be lower than the Davies model predicts.

Further, the model assumed that subsidies would be needed to cover the entire cost differential between the new technology and a new or used diesel. The Davies study did not evaluate if subsidies at the levels evaluated would be necessary to compel the transition to NZE and ZE trucks, and in fact, the subsidies that have been made available today for the purchase of cleaner truck technologies have been lower. For example, the California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP) program currently offers up to $45,000 for the purchase of a new low NOx truck (much less than the $125,000 to $210,000 subsidy assumed in the model). Other early action incentive programs for low NOx trucks, including one that POLA/POLB participated in with South Coast Air Quality Management District, leveraging a grant from the California Energy Commission, have offered $100,000 toward the purchase of a low NOx truck. Even though these subsidy programs do not cover the full cost differential, they have been so popular that they are currently oversubscribed. Values used in the model for zero-emission trucks were even higher, with assumed subsidies of up to $310,000 per truck.

It is important to keep in mind that the modeling that was conducted was not designed to assess the specific amount of subsidy required or to identify the optimized structure for an incentive program, but rather to provide an understanding of the potential effects of the rate and subsidies over a range of different conditions. These estimates should be viewed as a conservative "worst case" estimate.

Further, as the Ports have long stated, no one entity alone can shoulder the full responsibility to make the change we are seeking. The CTF Rate has the potential to provide a significant source of funding to support the transition of drayage trucks into cleaner technologies, however, regional, state, and federal funding agencies, industry, and technology providers, among others, will all have a role and a financial stake in the transition.

## 7.4     Stakeholder Input on Drayage Impact Modeling

Input on rates has come from many stakeholders. Some trucking companies have urged a higher rate to help pay for new trucks. Other stakeholders seek a higher rate as an incentive to push truckers into newer equipment. On the other side of the discussion, some stakeholders are worried about diversion, while still others argue that a rate is regulation of trucking that is pre-empted by federal regulations. We look forward to further input on this issue.

## 8.0    CONCLUSIONS

The Ports conducted this economic study to consider the potential economic effects of the proposed rate on the Ports and their supply chain partners, as well as the effectiveness of the rate as a mechanism to achieve the emissions reduction goals laid out in the 2017 CAAP Update. To conduct this evaluation, the Ports reviewed past studies, engaged a consultant to conduct a modeling analysis, relied on our own industry expertise, and sought input from stakeholders. The study reaches the following conclusions:

### 8.1    Import Analysis

For more than a decade, POLA/POLB have experienced growth in overall container volume but at the same time, have seen losses in market share to Canadian, East Coast and Gulf Coast ports. Therefore, it is important that the Ports understand the potential for further cargo diversion and additional losses in market share that may follow from the implementation of the CTF Rate.

Previous cargo diversion analyses for the San Pedro Bay have concluded that import cargo destined for local customers has a low elasticity due to the lack of other port alternatives from which to receive this cargo. This cargo is what would most likely be subject to a Clean Truck Fund rate since it is typically moved by truck.

The technical analysis conducted by the consultant modeled the elasticity of demand (i.e. Ports' market share) in response to changes in transit time and shipping costs, based upon historic data. The model estimated the price elasticity of local cargo to be zero, based on assumptions listed in their report, with some diversion expected for transload to rail cargo. Over the range of rates evaluated, using the elasticity results, a moderate amount of diversion would be expected with 17,000 TEU on the low end ($5/TEU) up to 241,000 TEU or 1.4 percent of total import traffic diverted annually ($70/TEU).

Regression and elasticity analysis can be very helpful in understanding how the Ports' market share has historically reacted to changes in competitive factors that impact the cost and transit time of cargo moving through this gateway. However, projecting these relationships into the future may ignore industry and competitive developments that impact the sensitivity of market share to cost and transit time. More recent changes in the economy and/or competitive environment may influence current routing choices of cargo owners in unexpected ways. Examples include but are not limited to:

- In-port and regional development choices both in the San Pedro Bay and at competing gateways
- Vessel deployments by carriers and carrier alliances
- Supply chain reliability (e.g. truck service and rail service)
- Changes in the cargo origins and destinations for high volume cargo owners
- Geopolitics and global trade policies
- Local regulations and policies

Given the potential impacts to the Ports' immediate supply chain partners and possible direct financial losses to the Ports, consideration of the potential effects of a CTF Rate should be undertaken with considerable deliberation and care.

## 8.2    Export Analysis

Low value export commodities may not able to absorb the cost increases from a CTF Rate. If the exported goods are relatively high value, they may more readily absorb increased cost of transport in the final selling price.

For locally sourced export commodities, there is a possibility that at higher levels of the CTF Rate, the increased costs may make the Port of Oakland more attractive as an export gateway.

Export commodities that are sourced from locations beyond the Ports' natural hinterland and that arrive directly to the marine container terminal by on-dock intermodal rail, would not be subject to the CTF Rate. Export cargos that arrive via rail and are transloaded into containers that arrive by truck to the Ports would be subject to the CTF Rate and therefore would be at risk for diversion.

## 8.4    Drayage Sector Impact Analysis and Fleet Projections

The Davies model estimated changes in the drayage truck fleet based on a variety of factors including growth of port traffic, "aging out" of trucks from the fleet as they reach the end of their service life, changes in emission requirements for drayage trucks and changes in relative costs due to the impact of the CTF Rates and subsidies, and the assumption that trucks will be replaced if a cheaper alternative becomes available.

The rate levels modeled were not high enough by themselves to provide a sufficient incentive for buying new NZE or ZE trucks due to the higher cost of those options. The proposed new registration requirement for NZE trucks and the subsidy will be the compelling factors for influencing truck transition to cleaner options. The timing and eligibility of the subsidies have an effect on the projected fleet mix.

The modeling used high estimates of capital costs for the new technologies and high levels of subsidies to offset the cost differential for the purchase of those new technology trucks. The model also assumed availability of other sources of subsidy funds, which could come from a combination of CTF Rate revenue and funding from other grant sources. Therefore, the analysis should be viewed as a conservative "worst case" estimate and the amount identified may be double to triple the amount that may actually be needed.

## 8.5    Summation

The Davies analysis, consistent with previous diversion analyses, indicates that a CTF Rate between $5 and $70 per TEU would have diversionary impact of up to 1.4 percent of the total import TEU volume through the Ports. The Davies analysis notes that at rates higher than $75 per TEU, drayage from the Port of

Oakland becomes cost competitive with drayage from the Ports, which marks the boundary where local and transload to truck cargo is no longer inelastic and thus also subject to diversion.

The Davies analysis also concludes that due to the significant cost advantage that older trucks have over new trucks (whether diesel, NZE, or ZE), no CTF Rate within the range studied is high enough on its own to make newer vehicles economically competitive with the existing fleet. Newer trucks, especially NZE and ZE technology trucks will only be competitive with the incumbent fleet if their purchase is subsidized.

In addition to the competitive factors of time and cost in the 2012-2017 reference period studied by Davies, the Ports face even greater competitive threats driven by the further development of ports in the U.S. Southeast, the accelerated shift of manufacturing in Asia from China to Southeastern Asia, and significant tariffs on trade with China that have put additional pressure on shippers' margins and have made them less able to absorb or pass on additional costs. The Ports' experience with cargo diversion during their 2014/2015 congestion event shows that once shippers have invested in moving their cargo through new gateways, it is extremely difficult to get that cargo back.

Given these economic considerations:

- charging a high CTF Rate has no more impact on turning over the truck fleet than charging a low CTF Rate;

- a high CTF Rate results in more cargo diversion than a low CTF Rate;

- changes in costs elsewhere along the supply chain in the future could dramatically alter the demand elasticity for the Ports;

- the majority of shippers using the Ports are facing unprecedented cost pressures; and

- lost cargo cannot easily be recaptured;

the most prudent course of action would be for the Ports to exercise caution in setting a CTF Rate, and follow a process whereby they start at a lower CTF Rate for the purpose of generating funds to support the subsidized purchase of NZE and ZE vehicles as the existing truck fleet is turned over, while monitoring the CTF Rate's impact on Port competitiveness. A low CTF Rate that is shown to have no competitive impact on the ports could always be safely incrementally raised; conversely, it may be impossible to undo the damage of a CTF Rate that is initially set too high.

# TECHNICAL APPENDIX

# San Pedro Bay Ports
# Clean Truck Fund Rate Study
# Final Report
**December 16, 2019**



 **Davies Transportation Consulting Inc.**

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# 1 EXECUTIVE SUMMARY

The Ports of Long Beach and Los Angeles (Ports) 2017 Clean Air Action Plan Update (2017 CAAP Update) committed to a Clean Truck Fund (CTF) Rate Study to evaluate the capacity of the industry to absorb this expense in light of existing costs and other fees.

The following CTF Rate Economic Study assesses how a range of potential rates, from \$5/TEU to \$70/TEU, could: (i) affect the Ports' economic competitiveness, including the potential for cargo diversion, (ii) impact the drayage industry, (iii) help to generate revenue from collection of the rate.

The following two-step sequential methodology was used to accomplish the research objectives:

1. Analysis of the effects of past changes in logistics costs on import container supply chain and transit times on port traffic to estimate port and modal elasticities.

2. Analysis of the impact of the proposed Clean Trucks Fund rates. It included modeling the impact of the rates at various levels on drayage revenue, the supply of drayage services, and potential revenue generation.

A synopsis of the research findings is presented in this Executive Summary.

## 1.1 Impact of CTF Rate on Import Cargo Diversion

POLA/POLB import container traffic is typically divided into categories based on the mode and/or destination of the cargo. The categories include:

- Inland Point Intermodal (IPI): cargo shipped intact in marine containers by rail to inland destinations.

- Transload to Rail: cargo unloaded from marine containers in the Los Angeles (LA) Basin and reloaded to larger (53 ft) domestic containers and then delivered to the off-dock rail yards for rail shipment to inland destinations.

- Transload to Truck:  cargo unloaded from marine containers in the LA Basin and reloaded to truck trailers and then delivered to inland destinations.

- Local: cargo trucked directly from the container Port terminals to an inland destination.

East Coast port options ("all-water routes") have a longer sailing distance but shorter inland transport requirements which are typically met by trucking services. Historically the West Coast route has higher transportation costs but a quicker transit time than East Coast routes to Eastern markets. The analysis undertaken for this study estimates the impact of these cost and transit time differentials on POLA/POLB container market share.

In economics, elasticity is the measurement of how an economic variable responds to a change in another. Elasticity is measured as a unitless value calculated as the percent (%) change in one variable divided by the percent change in the second variable. For our analysis of the impact of increased drayage costs on POLA/POLB traffic, this can be expressed as:

Price Elasticity = percent change in POLA/POLB market share/percent change in transportation costs relative to competing port gateways.

An elastic variable - with elasticity value greater than one (1) - is one which responds more than proportionally to changes in other variables. In contrast, an inelastic variable (with elasticity value less than one (1) is one which changes less than proportionally in response to changes in other variables.

Econometric analysis indicates that the elasticity of POLA/POLB import container traffic is 0.29; however, the elasticity for Inland Point Intermodal (IPI) import traffic is higher, at 0.77. This is consistent with Intermodal Association of North America (IANA) data which suggests that up to 75 percent of the POLA/POLB traffic lost to other ports from 2007 to 2017 was due to a lower market share for IPI traffic, particularly in the Southeast region. Based on the elasticities of total and IPI imports, the elasticity of transload to rail traffic is 0.2.

Local and transload to truck traffic is less likely to be diverted by an increase in drayage rates resulting from Clean Truck Program rate because of the relative proximity of the markets served. The only other segment of traffic directly impacted by drayage costs is the transload to rail traffic. Based on the economic definition on elasticity, total container traffic is inelastic. The details of our analysis of potential impacts of the CTF rate on port traffic are presented in Section 7 of this report.

The table below summarizes the results of the elasticity analysis. Overall import demand is inelastic; Inland Point Intermodal (IPI) traffic is more elastic, and accounts for the largest portion of the loss in import container market share for POLA/POLB since 2007.

**Figure 1-1 Elasticity Estimates Summary**

| Elasticity Estimates | |
|---|---|
| **Traffic Type** | **Estimated Elasticity** |
| Total Imports | 0.29 |
| IPI Traffic | 0.77 |
| Transload to rail | 0.20 |
| Local and Transload to Truck | 0.00 |

Based on these elasticity estimates, the estimated impact of cost increases proportionate to drayage cost increases due to implementation of the CTF rates is shown below.

**Figure 1-2 Estimated Impact of Drayage Cost Increases on Port Traffic**

| CTP Rate $ per TEU | % Increase in Total Cost ($ per FEU Chicago IPI) | Total Annual Traffic (000 TEUs) | IPI (000 TEUs) | Transload to Rail (000 TEUs) | Local and Transload to Truck (000 TEUs) | Transload & Local Drayage Traffic (000 TEUs) | % Decrease in Total Traffic | % Decrease in Drayage trips |
|---|---|---|---|---|---|---|---|---|
| \$0 | 0.0% | 16,887 | 4,894 | 4,648 | 7,345 | 11,993 | 0 | 0 |
| \$5 | 0.3% | 16,870 | 4,881 | 4,644 | 7,345 | 11,989 | -0.1% | 0.0% |
| \$20 | 1.4% | 16,818 | 4,842 | 4,632 | 7,345 | 11,977 | -0.4% | -0.1% |
| \$35 | 2.4% | 16,767 | 4,803 | 4,619 | 7,345 | 11,964 | -0.7% | -0.2% |
| \$50 | 3.5% | 16,715 | 4,763 | 4,607 | 7,345 | 11,952 | -1.0% | -0.3% |
| \$70 | 4.9% | 16,646 | 4,711 | 4,590 | 7,345 | 11,935 | -1.4% | -0.5% |

For purposes of modelling a maximum diversion rate for imports of 1.4 percent has been used as the "upper bound" of potential diversion. The impact to 2035 based on the baseline forecast and the 1.4 percent diversion factor is shown below.

**Figure 1-3 POLA/POLB Total Traffic Forecasts Baseline and Diversion Case**

| POLA/POLB Total Traffic Forecast Baseline And Diversion Case | | |
|---|---|---|
| **000 TEUs** | | |
| Year | Baseline Forecasts | Diversion Forecast |
| 2021 | 20,139 | 19,857 |
| 2022 | 21,047 | 20,752 |
| 2023 | 21,862 | 21,556 |
| 2024 | 22,652 | 22,335 |
| 2025 | 23,470 | 23,142 |
| 2026 | 24,250 | 23,910 |
| 2027 | 25,210 | 24,857 |
| 2028 | 26,205 | 25,839 |
| 2029 | 27,238 | 26,857 |
| 2030 | 28,312 | 27,916 |
| 2031 | 29,433 | 29,021 |
| 2032 | 30,588 | 30,160 |
| 2033 | 31,607 | 31,164 |
| 2034 | 31,707 | 31,263 |
| 2035 | 31,772 | 31,327 |

## 1.2 Impact of the CTF Rate on the Drayage Sector

Analysis was carried out using the Drayage Cost and Fleet Projections Model to estimate the potential impacts of the CTF rate under various assumptions regarding CTF rate levels and capital subsidies. The key input variables, the model structure and the computational processes are documented in Section 5. Summaries of the results for each scenario are provided in individual sections of the report.

Six scenarios were modelled. These are summarized below.

**Figure 1-4 Key Assumptions for Model Scenarios**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 0 | CARB regulation 2023; Ports' tariff 2018 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 1 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 2 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | 0 % and 2% |
| 2 | | | non-NZE and NZE | 2030-2035 | | | | |
| 3 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | NZE only | 2021-2027 | 0 % and 2% |
| 3 | | | non-NZE and NZE | 2030-2035 | | ZE only | 2028-2035 | |
| 4 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | ZE only | 2021-2035 | 0 % and 2% |
| 4 | | | non-NZE and NZE | 2030-2035 | | | | |
| 5 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | New diesel | NZE only | 2021-2023 | 0 % and 2% |
| 5 | | | non-NZE and NZE | 2030-2035 | | ZE only | 2024-2035 | |

The scenarios included varying assumptions regarding the timing and application of CTF rates by truck type, and the availability of capital subsidies. The impacts were estimated for each scenario for five potential CTF rate levels to be charged for loaded containers picked up from or delivered to the port terminals: $5, $20, $35 $50 and $75 per loaded TEU. Four of the scenarios included sensitivities to the impact of potential cargo diversion, making a total of ten scenarios to be modelled.

The figure below shows forecasts of the impact of the combinations of emissions requirements, rates and subsidies on the percentage of non-NZE diesel trucks in the fleet from 2019 to 2035.

**Figure 1-5 Non-NZE Diesel Trucks as a Percentage of the Drayage Fleet 2019 – 2035**
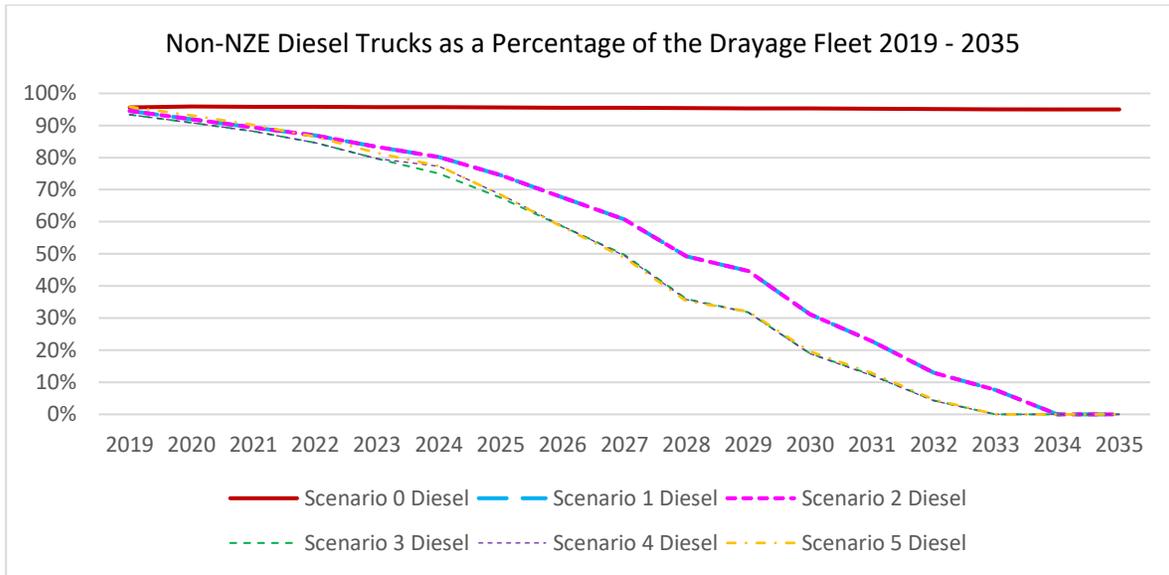


The modelling results lead to the following findings:

- In the absence of the restrictions on the entry of non-NZE diesel trucks into the Ports Drayage Truck Registry (PDTR), used non-NZE diesel trucks will retain their predominant role in drayage operations throughout the period (Scenario 0).

- If the 2023 restriction on the new registration of NZE or better trucks is implemented as identified in the 2017 CAAP Update, the non-NZE diesel fleet will decline as the trucks "age out" of the fleet (Scenario 1).

- The implementation of CTF rates at the levels modelled will not modify the fleet composition from Scenario 1 because the rate levels are not sufficiently large to compensate for the increased costs of operating NZE and ZE trucks (Scenario 2).

- The combinations of rates and subsidies modelled in Scenarios 3-5 accelerate the retirement of the non-NZE diesel fleet and affect the NZE and ZE trucks' shares of the drayage fleet.

- None of the scenarios modelled result in a 100 percent ZE fleet by 2035. Scenario 3 achieves 53 percent ZE by 2035; Scenario 4 achieves 75 percent ZE by 2035; and Scenario 5 achieves 85 percent ZE by 2035. The share of ZE trucks in the fleet in Scenarios 3-5 in each year are depicted below.

**Figure 1-6 Zero Emission Fleet Percentage by Scenario**
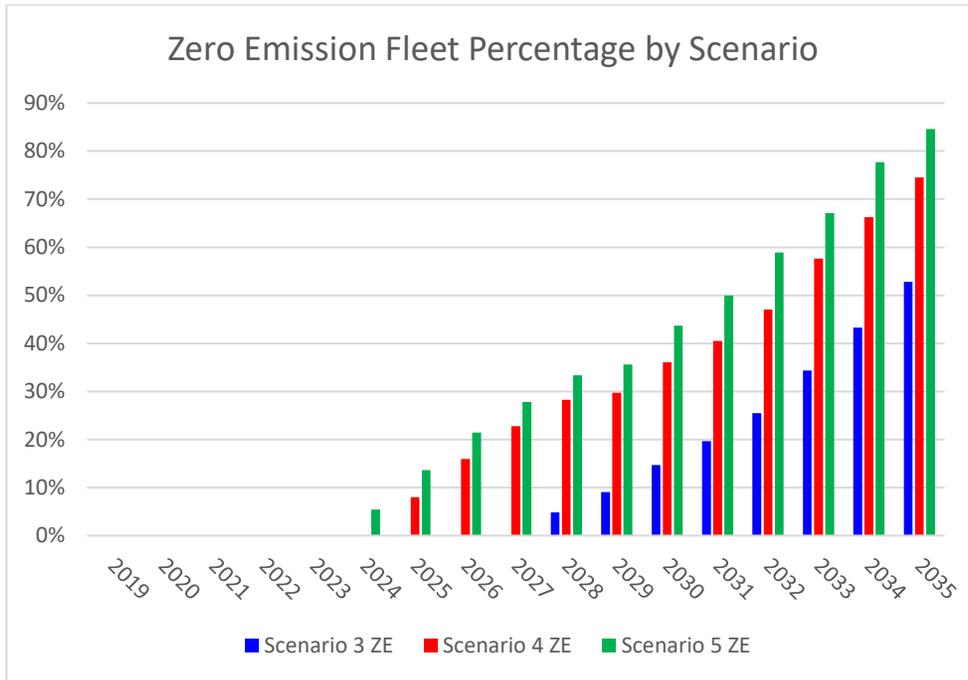


The present values of CTF rate revenues, subsidies and capital requirements for Scenarios 3 to 5 are shown below.

**Figure 1-7 Scenarios 3 - 5 Present Value of CTF Rates and Subsidy Requirements**

| Present Value of CTF Rates and Subsidy Requirements Summary | | | |
|---|---|---|---|
| $ Millions (2019 Constant) | | | |
| **CTF Rate** | **Scenario 3** | **Scenario 4** | **Scenario 5** |
| $70 | $6,090 | $5,307 | $4,859 |
| $50 | $4,350 | $3,790 | $3,471 |
| $35 | $3,045 | $2,653 | $2,429 |
| $20 | $1,740 | $1,516 | $1,388 |
| $5 | $435 | $379 | $347 |
| Subsidy Requirements | $3,642 | $3,000 | $2,419 |
| Total Capital Invested | $5,052 | $5,348 | $5,526 |

The present values of CTF rate revenues, subsidies and capital requirements for Scenarios 3 to 5 with 2 percent cargo diversion are shown below.

**Figure 1-8 Scenarios 3 – 5 Present Value of CTF Rates and Subsidy Requirements with Diversion**

| Present Value of CTF Rates and Subsidy Requirements With Diversion Summary | | | |
|---|---|---|---|
| $ Millions (2019 Constant) | | | |
| CTF Rate | Scenario 3 | Scenario 4 | Scenario 5 |
| $70 | $5,523 | $5,041 | $4,566 |
| $50 | $3,945 | $3,601 | $3,261 |
| $35 | $2,762 | $2,521 | $2,283 |
| $20 | $1,578 | $1,440 | $1,305 |
| $5 | $395 | $360 | $326 |
| Subsidy Requirements | $3,871 | $3,150 | $2,538 |
| Total Capital Invested | $5,242 | $5,476 | $5,681 |

The estimated present values of CTF rate revenues and subsidy requirements suggest that for the specific scenarios modelled, and for the high level of subsidy amounts applied, a CTF rate between $35 and $50 could generate sufficient revenue to fund the full cost of the subsidy amounts. This represents a conservative analysis of the amount of funding required. This study did not evaluate if subsidies at the levels evaluated would be necessary to compel the transition to NZE and ZE trucks. Nor did this study make assumptions about the amount of subsidies that may be available from other sources, such as state and federal grants.

## 2    INTRODUCTION

### 2.1    2017 Clean Air Action Plan Update – Clean Truck Program

The Ports of Long Beach and Los Angeles (Ports) 2017 Clean Air Action Plan Update (2017 CAAP Update) committed to a Clean Truck Fund (CTF) Rate Economic Study to evaluate the capacity of the industry to absorb this expense in light of existing costs and other fees.

The following CTF Rate Economic Study assesses how a range of potential rates, from $5/TEU to $70/TEU, could: (i) affect the Ports' economic competitiveness, including the potential for cargo diversion, (ii) impact the drayage industry, (iii) help to generate revenue from collection of the rate.

### 2.2    Methodology Overview

The purpose of this study is to assess how the CTF rates proposed in the 2017 CAAP Update will affect the drayage industry and the Ports' economic competitiveness and the potential for cargo diversion. The CTF rates will be charged to the beneficial cargo owners (BCOs) per loaded container move by truck if the truck is not near-zero or zero-emissions.

To accomplish this evaluation, a two-step sequential methodology has been used:

**Figure 2-1 Overview of Clean Truck Fund Rate Study Methodology**
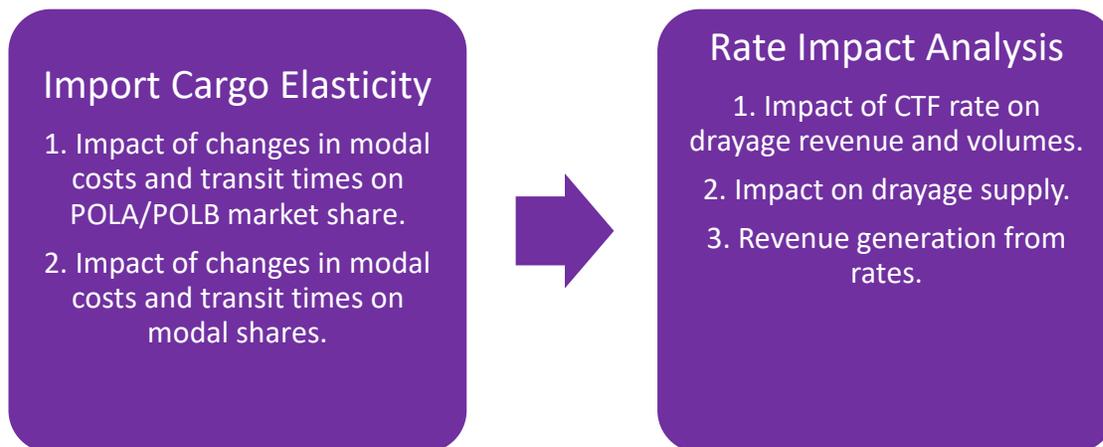


The two steps include:

1. Analysis of the effects of past changes in logistics costs on import container supply chain and transit times on port traffic to estimate port and modal elasticities.

2. Analysis of the impact of the proposed CTF rates. This includes modeling the impact of the rates at various levels on drayage revenue, the supply of drayage services, and potential revenue generation.

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## 2.3 Modeling Port and Modal Choice

Port routing and mode choice decisions rely on a multitude of factors. Our analysis starts with the following hypotheses:

- The relevant market for analyzing port competitiveness is Asia-Pacific containerized imports into the U.S.

- Port routing decisions are made by BCO's based on transportation costs and transit time as the primary factors.

- The relevant metric for transportation costs is costs paid directly by shippers (i.e. rates), rather than costs incurred by service providers (shipping lines, terminal operators, etc.) in providing the service.

- The choice of competitive routings for analysis is based on container market share performance. The three major U.S. ports with the largest increase in market share between 2008 and 2017 were Savannah, Norfolk and New York/New Jersey.

The project requires development of forecasts of San Pedro Bay ports container traffic by modal shares (i.e. local, on-dock, near-dock, and off-dock Inland Point Intermodal (IPI) and transload) taking into account the potential impacts of the CTF rate. Our starting point for this analysis is the baseline forecasts from the San Pedro Bay Ports Forecast[1] and the rail and truck traffic forecasts from the Quick Trip Train Builder Models provided by the Ports. These forecasts are described in Section 5.

## 2.4 Modeling the Impact of the Clean Truck Fund Rate

Our methodology for modeling the impacts of various levels of CTF rates is the schematic below. The diagram shows the conceptual logic of a model to generate annual forecasts of the fleet mix, drayage rates, San Pedro Bay (SPB) ports cargo volumes and truck trips from 2020 through 2035 to fulfill the project requirements. This is a dynamic model with each succeeding year linked to the last by the fleet mix (i.e. the beginning fleet mix in any year will be a function of the previous year's results).

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[1] San Pedro Bay Ports Cargo Forecast Final Report Mercator International and Oxford Economics Feb 25, 2016.

**Figure 2-2 Clean Truck Fund Rate Study Modeling Logic**

**Truck Rate Study Modeling Logic**
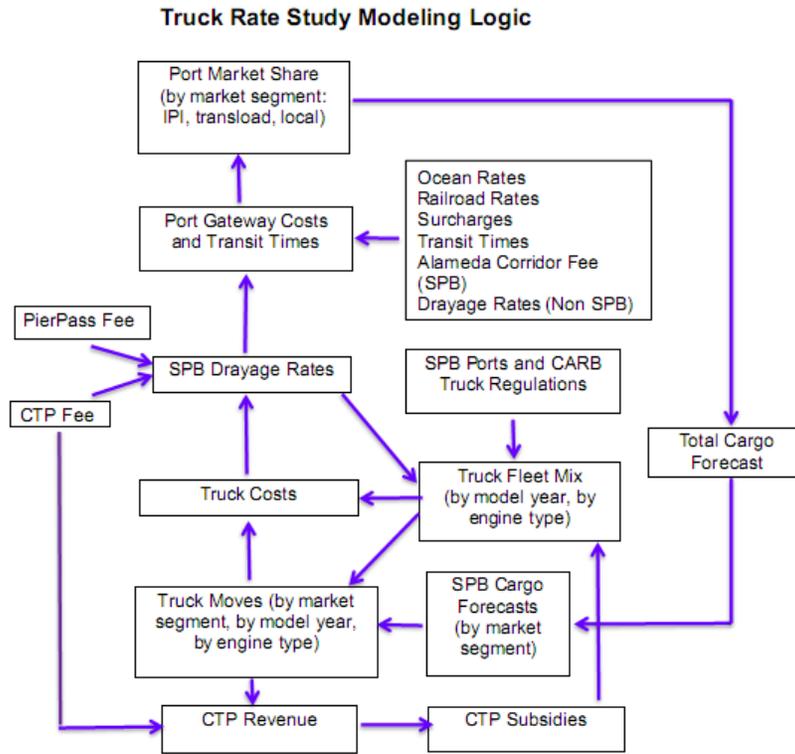


Total United States Asia-Pacific import volumes and competitive gateway costs (non-drayage gateway costs at SPB, gateway costs at other ports, transit times, fuel prices, etc.) are exogenous to the model, but could be adjusted to examine the impact of future changes. Truck costs have been modeled using a proprietary activity-based model that estimates total drayage costs and revenues based on input costs and trip parameters.

# 3    TransPacific Containerized Imports Overview

## 3.1    Port Traffic Trends

The TransPacific import container trade consists primarily of consumer goods destined for several major markets in California and the densely populated interiors regions of the United States. Based on the regional distribution of the population the largest share of demand for consumer goods – the largest component of TransPacific import cargos – is east of the Mississippi River. The primary locational advantage of the Ports of Los Angeles and Long Beach is their proximity to Asian export ports which results in a shorter ocean voyage from Asia but much longer inland transportation routes. The densely populated Southern California consumer market is also advantageous for the San Pedro Bay ports. United States East Coast (Atlantic) or Gulf Coast port options ("all-water routes") have a longer sailing distance but shorter inland transport requirements to major markets. Historically the Pacific Coast route has higher transportation costs but a quicker transit time than East Coast routes to Eastern markets.

**Figure 3-1 Population Density by State 2018**
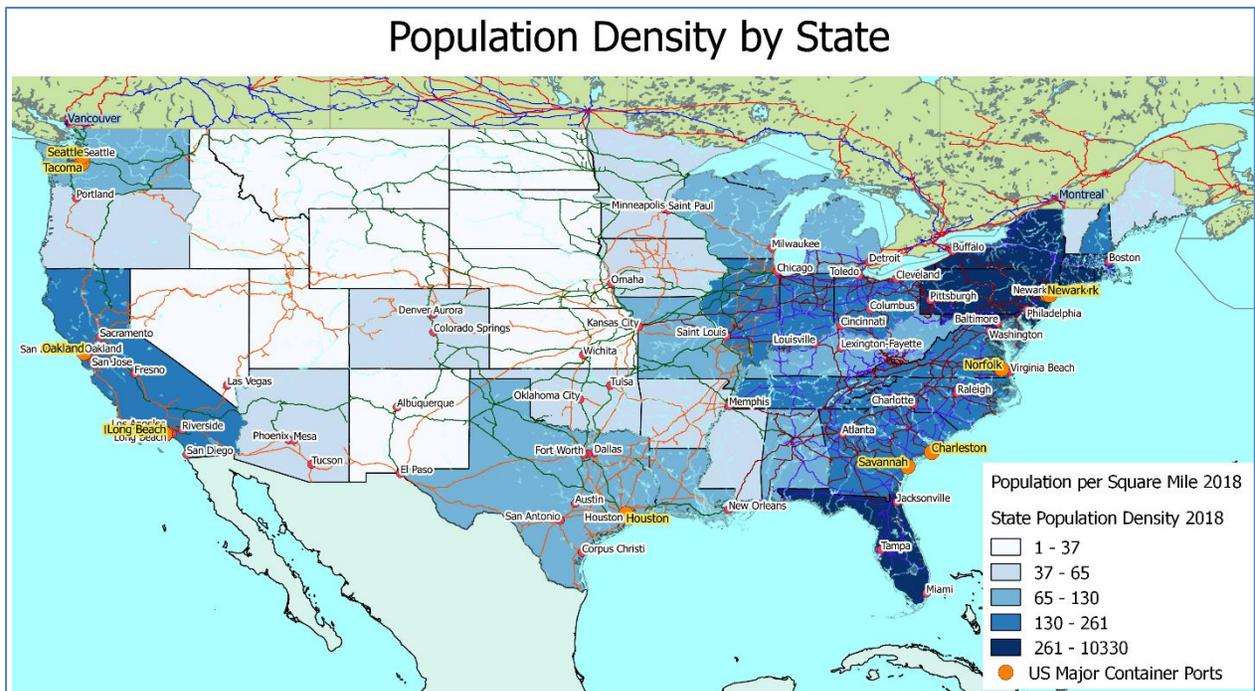


Based on data from the U.S. Census Bureau,[2] U.S. containerized imports from Pacific Rim countries grew very rapidly from 2003 to 2007. Traffic declined significantly during the 2008 – 2009 recession but has continued to grow at a lower rate since 2011.

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[2] Source: USA Trade Online https://usatrade.census.gov/

**Figure 3-2 U.S. Pacific Rim Containerized Imports 2003 – 2018**
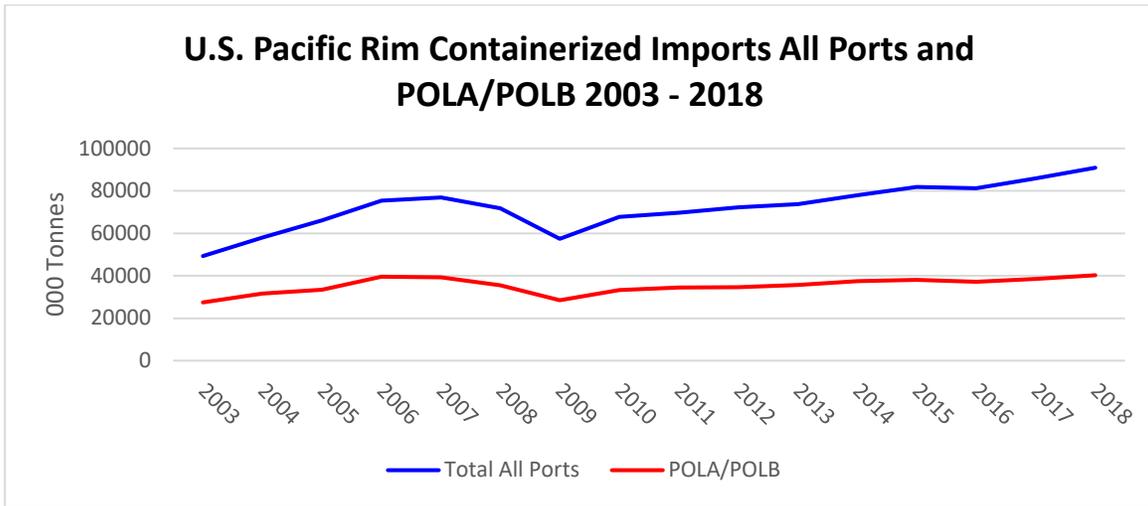


## 3.2    Intermodal Traffic Trends

There is no reliable source of data on the ultimate destination of import cargoes after they leave the port. The destination of cargo shipped inland intact in an international container (Inland Point Intermodal Traffic) can be tracked by tracking the movements of the container. Data on rail movements of international and domestic containers is reported by the railways to the Intermodal Association of North America (IANA). This data provides additional insights into market trends in the TransPacific container trade.

Monthly data from January 2007 to December 2018 was purchased from IANA for analysis in this study. The figure below shows domestic and international rail intermodal traffic trends for United States destined containers (i.e. excluding movements destined for Canada or Mexico).

**Figure 3-3 Intermodal Traffic Trends 2007 – 2018**
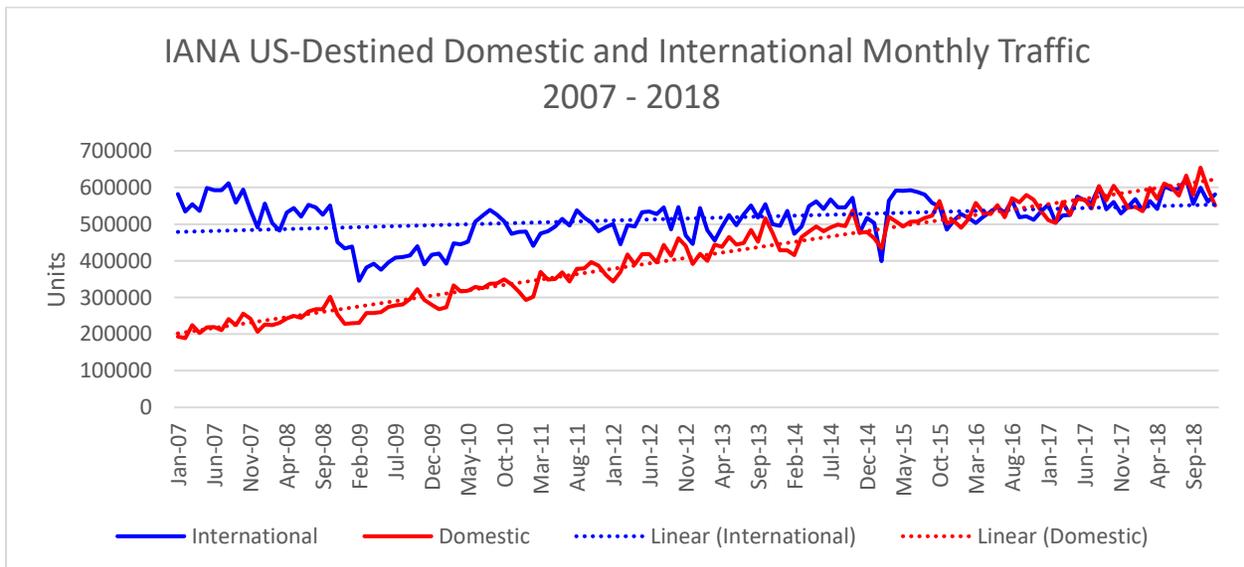
Domestic intermodal movements are distinguished from international traffic by the size of container used; international movements include movements of 20, 40 and 45-foot containers while all other containers are considered domestic movements. By far the largest share of domestic traffic consists of movements of 53-foot containers.

The figure below compares indexes of U.S. Pacific Rim containerized imports and domestic and international rail intermodal traffic from 2007 to 2018.

**Figure 3-4 US Pacific Rim Imports and Rail Intermodal Traffic 2007 – 2018**
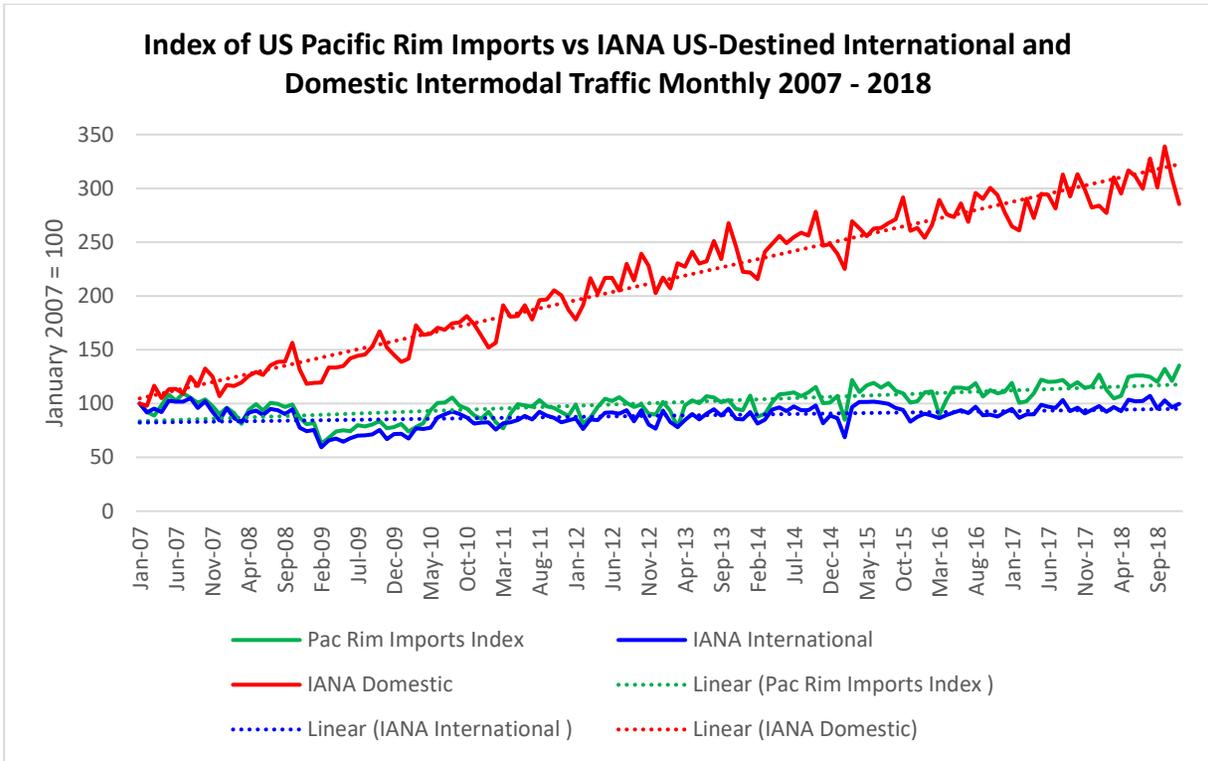


Domestic traffic has shown steady growth since 2007. International traffic declined significantly following the 2008 downturn and has struggled to regain the levels reached in 2007. International intermodal traffic grew at a lower rate than containerized imports, suggesting that a larger percentage of import cargo is either being consumed locally or transloaded.

# 4    Potential Import Cargo Diversion Resulting from CTF Rates

## 4.1    POLA/POLB Import Traffic Categories

POLA/POLB import traffic is typically divided into categories based on the mode and/or destination of the cargo. The categories include:

- Inland Point Intermodal: cargo shipped intact in marine containers by rail to inland destinations. This traffic can be further divided into on-dock IPI which includes containers loaded to rail at the Ports, and off-dock IPI which consists of containers transferred by truck to off-dock railyards including UP's Intermodal Container Transfer Facility (ICTF) and City of Commerce intermodal yard, and BNSF's terminal at Hobart.

- Transload to Rail: cargo unloaded from marine containers in the LA Basin and reloaded to larger (53 foot) domestic containers and then delivered to the off-dock rail yards for rail shipment to inland destinations.

- Transload to Truck:  cargo unloaded from marine containers in the LA Basin and reloaded to truck trailers and then delivered to inland destinations.

- Local: cargo trucked directly from port terminals to an inland destination.

In general rail intermodal options are slower and less reliable than trucking, and competitive only for longer distances (500 to 700 plus miles).

The estimated shares of POLA/POLB import traffic by market segment in 2017 are shown below.

**Figure 4-1 POLA/POLB Traffic Shares by Segment 2017**
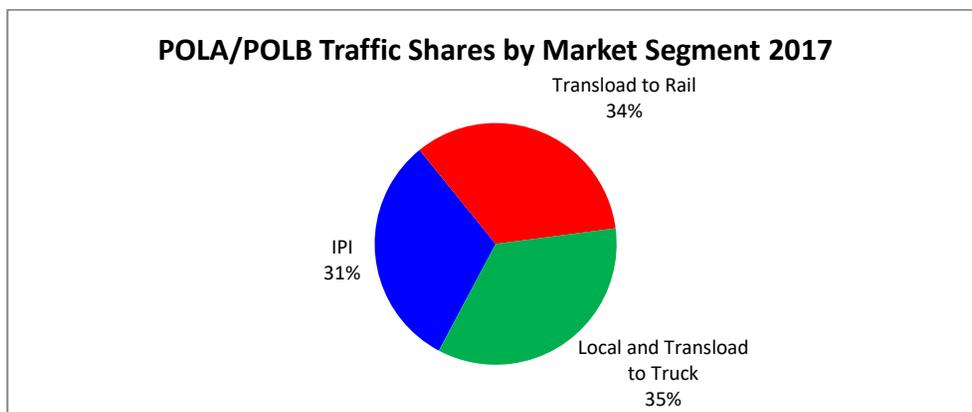


## 4.2    POLA/POLB Inland Point Intermodal (IPI) Market Share

The IANA data includes monthly origin-destination data on container and trailer movements by region and equipment type (private or railway) and size. International and domestic traffic can be distinguished by container sizes; international (IPI) traffic uses 20, 40 and 45-foot containers,

and domestic traffic uses 28, 48 and 53-foot containers (including international cargo transloaded into domestic equipment. Traffic consists primarily of 53-foot containers).

IANA's Southwest Region accounts for the second largest share of both domestic and international (IPI) traffic.[3] POLA/POLB is responsible for by far the largest portion (approximately 90%) of IPI traffic originating in the Southwest region. The only other major port in the region is Oakland, which primarily handles local traffic.

IPI traffic originating in IANA's Southwest Region is concentrated among three major destination regions: the Midwest,[4] Southeast[5], and South Central[6] regions. Of these, the Midwest is the largest.

**Figure 4-2 Southwest Origin IPI Traffic by Destination Regions**
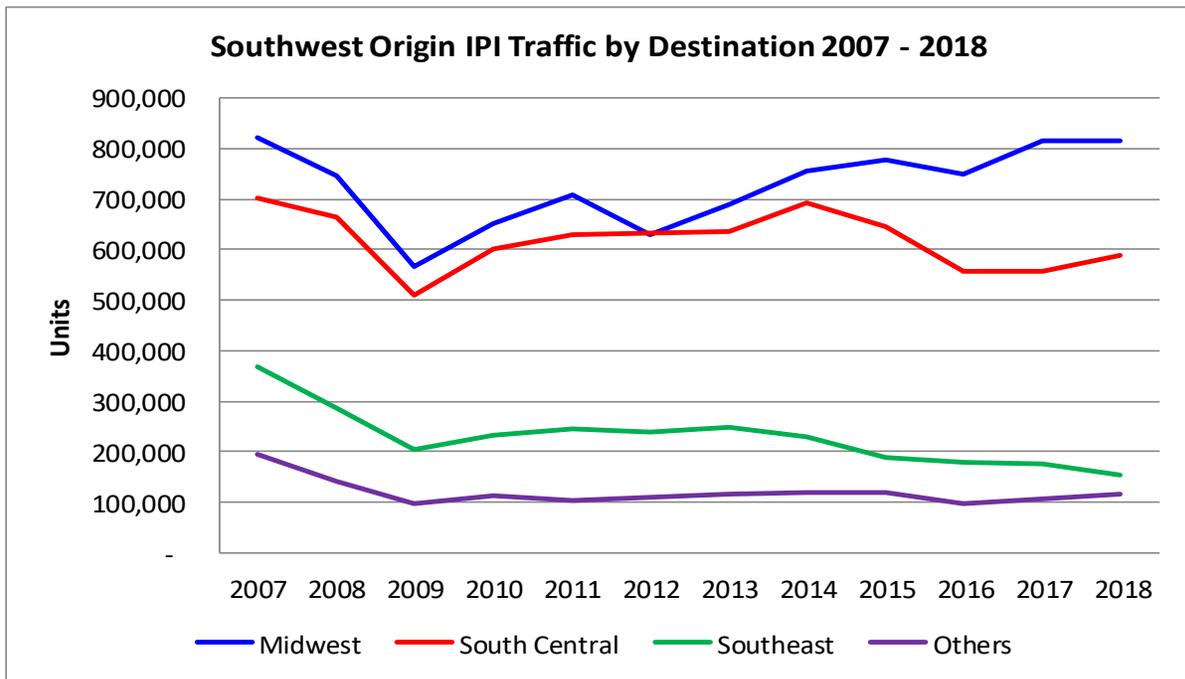


The Midwest and Southeast markets have seen substantial growth in IPI traffic; the South-Central market has not.

Market shares of international containers destined for the Midwest by origin region are shown below.

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[3] IANA's Southwest Region includes California, Arizona and Nevada.

[4] The Midwest region includes the states of IL, IN, IA, KS, KY, MI, MN, MO, OH and WI. The major intermodal hub is Chicago.

[5] The Southeast region includes the states of AL, FL, GA, MS, NC, SC, and TN. Major intermodal hubs include Atlanta and Memphis.

[6] The South Central region includes the states of AR, LA, NM, OK and TX. The major intermodal hub is Dallas/Fort Worth.

**Figure 4-3 Midwest Destination IPI Traffic Market Shares 2007 – 2018**
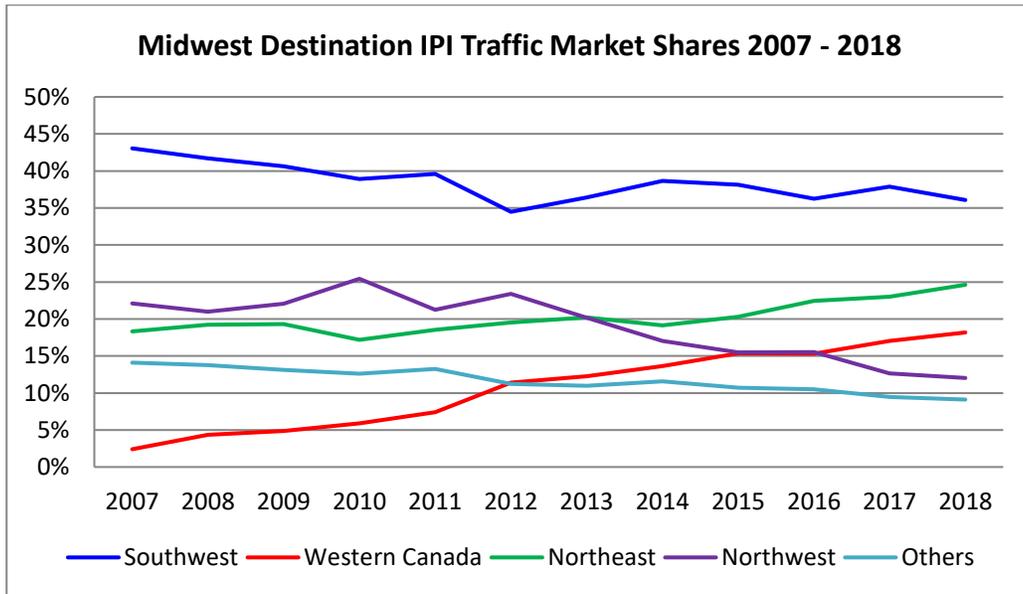


Based on the IANA data, the Southwest share fell from 43.1 percent in 2007 to 36.1 percent in 2018. Major gains in market share were made by Western Canada (Ports of Prince Rupert and Vancouver) and the Northeast (Ports of New York/New Jersey and Norfolk). The Pacific Northwest share (Ports of Seattle and Tacoma, now operating as the Northwest Ports Alliance) fell significantly.

Market shares of international containers destined for the Southeast by region of origin are shown below.

**Figure 4-4 Southeast Destination IPI Traffic Market Shares 2007 – 2018**
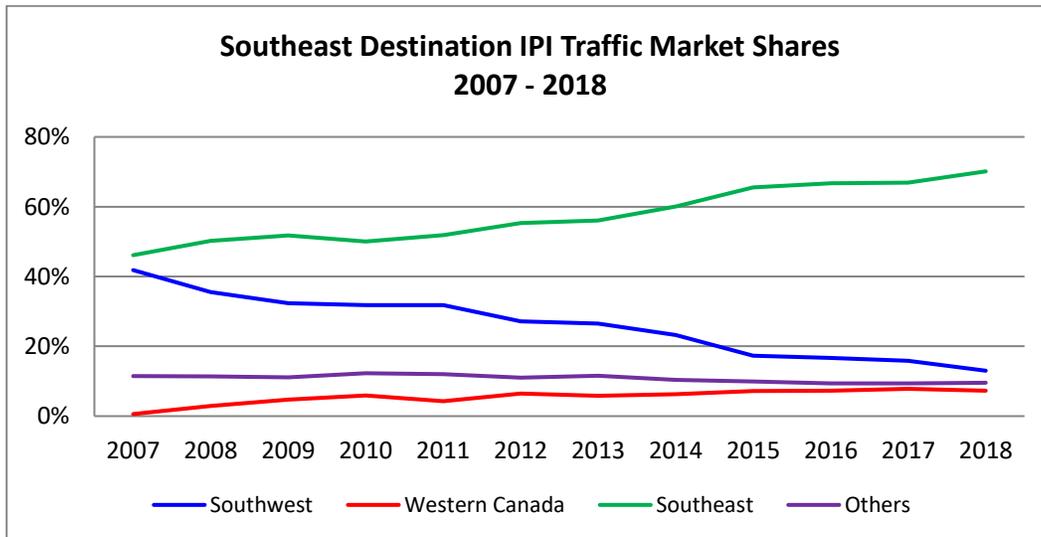


The Southwest share of this market fell from 41.8 percent in 2007 to 13.0 percent in 2018, largely due to an increase in the market share of the Southeast region (which includes the Ports

of Savannah and Charleston) from 46.1 percent in 2007 to 70.1 percent in 2018. Western Canada also increased its share from 0.6 percent to 7.3 percent, no doubt based on the success of CN leveraging its single line routing from the Ports of Prince Rupert and Vancouver to their Memphis hub.

Market shares of international containers destined for the South-Central region by region of origin are shown below. The Southwest region has maintained a dominant share of this market, though in 2017 and 2018 the intraregional market share increased, presumably due to increased volume through the Port of Houston.

**Figure 4-5 South Central Destined IPI Traffic by Origin Region 2007 – 2018**
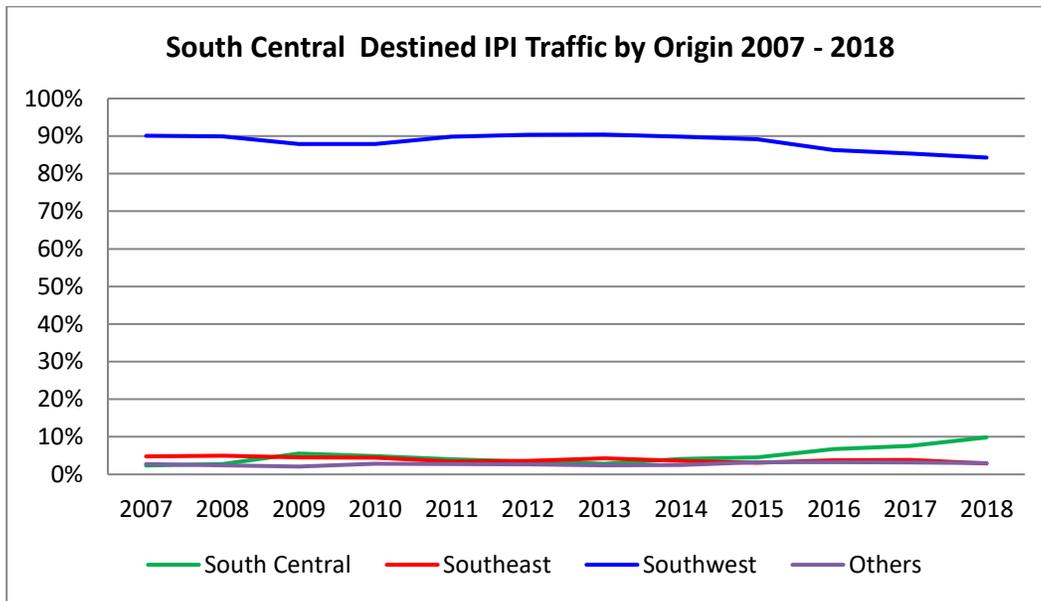


The portion of the loss in market share by POLA/POLB accounted for by IPI traffic can be estimated by comparing the volume which would have been shipped through POLA/POLB if the Ports had maintained their market share in both total imports and in major IPI markets. The results show that the loss in IPI traffic to these three major markets accounted for as much as 75 percent of the annual loss in POLA/POLB import market share over this period.

**Figure 4-6 POLA/POLB IPI Traffic Loss as % of Total Traffic Loss 2008 – 2017[7]**



**Estimated POLA/POLB IPI Loss as % of Total Traffic Loss 2008 - 2017**
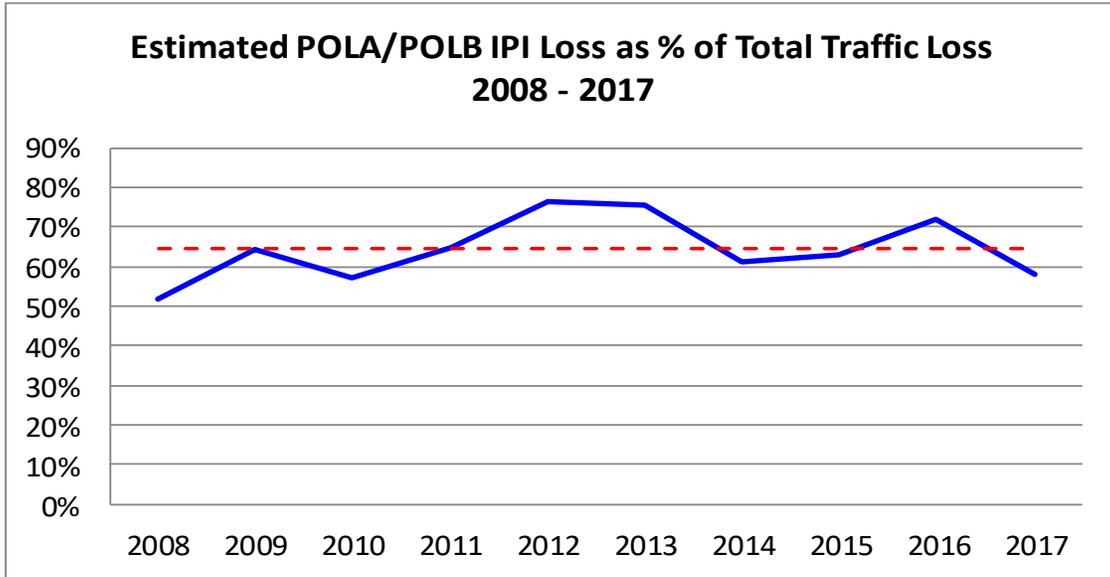
The estimated loss by market is shown below. By far the largest loss was due to the substantial decline in POLA/POLB market share to the Southeast region.

**Figure 4-7 IPI Loss by Region as % of Total Traffic Loss 2008 - 2017**



**POLA/POLB IPI Loss by Region as % of Total Import Traffic Loss 2008 - 2017**

Midwest   Southeast   South Central

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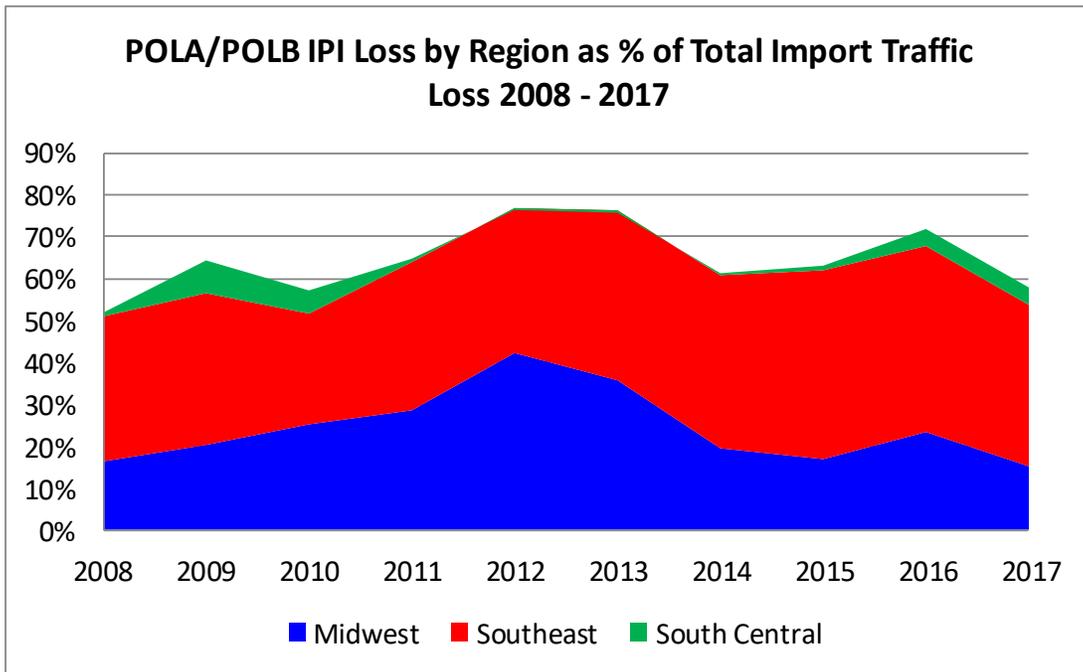
[7] Assumes a 90 percent share of international container traffic originating in the Southwest Region.

## 4.3      Potential Cargo Diversion Due to the CTF Rate

POLA/POLB traffic segments which are likely to be directly affected by additional costs resulting from implementation of CTF rates are highlighted in red in the diagram below. These are the options which use local drayage service.

**Figure 4-8 Import Container Modal Options and Associated Costs**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Direct Truck** | Ocean Rate | PierPass Fee | Local or Regional Dray Rate to Destination Warehouse | | | | |
| **Direct Intermodal Rail (IPI) On-dock** | Ocean Rate | ACTA Fee | Line Haul Rail Charge* | Local Dray Rate from Destination Rail Ramp to Destination Warehouse | | | |
| **Direct Intermodal Rail (IPI) Near- Dock** | Ocean Rate | ACTA Fee | Local Dray Rate to ICTF | Line Haul Rail Charge | Local Dray Rate from Destination Rail Ramp to Warehouse | | |
| **Direct Intermodal Rail (IPI) Off-Dock** | Ocean Rate | ACTA Fee | Local Dray Rate to ELA/Hobart | Line Haul Rail Charge | Local Dray Rate from Destination Rail Ramp to Warehouse | | |
| **Transload Marine Container to Truck Trailer** | Ocean Rate | PierPass Fee | Local Dray Rate to Transload Warehouse | Transloading Fee | Long-Haul Truck Rate to Warehouse | | |
| **Transload Marine Container to Domestic Rail Container** | Ocean Rate | PierPass Fee | Local Dray Rate to Transload Warehouse | Transloading Fee | Local Dray Rate from Transload Facility to Origin Rail Ramp | IMC Booking Fee | Line Haul Rail Charge | Local Dray Rate from Destination Rail Ramp to Warehouse |

In economics, elasticity is the measurement of how an economic variable responds to a change in another. In the context of port traffic, elasticity is a measure of the extent to which a change in variables such as transportation costs or transit time for cargo shipped through the port gateway affects the volume of traffic. Elasticity is measured as a unitless value calculated as the percent change in one variable divided by the percent change in the second variable:

Price Elasticity = percent change in quantity demanded **/** percent change in price

An elastic variable - with elasticity value greater than one (1) - is one which responds more than proportionally to changes in other variables. In contrast, an inelastic variable - with elasticity value less than one (1) - is one which changes less than proportionally in response to changes in other variables.

Quantitative estimates of the potential impact of the imposition of a CTF rate have been developed by estimating the elasticity of POLA/POLB import traffic segments using regression analysis.  The availability of detailed data on traffic volumes enabled estimation of the elasticity of IPI traffic and total import traffic directly. The elasticity of the other traffic segments (local trucking, transload to rail and transload to truck) was estimated indirectly based on the elasticities of the first two categories.

## 4.4        Elasticity of POLA/POLB Inland Point Intermodal (IPI) Traffic

Regression analysis was undertaken to estimate the impacts of transit time and cost changes on the Southwest region market share IPI traffic to the three major markets; the Midwest, Southeast and South-Central regions. Based on the results of the analysis in Section 4.2, these three major markets accounted for as much as 75 percent of the annual loss in POLA/POLB import market share from 2008 to 2017.

 Key features of the analysis include:

•       Market shares are based on port-level import data published by the U.S. Bureau of the Census.

•       Changes in relative costs are based on Beneficial Cargo owner (BCO) costs. These are estimated based on reported shipping line and railway revenues.

•       Relative transit time is explicitly incorporated as an explanatory variable.

IPI cost estimates from POLA/POLB and New York/New Jersey (NY/NJ) to Chicago are used as the benchmark for relative BCO costs because Chicago is the largest destination for POLA/POLB IPI traffic.

Estimates of individual cost components (rail rates, ocean shipping rates, and bunker fuel surcharges) are based on available public data. Data sources include:

•       The TransPacific Stabilization Agreement (TSA), the discussion group for ocean carriers on the Eastbound Transpacific routes, publishes an index showing the average revenue (net of bunker surcharges) received by carriers on West Coast and East Coast routes. The data is indexed to rates prevailing in the second quarter of 2008 and includes monthly data from January 2010. The TSA data has the advantage of including revenue from traffic moving under

both contract and spot rates and therefore gives a more reliable and stable indication of overall rates paid by shippers.

- Data on bunker surcharges was taken from the TSA website.
- Rail rate estimates are derived from data in the U.S. Surface Transportation Public Waybill Sample for various years.
- POLA/POLB costs include Alameda Corridor fees.
- NY/NJ costs include rail surcharges reported in the STB Public Waybill Sample data.

The resulting cost estimates are depicted below.

**Figure 4-9 Relative Shipper Costs POLA/POLB vs New York/New Jersey to Chicago**
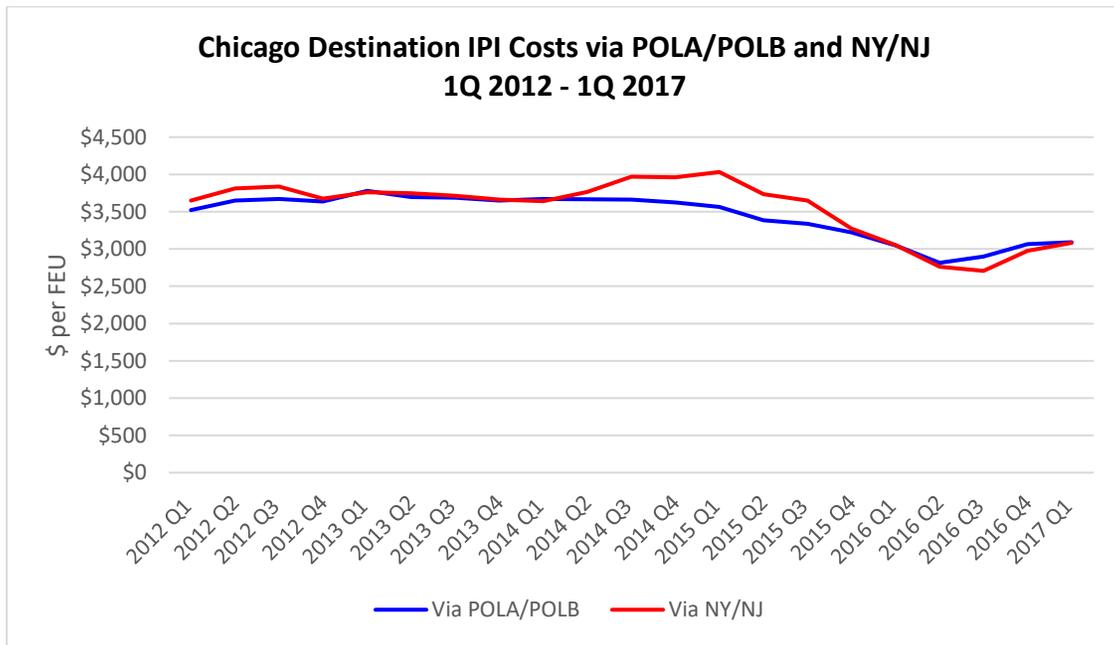


Previous studies have identified relatively faster transit time for shipments from Asia through POLA/POLB as a key competitive advantage but have implicitly assumed that this advantage is constant. However, there are two routes for Asian imports through East Coast ports: the Panama Canal and the Suez Canal. Transit time for Suez shipments is longer due to the greater distance involved. Consequently, the average transit time from Asian ports to the U.S. East Coast is a function of the share of traffic on each of these routes.

Data on shipping line capacity and transit times from 2012 to 2017 was provided courtesy of BlueWater Reporting. The data shows a dramatic shift in capacity from the Suez Canal to the Panama Canal following the opening of the expanded Panama Canal in June 2016. Since the Panama Canal has a faster transit time, this results in a lower average transit time for Asian imports to the U.S. East and Gulf Coasts as traffic shifts from the Suez Canal to the Panama Canal.

Port-to-port transit times for liner services to POLA/POLB and to NY/NJ via the Panama and Suez Canals were estimated from data provided by BlueWater Reporting. Transit times vary

among different shipping lines based on port rotations and other factors; for purposes of this analysis representative transit times were based on express services from Shanghai. Weighted transit times for NY/NJ shipments were then calculated based on the share of liner capacity on each route. The resulting estimates of POLA/POLB's transit time advantage over the East/Gulf Coast weighted average from 2012 to 2017 are depicted below.

**Figure 4-10 POLA/POLB Transit Time Advantage 2012 – 2017**
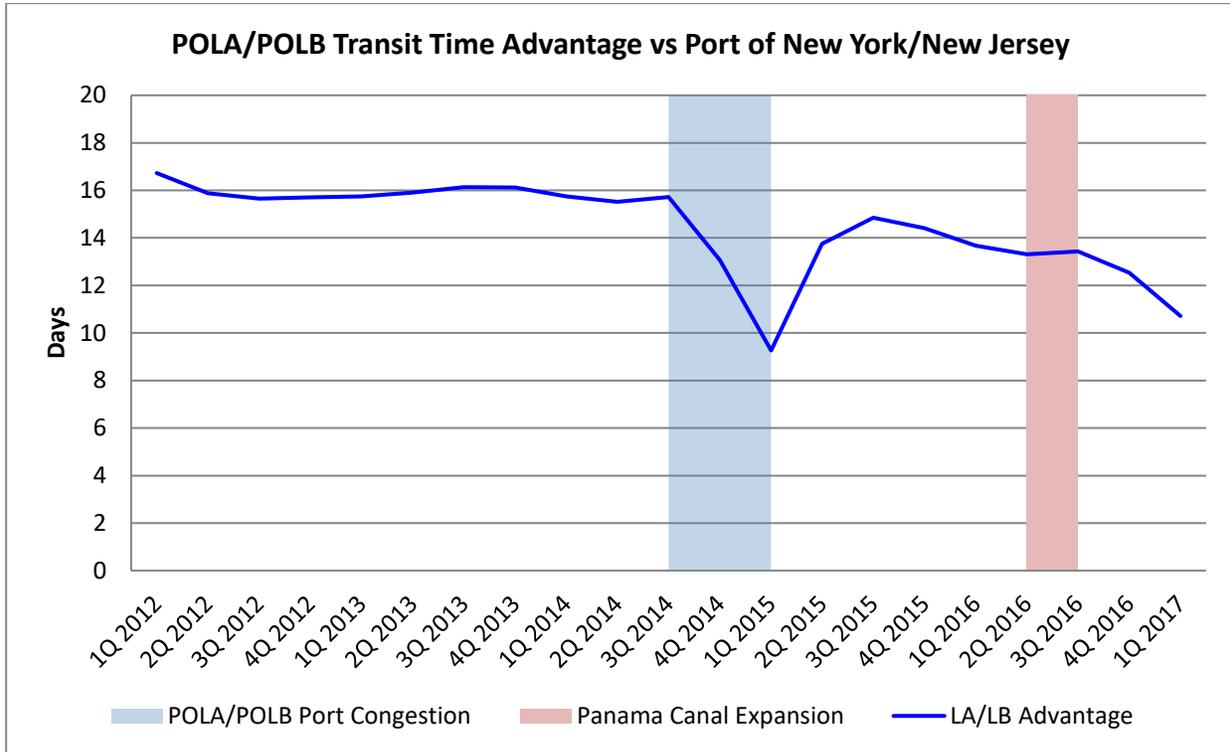


The POLA/POLB transit time advantage was substantially affected by congestion due to a variety of factors including arrival of larger vessels, chassis dislocation and equipment imbalance, and a protracted labor contract negotiation from November 2014 to February 2015. It recovered somewhat since early 2015 but has trended downward due to the decline in average transit time for East Coast shipments as carriers shifted services from the Suez to the Panama Canal.

**Model Results**

Regression analysis was undertaken to estimate the impacts of transit time and cost changes on the Southwest region market share IPI traffic to the three major markets; the Midwest, Southeast and South-Central regions. The resulting equation is shown below. The equation yields an adjusted $R^2$ of 0.79 and all variables are significant at the 99 percent level.

LALB Share = 0.94- 0.343 LALB IPI /NYNJ IPI - 0.395 LALB/NYNJ Transit Time
t statistics      (15.3)   (-6.19)                (-6.97)

Where:

•      LALB Share is the market share of IPI traffic destined to three major markets (Midwest, Southeast and South-Central regions).

•      LALB IPI/NYNJ IPI is the ratio of IPI cost to Chicago via POLB/POLB divided by IPI costs via New York/New Jersey.

•      LALB/NYNJ transit time is transit time from Shanghai to LA/LB divided by the weighted average transit time to New York/New Jersey.

The figure below shows actual versus fitted values for the Southwest region share of IPI traffic to the three major markets.

**Figure 4-11 Actual vs Fitted Southwest IPI Market Shares 2012 – 2017**



The model indicates a price elasticity of 0.77 for POLA/POLB Inland Point Intermodal (IPI) traffic.

**Figure 4-12 POLA/POLB Three Major IPI Markets Elasticity Calculations**

| | | | Elasticity Calculations - Three Major IPI Markets | | | | |
|---|---|---|---|---|---|---|---|
| CTF Rate | EC Rate + Bunker | WC IPI | Total Annual IPI 3 Mkts (000 TEUs) | Market Share | % Volume increase | % Cost Increase | Elasticity |
| $0 | $3,157 | $2,881 | 4,894 | 40.7% | 0.0% | 0.0% | |
| $5 | $3,157 | $2,891 | 4,881 | 40.6% | -0.3% | 0.3% | -0.77 |
| $20 | $3,157 | $2,921 | 4,842 | 40.2% | -1.1% | 1.4% | -0.77 |
| $35 | $3,157 | $2,951 | 4,803 | 39.9% | -1.9% | 2.4% | -0.77 |
| $50 | $3,157 | $2,981 | 4,763 | 39.6% | -2.7% | 3.5% | -0.77 |
| $70 | $3,157 | $3,021 | 4,711 | 39.2% | -3.7% | 4.9% | -0.77 |

The significance of relative transit times to POLA/POLB market share is highlighted by the model. It successfully tracks POLA/POLB market performance from the first quarter of 2012 to the first quarter of 2017. The time period includes the influence of two major events affecting relative transit times: POLA/POLB port congestion from November 2014 to February 2015, and the opening of the expanded Panama Canal in June 2016.

The largest share of IPI traffic is loaded at on-dock rail yards and thus is unlikely to be affected by increases in drayage costs. IPI traffic which is trucked to off-dock rail yards incurs drayage costs paid by the shipping lines. Off-dock IPI traffic has seen a steady decline since 2003.

To test the hypothesis that higher drayage rates affect the volume of off-dock IPI traffic, a time series regression was used, with a dummy variable to measure the impact of higher rates over the 2009 to 2013 period which can be attributed to the impact of the original Clean Truck Program rate. The actual vs fitted values are shown below.

**Figure 4-13 Impact of Clean Truck Program Rate on Off-Dock Rail Traffic**

The results suggest that the additional drayage costs did result in a decrease in off-dock IPI traffic i.e. traffic was depressed below the trendline values while the rate was in effect. The value of the coefficient on the dummy variable is 98,945; this provides an estimate of the decrease in off-dock traffic resulting from the rate of approximately 175,000 TEUs, though it is impossible to tell whether this traffic was lost or simply diverted to another mode (i.e. on-dock rail or transloaded to rail or truck). This amounts to approximately 2.5 percent of total import volume in 2010. The share of total POLA/POLB IPI traffic trucked to off-dock rail yards has declined substantially since 2010. In 2017, off-dock IPI traffic accounted for approximately 20 percent of total IPI traffic in 2017.

## 4.5 Elasticity of Total Import Traffic

Regression analysis was undertaken to estimate the impacts of transit time and cost changes on the market share of POLA/POLB from 1Q 2012 to 1Q 2017. The resulting equation is shown below. The equation yields an adjusted $R^2$ of 0.74 and all variables are significant at the 99 percent level.

LALB Share = 0.76 - 0.153 LALB IPI /NYNJ IPI + Surcharge - 0.284 LALB/NYNJ Transit Time

t statistics     (16.75)   (-3.61)                                  (-7.2)

Where:
- LALB Share is the market share of Asian imports
- LALB IPI/NYNJ IPI is the ratio of IPI cost to Chicago via POLB/POLB divided by IPI costs via New York/New Jersey
- LALB/NYNJ transit time is transit time from Shanghai to LA/LB divided by the weighted average transit time to New York/New Jersey.

The figure below shows actual versus fitted values for POLA/POLB total import market share.

**Figure 4-14 Actual vs Fitted POLA/POLB Share of Pacific Rim Imports 2012 – 2017**

Based on these results, the estimated elasticity of demand for relative transportation cost increases is 0.29 as per the calculations below.

**Figure 4-15 POLA/POLB Total Import Elasticity Calculations**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Elasticity Calculations - Total Imports** | | | | |
| **CTF Rate** | **EC Rate + Bunker** | **WC IPI** | **Total Annual TEUs (000s)** | **Market Share** | **% Volume increase** | **% Cost Increase** | **Elasticity** |
| $0 | $3,157 | $2,881 | 16,887 | 46.8% | 0.0% | 0.0% | |
| $5 | $3,157 | $2,891 | 16,870 | 46.7% | -0.1% | 0.3% | -0.29 |
| $20 | $3,157 | $2,921 | 16,818 | 46.6% | -0.4% | 1.4% | -0.29 |
| $35 | $3,157 | $2,951 | 16,767 | 46.4% | -0.7% | 2.4% | -0.29 |
| $50 | $3,157 | $2,981 | 16,715 | 46.3% | -1.0% | 3.5% | -0.29 |
| $70 | $3,157 | $3,021 | 16,647 | 46.1% | -1.4% | 4.9% | -0.29 |

## 4.6 Elasticity of Local & Transload to Truck Traffic

Transload and local traffic includes the following categories:

- Transload to Rail: cargo unloaded from marine containers in the Los Angeles (LA) Basin and reloaded to larger (53-foot) domestic containers and then delivered to the off-dock rail yards for rail shipment to inland destinations.

- Transload to Truck:  cargo unloaded from marine containers in the LA Basin and reloaded to truck trailers and then delivered to inland destinations.

- Local: cargo trucked directly from the Port terminals to an inland destination.

POLA/POLB total transload and local traffic can be calculated by subtracting IPI traffic from total imports. The figure below shows quarterly estimates of transload and local traffic by mode based on total import and IPI traffic[8].

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[8] IPI traffic estimates are based on IANA data.

**Figure 4-16 POLA/POLB Import Traffic by Mode 2007 - 2018**
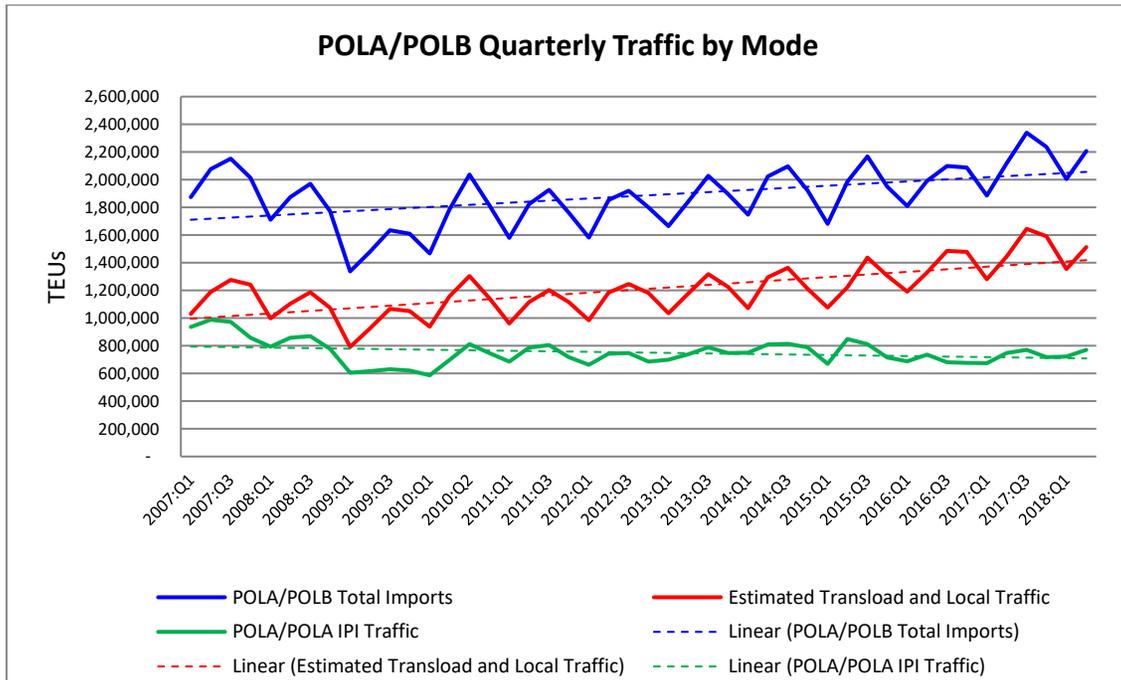


Since 2002, TTX Company has developed quarterly estimates of transload to rail traffic volumes to track trends in international logistics and intermodal operations. Transload to truck and local traffic volumes can be estimated by subtracting the TTX transload to rail traffic from total local and transload traffic IPI and transload to rail traffic from total imports.

**Figure 4-17 POLA/POLB Transload to Rail vs Local & Transload to Truck Traffic**
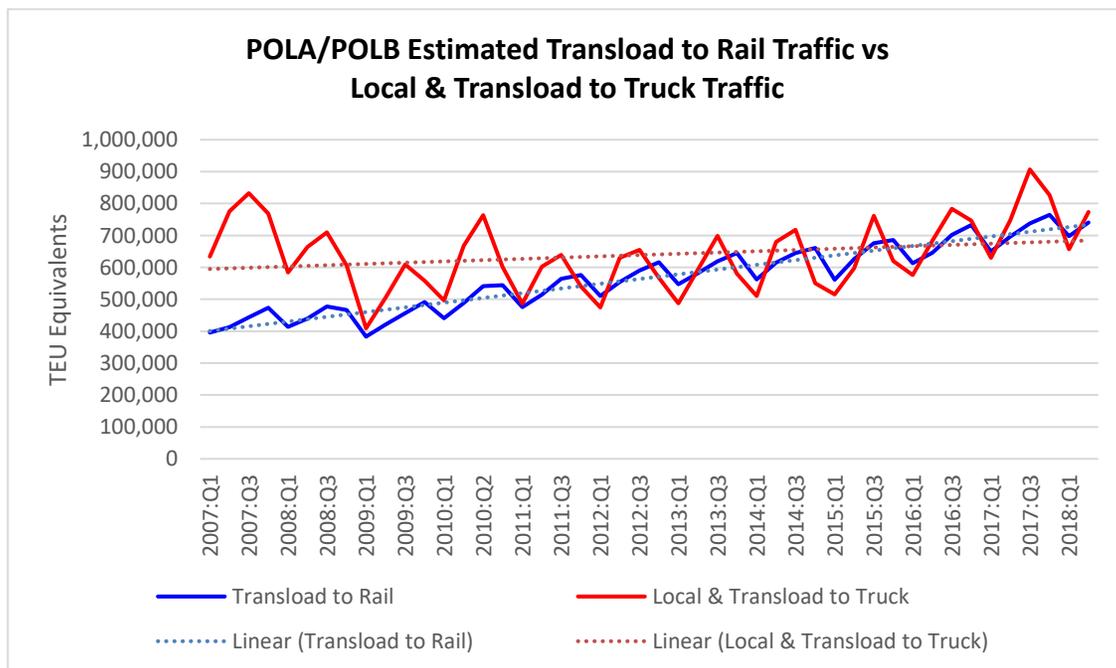
### 4.6.1    Local Traffic

Local traffic consists of cargo trucked directly from the Port terminals to an inland destination. Drayage of cargo in an international container direct from the port to destination is typically restricted to relatively short distance hauls for two reasons:

- It is significantly more economical to transport cargo long distances in truck trailers or domestic intermodal containers due to the higher cubic capacity of these units relative to international containers. On average the contents of three 40-foot international containers can be transferred to two 53-foot domestic containers which can be trucked at approximately the same cost i.e. long-distance trucking of cargo in an international container is 50 percent more expensive on a cargo capacity basis.

- Container lines typically allow only a limited time for BCOs to retain possession of marine containers and charge significant amounts ("detention") for late return. For example, Maersk allows shippers four days from the day of pickup to return a standard dry container ("free time") and charges a detention fee starting at $125 per day escalating to $170 per day after four days (and higher thereafter).

Based on surveys carried out at the Ports of Los Angeles and Long Beach in 2010, less than 5 percent of drayage trips from the port terminals were destined outside the state of California. The largest portion of this traffic appears to be destined for Phoenix, which is approximately 380 miles from the Ports.

Due to the restricted range of local dray movements, the only major container port that could potentially compete with POLA/POLB for local traffic is Oakland. However, it is unlikely that drayage cost increases caused by CTF rates at the levels studied would be sufficient on their own to shift local POLA/POLB traffic to Oakland for the following reasons:

- The largest portion of the California population is clustered close to the Ports of Los Angeles and Long Beach. Demand for Asia Pacific imports is clustered close to POLA/POLB in Southern California. Due to the additional distance of trucking from Oakland to Southern California, drayage rates would be significantly higher for Southern California- destined import containers. The figure below shows the distribution of population by county in California in 2019, and comparative drayage[9] rates for cities in the Central Valley between POLA/POLB and Oakland.

Drayage costs from POLA/POLB as far north as Bakersfield are approximately $150 cheaper than those from Oakland. Bakersfield is approximately 140 miles from POLA/POLB and 270 miles from Oakland. Most local drayage trips from POLA/POLB are shorter than 140 miles, and even at the highest rate of $75 per TEU drayage rates from Oakland would not be competitive for destinations south of Bakersfield.

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[9] Drayage rates are based on load board quotes.

**Figure 4-18 California Population Distribution and Comparative Drayage Rates**

California Population Distribution and Drayage Rates POLA/POLB vs Oakland

California Population by County 2019
- 1150 - 283000
- 300000 - 1 million
- 1 million - 2.5 million
- 2.5 million - 3.5 million
- 3.5 million - 10.5 million
- Major Cities

POLA/POLB Drayage

Oakland Drayage Rates
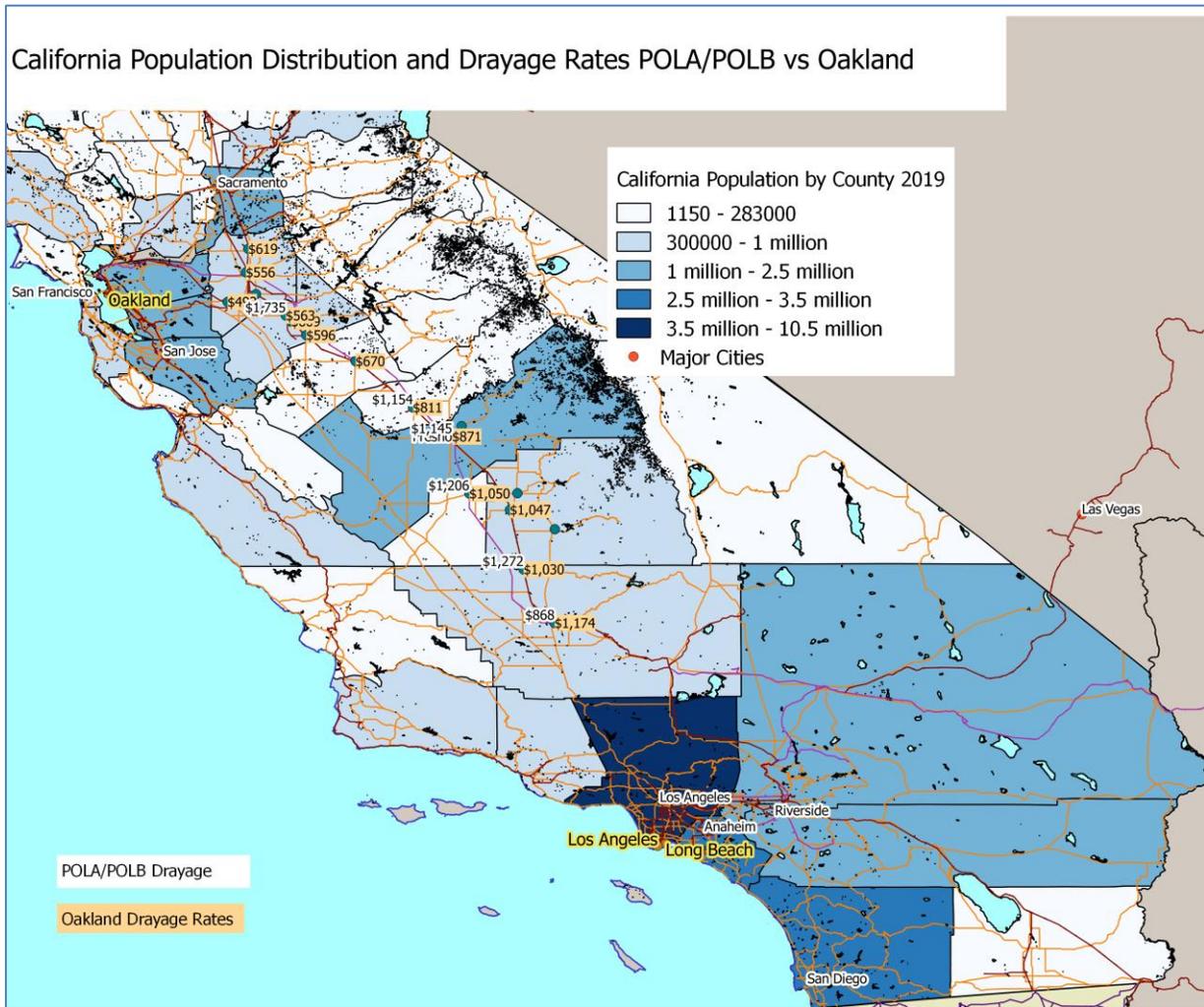
- Transit times for imports through the Port of Oakland are likely to be significantly longer than through POLA/POLB. For shipping line services calling at POLA/POLB and Oakland, POLA/POLB is generally the first port of call. Southern California importers using the Port of Oakland would have to wait until the vessel was unloaded at POLA/POLB, shifted to Oakland, and unloaded at the Port of Oakland before they could receive their containers. For example, Maersk's TP2 Eastbound service from Singapore to the U.S. West Coast via Vung Tau Vietnam, and Yantian, Ningbo and Shanghai China vessel calls, first at the Port of Long Beach, with a transit time from Shanghai of 13 days. The service stops at Oakland six days later.

### 4.6.2    Transload to Truck

Transloading of cargo from an international marine container to domestic trailers or domestic rail containers enables BCOs to lower their costs per cubic foot of cargo. This fact is especially relevant to the San Pedro Bay ports container traffic since many of the imported goods are relatively light weight and the additional cubic capacity of a domestic container is therefore

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maximized. Secondly, transloading of cargo in the San Pedro Bay area allows BCOs to engage in other tactics (i.e. value-added logistics services, order fulfilment) that maximize their customer service. Transloading can be used by BCOs to build more agile supply chains.

Transloading necessitates additional costs for transferring the cargo from international to domestic containers or trucks. In the case of domestic rail intermodal transportation, it also adds additional dray costs to the origin rail ramp and from the destination rail ramp to the final destination. In contrast, cargo transloaded to truck can be delivered directly from the transloading site to destination.

Due to the high fixed costs of rail relative to trucking, rail intermodal is generally uncompetitive and unavailable for short haul service and struggles to compete with truckload service at medium distances (up to 750 to 800 miles). Trucking is less competitive over longer distances due to the higher variable cost per mile.

The figure below shows truck catchment areas for major U.S. container ports based on the 800 mile "rule of thumb" for the most competitive zone for trucking relative to intermodal rail.

**Figure 4-19 Major U.S. Ports Truck Catchment Areas**
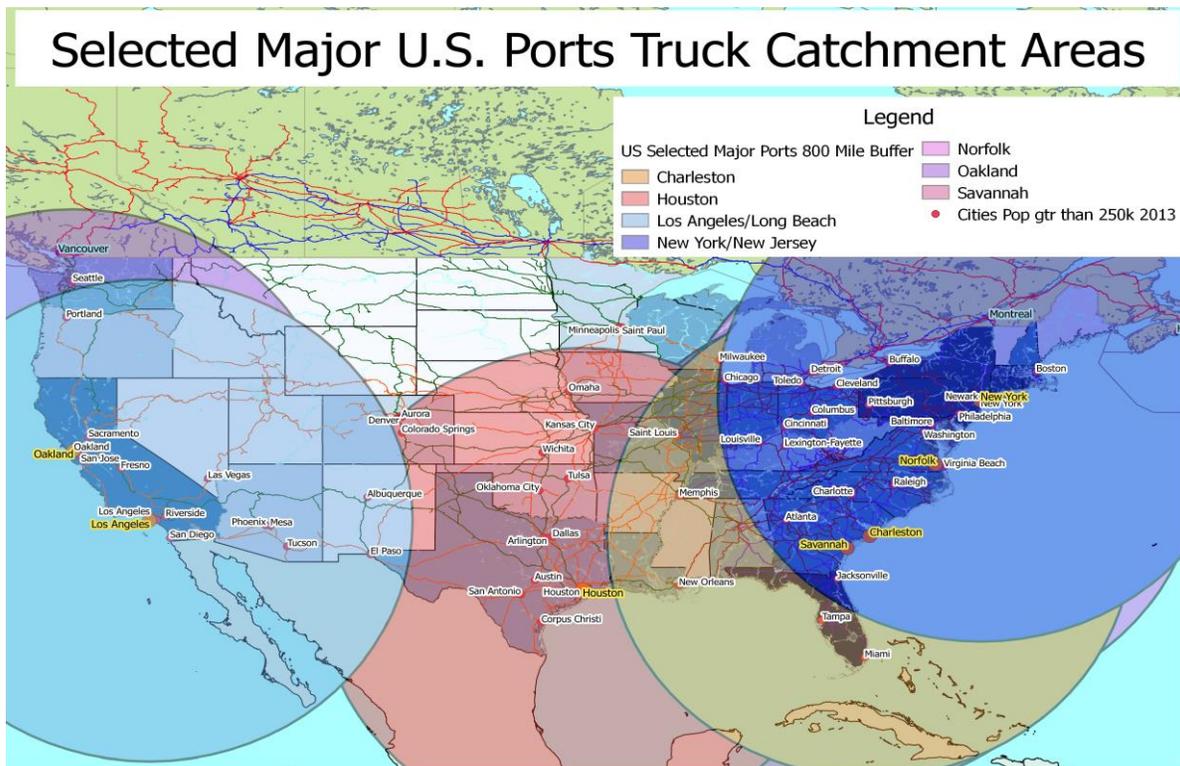


The catchment zones of POLA/POLB and Oakland intersect; however, all of the major cities in the Southwest are closer to POLA/POLB, including Phoenix, Las Vegas, Mesa, Tucson and El Paso.

The POLA/POLB truck catchment area also intersects with the catchment zone for the Port of Houston, but Houston is not a competitive option for transload to truck traffic due to higher ocean costs and longer ocean transit times:

- Recent spot prices for a 40-foot container from Central China to Houston are quoted at $2,950 per 40-foot container, compared to $1,550 for POLA/POLB.[10]

- Transit times for serving Southern California for Asian imports via Houston are not competitive with POLA/POLB. Compared to a 13-day transit from Shanghai to Long Beach on Maersk's TP 2 service, the CMA CGM Pacific Express 3 service takes 25 days.[11]

Based on the inability of other ports to compete with POLA/POLB for local and transload to truck traffic, we assume that the elasticity for this traffic is zero and that the implementation of CTF rates at the levels modelled will not result in any diversion for this traffic based on cost alone. Consequently, we can calculate the elasticity of transload to rail traffic by subtracting estimated losses of IPI traffic from estimated loses of total imports. This generates an estimated elasticity for transload to rail traffic of 0.20.

## 4.7    Elasticity Summary

The table below summarizes the results of the elasticity analysis. Overall import demand is inelastic; Inland Point Intermodal (IPI) traffic is more elastic, and accounts for the largest portion of the loss in import container market share for POLA/POLB since 2007.

**Figure 4-20 Elasticity Estimates Summary**

| Elasticity Estimates | |
|---|---|
| **Traffic Type** | **Estimated Elasticity** |
| Total Imports | 0.29 |
| IPI Traffic | 0.77 |
| Transload to rail | 0.20 |
| Local and Transload to Truck | 0.00 |

Based on these elasticity estimates, the estimated impact of drayage cost rates due to implementation of the CTF rates is shown below.

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[10] Goodhope Freight: data retrieved on October 2, 2019
https://www.goodhopefreight.com/shipfromchina/shipping-china-us.html
[11]  CMA/CGM  http://www.cma-cgm.com/products-services/line-services/flyer/PEX3

**Figure 4-21 Estimated Impact of Drayage Cost Increases on Port Traffic**

| CTP Rate $ per TEU | % Increase in Total Cost ($ per FEU Chicago IPI) | Total Annual Traffic (000 TEUs) | IPI (000 TEUs) | Transload to Rail (000 TEUs) | Local and Transload to Truck (000 TEUs) | Transload & Local Drayage Traffic (000 TEUs) | % Decrease in Total Traffic | % Decrease in Drayage trips |
|---|---|---|---|---|---|---|---|---|
| Impact of Drayage Cost Increase |
| $0 | 0.0% | 16,887 | 4,894 | 4,648 | 7,345 | 11,993 | 0 | 0 |
| $5 | 0.3% | 16,870 | 4,881 | 4,644 | 7,345 | 11,989 | -0.1% | 0.0% |
| $20 | 1.4% | 16,818 | 4,842 | 4,632 | 7,345 | 11,977 | -0.4% | -0.1% |
| $35 | 2.4% | 16,767 | 4,803 | 4,619 | 7,345 | 11,964 | -0.7% | -0.2% |
| $50 | 3.5% | 16,715 | 4,763 | 4,607 | 7,345 | 11,952 | -1.0% | -0.3% |
| $70 | 4.9% | 16,646 | 4,711 | 4,590 | 7,345 | 11,935 | -1.4% | -0.5% |

For purposes of modelling a maximum diversion rate for imports of 1.4 percent has been used as the "upper bound" of potential diversion. The impact to 2035 based on the baseline forecast and the 1.4 percent diversion factor is shown below.

**Figure 4-22 POLA/POLB Total Traffic Forecasts Baseline and Diversion Case**

| POLA/POLB Total Traffic Forecast Baseline And Diversion Case | | |
|---|---|---|
| 000 TEUs | | |
| Year | Baseline Forecasts | Diversion Forecast |
| 2021 | 20,139 | 19,857 |
| 2022 | 21,047 | 20,752 |
| 2023 | 21,862 | 21,556 |
| 2024 | 22,652 | 22,335 |
| 2025 | 23,470 | 23,142 |
| 2026 | 24,250 | 23,910 |
| 2027 | 25,210 | 24,857 |
| 2028 | 26,205 | 25,839 |
| 2029 | 27,238 | 26,857 |
| 2030 | 28,312 | 27,916 |
| 2031 | 29,433 | 29,021 |
| 2032 | 30,588 | 30,160 |
| 2033 | 31,607 | 31,164 |
| 2034 | 31,707 | 31,263 |
| 2035 | 31,772 | 31,327 |

The CTF rate as a percentage of current estimated drayage costs by distance-based zones is shown below.

**Figure 4-23 CTF Rate as a Percentage of Trucking Cost**

| CTF Rate as a Percentage of Total Trucking Cost (40 ft Container) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Zones | Base Rate + Fuel Surcharge | $0 | $5 | $20 | $35 | $50 | $70 |
| Near Dock | $344 | 0.0% | 2.9% | 11.6% | 20.3% | 29.1% | 40.7% |
| Local (near) | $344 | 0.0% | 2.9% | 11.6% | 20.3% | 29.1% | 40.7% |
| Local (away) | $375 | 0.0% | 2.7% | 10.7% | 18.7% | 26.7% | 37.3% |
| Regional (near) | $500 | 0.0% | 2.0% | 8.0% | 14.0% | 20.0% | 28.0% |
| Regional (away) | $750 | 0.0% | 1.3% | 5.3% | 9.3% | 13.3% | 18.7% |
| Long Distance | $1,625 | 0.0% | 0.6% | 2.5% | 4.3% | 6.2% | 8.6% |

## 4.8 Other Competitive Factors

The analysis is this section has demonstrated a strong relationship between POLA/POLB market share and relative costs and transit times over the 2012 to 2017 period. However, this may only provide a partial picture due to a lack of detailed data on other factors affecting port choices by BCOs, and due to the time period (2012 – 2017) for which detailed data on costs and transit times was available for this study.

Ocean transit time is used in this analysis is used as an indicator of service quality. However, this is only one aspect of service quality. Total transit time from origin to destination, including dwell time of containers at the port and inland transit times as well as ocean transit times, would be a more appropriate measure. Reliability is also a key factor; the appropriate measure of reliability is the variability of costs and transit times for competing gateway ports. There is no reliable source of data on these aspects of service quality; however, it must be recognized that they have an impact on port choices.

# 5 Impact of the CTF Rates on the Drayage Sector

This section of the report describes the analysis carried out using the Drayage Cost and Fleet Projections Model to estimate the potential impacts of the Clean Truck Fund (CTF) rate under various assumptions regarding CTF rate levels and capital subsidies. The key input variables, the model structure and the computational processes are documented in this section. Also, summaries of the results for each scenario are provided.

The model is designed to estimate the potential impacts of the proposed CTF rates on the Southern California drayage sector, focusing on fleet composition and program costs and revenues. Essentially the model estimates an efficient fleet mix based on forecasts of port traffic volumes, operational parameters of Southern California drayage operations, trip characteristics, truck costs for both Licensed Motor Carrier (LMC) fleets and Independent Owner Operator (IOO) options, and drayage rates. The model also estimates program revenues and capital requirements for fleet renewal based on the forecast fleet composition.

The predicted fleet size and mix of truck types and ages is intended to replicate truckers' choices of vehicle replacement and timing which maximizes their margins (i.e. the difference between their daily revenue and costs per truck) subject to two key constraints: actual or possible requirements regarding eligibility to serve the Ports; and the supply of new or used trucks compliant with Near-Zero-Emission (NZE) and Zero-Emission (ZE) requirements that may be in force. For the purposes of this report, NZE is assumed to be a truck with an engine that meets the 0.02g NOx/bhp-hr optional low NOx engine emission standard.

The design of the model is compatible with economic theory, observed behavior in the industry, and institutional and regulatory constraints.

Economic theory predicts that for markets like the Southern California drayage sector that closely resemble the theoretical model of perfect competition, individual firms are too small to influence the price of services, and they maximize their profits by minimizing their costs. The model predicts firms' choices among technological and operational options under the assumption that they minimize their costs by selecting the least costly option.

The model's predictions take into account observed behavior in the drayage sector, which is consistent with the predictions of economic theory; for example, the predominance of low cost used trucks in the fleet.

The model incorporates institutional constraints of Clean Air Action Plan (CAAP) requirements and anticipated Environmental Protection Agency (EPA) and California Air Resources Board (CARB) regulations: including the 2017 CAAP Update requirement that new trucks entering the port drayage registries meet the cleanest state or federal engine manufacturing standard (e.g. engine model years 2014 and newer effective in 2018; and the adopted state or federal manufacturing standard effective for 2023/24).

The forecasts are also shaped by institutional constraints related to the economics of the industry; for example, the limited capability of IOOs to obtain financing for new trucks.

The fleet forecasts also consider our estimates regarding the timing of introduction and/or improvement of non-diesel propulsion systems, and the pace of adoption of new technologies which influences the balance between new and used vehicles in the drayage fleet.

## 5.1 Drayage Cost and Fleet Projections Model

### 5.1.1 Model Description and Key Parameters

The primary objective of the model is to estimate the change in fleet composition and the revenues and costs associated with various rates and subsidy scenarios. The model is based on LMCs' choice of truck type and operating model (fleet or IOO) to maximize margins (i.e. the difference between their daily revenue and costs per truck) based on an analysis of truck costs. A structural representation of the model is shown below.

**Figure 5-1 Model Structure**
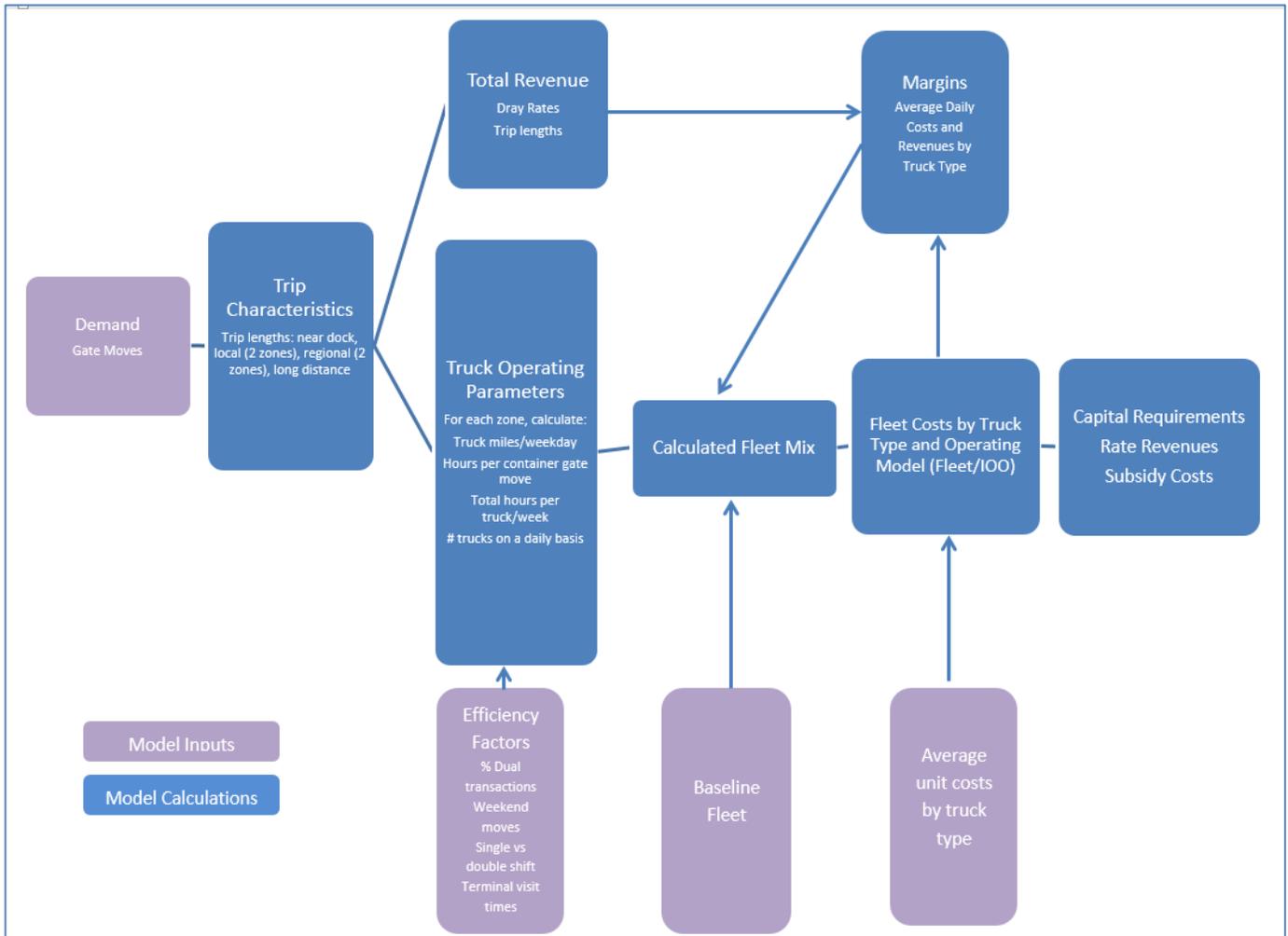
## 5.1.2 Demand

Forecasts of future drayage demand are based on the base case scenario for total port container traffic forecasts developed by Mercator International and Oxford Economics in 2016, adjusted to revised forecasts of terminal capacity at the Port of Long Beach. The forecast of gate moves is based on the allocation of the portion of total traffic which incurs drayage costs (i.e. the off-dock inland point intermodal, transload to rail and local traffic segments) in the Ports' QuickTrip-Train Builder (QTTB) model.

The table below displays results for the baseline forecasts for weekday truck trips and total loaded container ("Full") gate moves annually for 2020-2040. Since terminal capacity is expected to reach a maximum in 2037, values beyond 2037 are constant.

**Figure 5-2 QTTB Truck Trip and Gate Move Forecasts 2020 – 2040**

| QTTB Trucks Trip and Gate Move Forecasts 2020 - 2040 | | | |
|---|---|---|---|
| Year | Total Truck Trips | Total Port Visits | Full Gate Moves |
| 2020 | 61,304 | 30,652 | 19,508 |
| 2021 | 63,820 | 31,910 | 20,309 |
| 2022 | 66,458 | 33,229 | 21,148 |
| 2023 | 68,787 | 34,393 | 21,889 |
| 2024 | 71,014 | 35,507 | 22,598 |
| 2025 | 73,316 | 36,658 | 23,608 |
| 2026 | 75,476 | 37,738 | 24,303 |
| 2027 | 78,181 | 39,091 | 25,174 |
| 2028 | 80,972 | 40,486 | 26,073 |
| 2029 | 83,854 | 41,927 | 27,001 |
| 2030 | 86,841 | 43,420 | 28,050 |
| 2031 | 89,947 | 44,973 | 29,053 |
| 2032 | 93,132 | 46,566 | 30,082 |
| 2033 | 95,875 | 47,938 | 30,968 |
| 2034 | 95,823 | 47,911 | 30,951 |
| 2035 | 95,660 | 47,830 | 31,027 |
| 2036 | 95,861 | 47,930 | 31,093 |
| 2037 | 95,997 | 47,998 | 31,137 |
| 2038 | 95,997 | 47,998 | 31,137 |
| 2039 | 95,997 | 47,998 | 31,137 |
| 2040 | 95,997 | 47,998 | 31,137 |

Estimates of container gate moves for the third quarter of 2018 are based on data extracted from the PierPass data files and adjusted to exclude gate moves involving bob-tail tractors and empty chassis. This represents the baseline total number of gate moves involving either a loaded or an empty container. For the subsequent five-year snapshots, total gate moves are forecast by applying the compound growth rate that was derived from the port forecasts to the

Q3 2018 baseline. Potential cargo diversion resulting from increased costs to Beneficial Cargo Owners (BCOs) is taken into account by applying a cargo diversion factor to the gate moves forecasts, with a lower bound of zero percent and an upper bound of 2 percent.

Loads as a percentage of total moves are calculated directly from the gate move data. Based on this data, 55 percent of gate moves involve a loaded container, while empty containers, bob-tail tractors or tractors with an empty chassis account for the remaining 45 percent.

For purposes of the costing model, only container movements are used, whether loaded or empty. Gate transactions with bobtails or empty trailers are not included. Consequently, unless the gate move involves a dual transaction, the actual workload for a single gate move consists of both an inbound trip to the container terminal and an outbound trip from the container terminal.

### 5.1.3 Trip Characteristics

Trip characteristics are based on the geographic distribution of container trips originating or terminating at the Port terminals. Six zones were defined, and a typical distance was attributed to each one to represent a centroid for port generated trips. Current and future trip characteristics are shown below.

**Figure 5-3 Model Trip Distribution 2018 - 2035**

| Model Trip Distribution 2018 - 2035 | | | | | | |
|---|---|---|---|---|---|---|
| Category | One Way Miles | 2018 | 2020 | 2025 | 2030 | 2035 |
| | | % of Gate moves | % of Gate moves | % of Gate moves | % of Gate moves | % of Gate moves |
| Near Dock | 2 | 11% | 10% | 8% | 7% | 7% |
| Local (near) | 5 | 19% | 17% | 15% | 14% | 14% |
| Local (away) | 20 | 17% | 15% | 13% | 13% | 13% |
| Regional (near) | 40 | 41% | 45% | 40% | 36% | 36% |
| Regional (away) | 75 | 8% | 9% | 15% | 18% | 18% |
| Long Distance | 300 | 4% | 4% | 9% | 12% | 12% |
| Total | | 100% | 100% | 100% | 100% | 100% |

Origins and destinations of dray moves were estimated based on data from several sources, including the allocation of traffic in the Ports' PorTAM model trip distribution model; and studies related to the estimation of duty cycles for drayage trucks in Southern California.[12]

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[12] Characterization of Drayage Truck Duty Cycles at the Port of Long Beach and Port of Los Angeles Report FINAL (Revised) Prepared for: Port of Long Beach/ Contract HD-7188 Port of Los Angeles/ Tetra Tech Prepared by Patrick Couch & Jon Leonard TIAX LLC March 2011 p. 10; Heavy-Duty Vehicle Port Drayage Drive Cycle Characterization and Development NREL/PR-5400-67291 Robert Prohaska, Arnaud Konan, Kenneth Kelly & Michael Lammer SAE 2016 Commercial Vehicle Engineering Congress October 4-6, 2016 Rosemont, Illinois, USA p.3.

## 5.1.4    Drayage Rates

Drayage rates are estimated for each of the zones based on information gathered from a variety of public sources and interviews with trucking firms and other stakeholders. The analysis is based on 2019 constant dollars; rates vary with trip distance and are assumed to be stable over the time periods in the study. The figure below shows estimated drayage rates used in the modelling.

**Figure 5-4 Estimated Drayage Rates**

| Estimated Revenue by Trip Distance 2021 | | | |
|---|---|---|---|
| | % of Gate moves | Base Rate $/gate move | Carrier Surcharges $/gate move | Total Revenue per Gate Move |
| Near Dock | 10% | $275 | $69 | $344 |
| Local (near) | 17% | $275 | $69 | $344 |
| Local (away) | 15% | $300 | $75 | $375 |
| Regional (near) | 45% | $400 | $100 | $500 |
| Regional (away) | 9% | $600 | $150 | $750 |
| Long Distance | 4% | $1,300 | $325 | $1,625 |
| Weighted Average | | $405 | $101 | $507 |

## 5.1.5    Truck Efficiency Factors

The number of trucks required to accommodate a given level of demand is influenced by a number of factors related to the efficiency of operations. These include the percentage of dual transactions at the container terminals; percentage of gate moves which take place on weekends; shift schedules; and terminal visit times.

Dual transactions at the container terminals (i.e. returning an empty or dropping off loaded export container combined with picking up a loaded import or an empty in a single trip to the terminal) reduce the number of empty miles driven by the truck fleet. The percentage of dual transactions as a percent of container moves has been estimated using date and time stamps in the movement records for each vehicle RFID (Radio-Frequency Identification). Based on historical information from files that were used, 22.4 percent of gate moves involved dual transactions.

Weekend moves can reduce the number of trucks required by increasing truck utilization (i.e. trucks are not sitting idle on weekends). The percentage of moves taking place on the weekend has also been estimated based on the PierPASS data. For purposes of modelling, it has been assumed that 6.3 percent of gate moves take place on weekends.

The use of multiple shifts can reduce the number of trucks required by improving the utilization of trucks (i.e. running trucks longer each day). Multiple shifts average duration (hours) and multiple shift trucks (percentage of active trucks on an average day) are based on analysis of the movement data and on the judgement of the consulting team. For purposes of modelling, workday hours for each driver are set to default at 11 hours per day, which is consistent with Federal Motor Carrier Safety Administration (FMCSA) hours of service regulations which

stipulate a maximum of 11 hours of driving per day. Drivers in multiple-shift operations are assumed to work eight hours (i.e. each truck will be in operation with two drivers for 16 hours per day). Trucks working multiple shifts are factored in at a rate of 35 percent of the fleet working on a weekday. The basic work week is Monday through Friday, rounded to 261 days per year.

The number of trips each truck can make in a day is strongly influenced by the time required to pick up or drop off containers at the container terminals. This is largely outside of the control of LMCs. For purposes of the modelling, we have assumed an average total terminal time per visit of approximately 90 minutes. Based on data from the Harbor Trucking Association, average time per visit was in the range of 90 to 98 minutes from October 2018 through February 2019. Average truck turn times in Los Angeles-Long Beach have remained at seasonal norms of 83 to 84 minutes from March through August 2019.[13]

### 5.1.6 Truck Operating Parameters

Truck operating parameters are used to estimate the drayage workloads that will be required to fulfill demand, as inputs in the calculation of daily and weekly operating costs. The key parameters used for the costing analysis include:
- Trips per day per truck,
- Total miles on weekdays per truck,
- Total hours of operation per day per truck,
- Number of trucks active on a day,
- Weekly miles per truck,
- Total miles per year per truck (dray and other work),
- Total fleet adjusted for utilization.

The number of driver hours per week and the number of drivers required are calculated, but not otherwise used. The payroll cost calculations are based on truck hours operated.

### 5.1.7 Fleet Composition

The composition of the current fleet by type, age and ownership provides the starting point for future fleet projections. In November of 2018, the truck fleet was 96.8 percent diesel and 3.2 percent natural gas. There were a few prototype battery and hydrogen fuel cell trucks coming online for testing purposes, but no NZE or ZE trucks were included in the baseline fleet. To forecast fleet composition in future years, the fleet composition is revised to minimize fleet costs subject to a number of constraints based on regulatory requirements and the availability of new and used trucks. This process is discussed in more detail below.

### 5.1.8 Average Unit Costs

The table below shows details of input cost factors for new and used diesel trucks for fleet and IOO operations. Truck cost factors were developed separately for non-NZE diesel, diesel/hybrid

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[13] "LA/LB port terminals: Empty containers only peak season challenge" Bill Mongelluzzo <u>Journal of Commerce</u> Sep 04, 2019

electric (not used in the model), NZE trucks, and ZE trucks including battery electric and hydrogen fuel cell – electric. The specific requirements for NZE engines have not yet been established by the regulatory agencies. For the purposes of the analysis the cost profile for NZE trucks is based on a 0.02g NOx natural gas truck.[14] If a lower cost diesel option becomes available that meets the yet-to-be determined standard, the costs and fleet mix are expected to be different, however not enough is known and it is too speculative to quantify at this time.

Costs are analyzed by truck type using two operating models: company fleets (LMC) and IOO. New trucks are assumed to be used only by fleet operators. IOOs are assumed to employ used trucks due to the difficulty they have financing new trucks. Some used trucks are utilized by fleet operators if there are more used trucks than IOOs, which was the case in 2018. All costs are in constant dollars at 2019 values. The input costs do not include costs related to chassis; these are assumed to be acquired from a chassis pool as required at an additional cost.

### Figure 5-5 Diesel Truck Input Cost Factors

Diesel tractors - pooled chassis
2019 Constant costs - applicable in all years

| Common Assumptions: | | | Default | |
|---|---|---|---|---|
| Tractor Ownership | | | New Tractor | IOO Used |
| | Purchase Price | $Const. 2019 | - 125,000 | - 40,000 |
| | Grant | | | |
| | Service Life | yrs | 4 | 9 |
| | Residual Value | % | 32.0% | 10.0% |
| | Debt Rate | % | 6.0% | 15.0% |
| | ROE | % | 10.0% | 10.0% |
| | % debt | % | 75.0% | 75.0% |
| | Blended Rate | % | 7.0% | 13.8% |
| | Annual Cost | $Const. 2019 | $44,614 | $7,997 |
| | Weekly cost | $Const. 2019 | $858 | $154 |
| Maintenance & Repair | | | | |
| | % of original cost | %p.a. | 10% | 30% |
| Insurance | % of Gross Capital | % | 5% | 15% |
| | Annual Cost/tractor | $Const. 2019 | $6,250 | $6,000 |
| Sub Total | Weekly Cost | | | |
| Driver | | | | |
| | Wage Rate | $/Hr | $25 | |
| | Hours per week-tractor | # | 67.8 | |
| | Vacation | % | 4% | |
| | Fringe Benefits | | 20% | |
| | Weekly Cost/tractor | 52 weeks | $2,101 | |
| Energy | | | | |
| | Consumption rate | MPG | 6 | 6 |
| | Cost per gallon | $ | $4.00 | $4.00 |
| | Cost per mile | $ | | |
| Tires | Cost per mile | $Const. 2019 | $0.06 | $0.06 |
| Chassis | Cost per chassis - week | $Const. 2019 | $75.00 | $75.00 |
| | Chassis/per truck in use | | 2 | 2 |
| | Cost per week | | $150 | $150 |

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[14] Note: technically a g/ghp-hr standard.

Capital cost estimates are based on market research and informed by comments received from industry stakeholders during field interviews. Based on information gathered in the course of stakeholder consultations and on gate move and fleet data, under normal conditions new tractors account for only a very small percent of the fleet and are heavily utilized on long-distance routes during the first three to four years of operation. Then they may be either sold or transferred to local operations. In order to take this into account for the default parameters, the service life as a new diesel tractor is estimated to be four years, after which it is assumed to have a residual value of $40,000. This represents approximately 32 percent of the new cost for diesel trucks. After four years, it would be considered a used tractor with slightly different cost characteristics, mainly for maintenance and repair and insurance. A new tractor is financed by 75 percent debt at 6 percent interest, and 25 percent equity at 10 percent (pretax). A used tractor is considered to have a similar capital structure, but the debt portion is more costly to reflect the fact that many the used tractors are owned by IOOs. The annual capital cost is determined using a blended rate and a capital recovery factor incorporating both cost of capital and amortization (surrogate for depreciation) from original value to the residual value.

Projected capital costs differ considerably over the range of technologies considered. Unfortunately, there is no established commercial market for battery electric and hydrogen fuel cell trucks, as they are not yet beyond the prototype stage, and the timing of commercialization is uncertain. With those caveats in mind, the following table summarizes the default capital cost estimates for each of the technologies used in this analysis. All the NZE and ZE options will be considerably more costly than existing diesel configurations.

**Figure 5-6 New Truck LMC Capital Costs (Constant 2019$)**

| Description | When used | Diesel | NZE | Battery | Hydrogen |
|---|---|---|---|---|---|
| Cost New | All years | $125,000 | $250,000 | | |
| | Pre 2030 | | | $320,000 | $350,000 |
| | 2030 on | | | $250,000 | $250,000 |
| Residual Value (5th year) | All years | 32% | 20% | | |
| | Pre 2030 | | | 15% | 15% |
| | 2030 on | | | 16% | 16% |
| Used Truck Value | All years | $40,000 | $50,000 | | |
| | Pre 2030 | | | $48,000 | $52,500 |
| | 2030 on | | | $40,000 | $40,000 |
| Capital Recovery Factor | | 7% | 8% | 8% | 8% |

The residual values are calculated as the ratio of the used-to-new price. They are based on the best information that was available during the study. The residual values were also employed in the model as the cost of a used truck for each type. The residual value of the NZE trucks is assumed to be slightly higher than the ZE trucks due to lower technological risk.

For truck costing models, maintenance and repair costs are normally associated with duty cycles and generally accrued on a mileage basis as variable costs. However, our experience indicates that estimates based on a percentage of original costs are sufficiently accurate for modelling drayage operations due to the large percentage of time spent idling. Maintenance costs for new tractors are significantly lower than for older trucks. We have estimated maintenance costs at 10 percent of initial capital costs for new trucks and 30 percent for older trucks using internal combustion engines (ICE). Zero-Emission trucks are modelled using 5 percent and 15 percent respectively.

The default reference price for diesel fuel is set at a constant $3.88 a gallon in 2019 dollars. The default consumption rate used is six miles per gallon for diesel. Energy consumption for other technologies is based on Diesel Gallon Equivalent (DGE) usage: 4.5 miles per DGE for natural gas, at $3.00 per DGE; 15 miles per DGE for battery electric, at $3.50; and, 7.5 miles per kilogram for hydrogen fuel cells at $3.00.

Driver wages are calculated using an hourly rate of $25 plus four percent vacation allowance and an additional 20 percent for fringe benefits and payroll taxes. It is assumed that IOOs are paid on a revenue share basis by LMCs at a rate of 70 percent of total revenue.

General and Administration costs for LMCs are estimated at 20 percent of gross revenues (i.e. prior to paying Owner Operators) – this is to consider non-vehicle related costs such as terminals and supporting infrastructure, as well as administration and general overheads. A small element of profit may be included. However, it should be noted that the capital recovery factor includes a return on the equity portion of the investment fleet. For IOOs the default is 10 percent of operating costs.

Cost elements considered to be generic to all categories include tires, which are costed at a rate of six cents a mile; and insurance which is estimated using 5 percent of the original (i.e. undepreciated) capital cost for new trucks, and 15 percent of purchase price for used trucks.

### 5.1.9    Fleet Costs

Total fleet costs are calculated as a weighted average of the average daily costs for each truck type and operating model (company fleet and IOO) and the number of trucks of each type in the fleet.

### 5.1.10    Margins

The margins represent the net revenue left for the LMC after subtracting all of their costs. These are calculated by subtracting the daily total costs for each truck type from the average daily revenue (which is assumed to be the same the same for all truck types). The margins are used as the basis for estimating LMCs' decisions regarding the type of truck and operating model they will use; LMCs maximize their profits by minimizing their costs (i.e. LMCs will choose the option which has the highest margin).

Based on the third quarter 2018 estimates, the highest short-term margins are provided by used diesel trucks driven by IOOs ($357 per day in 2018), followed by used diesel trucks in fleet

operations (i.e. with employee drivers) at $23 per day. However, if using an IOO would require idling an available fleet used truck, the difference between the two is negligible. In the third quarter of 2018, used trucks (more than four years old) accounted for 92 percent of the fleet.

### 5.1.11    Fleet Mix Calculations

Fleet mix calculations result from an iterative process that is carried out in three stages and then repeated until a consistent size and distribution of fleet (number of trucks by type and age for each year from 2019 to 2035) is attained.

The first stage is development of an initial fleet projection by truck type and engine year based on historical trends in the existing fleet, and on regulatory constraints (i.e. institutional constraints of CAAP requirements and anticipated EPA and CARB regulations), including the CAAP requirement that new trucks entering the port drayage registries meet the cleanest state or federal engine manufacturing standard, (e.g. engine model years 2014 and newer effective in 2018; and the adopted state or federal manufacturing standard effective for 2023/4).

#### Figure 5-7 Initial Fleet Projection Assumptions: Non-NZE Diesel Trucks

| Initial Fleet Projection Assumptions - Diesel Trends | |
|---|---|
| **Truck Age (Engine Year)** | **Projected Participation** |
| New trucks (<5 years) | Aggressive purchase to 2023; no entry thereafter. |
| Used trucks 5-10 years | Entry based on historical trends up to 2023, post 2014 models. |
| Used trucks 10-13  years | No entry. |
| Used trucks over 13 years | Exit the fleet. |

Historical trends for non-NZE diesel and LNG trucks are based on PDTR data from 2009 to 2018 for each type of truck active in the PierPASS gate move data. For trucks with diesel engines, the initial fleet projection is based on the rules shown above. All parameters are modifiable within the model.

For new technology (NZE, hybrid electric, battery electric, and fuel cell electric trucks) there is no history on which to base future projections. It is assumed that battery and hydrogen fuel cell electric trucks will start to become available in small numbers by 2024 and then gradually increase over time.

In general, the fleet forecasts show a larger share of hydrogen fuel cell trucks relative to battery electric trucks in the ZE fleet. This is based on a judgement on the probable range of limitations of battery electric trucks. Based on currently available information it appears that the battery electric trucks will not have sufficient range to serve longer haul markets.

The second stage is to combine these projections for the entire fleet of trucks, and then compare them with the demand requirements derived in the calculation of Truck Operating Parameters. The variance between the projected total fleet and the required fleet should be sufficiently small that it could easily be accommodated by small variations in utilization. The projected fleets for each truck type are adjusted with respect to acquisition of new vehicles,

acquisition of used vehicles by age of vehicle and operating life until the total number of trucks is in balance with projected needs.

The tables are constructed in a way to permit the calculation of fleet size for each type of truck by classification of new or used in each year. Trucks up to four years (five years in some cases) old are costed as new vehicles, and older ones are costed as used trucks. The unit costs are applied separately using the fleet operating costs for new trucks, used trucks in fleets and IOO revenue shares.

The third stage combines revenues and costs to calculate the margins. This is a crucial step, because a comparison of the margins between truck types is the key factor used to develop the final forecast for each type of truck for each year. The margin for used diesel trucks is employed as a reference point, as this option provides the highest margin in 2018. When the supply of these trucks is exhausted, the next best option from the available inventory is used. This process of optimizing according to margin requires some iterations, going back and forth between the combined view and the detailed projection by type of truck, both one year at a time and looking ahead to future years to provide for supply of used trucks in later years.

When the total fleet projection is sufficiently aligned to the demand forecast, then the final computation of revenues, costs, margins, capital Investment, and CTF rate revenues and subsidies (if applicable) are completed from these final tables.

The fleet forecasts are used to generate the following information:

- The number of new and used trucks acquired in each year, which is multiplied by the input cost assumptions for each type of acquisition to estimate capital investment;

- The number of trucks subject to CTP rates is extracted from the tables for each year, and rate estimates are computed for each one of the subsidy levels identified in the study design;

- If the scenario being studied involves subsidies, subsidy costs are calculated as the number of trucks eligible for subsidies multiplied by the individual subsidy amounts;

- Summaries of costs, revenues and margins for each type of truck are also compiled.

### 5.1.12    Modelling the Impact of CTF Rates

The modelling approach is based on the assumptions that LMCs make decisions regarding fleet composition, and beneficial cargo owners (BCOs) make decisions regarding the LMC they will hire to do their work. The assumption is that BCOs will choose the lowest cost alternative among LMCs. Similarly, the LMC is assumed to choose the cheapest alternative among the truck options available to them.

The CTF rates are proposed to be charged directly to BCOs rather than to LMCs. However, for modelling purposes the rates are considered as an operating cost increase to LMCs. This has been done for two reasons:

- This assumption focuses the analysis on the impact of the rates on LMC decisions on their fleet composition.

- Based on economic theory, the impact of the rates is the same whether the rate is charged to the consumer (BCO) or the producer (LMC).

## 5.2　　The Role of Used Trucks in the Drayage Fleet

The POLA/POLB drayage fleet consists almost exclusively of older trucks that were purchased as used trucks. In April 2018, trucks with model year earlier than 2014 accounted for 14,345 or almost 84 percent of the current fleet. This is due to the highly competitive nature of the industry, and the substantially lower purchase price of used trucks compared to new trucks. Due to their high capital costs, new trucks are not competitive in the local drayage market. The figure below highlights the substantial difference in capital costs between new and used trucks.

**Figure 5-8 New and Used Diesel Trucks Average Auction Prices December 2018**

| Average Auction Prices December 2018 - Tractors with Sleeper | | | |
|---|---|---|---|
| Model Year | Truck Age | Average Price | % of New Cost |
| New Truck (2019) | New | $125,000 | 100% |
| 2015 | 4 years | $43,550 | 35% |
| 2014 | 5 years | $32,000 | 26% |
| 2013 | 6 years | $30,250 | 24% |
| 2012 | 7 years | $25,000 | 20% |
| 2011 | 8 years | $21,850 | 17% |
| Source: J.D. Power Commercial Truck Guideline January 2019 | | | |

New trucks are purchased by carriers for long-haul highway use, where reliability is a key requirement; for example, direct drayage of international containers to Phoenix. New vehicles are typically retired from long haul use after a few years and are then available to be purchased for local drayage service. New trucks are typically added to the drayage fleet at a rate of a few hundred per year.

The reliance of the drayage sector on the availability of used vehicles to minimize their costs provides a challenge for modelling the impacts of the CTF rates. Historically the drayage sector could rely on the availability of used trucks for purchase from the long-haul sector. Even during the first Clean Trucks Program, diesel trucks which were compliant with the 2007 emissions standards could be purchased as used trucks prior to the deadline for compliance in 2012.

It is very important to note that under the 2017 CAAP update the emissions performance requirements for entrance into the drayage registry will exceed those required for trucks in the long-haul sector. Consequently, the supply of used NZE and ZE trucks available for purchase will be limited to those purchased as new for use in the drayage sector. Therefore, the mix between new and used NZE and ZE trucks in later years will be affected by the rate at which

new trucks are purchased in earlier years, with resulting impacts on capital costs, CTF rate revenues and subsidies.

# 6 Model Scenario Descriptions

Six scenarios were modelled under various assumptions regarding the timing and application of CTF rates by truck type, and the availability of capital subsidies. The impacts were estimated for each scenario for five potential CTF rate levels to be charged for loaded containers picked up from or delivered to the port terminals: $5, $20, $35 $50 and $70 per loaded TEU (Twenty Foot Equivalent Unit). Four of the scenarios included sensitivities to the impact of potential cargo diversion, making a total of ten possible outcomes to be modelled.

These scenarios provide a potential range of outcomes for illustrative purposes using a conservative set of assumptions based on a relatively high level of subsidies provided. This analysis was not designed to assess the specific amount of subsidy required or to identify the optimized structure for an incentive program, but rather to provide an indication of how the rate and subsidies could affect the drayage truck fleet.

The scenarios that were modelled are summarized below.

**Scenario 0:** Baseline projection of truck fleet, taking into account existing requirements: a) the California Air Resources Board (CARB) regulation which will require all trucks to be 2010+ by 2023; b) the Port's October 2018 tariff change requiring new trucks entering the PDTR to be MY 2014 or newer. No Clean Truck Fund rate or subsidies included.

**Scenario 1:** Baseline projection of truck fleet. Building on Scenario 0, taking into account existing requirements, and adding a requirement : a) the CARB regulation which will require all trucks to be 2010+ by 2023, and b) the Port's October 2018 tariff change requiring new trucks entering the PDTR to be MY 2014 or newer. The difference from Scenario 0 is that starting in 2023, all new entries to the registry will be at least NZE trucks as identified in the proposed 2017 CAAP Update, based on the assumption that the engine manufacturing standard for NZE trucks would be required for new engines starting in 2023.

**Scenario 2:** Refines Scenario 1 by including the application of the Clean Truck Fund rate on all non-NZE or ZE trucks starting on January 1, 2021 and is extended to all non-ZE trucks on January 1, 2030. Revenues generated for each of the identified $/TEU rates included in the project scope ($5/TEU to $70/TEU) were estimated.

**Scenario 3:** Builds upon the existing requirements and the application of the Clean Truck Fund rate in Scenario 2 by incorporating subsidies to cover the cost differential between the new technology and a used diesel in two stages:
- Only NZE trucks starting January 1, 2021 through 2027,
- Only ZE trucks from 2028 to 2035.

**Scenario 4**: Considers the existing requirements and the application of the Clean Truck Fund rate in Scenario 2 but incorporating subsidies to cover the cost differential between the new technology and a used diesel. It differs from Scenario 3 in that the subsidies are applied only to ZE trucks from rate initiation to 2035.

**Scenario 5:** Builds on the existing requirements and the application of the Clean Truck Fund rate in Scenario 2 by incorporating subsidies to cover the cost differential between new technology and a new diesel. Subsidies are applied in two stages:

- Only NZE trucks starting in 2021 through 2023,
- Only ZE trucks starting in 2024 through 2035.

### Figure 6-1 Key Parameters for Model Scenarios

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 0 | CARB regulation 2023; Ports' tariff 2018 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 1 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 2 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |
| 3 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | NZE only | 2021-2027 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2028-2035 | |
| 4 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | ZE only | 2021-2035 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |
| 5 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | New diesel | NZE only | 2021-2023 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2024-2035 | |

The scenarios described above are all driven by the base forecasts of demand. Those scenarios involving application of a Clean Truck Fund rate (Scenarios 2 through 5) may incur diversion of container traffic on account of the CTF rate, as discussed in the Cargo Diversion sections of this report. The scenarios with diversion are conservatively modelled using a diversion factor of 2 percent based on the maximum CTF Rate of $70/TEU. The diversion factor assumes that application of the CTP rate will result in a 2 percent reduction in truck trips each year.

Scenarios 3-5 incorporate subsidies as well as CTF rates. These levels of subsidies were used to provide a conservative estimate of the amount of funds that could be needed. Scenarios 3 and 4 include a subsidy sufficient to reduce capital costs for NZE and/or ZE trucks to those of a used diesel truck. Scenario 5 includes a subsidy sufficient to reduce capital costs for NZE and/or ZE trucks to those of a new diesel truck. Details are shown below.

**Figure 6-2 Subsidies  Modelled**

| Scenario 3 and 4 Subsidies | | | Scenario 5 Subsidies | | |
| --- | --- | --- | --- | --- | --- |
| **Truck Type** | **Capital Cost** | **Subsidy** | **Truck Type** | **Capital Cost** | **Subsidy** |
| Used Non-NZE Diesel | $40,000 | | Used Non-NZE Diesel | $40,000 | |
| New Non-NZE Diesel | $125,000 | | New Non-NZE Diesel | $125,000 | |
| NZE | $250,000 | $210,000 | NZE | $250,000 | $125,000 |
| ZE Battery Electric Pre 2030 | $320,000 | $280,000 | ZE Battery Electric Pre 2030 | $320,000 | $195,000 |
| ZE Battery Electric 2030 on | $250,000 | $210,000 | ZE Battery Electric 2030 on | $250,000 | $125,000 |
| ZE Hydrogen Fuel Cell pre 2030 | $350,000 | $310,000 | ZE Hydrogen Fuel Cell pre 2030 | $350,000 | $225,000 |
| ZE Hydrogen Fuel Cell 2030 on | $250,000 | $210,000 | ZE Hydrogen Fuel Cell 2030 on | $250,000 | $125,000 |

# 7 Scenario 0 – Base Projection

The assumptions used in developing the baseline forecast of fleet size and fleet mix are summarized below.

**Figure 7-1 Scenario 0 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Differential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 0 | CARB regulation 2023; Ports' tariff 2018 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |

The figure below shows the baseline forecast of the fleet composition by emission standard. In the absence of rates or subsidies, truck owners are likely to accommodate the requirement to replace the 2007 to 2009 trucks by buying newer (i.e. 2014+) used trucks which will be relatively inexpensive and will be in compliance with the CARB rules and the Ports' 2018 tariff. The use of older used trucks is typical practice in the drayage industry. In the absence of rates or subsidies, used non-NZE diesel trucks will remain the lowest cost options and these trucks will continue to dominate the fleet through 2035.

**Figure 7-2 Scenario 0 Fleet Mix Forecast**
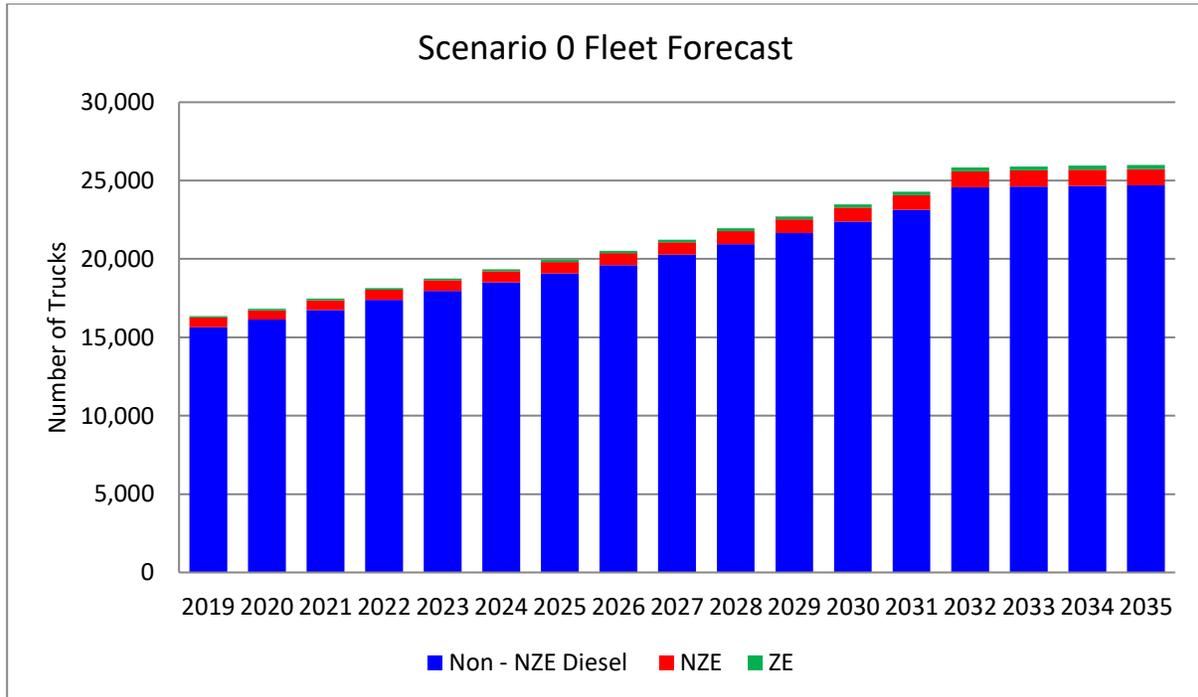
# 8      Scenario 1 – Base Projection with Restricted Entry after 2022

Scenario 1 builds on the baseline forecast in Scenario 0 by incorporating the proposed restriction on the entry of non-NZE trucks into the drayage registry from January 2023. This assumption is from the proposed timeline in the 2017 CAAP Update, based on the understanding at the time that CARB would adopt a new NZE engine manufacturing standard that would go into effect in 2023. A summary of the assumptions used in Scenario 1 is shown below.

**Figure 8-1 Scenario 1 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 1 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |

Comparative daily truck operating costs for non-NZE diesel and NZE trucks in the absence of rates and subsidies are shown below. Battery electric and hydrogen fuel cell costs are significantly higher.

**Figure 8-2 Scenario 1 Daily Truck Costs Diesel and NZE**
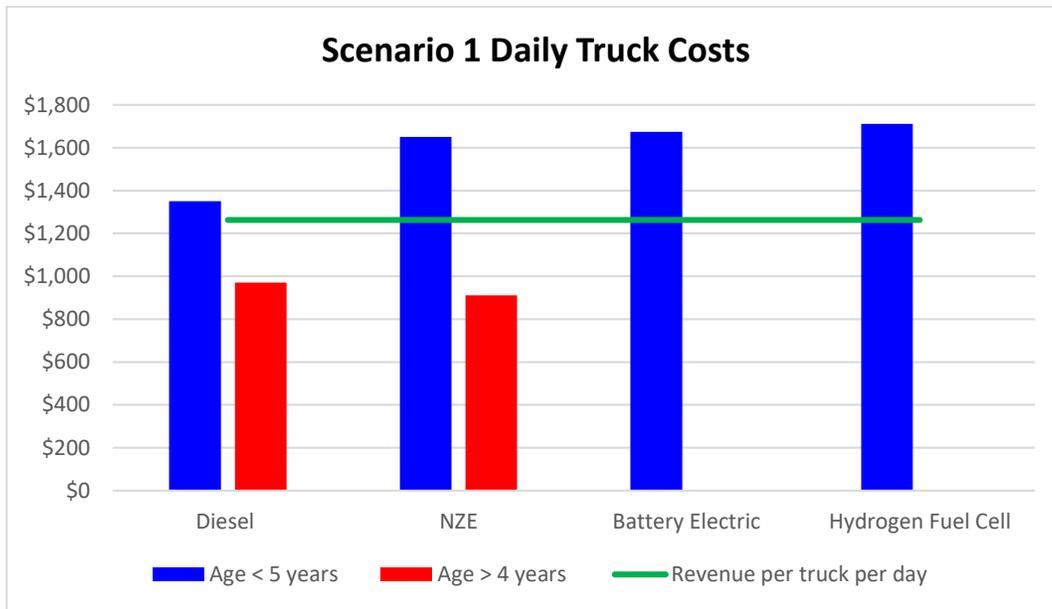


Since there is no Clean Truck Fund rate in this scenario, the forecast of fleet mix is based entirely on LMCs choosing the trucks with the lowest costs. The drayage fleet would remain dominated by non-NZE diesel trucks. However, after 2023 the non-NZE diesel fleet diminishes as the trucks age out and are not replaced. The next lowest price replacement option after 2023, due to the proposed Port tariff, is NZE trucks, and these constitute the balance of the fleet to 2035 because they have lower costs than ZE trucks.

**Figure 8-3 Scenario 1 Fleet Mix Forecast**
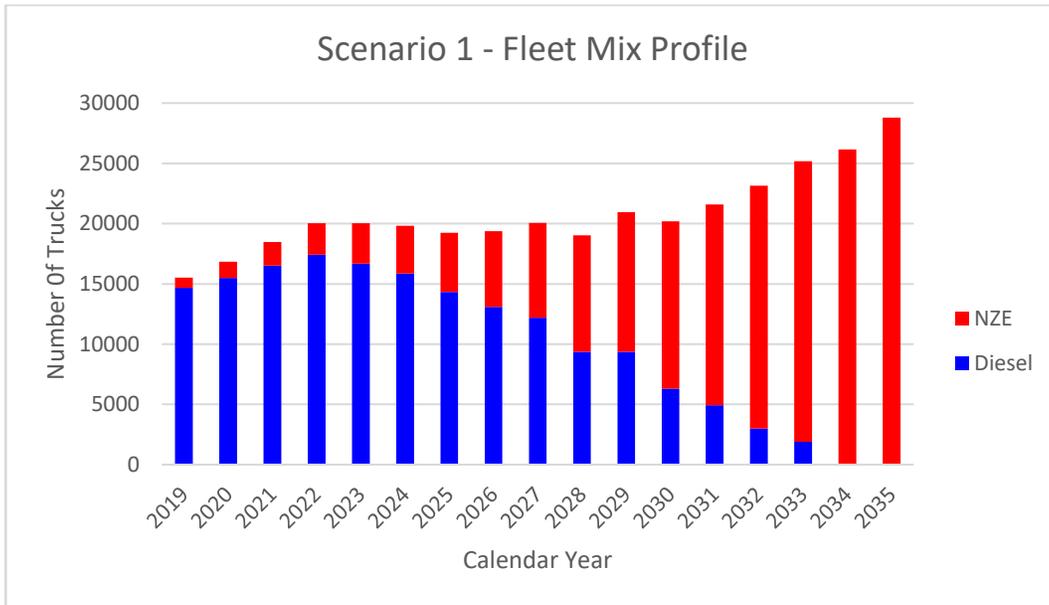


Used trucks provide the lowest operating costs. To accommodate increases in demand, it will be necessary to purchase new vehicles at a rate that is considerably higher in initial years than would normally be required for the typical fleet lifecycle (i.e. because used vehicles which are compliant with the new requirements will not be available for purchase).

# 9     Scenario 2 - Staged CTF Rates No Subsidies

Scenario builds on Scenario 1 by adding CTF rates. A summary of the assumptions used in Scenario 2 is shown below.

**Figure 9-1 Scenario 2 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|----------|-------------|----------|---------------------|--------|-------------------------|--------------------|--------|-----------------|
| 2 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |

Scenario 2 estimates the impact of CTF rates on non-NZE and non-ZE trucks from 2021 to 2029, and CTF rates on non-ZE trucks from 2030 to 2035. The impacts of the CTF rates on comparative costs of specific truck types are highlighted below.

**Figure 9-2 Scenario 2 Daily Truck Costs with Rates 2021 – 2029**
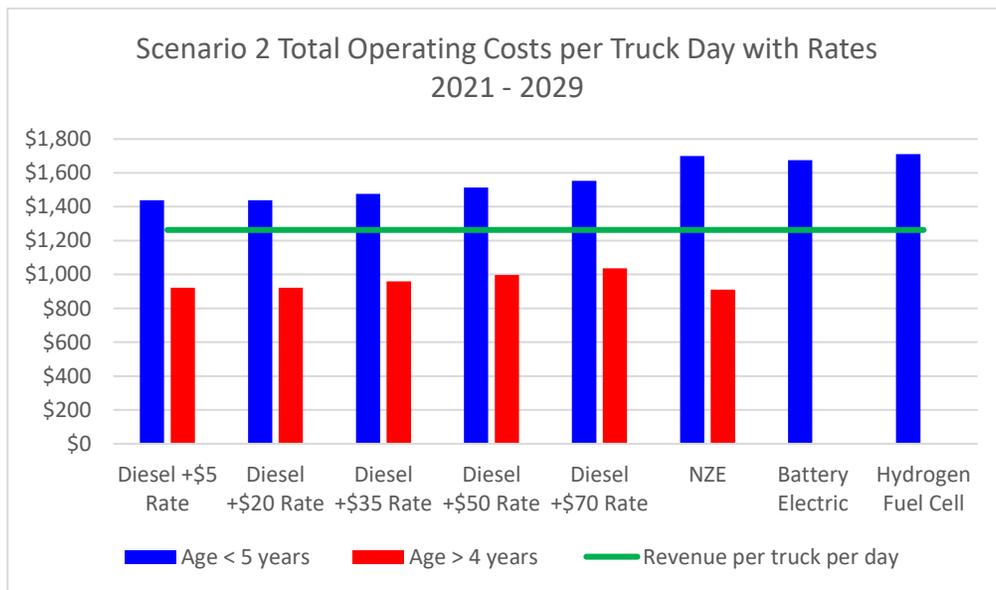
**Figure 9-3 Scenario 2 Daily Truck Costs with Rates 2030 – 2035**
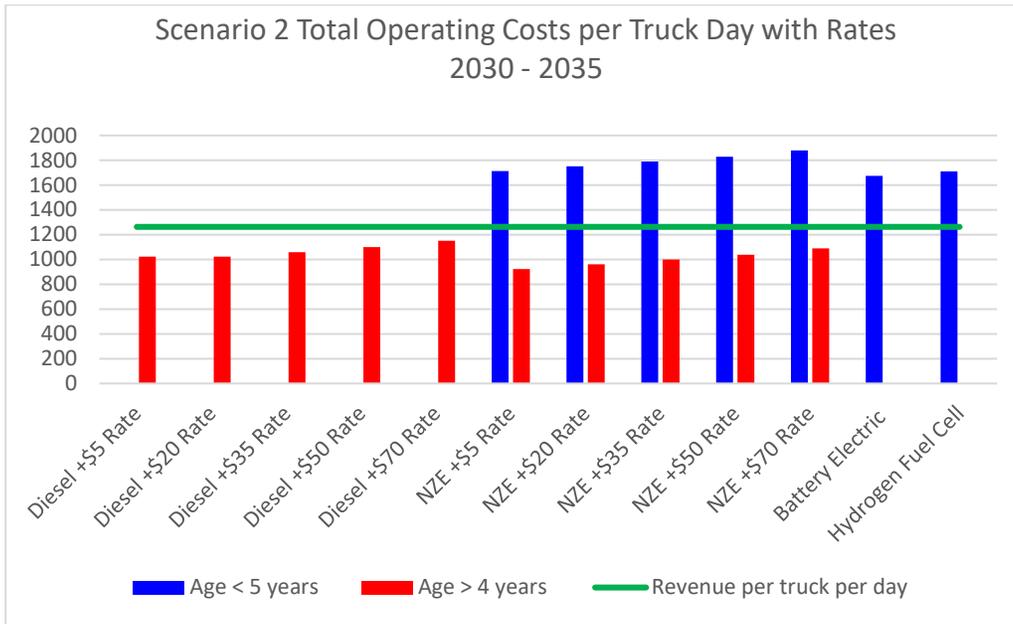


The fleet mix forecast is shown below. Application of the CTF rates does not alter the fleet mix profile in comparison with Scenario 1. The incremental cost of the rate is not sufficient to offset the increased costs of using a new NZE or ZE truck. The natural gas fleet increases as the non-NZE diesel trucks age out of the fleet; no ZE trucks are added.

**Figure 9-4 Scenario 2 Fleet Mix Forecast**
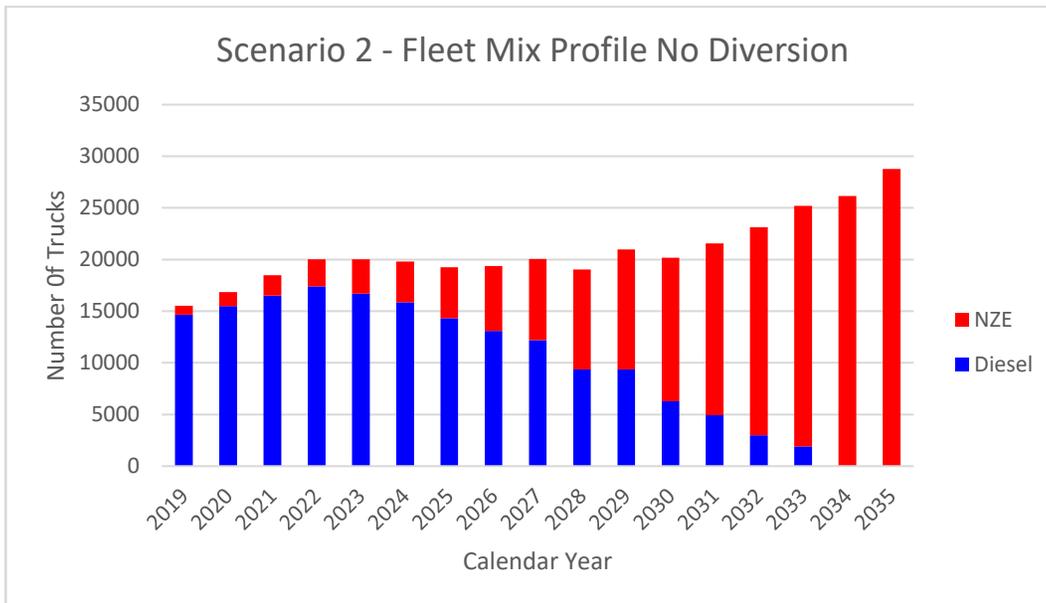


The revenues from the Clean Truck Fund rate for each of the specified rate levels are shown below for the base case and diversion forecasts.

**Figure 9-5 Scenario 2 CTF Rate Revenues**
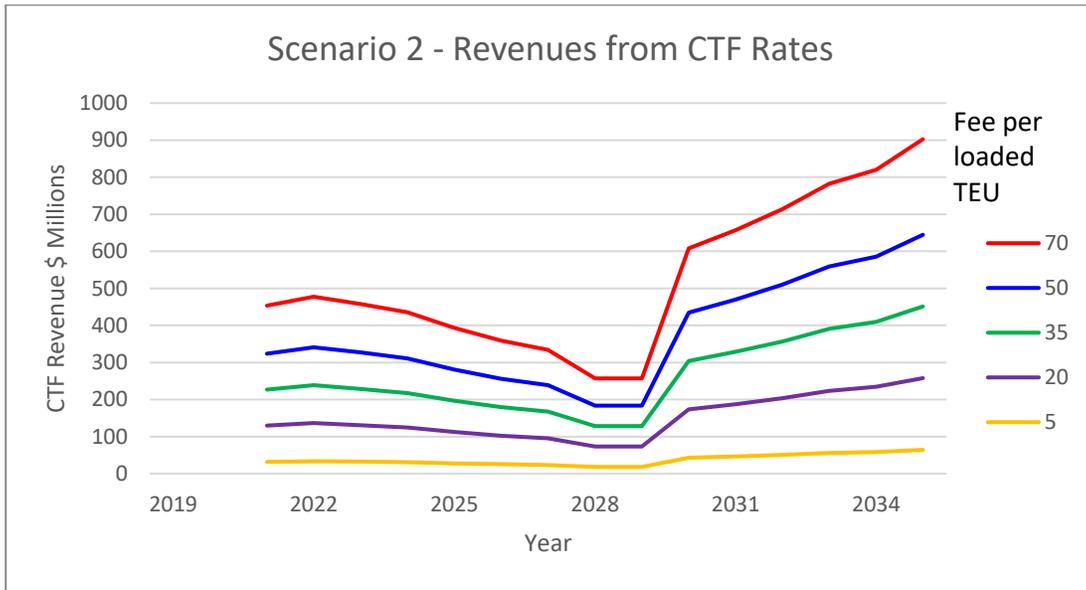


Annual revenues are high at the beginning of the period due to the application of the CTF rates to non-NZE diesel trucks. Revenues diminish with the retirement of these trucks because no new ones are added to the registry. Based on the scenario parameters, beginning in 2030 the revenues show sharp increases at all levels because the rate is applied to all trucks, with exemptions only for ZE trucks which do not exist in the fleet (based on the model results). At the CTF rate levels modelled, the additional cost of the rate is not sufficient to offset the additional costs of using a new ZE truck.

The only significant change in the diversion scenario is that fewer trucks will be required because of the lower cargo volumes. The difference between with diversion and no diversion is a scaling down of the fleet by 2 percent, with no alteration in the fleet mix. All the non-NZE diesels in the fleet are subject to the CTF Rate as of January 1, 2021 until they retire. NZE trucks become subject to the rate as of January 1, 2030 through 2035. There are no subsidies in Scenario 2, and no ZE trucks will have entered the fleet by 2035.

**Figure 9-6 Scenario 2 Present Values of CTF Rate Revenues**

| Scenario 2 Present Value of CTF Rates | | |
|---|---|---|
| $ Millions (2019 Constant) | | |
| Rate | No Diversion | With Diversion |
| $70 | $7,492 | $7,342 |
| $50 | $5,351 | $5,244 |
| $35 | $3,746 | $3,671 |
| $20 | $2,140 | $2,098 |
| $5 | $535 | $524 |

# 10    Scenario 3 – Staged CTF Rates and Subsidies

Scenario 3 builds on Scenario 2 by incorporating subsidies to cover the cost differential between the new technology and a <u>used</u> non-NZE diesel truck in two stages:

- Subsidizing only NZE trucks starting January 1, 2021 through 2027;
- Subsidizing only ZE trucks from 2028 to 2035.

A summary of the assumptions used in Scenario 3 is shown below.

**Figure 10-1 Scenario 3 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 3 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | NZE only | 2021-2027 | 0% and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2028-2035 | |

The values of subsidies by truck type Scenario 3 are shown below.

**Figure 10-2 Scenario 3 Subsidies**

| Truck Type | Capital Cost | Subsidy |
|---|---|---|
| Used Non-NZE Diesel | $40,000 | |
| New Non-NZE Diesel | $125,000 | |
| NZE | $250,000 | $210,000 |
| ZE Battery Electric Pre 2030 | $320,000 | $280,000 |
| ZE Battery Electric 2030 on | $250,000 | $210,000 |
| ZE Hydrogen Fuel Cell pre 2030 | $350,000 | $310,000 |
| ZE Hydrogen Fuel Cell 2030 on | $250,000 | $210,000 |

The impacts of the rates and subsidies on comparative costs of specific truck types are highlighted below.

**Figure 10-3 Scenario 3 Daily Truck Costs with Rates and Subsidies 2021 – 2027**
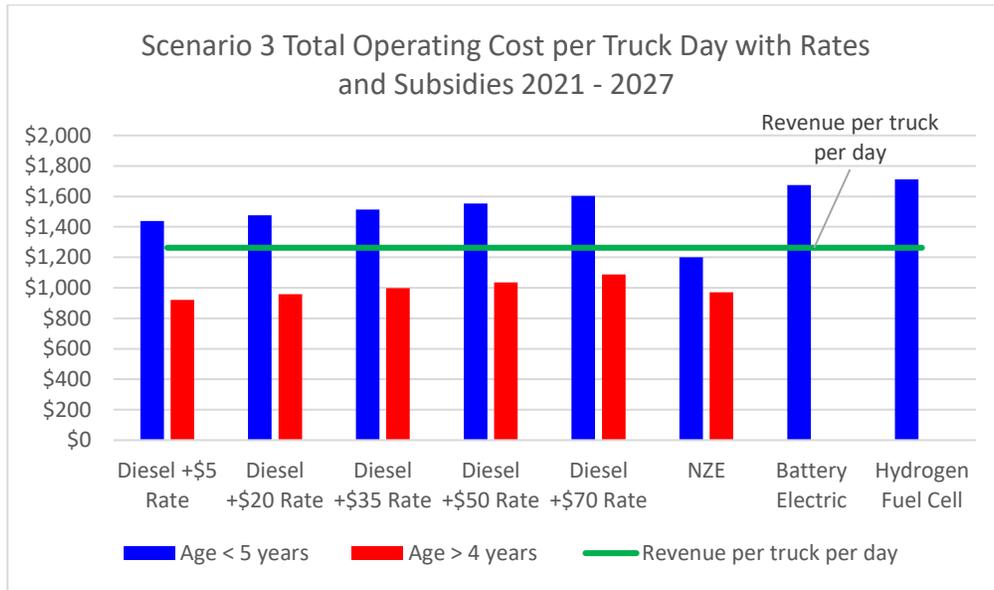


Charging of the CTF rates on non-NZE diesel trucks makes a used NZE truck the lowest cost option. However, there are few used NZE trucks available; LMCs will continue to use the existing non-NZE diesel fleet in spite of the CTF rate impact and accommodate required fleet growth by buying new NZE trucks.

**Figure 10-4 Scenario 3 Costs with Rates and Subsidies 2028 – 2029**
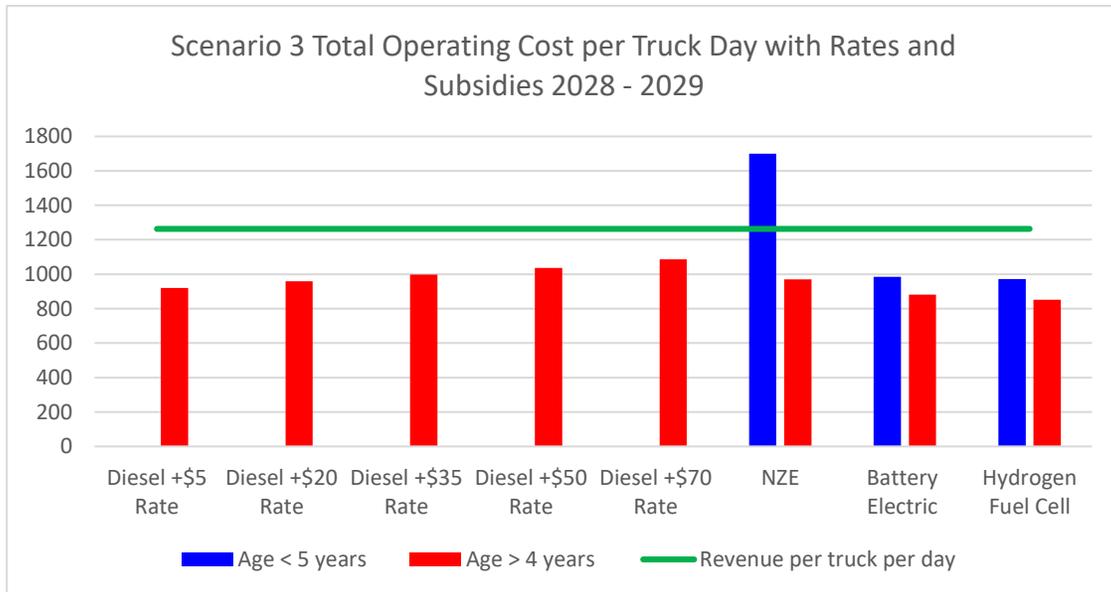
Starting in 2028, new NZE trucks will no longer be subsidized. This results in a substantial increase in cost relative to other trucks for new NZE trucks and no more will be added to the fleet. LMCs will obtain as many used NZE trucks as are available and any new trucks which are required will be ZE trucks due to the availability of subsidies.

**Figure 10-5 Scenario 3 Costs with Rates and Subsidies 2030 – 2035**
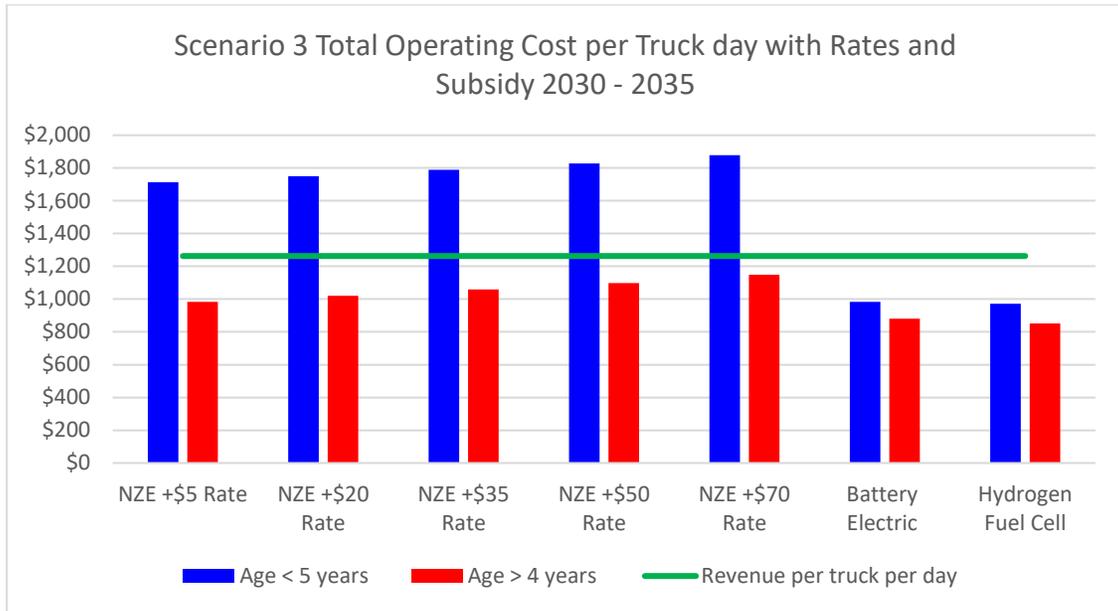


Starting in 2030, the CTF rates will be charged to NZE trucks. Diesels will age out of the fleet by 2033. The additional costs for NZE trucks as a result of the application of the rates from 2030 on is sufficient to tip the balance in favor of new ZE trucks at the higher CTF rate levels. All new trucks will be ZE trucks purchased with the assistance of subsidies.

The fleet forecasts based on the Scenario 3 cost analysis is shown below.

**Figure 10-6 Scenario 3 Fleet Mix Forecast**
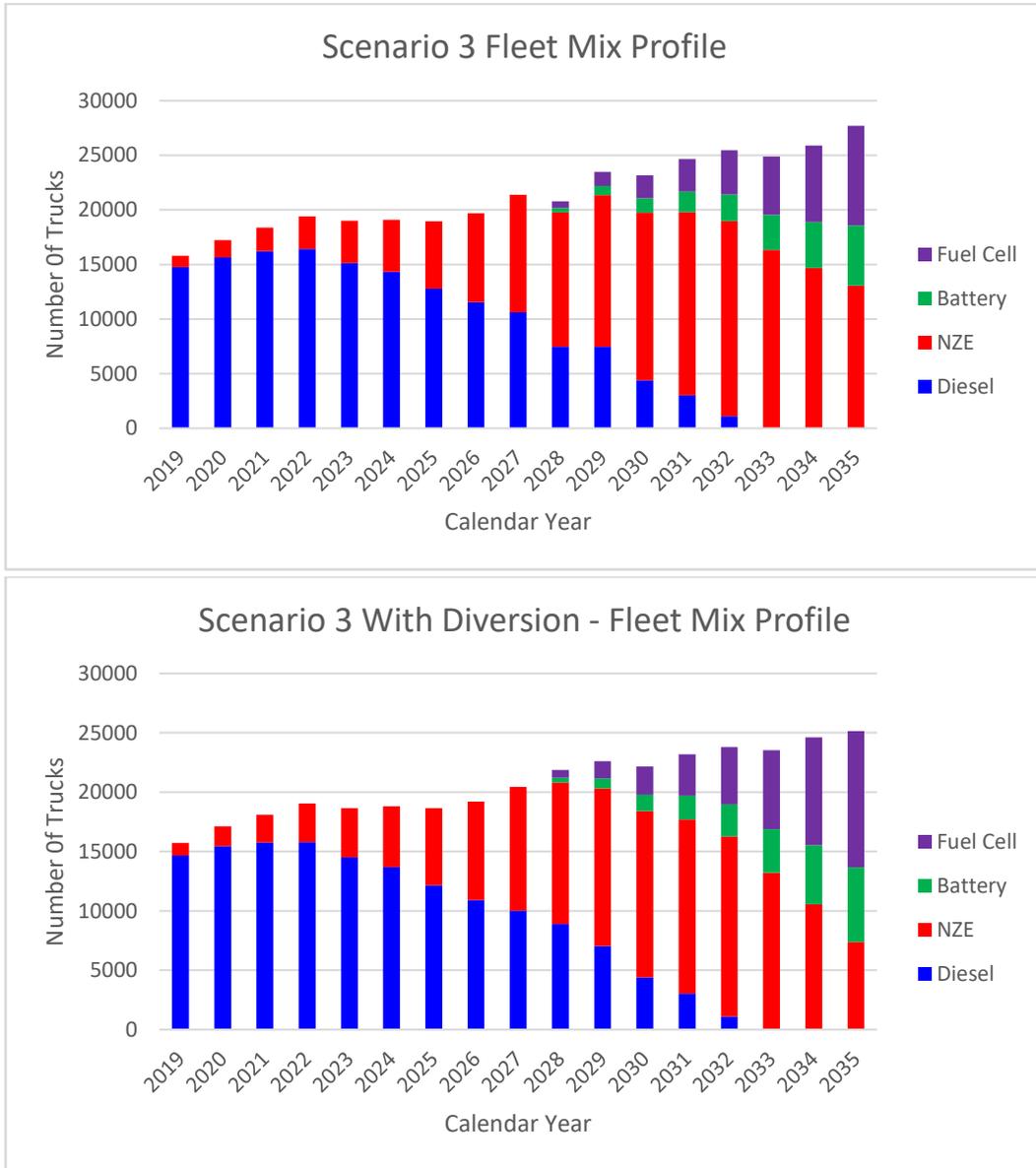


The cargo diversion scenario reduces overall truck trips by 2 percent in each year, based on the assumption of a $70 CTF rate. The NZE fleet starts to decline more quickly in the diversion scenario due to the impact of the $70 CTF rate which makes the NZE trucks more expensive than highly subsidized ZE trucks after 2030. This also raises the subsidy requirements and capital costs.

Estimated CTF rate revenues and subsidy requirements for Scenario 3 based on the fleet forecast are shown below.

**Figure 10-7 Scenario 3 CTF Rate Revenues and Subsidy Requirements**
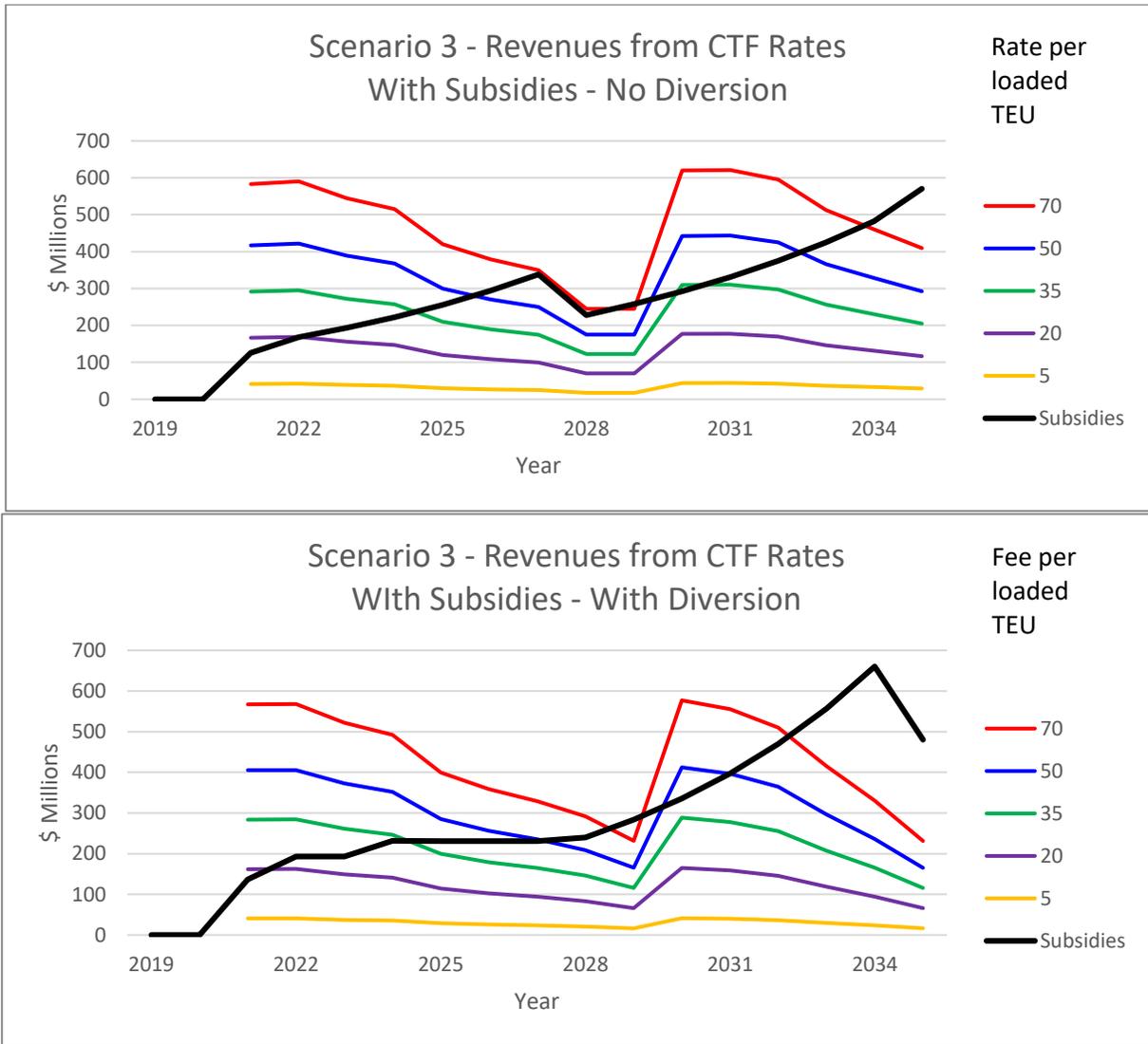
**Figure 10-8 Scenario 3 Clean Truck Fund Annual Balances**

## Scenario 3 Clean Truck Fund Balance



## Clean Truck Fund Balance Scenario 3 With Diversion
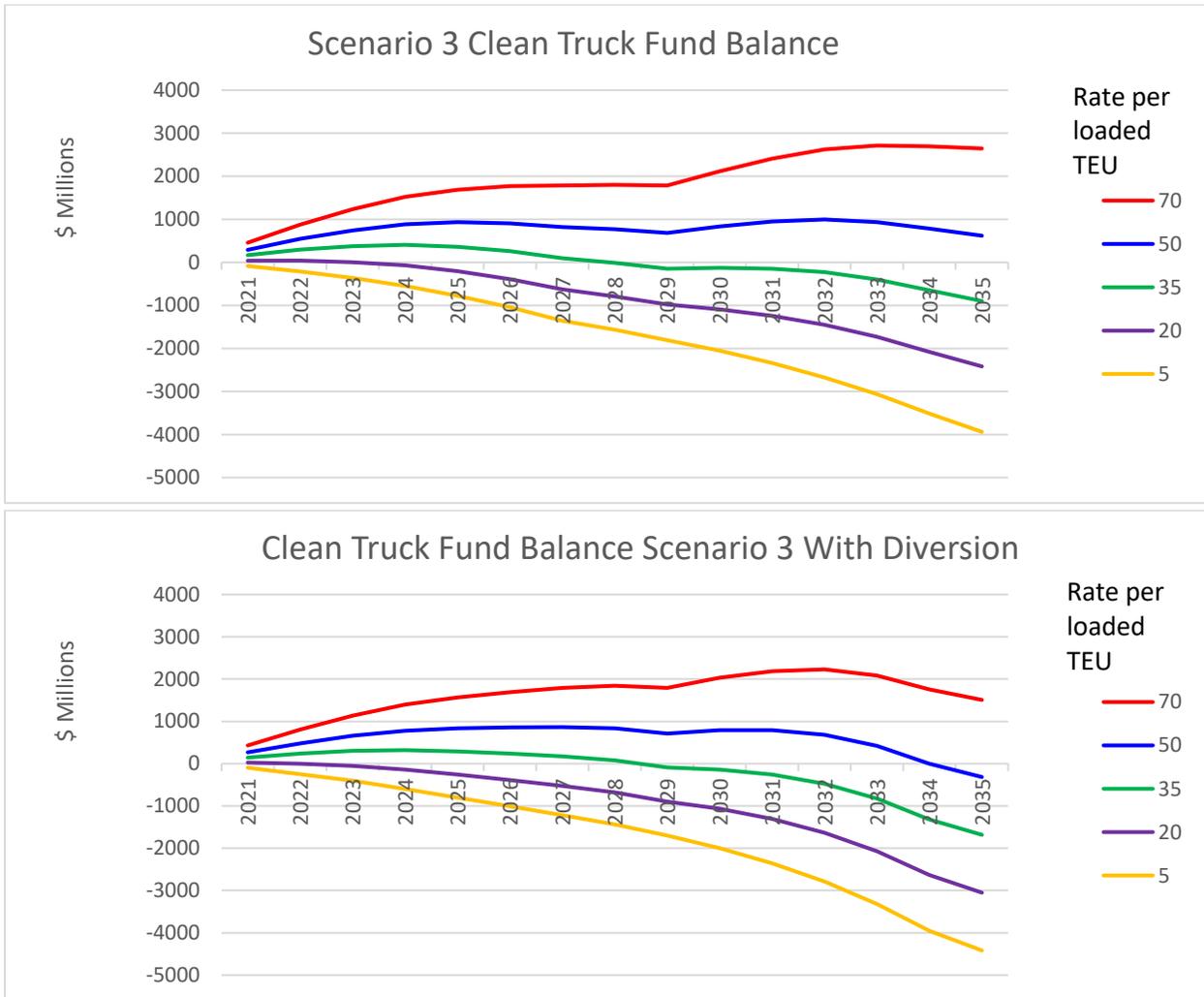


The balance would be positive in all years for rates of $50 and $70. The $35 rate would keep the balance positive for around 10 years and then slip into negative territory. The rates of $5 and $20 are not adequate to cover the full costs of the subsidies modelled from the early days onward. Under the diversion scenario in 2035, the total truck fleet declines by approximately 500 trucks or 2 percent. CTF rate revenues and subsidy requirements for the No Diversion and Diversion scenarios are shown below. The diversion case results in lower CTF rate revenues and higher subsidy requirements and capital costs because more ZE trucks are purchased

**Figure 10-9 Scenario 3 Present Values of CTF Rate Revenues and Subsidy Requirements**

| Scenario 3 Present Value of CTF Rates and Subsidy Requirements | | |
|---|---|---|
| $ Millions (2019 Constant) | | |
| **CTF Rate** | **No Diversion** | **With Diversion** |
| $70 | $6,090 | $5,523 |
| $50 | $4,350 | $3,945 |
| $35 | $3,045 | $2,762 |
| $20 | $1,740 | $1,578 |
| $5 | $435 | $395 |
| Subsidy Requirements | $3,642 | $3,871 |
| Total Capital Invested | $5,052 | $5,242 |

# 11 Scenario 4 – Staged CTF Rates & Subsidies (ZE Only)

Scenario 4 builds on Scenario 2 by incorporating subsidies to cover the cost differential between ZE trucks and a used diesel truck from 2021 through 2035.

A summary of the assumptions used in Scenario 3 is shown below.

**Figure 11-1 Scenario 4 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 4 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | ZE only | 2021-2035 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |

The values of subsidies by truck type for Scenario 4 are shown below.

**Figure 11-2 Scenario 4 Subsidies**

| Truck Type | Capital Cost | Subsidy |
|---|---|---|
| Used Non-NZE Diesel | $40,000 | |
| New Non-NZE Diesel | $125,000 | |
| NZE | $250,000 | |
| ZE Battery Electric Pre 2030 | $320,000 | $280,000 |
| ZE Battery Electric 2030 on | $250,000 | $210,000 |
| ZE Hydrogen Fuel Cell pre 2030 | $350,000 | $310,000 |
| ZE Hydrogen Fuel Cell 2030 on | $250,000 | $210,000 |

The impacts of the rates and subsidies on the costs of specific truck types are highlighted below. It is assumed that the first ZE trucks will be introduced in 2025. Therefore, subsidies are not expected to be allocated in the initial years, until the trucks are available. If there should be developments in the manufacturing sector to advance this timetable, then under the subsidy assumptions in this scenario, these trucks will appear sooner than 2025.

**Figure 11-3 Scenario 4 Daily Truck Costs with Rates and Subsidies 2021 – 2029**
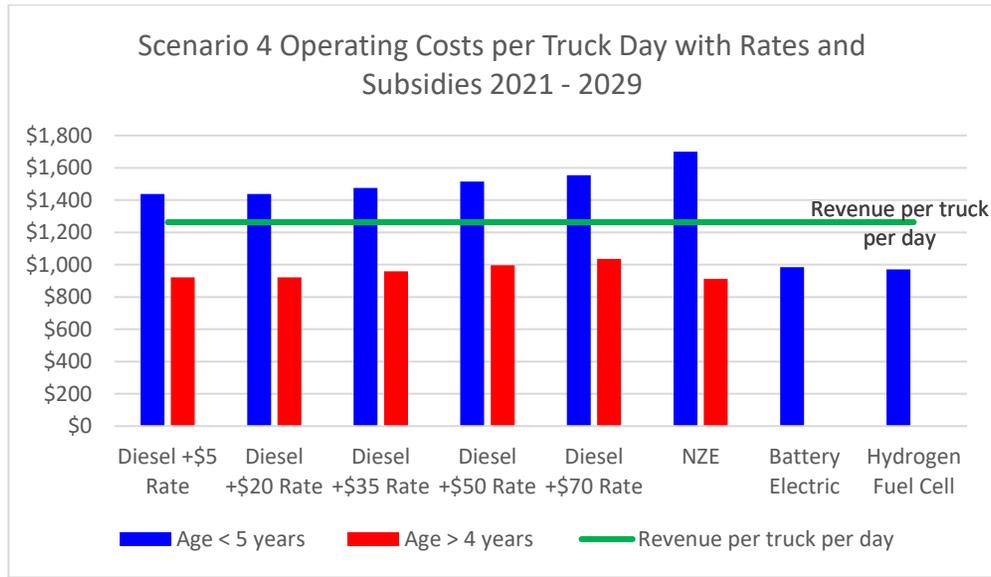


At the $70 CTF rate a used non-NZE diesel truck would be more expensive than a subsidized ZE truck. The best option would be a used NZE truck, and these would be purchased to the extent of their availability. New truck purchases would be entirely ZE trucks bought with the assistance of subsidies.

**Figure 11-4 Scenario 4 Daily Truck Costs with Rates and Subsidies 2030 – 2035**
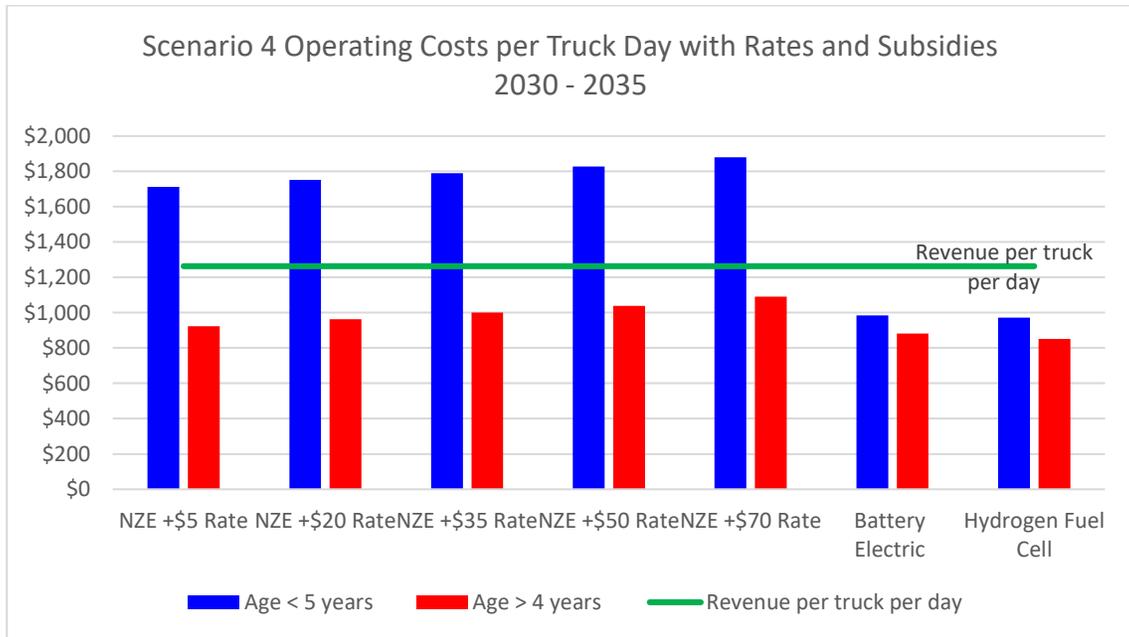
In 2030 the CTF rates will be charged on NZE trucks, and the lowest cost option would be a used ZE truck. These would be purchased to the extent of their availability. New truck purchases would be entirely ZE trucks bought with the assistance of subsidies. The fleet forecast based on the Scenario 4 cost analysis is shown below.

**Figure 11-5 Scenario 4 Fleet Profile Forecast**
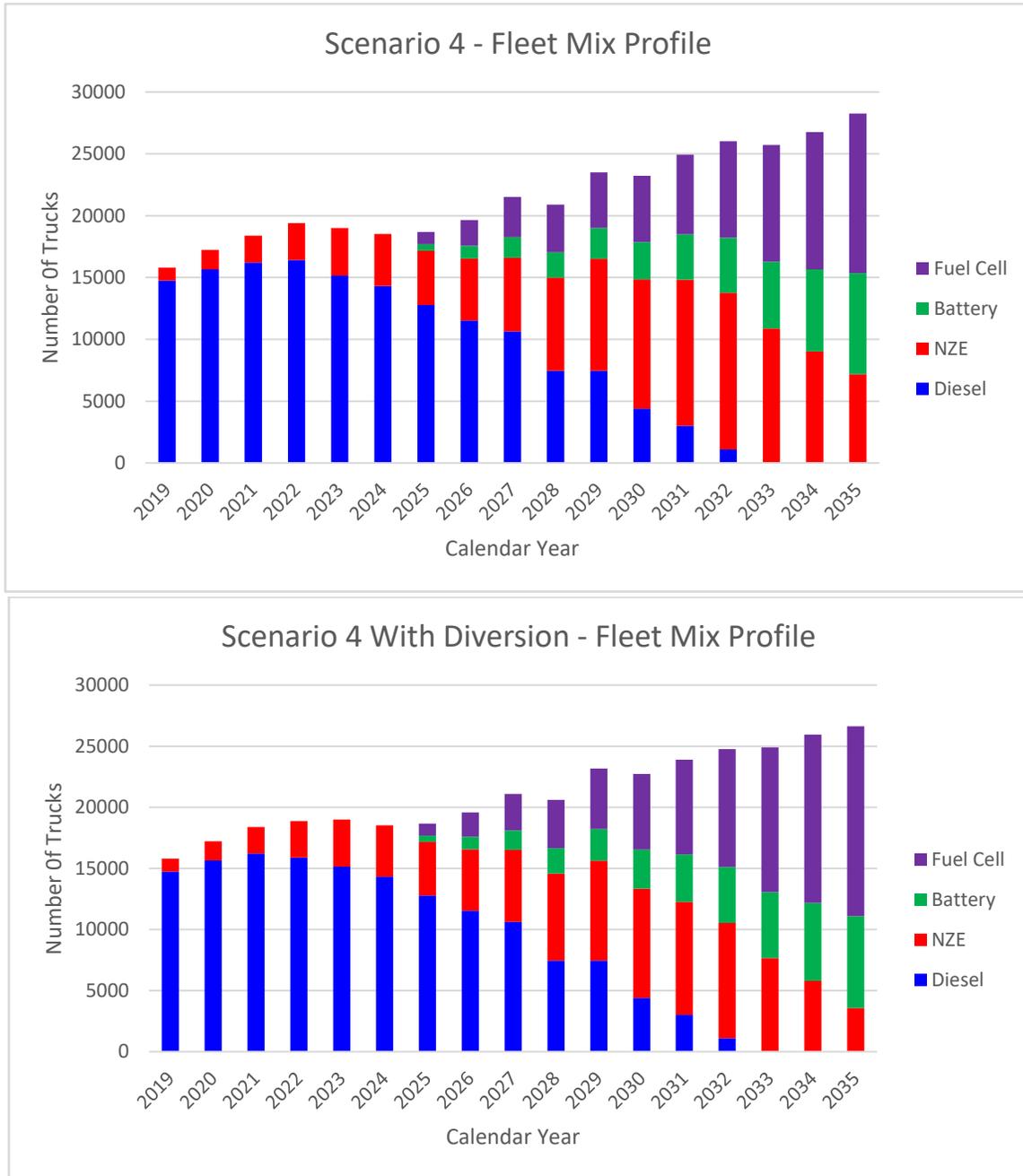
The fleet forecast under this scenario reflects a much more rapid introduction of ZE trucks compared with other scenarios. ZE trucks account for approximately 75 percent of the fleet by 2035. Under the diversion scenario the truck fleet declines by approximately 2 percent. There would be less reliance on NZE trucks and more rapid uptake of ZE technology.

The diversion scenario results in a more rapid introduction of ZE trucks due to the impact of the cargo diversion on the uptake of NZE trucks from 2022 to 2025. Prior to 2025, any new trucks which are required due to traffic growth would be (unsubsidized) NZE trucks, because it is assumed that the ZE trucks will be unavailable until 2025. The 2 percent cargo drop results in fewer NZE trucks added to the fleet in this period, and therefore fewer used NZE trucks available for service in later years. More, new ZE, trucks must be purchased to accommodate traffic growth because of the decline in the non-NZE diesel fleet. In addition, the application of the $70 rate to NZE trucks after 2030 results in an accelerated decline in the NZE fleet and more rapid growth in the ZE fleet. The overall fleet size is smaller, but more costly and more highly subsidized.

The figures below show CTF rate revenues and subsidy requirements for Scenario 4.

**Figure 11-6 Scenario 4 CTF Rate Revenue and Subsidy Requirements**



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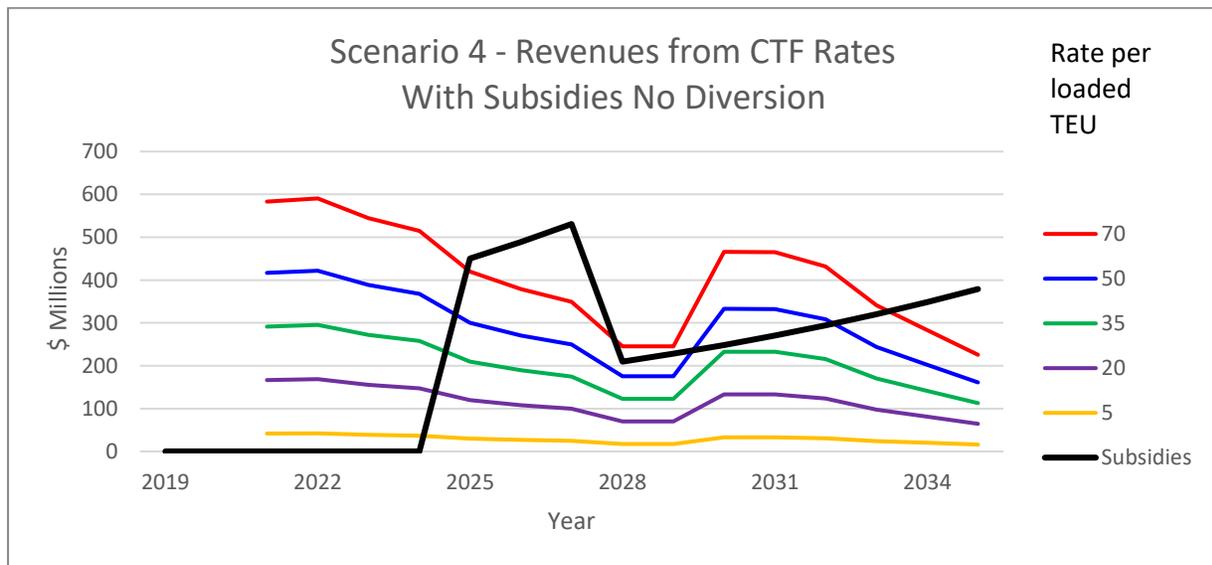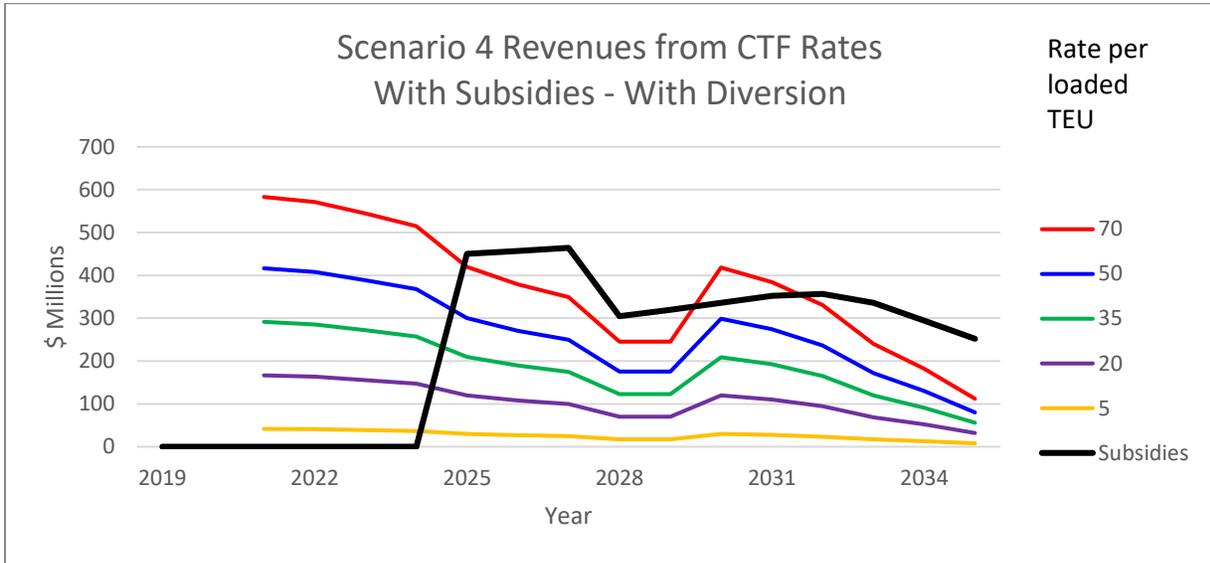
In Scenario 4 the early take-up of new technology also advances the timetable for availability of used trucks, which normally dominate the drayage fleet acquisition profile. As the share of used trucks in the fleet increases the subsidy requirements decline, as do the CTF rate revenues.

**Figure 11-7 Scenario 4 Annual Clean Truck Fund Balance**
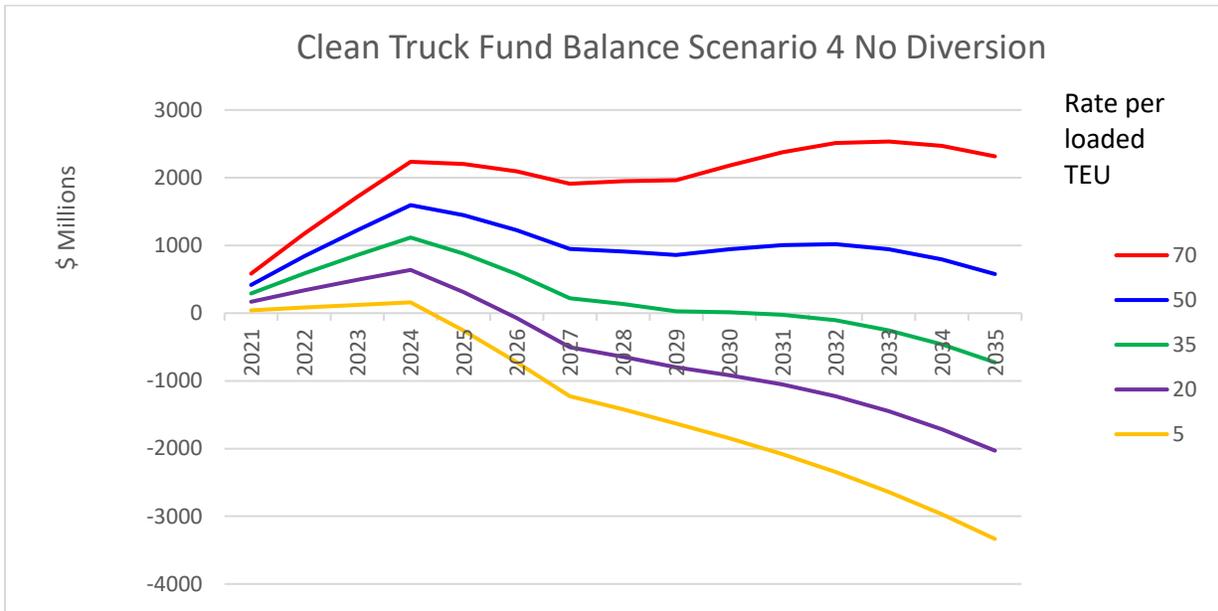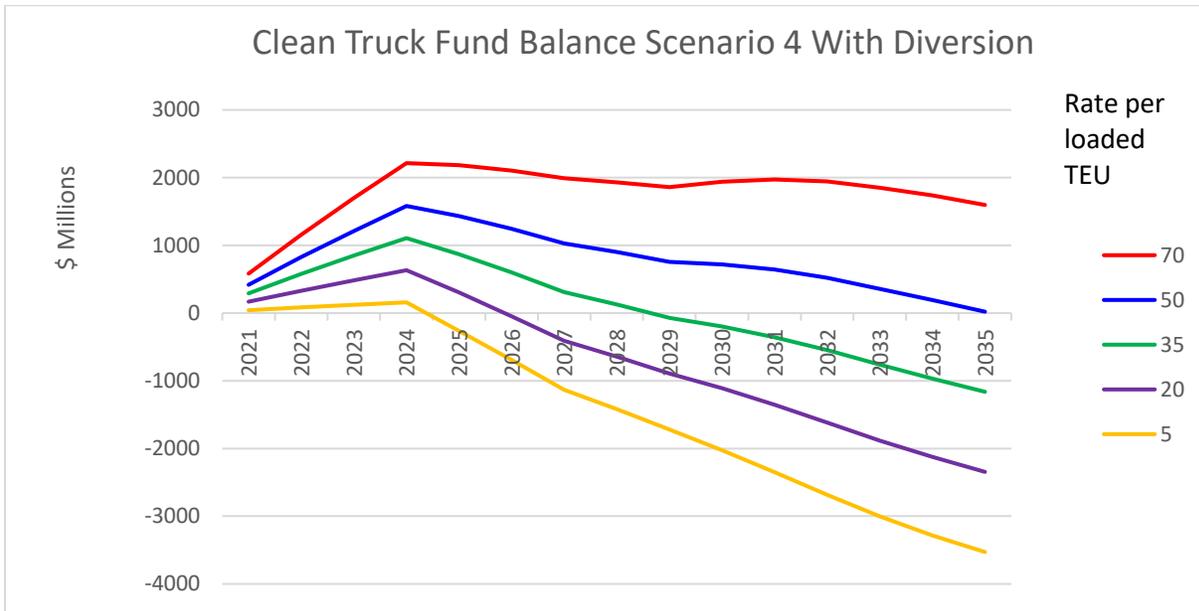
**Clean Truck Fund Balance Scenario 4 With Diversion**



CTF rate revenues and subsidy requirements for the No Diversion and Diversion scenarios are shown below.

**Figure 11-8 Scenario 4 Present Value of CTF Rate Revenues and Subsidy Requirements**

| Scenario 4 Present Value of CTF Rates and Subsidy Requirements | | |
|---|---|---|
| $ Millions (2019 Constant) | | |
| **CTF Rate** | **No Diversion** | **With Diversion** |
| $70 | $5,307 | $4,866 |
| $50 | $3,790 | $3,475 |
| $35 | $2,653 | $2,433 |
| $20 | $1,516 | $1,390 |
| $5 | $379 | $348 |
| Subsidy Requirements | $3,000 | $3,129 |
| Total Capital Invested | $5,348 | $5,476 |

The applicability of subsidies to zero emission trucks only (from their earliest availability) simplifies the process of transition away from non-NZE diesel trucks. Owing to issues of availability of new technology, there remains the need to invest in NZE trucks for a brief period. Acquisition of fewer new NZE trucks implies that there will be fewer of these trucks in the fleet by 2031 when rates are charged on these vehicles.

Conversely, this will put some pressure on the need for new ZE trucks, but not as significantly as Scenario 3, because there will also be the availability of used ZE trucks by that time. This would offset part of the need for subsidies but result effectively in the same overall fleet investment for new and used trucks.

# 12 Scenario 5 Staged Rates & Subsidies (Staged for NZE & ZE)

Scenario 5 builds on Scenario 2 with the addition of subsidies on NZE trucks from 2021 to 2023 and on ZE trucks from 2024 to 2035. The value of the subsidy is reduced from the previous scenarios to be the amount required to bridge the cost gap between a new non-NZE diesel truck and a new NZE or ZE truck.

A summary of the assumptions used in Scenario 5 is shown below.

**Figure 12-1 Scenario 5 Summary**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 5 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | New diesel | NZE only | 2021-2023 | 0% and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2024-2035 | |

The values of subsidies by truck type for Scenario 4 are shown below.

**Figure 12-2 Scenario 4 Subsidies**

| Truck Type | Capital Cost | Subsidy |
|---|---|---|
| Used Non-NZE Diesel | $40,000 | |
| New Non-NZE Diesel | $125,000 | |
| NZE | $250,000 | $125,000 |
| ZE Battery Electric    Pre 2030 | $320,000 | $195,000 |
| ZE Battery Electric    2030 on | $250,000 | $125,000 |
| ZE Hydrogen Fuel Cell pre 2030 | $350,000 | $225,000 |
| ZE Hydrogen Fuel Cell 2030 on | $250,000 | $125,000 |

This scenario differs from Scenarios 3 and 4 because the subsidies will be provided at a level to equalize the cost of NZE and ZE trucks with the cost of a <u>new</u> diesel truck; Scenarios 3 and 4 provided larger subsidies to equalize the cost of NZE and ZE trucks with a <u>used</u> diesel truck.

The impacts of the rates and subsidies on the costs of specific truck types are highlighted below.

**Figure 12-3 Scenario 5 Daily Truck Costs with Rates and Subsidies 2021 – 2023**
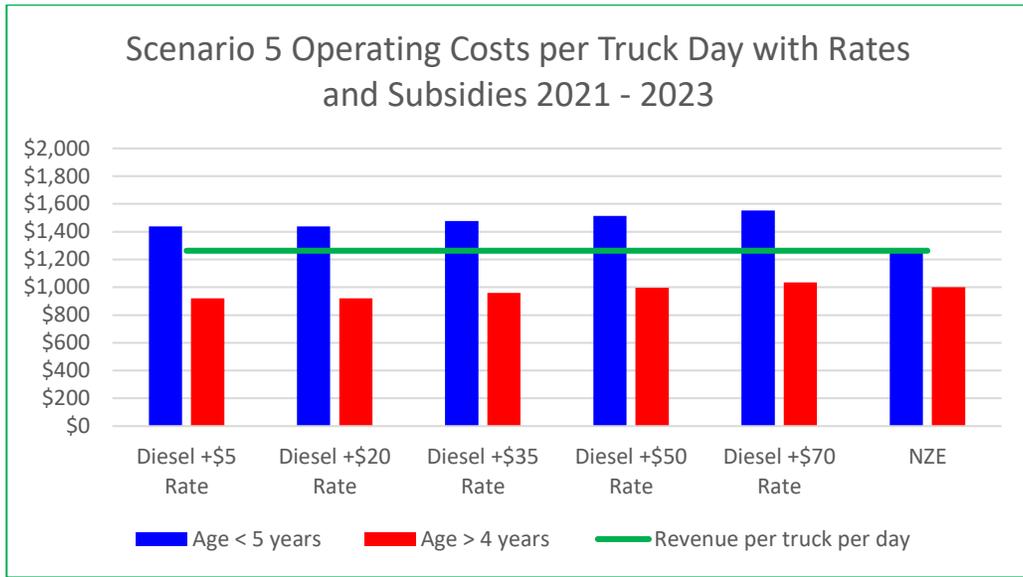


The continued use of non-NZE diesel trucks will be the lowest cost option even with the CTF rate applied at rates up to $35. New trucks added to the fleet will be NZE trucks.

**Figure 12-4 Scenario 5 Daily Truck Cost with Rates and Subsidies 2024 – 2029**
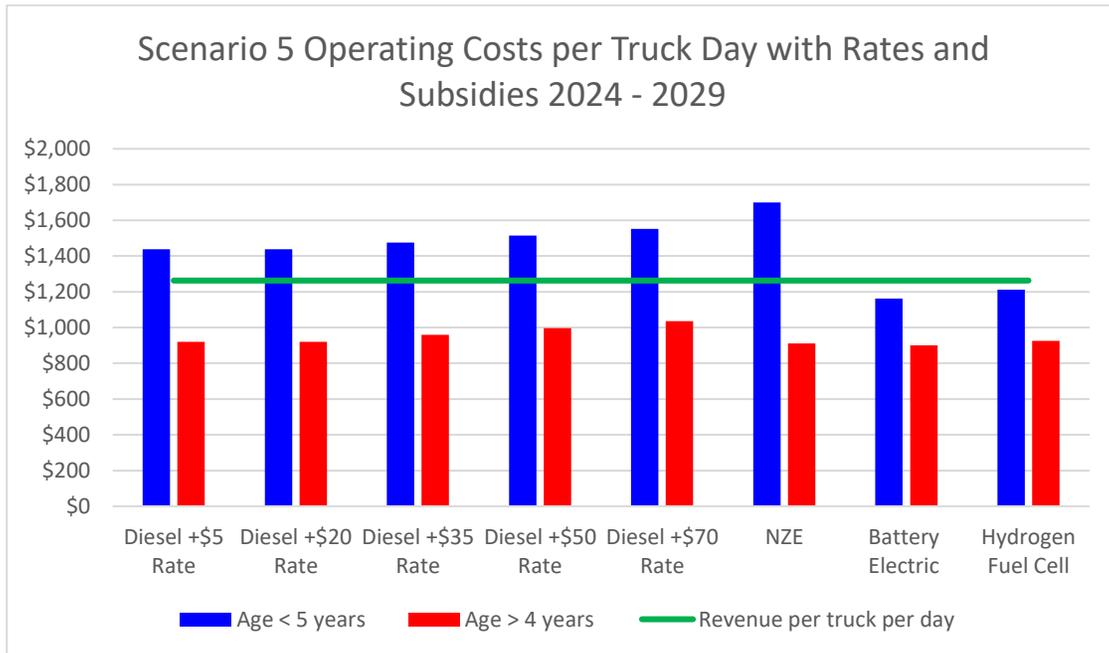


From 2024, subsidies will be provided only for the purchase of new ZE trucks. Used NZE or ZE trucks have the lowest costs, but the supply of these trucks is strictly limited. In their absence, the option is to continue to use non-NZE diesels even with the CTF rate applied. New trucks

added to the fleet during this time period will be ZE trucks purchased with the assistance of subsidies.

**Figure 12-5 Scenario 5 Daily Truck Costs with Rates and Subsidies 2030 – 2035**
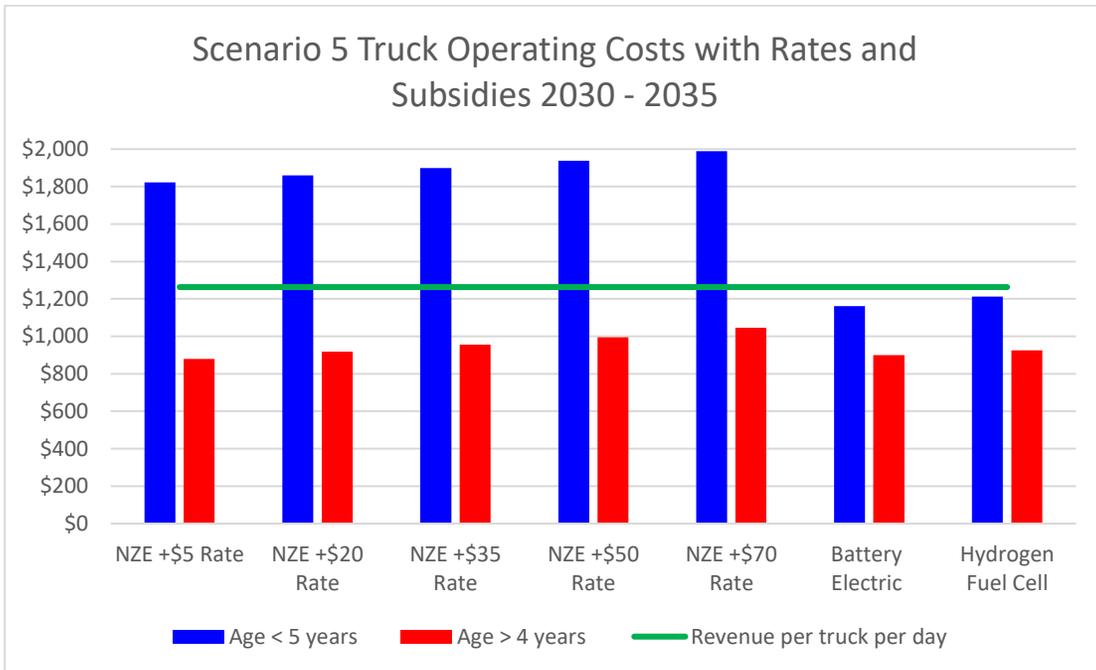


The fleet forecast based on the Scenario 5 cost analysis is shown below.

**Figure 12-6 Scenario 5 Fleet Profile Forecast**

Scenario 5 Fleet Mix Profile With Diversion
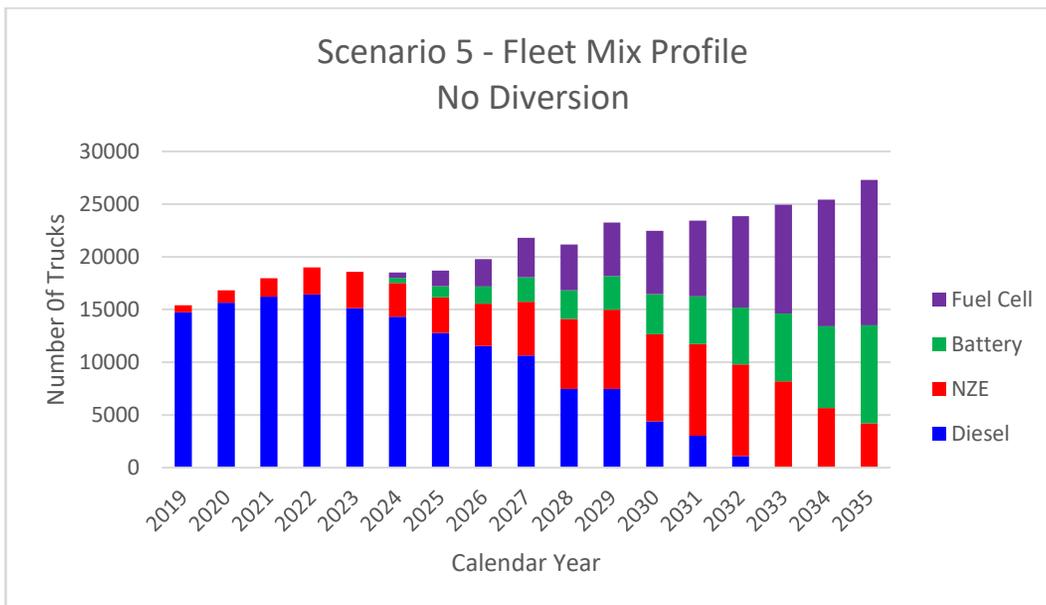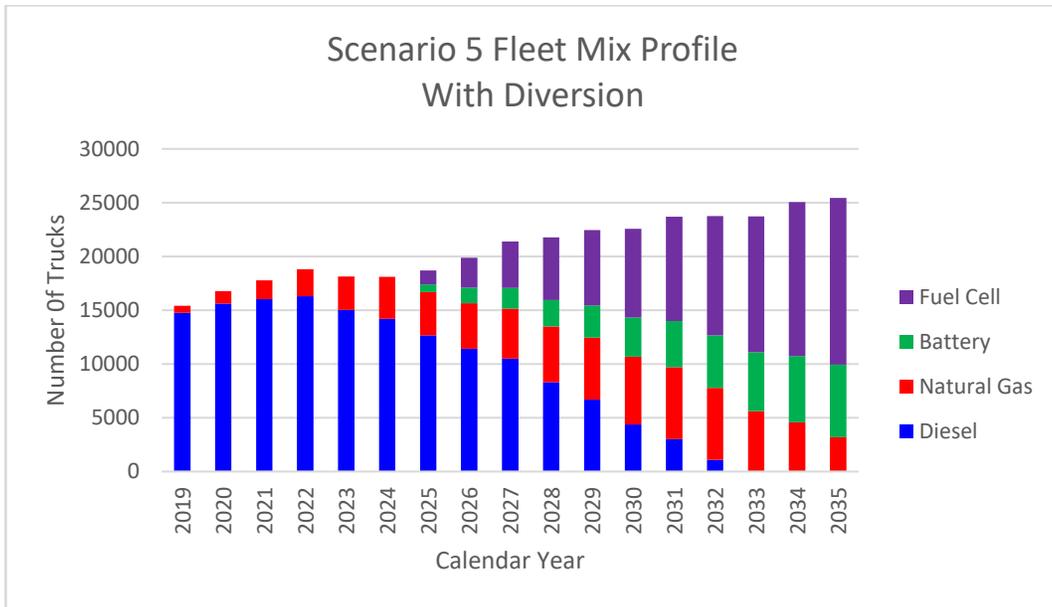
As in Scenario 4, the diversion scenario results in a more rapid introduction of ZE trucks due to the impact of the cargo diversion on the uptake of NZE trucks from 2022 to 2025. The 2 percent cargo drop results in fewer NZE trucks added to the fleet in this period. Therefore, fewer used NZE trucks available for service in later years. More, new ZE, trucks must be purchased to accommodate container traffic growth and the decline in the non-NZE diesel fleet. The overall fleet size is smaller, but more costly and more highly subsidized.

CTF rate revenues and subsidy requirements for the No Diversion and Diversion scenarios are shown below.

**Figure 12-7 Scenario 5 CTF Rate Revenue and Subsidy Requirements**



Scenario 5 - Revenues from CTF Rates With Subsidies No Diversion

Scenario 5 Revenues from CTF Rates With Subsidies With Diversion
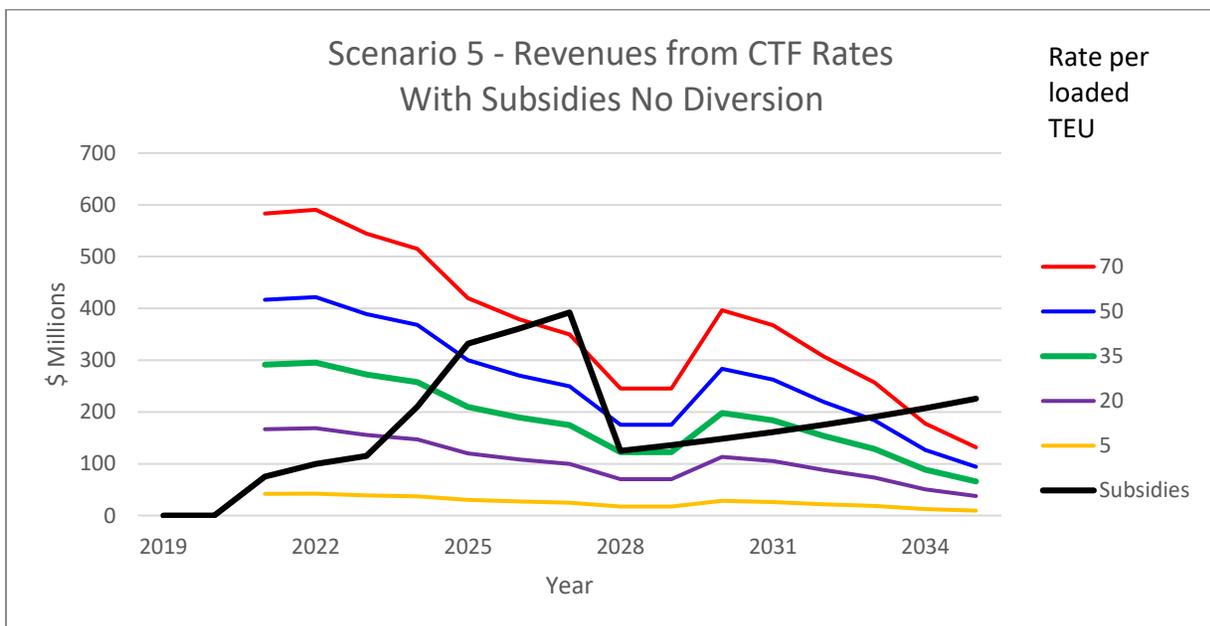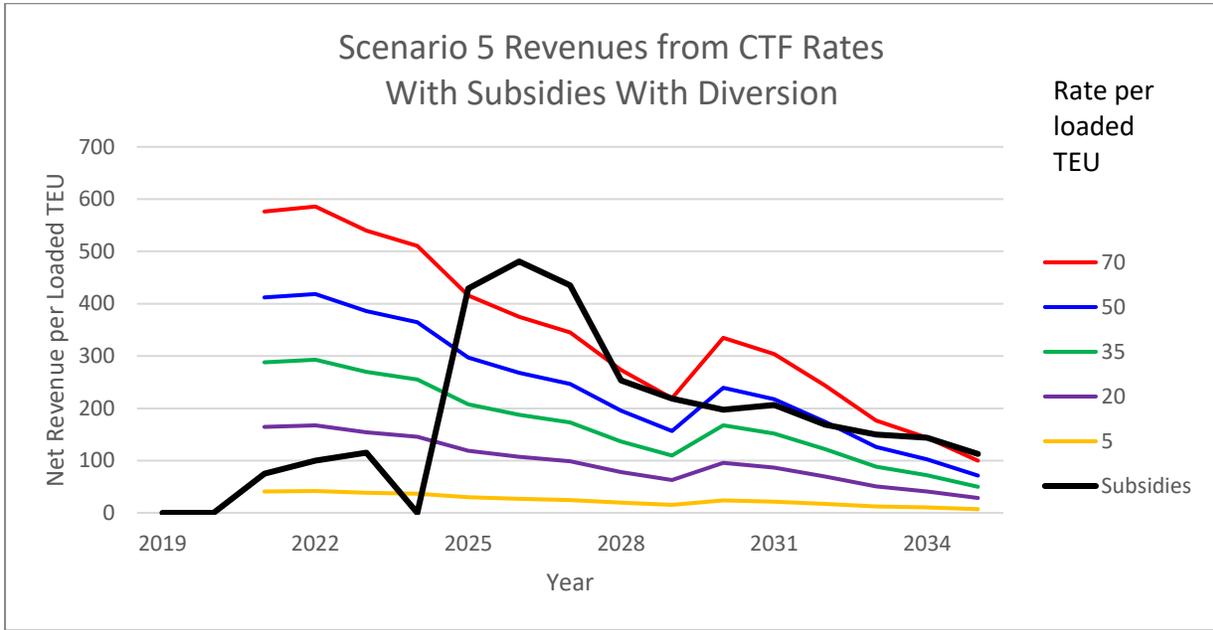
Annual Clean Truck Fund balances under Scenario 5 are shown below.

**Figure 12-8 Scenario 5 Clean Truck Fund Annual Balances**



Clean Truck Fund Balance Scenario 5

Clean Truck Fund Balance
Scenario 5 With Diversion
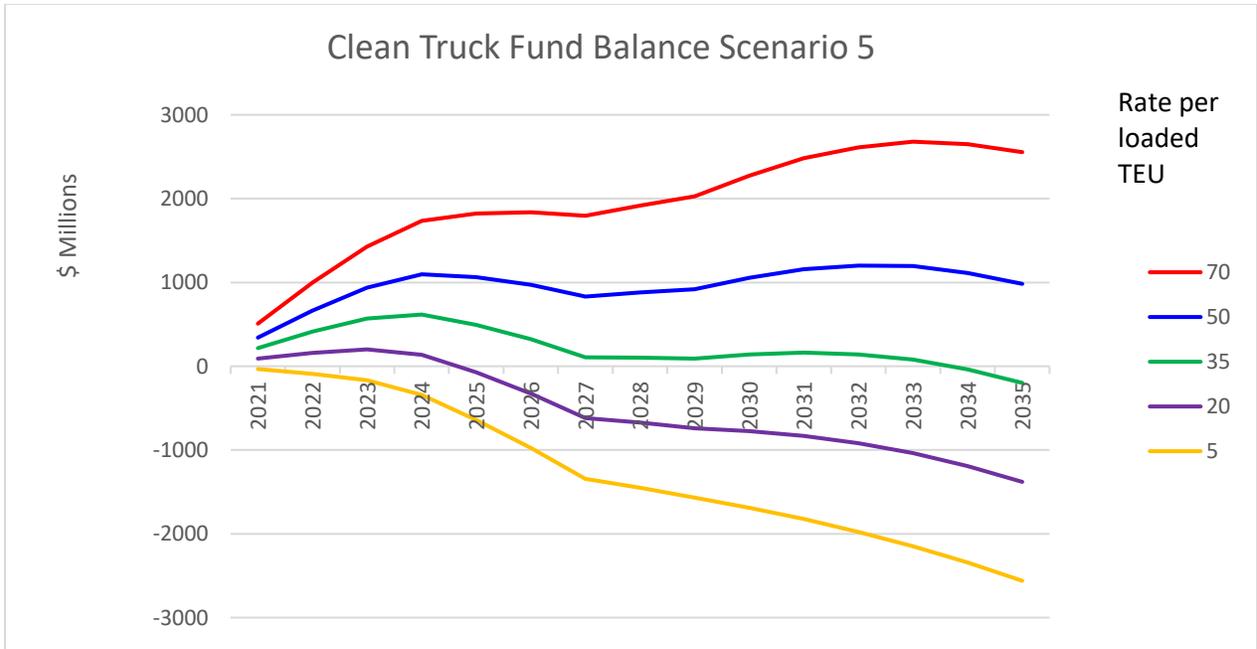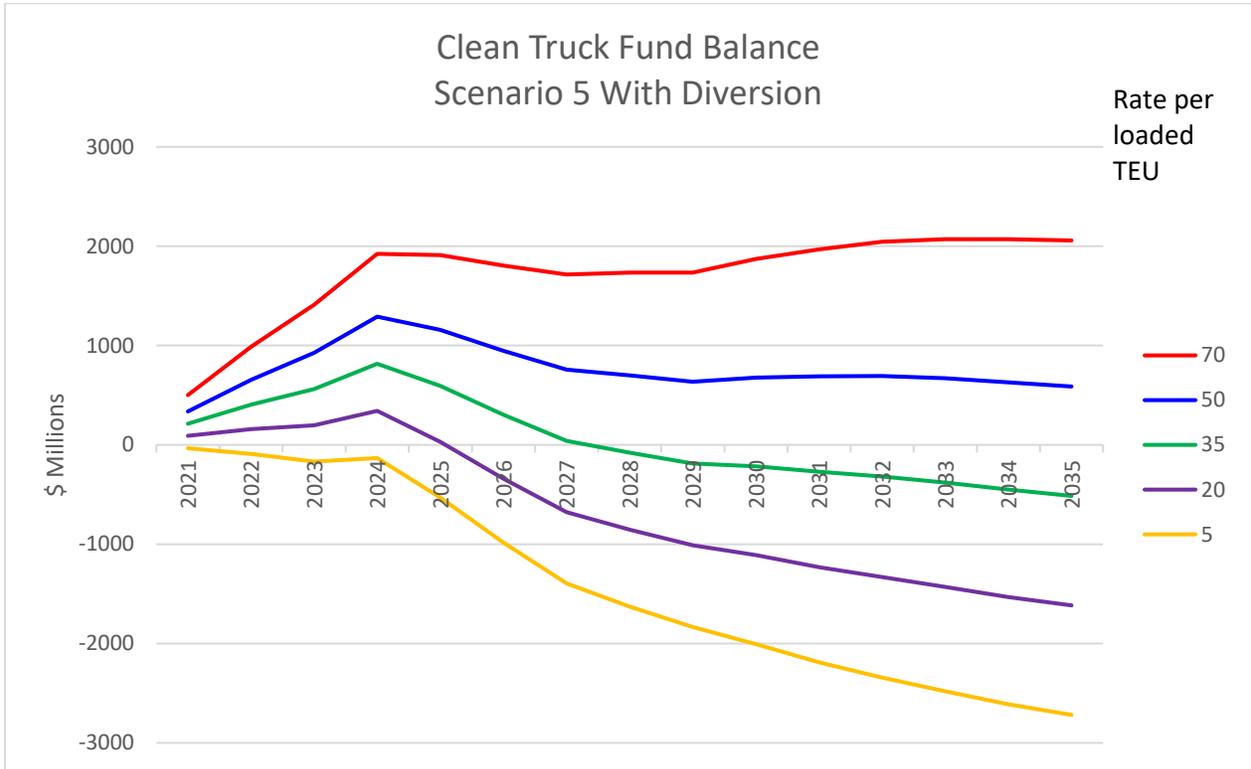
Under the diversion scenario, the fleet size is smaller. In both cases, by 2035 the fleet would be almost completely converted to ZE trucks.

**Figure 12-9 Scenario 5 Present Values of CTF Rate Revenues and Subsidy Requirements**

| Scenario 5 Present Value of CTF Rates and Subsidy Requirements | | |
|---|---|---|
| $ Millions (2019 Constant) | | |
| **CTF Rate** | **No Diversion** | **With Diversion** |
| $70 | $4,859 | $4,566 |
| $50 | $3,471 | $3,261 |
| $35 | $2,429 | $2,283 |
| $20 | $1,388 | $1,305 |
| $5 | $347 | $326 |
| Subsidy Requirements | $2,419 | $2,538 |
| Total Capital Invested | $5,526 | $5,681 |

Scenario 5 is like Scenario 4 in respect of the early encouragement of ZE trucks, with the added advantage of subsidizing NZE trucks ahead of availability of the new technologies. The subsidy level is lower compared to Scenarios 3 and 4 because subsidies are designed to close the cost gap between ZE trucks and new non-NZE diesel trucks rather than used diesel trucks.

Scenario 5 features the highest total capital invested of all Scenarios evaluated. It features an aggressive early uptake of new technology, which results in a significant availability of used ZE vehicles by 2030 and onward. This further relieves the burden on subsidies after 2030 because the use trucks are not subsidized.

# 13    Drayage Sector CTF Rate Impacts Summary

The modelling described in this report has been undertaken to estimate the impact of regulations, port requirements, Clean Truck Fund rates and subsidies on the Southern California drayage sector under certain scenarios, and to estimate potential program costs and revenues. The key features of the scenarios which were modelled are summarized below.

**Figure 13-1 Key Assumptions for Model Scenarios**

| Scenario | Regulations | CTF Rate | CTF Rate Applied to | Timing | Subsidy Cost Diffential | Subsidy Applied to | Timing | Cargo Diversion |
|---|---|---|---|---|---|---|---|---|
| 0 | CARB regulation 2023; Ports' tariff 2018 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 1 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | None | N/A (no CTF rate) | N/A (no CTF rate) | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | N/A (no CTF rate) |
| 2 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | N/A (no subsidy) | N/A (no subsidy) | N/A (no subsidy) | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |
| 3 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | NZE only | 2021-2027 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2028-2035 | |
| 4 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | Used diesel | ZE only | 2021-2035 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | | | |
| 5 | CARB regulation 2023; Ports' tariff 2018; only NZE + trucks after 2023 | $5-$70 | non-NZE | 2021-2029 | New diesel | NZE only | 2021-2023 | 0 % and 2% |
| | | | non-NZE and NZE | 2030-2035 | | ZE only | 2024-2035 | |

The figure below shows forecasts of the impact of the combinations of regulations, rates and subsidies on the percentage of diesel trucks in the fleet from 2019 to 2035.

**Figure 13-2 Non-NZE Diesel Trucks as a Percentage of the Drayage Fleet 2019 – 2035**
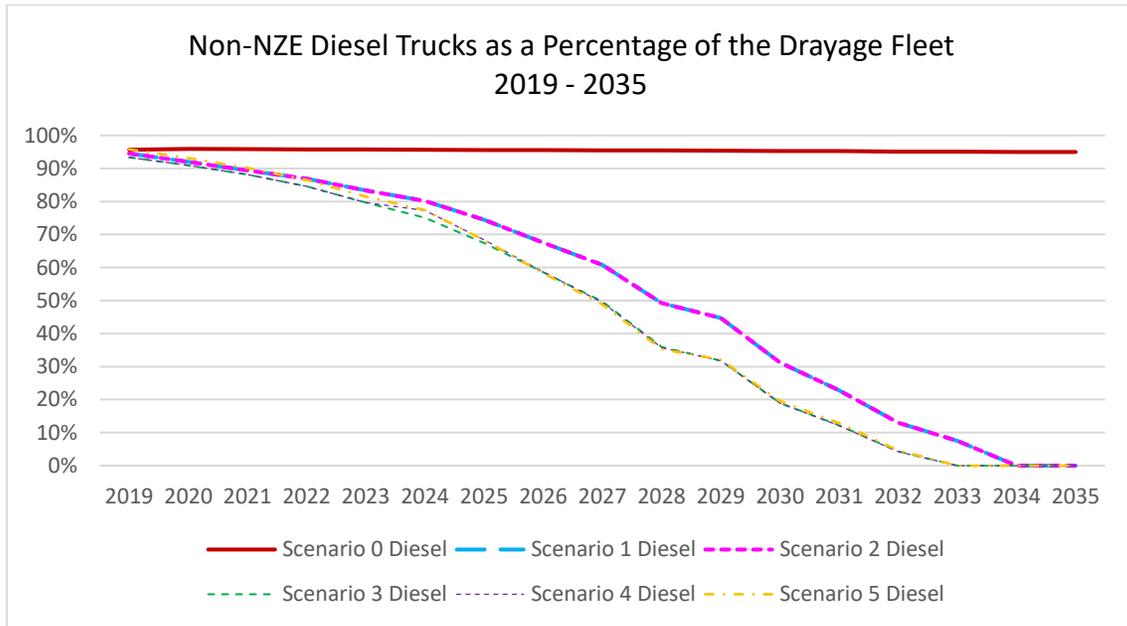


The modelling results lead to the following findings:

- In the absence of the restrictions on the entry of non-NZE diesel trucks into the Ports Drayage Truck Registry (PDTR), used non-NZE diesel trucks will retain their predominant role in drayage operations throughout the period (Scenario 0).

- If the 2023 restriction on the entry new registration of non-NZE trucks is implemented, the non-NZE diesel fleet will decline as the non-NZE diesel trucks "age out" of the fleet (Scenario 1).

- The implementation of Clean Truck Fund rates at the levels modelled will not modify the fleet composition from Scenario 1 because the rate levels are not sufficiently large to compensate for the increased costs of operating NZE and ZE trucks (Scenario 2).

- The combinations of rates and subsidies modelled in Scenarios 3-5 accelerate the retirement of the non-NZE diesel fleet and affect the NZE and ZE trucks' shares of the drayage fleet.

- None of the scenarios modelled result in a 100 percent ZE fleet by 2035. Scenario 3 achieves 53 percent ZE by 2035; Scenario 4 achieves 75 percent ZE by 2035; and Scenario 5 achieves 85 percent ZE by 2035. The share of ZE trucks in the fleet in Scenarios 3-5 in each year are depicted below.

**Figure 13-3 Zero Emission Fleet Percentage by Scenario**
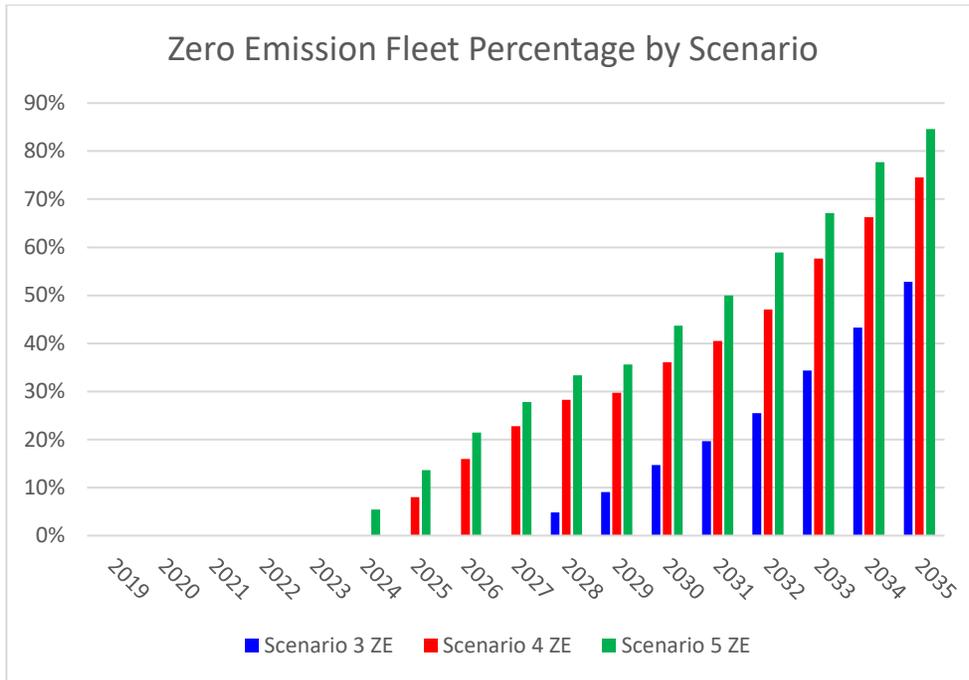


The shares of NZE and ZE trucks for each year for Scenarios 2 through 5 are shown below.

**Figure 13-4 NZE and ZE Fleet Shares Scenarios 2 – 5**
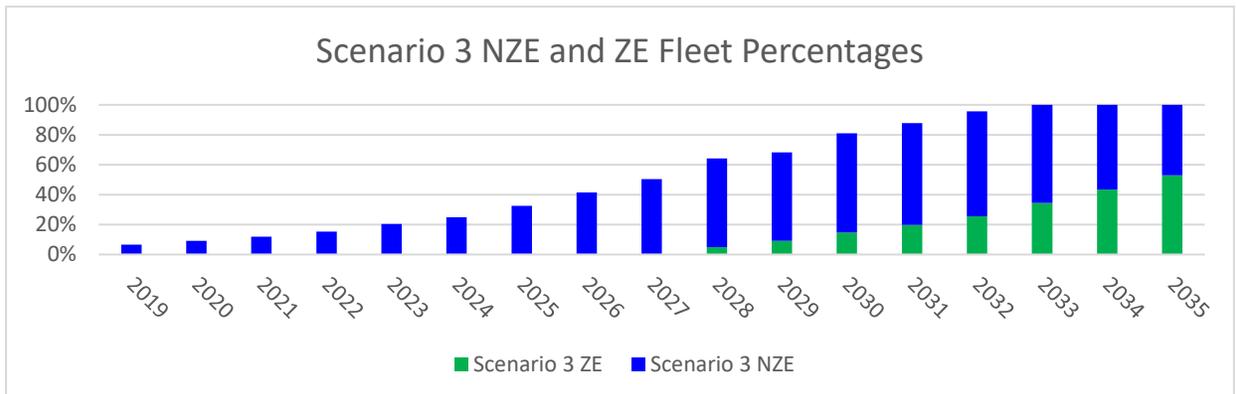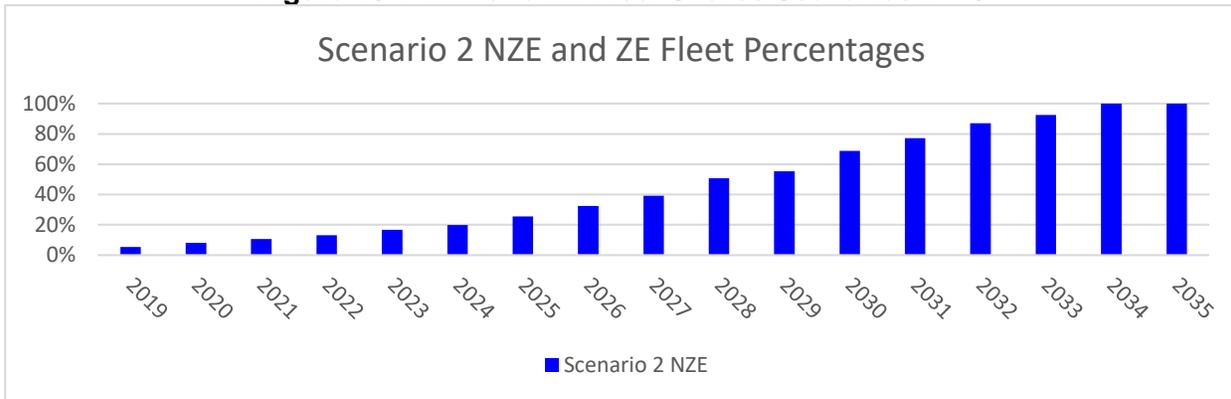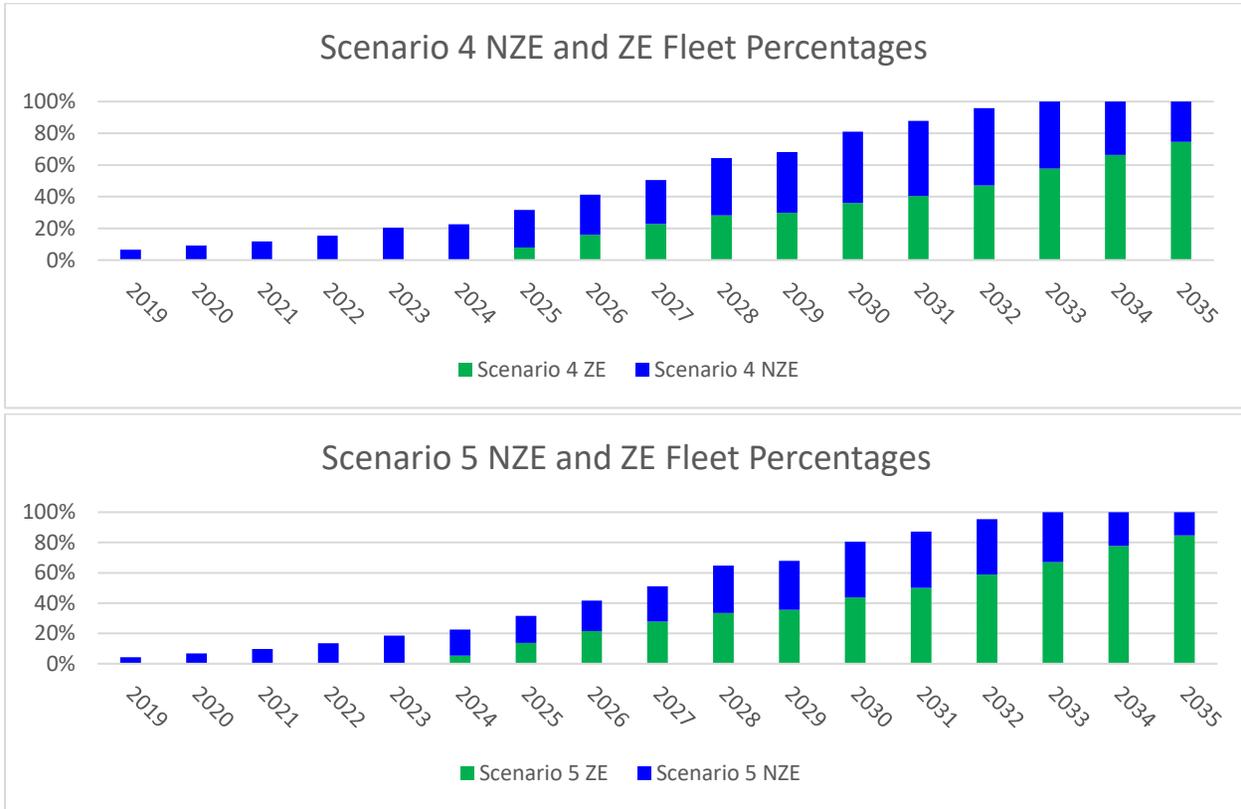
Scenario 4 NZE and ZE Fleet Percentages

■ Scenario 4 ZE  ■ Scenario 4 NZE



Scenario 5 NZE and ZE Fleet Percentages

■ Scenario 5 ZE  ■ Scenario 5 NZE

The present values of CTF rate revenues, subsidies and capital requirements for Scenarios 3 to 5 are shown below.

**Figure 13-5 Scenarios 3 - 5 Present Value of CTF Rates and Subsidy Requirements**

| Present Value of CTF Rates and Subsidy Requirements Summary | | | |
|---|---|---|---|
| $ Millions (2019 Constant) | | | |
| **CTF Rate** | **Scenario 3** | **Scenario 4** | **Scenario 5** |
| $70 | $6,090 | $5,307 | $4,859 |
| $50 | $4,350 | $3,790 | $3,471 |
| $35 | $3,045 | $2,653 | $2,429 |
| $20 | $1,740 | $1,516 | $1,388 |
| $5 | $435 | $379 | $347 |
| Subsidy Requirements | $3,642 | $3,000 | $2,419 |
| Total Capital Invested | $5,052 | $5,348 | $5,526 |

The present values of CTF rate revenues, subsidies and capital requirements for Scenarios 3 to 5 with 2 percent cargo diversion are shown below.

**Figure 13-6 Scenarios 3 – 5 Present Value of CTF Rates and Subsidy Requirements with Diversion**

| Present Value of CTF Rates and Subsidy Requirements With Diversion Summary | | | |
|---|---|---|---|
| $ Millions (2019 Constant) | | | |
| CTF Rate | Scenario 3 | Scenario 4 | Scenario 5 |
| $70 | $5,523 | $5,041 | $4,566 |
| $50 | $3,945 | $3,601 | $3,261 |
| $35 | $2,762 | $2,521 | $2,283 |
| $20 | $1,578 | $1,440 | $1,305 |
| $5 | $395 | $360 | $326 |
| Subsidy Requirements | $3,871 | $3,150 | $2,538 |
| Total Capital Invested | $5,242 | $5,476 | $5,681 |

The estimated present values of CTF rate revenues and subsidy requirements suggest that for the specific scenarios modelled, and for the high level of subsidy amounts applied, a CTF rate between $35 and $50 could generate sufficient revenue to fund the full cost of the subsidy amounts. This represents a conservative analysis of the amount of funding required. This study did not evaluate if subsidies at the levels evaluated would be necessary to compel the transition to NZE and ZE trucks. Nor did this study make assumptions about the amount of subsidies that may be available from other sources, such as state and federal grants.