PORT OF LOS ANGELES
2020 EXPANDED GREENHOUSE GAS INVENTORY

THE PORT OF LOS ANGELES

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Prepared by:
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TABLE OF CONTENTS

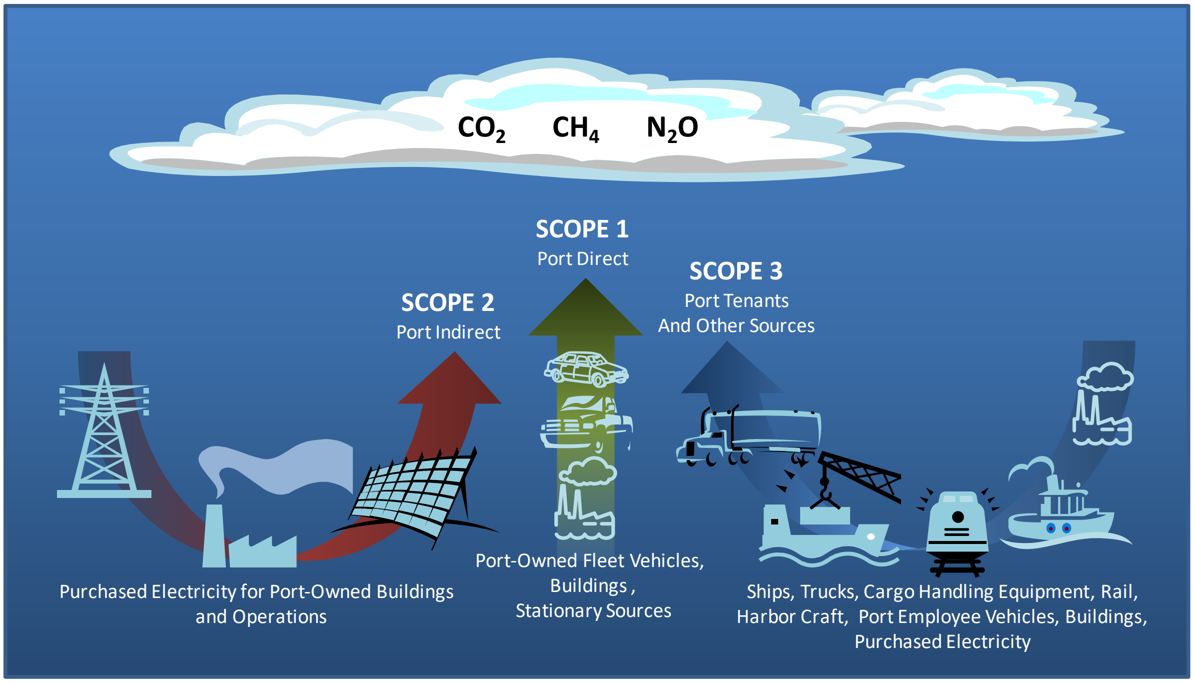
LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This document presents the evaluation of an expanded greenhouse gas (GHG) emissions domain associated with 2020 goods movements directly linked with the Port of Los Angeles (Port). The Port has previously conducted Expanded Greenhouse Gas Inventories covering calendar years 2006 through 2010 and 2015. Traditionally, the Port conducts annual emissions evaluations (Emissions Inventory) that are focused on a regional level, within the South Coast Air Basin (SoCAB). Beginning with the first Expanded Greenhouse Gas Inventory for 2006, the Port has expanded the scope of those evaluations to a national scale for trucks and rail, and a global scale for ships. The study includes all three Scopes of GHG emission sources. Scope 1 includes Port municipal operational emissions, Scope 2 includes emissions associated with Port municipal energy consumption, and Scope 3 includes tenant operations and energy consumption related emissions, Port employee vehicles and mobile operational equipment used by the tenants and shipping companies to move cargo through the Port to its final destination.as illustrated in Figure ES.1.

Figure ES.1: 2020 Port-wide GHG Emission Scopes



Scope 3 mobile sources include: ocean-going vessels (OGVs), heavy-duty vehicles (HDVs or trucks), cargo handling equipment (CHE), harbor craft (HC), rail locomotives and Port employee vehicles. Of these sources, OGVs, HDVs and rail locomotives travel beyond the regional SoCAB domain.

Please note that there may be minor inconsistencies, due to rounding associated with emission estimates, percent distribution, and other calculated numbers between various sections, tables, and figures of this report. All estimates are calculated using more significant figures than presented in various sections.

E.S.1 Study Domains

The Port-related GHG emission sources operate in three distinct geographical domains that are used to quantify activity and related emissions. These domains are:

- South Coast Air Basin (SoCAB)
- In-State (but outside the SoCAB)
- Out-of-State

SoCAB Domain

The SoCAB is the regional domain that is used for the annual emissions inventory of tenant operations and related goods movement and includes both land and over-water boundaries. The SoCAB land domain is presented in Figure ES.2 and includes all or part of four counties: Los Angeles County, Riverside County, Orange County, and San Bernardino County.

Figure ES.2: South Coast Air Basin-Boundary

The SoCAB over-water boundary extends from the Ventura and Orange County lines to the western edge of the California Waters (blue box), as presented in Figure ES.3.

Figure ES.3: Maritime Sources Geographical Extent

It is important to note that the SoCAB inventory domain for marine vessels is primarily within the CARB "In-State" domain.

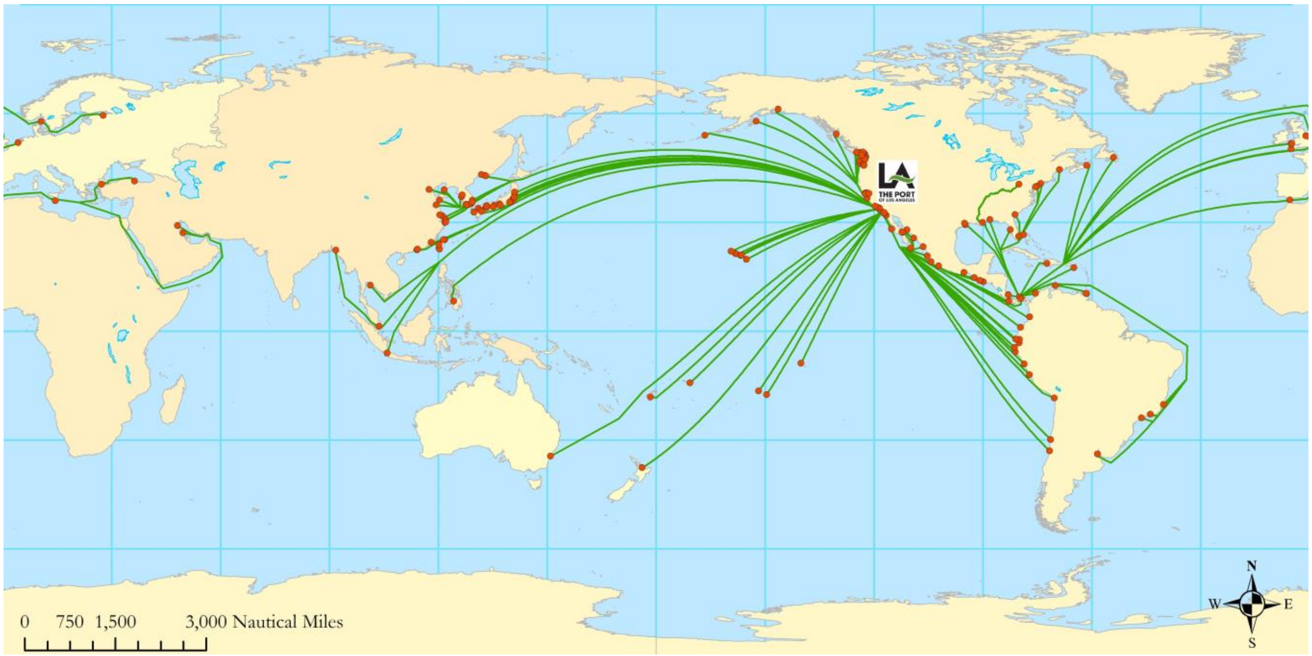
In-State Domain

The in-state domain also includes a land and an over-water boundary. The land boundary, for this study, is the entire State of California outside the SoCAB boundary (to avoid double counting). The over-water boundary, defined by the California Air Resources Board (CARB), is 24 nautical miles (nm) off the California Coast. Again to avoid double counting, for this study, the "In-State" over-water boundary is the area out to 24 nm from the coast, outside the SoCAB boundary (as presented in Figure ES.3 above). It should be noted that the CARB "In-State" over-water boundary was changed in late December 2011 to be consistent with the Contiguous Zone, so the "In-State" boundary in this report differs slightly from the 2006 through 2010 Expanded Greenhouse Gas Inventories but is consistent with the 2015 inventory.

Out-of-State Domain

The out-of-state domain also includes over-water and land components. The out-of-state domain's over-water component encompasses the world's oceans – over which ships travel to and from the Port. The 2020 ship routes therefore define the OGV out-of-state domain, as presented in Figure ES.4.

Figure ES.4: 2020 OGV Routes To and From the Port



The out-of-state domain's land component is made up of the HDV and rail locomotive domains. While many factors influence a shipper's choice of rail transport vs. truck transport, the assumption has been made that trucks are typically used for transport within 600 miles of the point of origin[1] so the HDV domain is a 600 mile arc from the Port as shown in Figure ES.5. It should be noted that it is assumed that population centers in California north of Fresno are most likely served by the Port of Oakland and, therefore, routes from the Port in this direction will be limited to the distance between Los Angeles and Fresno.

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[1] Evaluation of the 2010 origin/destination survey indicates that 95% of truck trips with origins or destinations outside the South Coast Air Basin are less than 600 miles.

Figure ES.5: Major On-Road Heavy-Duty Vehicle Routes from SoCAB Boundary to 600 Miles

The out-of-state rail locomotive domain component is out along the tracks to the major distribution centers from Los Angeles as shown in Figure ES.6.

Figure ES.6: Main Railways Traveled by BNSF and UP from the Port

E.S.2 Carbon Footprint Summary

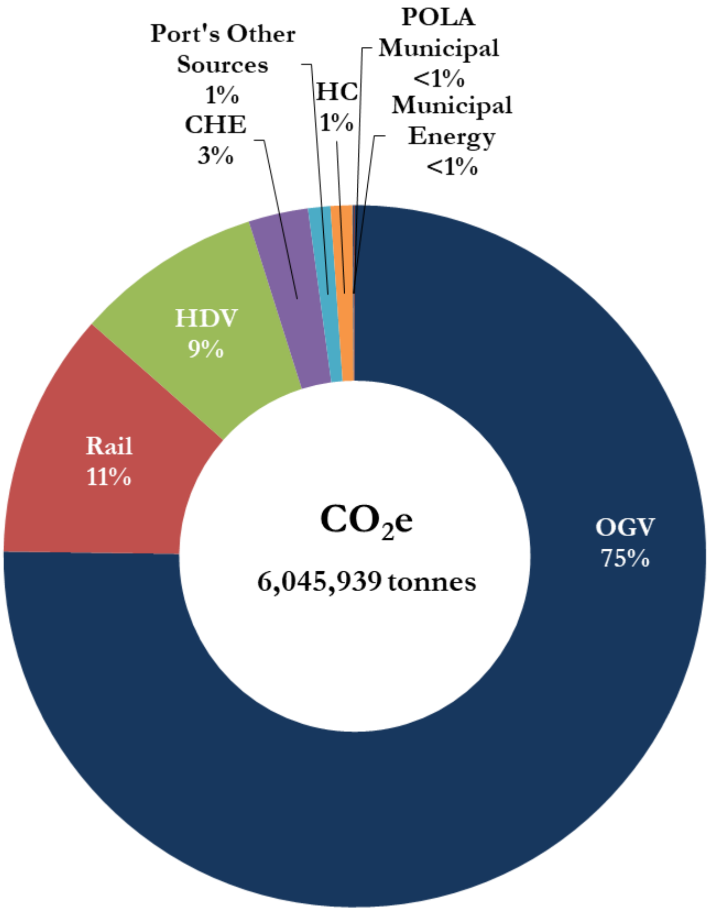
The 2020 combined emissions footprint for Port-related GHG emissions for all three Scopes is presented in Table ES.1.

Table ES.1: 2020 Port-Related GHG Emissions Scopes 1, 2, & 3

Scope	2020 Inventory Study	2020 Port-Related GHG Emissions CO_2 tonnes	 N_2O tonnes	 CH_4 tonnes	 CO_2e tonnes
1&2	Annual Municipal GHG Inventory	6,577	0.04	0.39	6,618
3	Electric Wharf Cranes	31,166	0.18	1.50	31,258
3	Buildings Electricity	8,743	0.05	0.42	8,769
3	AMP	15,890	0.09	0.76	15,936
3	Buildings Natural Gas	5,832	0.01	0.52	5,848
3	Port Employee Vehicles	301	0.01	0.02	305
3	Expanded GHG Inventory	5,870,487	346.85	134.50	5,977,206
Total		**5,938,996**	**347.23**	**138.10**	**6,045,939**

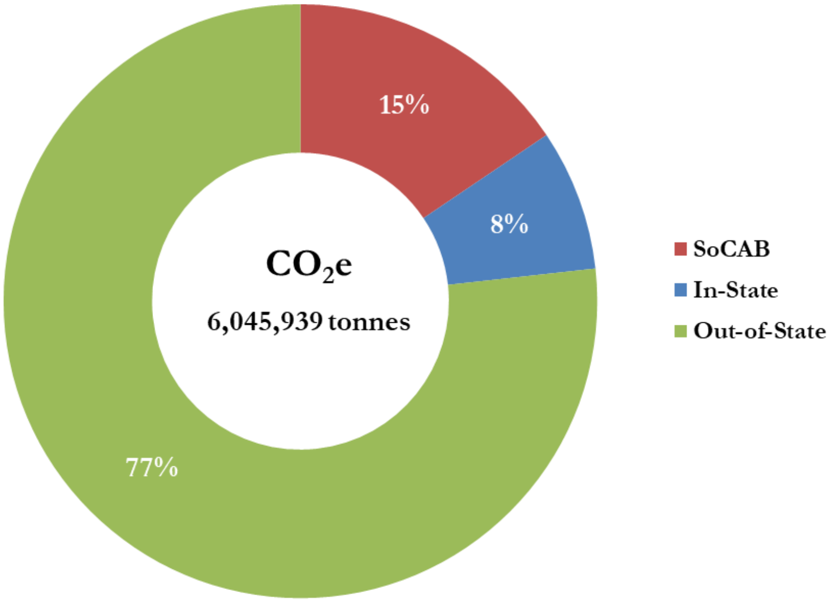
The distribution of Scopes 1, 2, & 3 emissions by source category is presented in Figure ES.7.

Figure ES.7: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Expanded Domain Emissions Distribution by Source Category



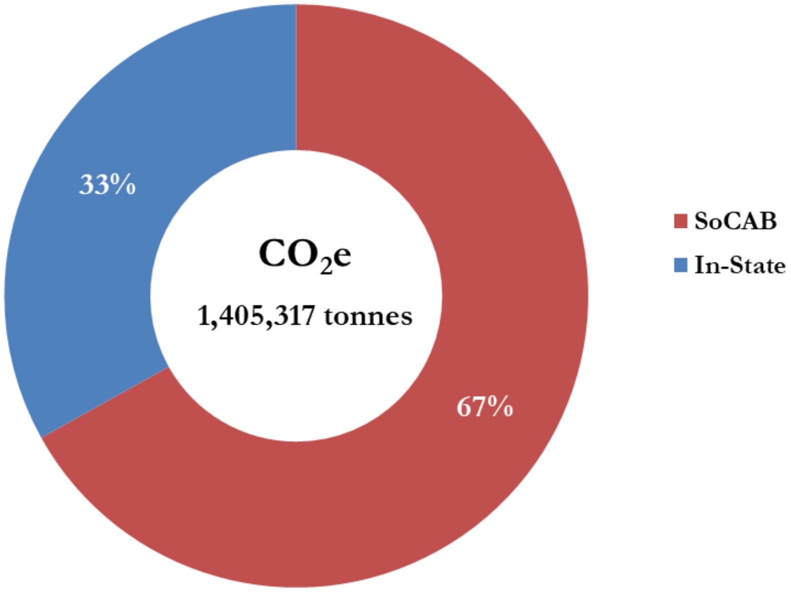
The total 2020 Port-related GHG emission distribution by domain (SoCAB, in-state, out-of-state) is presented in Figure ES.8.

Figure ES.8: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Emissions Domain Distribution



The California State domain is equal to the SoCAB emissions (all land and out to 24-nm from the California Coast) plus the in-state domain outside of the SoCAB. It should be noted that the majority of the emissions in the annual tenant inventories falls within the 24-nm line off the California Coast. The 2020 Port-related Scopes 1, 2, & 3 emission distribution for the State of California is presented in Figure ES.9.

Figure ES.9: 2020 Total California Port-Related Scopes 1, 2, & 3 GHG Emissions Domain Distribution



SECTION 1 INTRODUCTION

This document presents the evaluation of an expanded Greenhouse Gas (GHG) emissions domain associated with goods movements directly linked with the Port of Los Angeles (Port). Traditionally, the Port conducts annual emissions evaluations (Emissions Inventory) that are focused on a regional level, within the South Coast Air Basin (SoCAB). Beginning with the first expanded Greenhouse Gas Inventory in 2006, the Port has moved those evaluations to a national scale for trucks and rail, and a global scale for ships. In addition to this update for 2020, the Port has previously conducted expanded GHG Inventories for calendar years 2006 through 2010 and 2015.

1.1 Background

The Port is the largest container port in the United States and is ranked the number one container port in the Western Hemisphere, accounting for 9.21 million twenty-foot equivalents (TEUs) of cargo movement in the year 2020. Cargo throughput has slowly increased since the last expanded GHG Inventory was conducted for 2015, in spite of the economic trade war between the United States and China in 2018 that would see billions of dollars of tariffs imposed on goods traded and the global COVID-19 health pandemic that began in 2020. The COVID-19 pandemic impacted supply chain operations across the world from mandated shutdowns through stay-at-home orders to consumer panic buying, creating a bullwhip effect of cargo moving through the Port. Cargo volumes plunged by nearly 19 percent in the first half of 2020 at the start of the pandemic, followed by a surge in cargo volume that was driven by consumer spending, making 2020 the fourth highest-volume year of cargo throughput in the Port's history[2]. Economic forecasts, although conducted prior to the pandemic, suggest that the demand for containerized cargo moving through the San Pedro Bay region will continue to increase[3]. In order to meet containerized cargo demand and practice sound environmental stewardship, starting in 2005 the Port implemented the preparation of annual activity-based emission inventories (EIs) to monitor changes in Port-related emissions over time. These inventories are based on detailed activity data and are state-of-the-art for Port-related sources. To ensure that the methods and results continue to represent the best methods in emissions inventory development, the Port works with a Technical Working Group (TWG) consisting of staff of the California Air Resources Board (CARB), South Coast Air Quality Management District (SCAQMD), and the United States Environmental Protection Agency (USEPA). While the EI reports provide an in-depth analysis of Port-related emissions within the SoCAB, the Port is now evaluating a much broader national and global geographical domain with the expanded GHG inventory. While the study domain for this report is much broader, the emissions analysis is narrower, focusing only on GHGs. As concern over climate change is at the forefront of policy discussions and enactment, quantification and of anthropogenic GHG emissions has become a necessary first step towards reducing the emissions that cause global warming.

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[2] Seroka, G. (2021, Jan 14). *State of the Port*

[3] The Tioga Group, Inc., San Pedro Bay Container Forecast Update, Inc., July 2009

1.2 Purpose of Study

The purpose of this study is to quantify the greater GHG emissions associated with international goods movement directly related to the Port by expanding the geographical domain nationally and internationally. This report combines the existing regional (SoCAB) level inventories with estimates of the international and national emissions associated with those regional activities for 2020. Emissions resultant to the regional level of activity come directly from the 2020 Port estimates that are described in Section 1.8 below. This expanded GHG inventory contains new emission estimates from the expanded geographical extent for the following three source categories that operate beyond the regional domain:

- Ocean-going vessels
- Heavy-duty vehicles
- Rail locomotives

1.3 Cargo Movements Included

For activities beyond the existing geographical boundaries of the annual inventories, emissions are estimated from cargo movements within the following geographical extents:

- Ocean-going vessels: Ships inbound and outbound to and from the Port, from the ship's originating port to the next port of call as described in Section 2 of this report.
- Heavy-duty vehicles (trucks): Inbound and outbound truck movements to and from the Port to population centers within 600 miles of the Port, as described in Section 3 of this report.
- Rail locomotives: Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) (Class 1) inbound and outbound rail movements to and from the Port to major rail cargo destinations as described in Section 4 of this report.

The cargo movements that are included in this expanded GHG inventory represent only the direct movements to or from the Port. They are not intended to represent the greater international goods movement within the SoCAB or the expanded geographical area. An example of where this distinction is important is with container ships. Most ships follow trans-Pacific routes to the Port directly from Asia and then go to other west coast ports such as Oakland, Seattle, Tacoma, etc. The reverse can be true where the ship first arrives from a trans-Pacific voyage at one of these other west coast ports, comes to the Port, and then returns to Asia. Therefore, the majority of arrival and departures directly associated with the Port do not include two trans-Pacific legs.

A significant amount of cargo movement is indirectly associated with international goods movement but not directly related to the Port. An example would be imported goods that have been removed from international shipping containers to be distributed from transloading centers and repackaged into domestic trailers for local or regional transport. The movement of these goods after the transloading facility is not included in this expanded GHG inventory.

1.4 Greenhouse Gases

Climate change continues to be a global concern. The largest ever public opinion poll on global climate change, conducted by the United Nations Development Program and the University of Oxford, revealed that the majority of people surveyed consider climate change to be a global emergency[4]. During the 20th century, global average temperatures increased about one degree centigrade. In 2020, the earth's global average surface temperature tied with 2016 as the warmest year on record[5]. By the year 2100, the global mean temperature is likely to increase another 2.6 to 4.8 degrees Celsius[6] unless extraordinary efforts to reduce GHG emissions are adopted. A recent report by the Intergovernmental Panel on Climate Change (IPCC) concluded that unless there are immediate and wide-spread efforts to reduce GHG emissions, limiting global warming to close to 1.5 to 2 degrees Celsius will be unobtainable[7]. Climate models show that this overall increase in temperature will cause dramatic changes to regional climates and increase the incidence and intensity of severe weather events. Heatwaves, forest fires, and uncharacteristic storms were prevalent in 2020 on a global scale.

GHGs are gases present in the earth's atmosphere that reduce the loss of heat into space. GHGs primarily include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide, (N_2O), and certain fluorinated gases used in commercial and industrial applications. GHGs affect climate as they concentrate in the Earth's atmosphere and trap heat by blocking some of the long-wave energy normally radiated back into space.

While some GHGs occur naturally, there is widespread agreement among climate scientists worldwide that human activity is increasing the GHGs in the Earth's atmosphere and accelerating global warming and the changes in climate patterns that accompany it. Activities that release GHGs into the air include those that occur in and around a port setting, such as the burning of fossil fuels for industrial operations, transportation, heating, and electricity. The potential consequences of global warming to Los Angeles include longer and hotter summers, longer droughts, more devastating wildfires, and shortages of public water, all of which threaten public health and the economy. In 2020, the California wildfire season was the largest wildfire season on record[8] in both frequency and scale. Similarly, California experienced rolling blackouts during an extreme heat event in the middle of August 2020 due to a surge in power demand that exceeded the existing electrical resources[9]. These are just a few local examples of the adverse effects of climate-driven weather events.

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[4] United Nations Development Program. (2021). Peoples' Climate Vote*, https://www.undp.org/publication/peoples-climate-vote,* accessed November 2021

[5] NASA/Goddard Institute for Space Studies, *https://climate.nasa.gov/system/internal_resources/details/original/647_Global_Temperature_Data_File.txt,* accessed December 2021

[6] IPCC. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II, III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp 151

[7] IPCC. (2021). Climate Change 2021: the Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland

[8] Cal Fire*, https://www.fire.ca.gov/incidents/2020/* , accessed November 2021

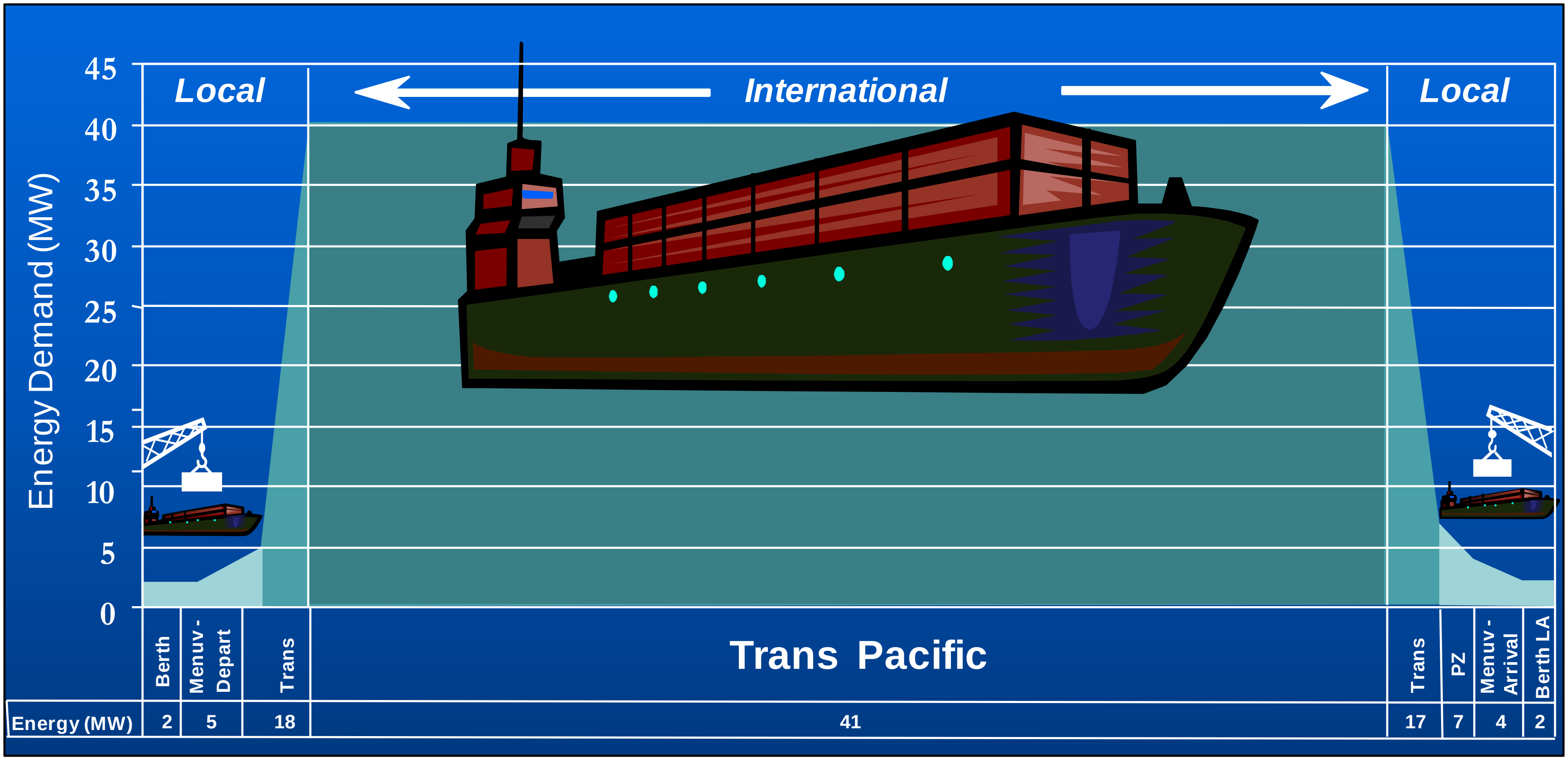
[9] CAISO. (2020). Preliminary Root Cause Analysis: Mid-August 2020 Heat Storm, *https://www.caiso.com/Documents/Preliminary-Root-Cause-Analysis-Rotating-Outages-August-2020.pdf* , accessed November 2021

1.5 The Bigger Picture: Goods Movement & Climate Change

Traditionally, air quality efforts in Southern California and the United States have focused on pollutants that impact the local or regional populations. With respect to climate change, emissions released anywhere along the goods movement logistic chains can have a negative impact on GHG concentrations globally, meaning it's not just a local concern. When estimating the Port-related GHG emissions from goods movement activities that pass directly through the Port, the expanded geographical domain of those activities brings into focus a significant source that is not accounted for in local or regional inventories.

This is particularly acute in ocean-going vessel (OGV) inventories. For example, when looking at the emissions covered in the existing Port tenants' inventories, only the local energy demand of ships calling the Port is estimated. In this local domain, the ship is typically transitioning from sea speed to maneuvering speeds and operations at-berth (when the propulsion engines are off). The same activities are evaluated on the Asia side as a local concern of the people there. However, the significant majority of a vessel's energy demand (which is directly related to emissions) occurs during the trans-Pacific leg (international) and is not included in the local inventories. It is during this international phase that the ship's energy demand is at its highest because the propulsion engine(s) is operating at its highest level and transiting time is significantly longer than the ship's time at berth. This is illustrated in Figure 1.1.

Figure 1.1: Energy Demand Example: Trans Pacific Transit from Shanghai to Los Angeles



This study represents the seventh installment of the first detailed Port-related evaluation of GHG emission levels from ships arriving and departing from their previous and next port, respectfully. The results of this study can be used to frame further carbon footprinting discussions on domain and source contributions associated with ports.

1.6 Climate Change Regulations & Initiatives

California has been leading the nation in developing a regulatory mechanism to respond to the changing climate. Assembly Bill AB 32, the California Global Warming Solutions Act of 2006 was the first comprehensive climate change regulation in the United States requiring significant reductions in GHGs and has been further extended through the recent authorization of Senate Bill 32. Locally, the City of Los Angeles has adopted the Los Angeles Sustainable City pLAn targeted to achieve environmental, economic, and social justice in the city with short- and long-term goals. At the national level, USEPA and the Department of Transportation have developed regulations[10] that set GHG emissions and fuel economy standards for the largest sources of GHG from the transportation sector which includes cars, light trucks, and heavy-duty trucks. Internationally, the International Maritime Organization (IMO) continues to work on greenhouse gas indexing of ships and potential engine and fuel standards targeting these pollutants. In 2011, the IMO adopted mandatory ship energy efficiency measures that entered into regulation on January 1, 2013. Also on the international front, in 2008 the International Association of Ports and Harbors (IAPH) board signed the World Ports Climate Initiative (WPCI) with a goal of reducing GHG from goods movement across oceans and within harbors. In 2017, IAPH established the World Ports Sustainability Program (WSPS) to further build upon and expand the goals of WPCI. More on these initiatives is provided below.

The California Global Warming Solutions Act – Assembly Bill 32 and Senate Bill 32

Assembly Bill 32[11] (AB 32) enacted as a part of the California Global Warming Solutions Act of 2006, was the first-in-the world comprehensive law requiring CARB to develop a scoping plan and provide an update every five years. The plan outlines regulatory and market mechanisms that will ultimately achieve GHG reduction targets outlined in Assembly Bill 32, subsequent executive orders and Senate Bill 32[12] (SB 32) as follows:

- By 2020, reduce GHGs to 1990 levels;
- By 2030, reduce GHGs to 40% below 1990 levels (Governor's Executive Order B-30-15 and Senate Bill 32);
- By 2045 achieve statewide carbon neutrality) Governor's Executive Order B-55-18;
- By 2050, reduce GHGs to 80% below 1990 levels (Governor's Executive Order S-3-05).

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[10] USEPA, *https://www.epa.gov/air-pollution-transportation/carbon-pollution-transportation,* accessed December 2021

[11] CARB, *https://www.arb.ca.gov/cc/ab32/ab32.htm,* accessed December 2021

[12] California Global Warming Solutions Act of 2006: emissions limit, SB 32. (2016). *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32,* accessed December 2021

In addition, per Assembly Bill 197[13] (AB 197), CARB has been authorized to consider the social costs of GHG reductions, to follow existing AB 32 requirements including considering cost-effectiveness and to prioritize measures resulting in direct emission reductions. Recently, Governor Newsom signed Executive Order N-79-20[14] which requires 100% of auto sales be zero emission, full transition to zero emission short-haul and drayage trucks by 2035, and where feasible full transition of off-road equipment to zero emission also by 2035. Additionally, where feasible, achieve full transition to zero emissions for long-haul heavy-duty trucks by 2045.

In December 2008, CARB approved its first Climate Change Scoping Plan to achieve the reductions in GHG emissions mandated in AB 32. The first update to the Climate Change Scoping Plan was later completed in May 2014[15], using the latest available climate science to identify priorities set forth by the initial plan and achieve long-term goals set forth in Executive Orders S-3-05 and B-16-2012. In the updated Scoping Plan, CARB revised the 2020 statewide GHG emission limit to 431 million metric tons of carbon dioxide equivalent (MMT CO_2e) from an initial budget of 427 MMT CO_2e. The 2017[16] update further defined a cost-effective and technologically feasible path forward to achieve the 2030 goal of 40% below 1990 emission levels. Recently, CARB has initiated the 2022[17] update of the Scoping Plan to assess the progress toward the 2030 goal and to lay out a path toward the goal of carbon neutrality by 2045.

Several of the initial Scoping Plan main strategies to reduce the GHGs that cause climate change targeted goods movement, including ports, and were expected to achieve a combined 3.5 MMT CO_2e reduction by 2020. The status of the proposed measures that were included in the original Scoping Plan affecting goods movement have been updated as follows[18]:

- T-5: Ship electrification at ports (previously adopted as regulation in December 2007)
- T-6: Goods movement efficiency measures (Port Drayage Trucks regulation adopted in December 2007 and later amended in December 2010 to include class 7 trucks; other measures such as electrification of cargo handling equipment, Goods Movement System Wide Efficiency Improvement, and Clean Ships are under development)

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[13] State Air Resources Board: greenhouse gasses: regulations, AB197. (2016). *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB197,* accessed December 2021

[14] CARB, *https://ww2.arb.ca.gov/resources/fact-sheets/governor-newsoms-zero-emission-2035-executive-order-n-79-20,* accessed December 2021

[15] CARB, *https://www.arb.ca.gov/cc/scopingplan/document/updatedscopingplan2013.htm,* accessed December 2021

[16] CARB, *https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2017-scoping-plan-documents,* accessed November 2021

[17] CARB, *https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan,* accessed November 2021

[18] CARB, *https://www.arb.ca.gov/cc/scopingplan/2013_update/appendix_b.pdf,* accessed December 2021

- T-7: Heavy-Duty Vehicle GHG Emission Reduction. Previously adopted as regulation in December 2008 Harmonized with USEPA and National Highway Traffic Safety Administration (NHTSA) Phase 1 standards are further strengthened with federal Phase 2[19] standards finalized in August of 2016. Phase 1 and 2 standards cut emissions and improve efficiency by including national standards for improved aerodynamics and more efficient low-rolling resistance tires on big-rig trailers for a wide range of vehicles, from heavy-duty pickups to large 18-wheel tractor-trailer trucks.

While the initial Scoping Plan identified measures to achieve 2020 GHG reduction goals, the 2014 update of the Scoping Plan focused on achieving long term, larger (compared to 2020) GHG reductions and an integrated planning effort to achieve not only GHG reductions, but other criteria pollutant reductions to meet federal and California clean air standards. For the Transportation sector of goods movement, the update requires the introduction of zero emissions vehicles and equipment and development of low carbon transportation fuel and Sustainable Freight Initiatives. CARB has set guidelines on emission sources or "Scopes" which ports and port tenants should include when determining their carbon footprint as well as the geographical domain for the State of California. These guidelines are discussed further in Section 1.7.

The 2017 Scoping Plan builds upon the successful framework established by the Initial Scoping Plan and First Update, while identifying new, technologically feasible, and cost-effective strategies to ensure that California meets its GHG reduction targets. Specific to goods movement, the Scoping Plan included proposed measures that would transition to a sustainable freight system with zero emissions everywhere feasible and near-zero emission with renewable fuels everywhere else.

CARB is in the process of developing the 2022 Scoping Plan which will look longer term to the 2045 carbon neural goal and the 2050 goal of 80% below 1990 levels with a continued focus on zero and near zero emission technologies for the goods movement sector.

California Sustainable Freight Action Plan[20]

Executive Order B-32-15 directs several state agencies, including CARB, to work together and develop an integrated freight action plan that promotes:

- Improving freight efficiency,
- Transitioning to zero-emission technologies to achieve compliance with federal clean air standards and 2030 GHG reductions goals per SB 32, and
- Increasing competitiveness of California's freight system

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[19] CARB, *https://www.arb.ca.gov/msprog/onroad/caphase2ghg/caphase2ghg.htm,* accessed December 2021

[20] CARB, Sustainable Freight: Pathways to Zero and Near-Zero Emissions. (2015). *https://ww2.arb.ca.gov/sites/default/files/2021-02/SustainableFreightPathwaystoZeroandNear-ZeroEmissionsDiscussionDocument.pdf*, accessed December 2021

In response, staff members of the California Department of Transportation, CARB, the California Energy Commission, and the Governor's Office of Business and Economic Development collaborated and developed the "California Sustainable Freight Action Plan"[21] in July 2016. In this plan, the State agencies have developed voluntary 2030 targets for improved efficiency, to transition to zero-emissions technology, and to increase State competitiveness providing future economic growth within the freight and goods movement industry so that progress can be measured. Appendix C of this plan lists actions outlined by CARB to reduce GHG as well as criteria pollutants from mobile sources that also operate at the Port. Additionally, Appendix E of the plan identifies long term transformational concepts that will need further research and planning.

Los Angeles Sustainable City pLAn [22]

Released in April 2015, the Los Angeles Sustainable City pLAn (pLAn) is designed to be a guideline for the City of Los Angeles to combat climate change locally, and to become leaders in climate change solutions both nationally and internationally. The pLAn outlines strategies for achieving near-term (2017) and long-term (2025 and 2035) emission reduction targets from multiple sources, including transportation and goods movement. The pLAn outlines the following GHG emission reduction targets:

- 2025 – Reduce GHG emissions by 45% below 1990 (baseline) levels
- 2035 – Reduce GHG emissions by 60% below 1990 levels
- 2050 – Reduce GHG emissions by 80% below 1990 levels

The Los Angeles Climate Action Report for the pLAn was completed in December 2015 and was accompanied by a City-wide GHG inventory of 2013 emissions as well as updated 1990 baseline emissions based on the latest available methodology. Emission reductions detailed in the report show that the city of Los Angeles is making progress to meet the pLAn's 2025 target and had already reduced GHG emissions by 20% below baseline levels.

The first four-year update to the pLAn was released in 2019. The City of Los Angeles' Green New Deal pLAn [23] augments, expands, and elaborates in even more detail Los Angeles' vision for a sustainable future and it addresses the climate emergency with accelerated targets and new aggressive goals. By 2050, the goal is for Los Angeles to achieve zero carbon grid, zero carbon transportation, zero carbon buildings, zero waste, and zero wasted water. The targets related to transportation and energy are:

- 2025 – Reduce GHG emissions by 55% below 2008 (baseline) levels
- 2035 – Reduce GHG emissions by 65% below 2008 levels
- 2050 – Carbon neutral

Achieving these accelerated targets will result in 30% more emission reductions than would have been realized from the original pLAn.

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[21] Caltrans, *https://www.dot.ca.gov/programs/transportation-planning/freight-planning/csfap* , accessed December 2021

[22] City of Los Angeles, *https://www,lamayor.org/sustainability,* accessed December 2021

[23] City of Los Angeles, *https://www.plan.lamayor.org,* accessed December 2021

San Pedro Bay Ports Clean Air Action Plan 2017 (CAAP 2017 Update)[24]

In 2006, in collaboration with local, state and federal agencies, as well as input from their stakeholders, the Port of Los Angeles and the Port of Long Beach (SPBP or Ports) adopted their Clean Air Action Plan (CAAP) which was their roadmap to reduce criteria pollutant emissions from sources that operated at the Ports. This plan was further updated in 2010, which included diesel particulate matter (DPM), nitrogen oxides (NO_x), and sulfur oxides (SO_x) standards to be achieved by 2014 and 2023. The strategies outlined in the CAAPs have been fully implemented, or are well underway, and the Ports have a mechanism to track progress through their annual emissions inventories estimation.

In 2017, the two Ports finalized another update of the CAAP (CAAP 2017 Update[25]) to address new challenges, which not only require further reductions in traditional criteria pollutants, but reductions in GHGs to meet state and local requirements as described under AB 32, SB 32 and Los Angeles Sustainable City pLAn above. The CAAP 2017 Update incorporated a new emissions reduction target which requires a reduction in GHGs from Port-related sources as follows:

- 2030 - 40% reduction from 1990 baseline and
- 2050 - 80% reduction from 1990 baseline.

The CAAP 2017 Update is aligned with the goals of the California Sustainable Freight Action Plan and contains 14 strategies to reduce emissions from sources in and around the Ports, a plan for zero-emissions infrastructure, encourages freight efficiency, and addresses energy resources. The two major strategies outlined in the plan are:

- 2030 - transition to zero emission cargo handling equipment
- 2035 - transition to zero emissions drayage trucks

IMO Greenhouse Gases Initiatives

The IMO's Maritime Environmental Protection Committee (MEPC) has been working to develop a "coherent and comprehensive future IMO regulatory framework on GHG emissions from ships." At MEPC 58, 6-10 October 2008, the CO_2 design and operational indices were renamed to Energy Efficiency Design Index (EEDI) and the Energy Efficiency Operational Index (EEOI). On July 15, 2011, the IMO amended the MARPOL to include energy efficiency standards for new ships through the designation of an EEDI. The EEDI standards are expressed as percent emissions reductions from reference lines established for each ship class. Currently, the EEDI standards are applicable to range of ship types ranging from container ships to cruise passenger ships to bulk liquid tankers.

As of January 2020, the IMO global fuel sulfur standard was reduced from 3.5% to 0.5% which significantly reduces sulfur emissions globally. In ECAs, sulfur content was limited to 1.0% beginning in August 2012, and was further reduced to 0.1% sulfur on January 1, 2015. In March 2009, the United States and Canada jointly proposed to IMO's MEPC the designation of a North America ECA for specified portions of the United States and Canadian coastal waters. On March 26, 2010, the IMO officially designated waters within 200 miles of

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[24] San Pedro Bay Ports, *https://www.cleanairactionplan.org/*, accessed December 2021

[25] San Pedro Bay Ports, *https://www.cleanairactionplan.org/2017-clean-air-action-plan-update*, accessed December 2021

North American coasts as an ECA. The North American ECA joined ECAs already designated in the Baltic Sea and North Sea areas in Europe. Further, the US Caribbean Sea ECA entered into force on January 1, 2013 and became effective a year later on January 1, 2014.

In 2018, MEPC adopted resolution MEPC.304 (72)[26] on *Initial IMO Strategy on reduction of GHG emissions from ships*. The main goal of this resolution is to reduce GHG emissions from international shipping possibly by 100% by end of this century. The emission reduction targets are:

- Develop improved energy efficiency design index (EEDI) for new ships
- 2030 - 40% reduction in carbon intensity from 2008 baseline
- 2050 - 70% reduction in carbon intensity from 2008 baseline
- 2050 – 50% reduction in total annual GHG emissions compared to 2008

Between 2020 and through 2021, MEPC worked on the near-term GHG measures including a carbon intensity indicator (CII), existing ship energy efficiency index (EEXI), and improvements to and strengthening of the ship energy efficiency management plan (SEEMP). At MEPC 77, it was agreed that the Initial Strategy update would commence and this work will include mid- and long- term GHG measures, updating the ambition levels of the strategy, and update other required elements.

IAPH World Ports Climate Initiative and Worlds Port Sustainability Program

The principal objective of the IAPH is to develop and foster good relations and cooperation among ports and harbors worldwide by providing a forum to exchange opinions and share experiences on the latest trends of port management and operations. IAPH strives to emphasize and promote the fact that ports form a vital link in the water-side transportation of goods and play a vital role in today's global economy. IAPH is committed to the protection of environment, viewing it as an indispensable element of sustainable economic growth. Recognized as the only international organization representing the voice of the world port industry, IAPH is granted Consultative Status as a Non-Governmental Organization (NGO) from five United Nations (UN) specialized agencies and one intergovernmental body:

- UN Economic and Social Council (ECOSOC)
- International Maritime Organization (IMO)
- UN Conference on Trade and Development (UNCTAD)
- UN Environment Programme (UNEP)
- International Labour Organization (ILO)
- World Customs Organization (WCO)

In July 2008, 55 member ports (including the Port of Los Angeles) adopted the World Ports Climate Declaration, which calls for member and non-member ports to work together, through the forum provided by IAPH, to address climate change issues. This forum is called the World Ports Climate Initiative (WPCI) and was officially launched in November, 2008. One of the key components outline by WPCI is for ports to share their best practices and experiences with the world's ports and various concerned parties. One of the focuses of this

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[26] IMO, *https://www.imo.org/en/OurWork/Environment/Pages/GHG-Emissions.aspx*, accessed December 2021

initiative is carbon footprinting associated with Port-related sources (Scopes 1-3). This document provides a broader domain evaluation to help to continue to facilitate those discussions and provide context to the greater carbon footprint associated with international goods movement. In May 2017, IAPH established the World Ports Sustainability Program (WSPS)[27], which seeks to build upon the objectives of WPCI and also expand to other areas of sustainability.

One of the goals of WPCI, and now the WSPS, was the development of an Environmental Ship Index (ESI). ESI is a voluntary program to create a database of ships that identifies a ship's ability to operate at or below the current emissions standards of the IMO. A series of formulas which evaluate NO_x, SO_x, and CO_2 are used to calculate an ESI Score which is designed to measure a ship's environmental performance. ESI can be used by ports or others in the shipping industry to measure and promote emissions reductions. Starting on July 1, 2012, the Port launched a voluntary Environmental Ship Index Incentive Program which utilizes ESI to determine incentive amounts on a per call basis based on a ship's quarterly ESI score. The Port ESI Program is designed to incentivize ship operators to bring their cleanest ships when visiting the Port, and encourages the broader use of cleaner technology to reduce emissions. As of July 2020, under the ESI program 8,426 ships are registered along with 58 incentive providers, worldwide.

Currently, ESI is undergoing a review by the ESI Advisory Group, a group comprised of international port environmental representatives and industry experts. The ESI Advisory Group is reviewing and making the necessary modifications to ESI in order to keep the index up to date with regulatory and industry sector priorities. The reworked ESI, referred to as ESI 2.0, is anticipated to be presented to IAPH in 2022.

The Practice of Slow Steaming

Throughout 2020, OGV operators continued to implement the practice of slow steaming in an effort to reduce fuel use among rising bunker fuel costs, which account for a large proportion of their total operating expenses. This practice requires vessel operators to reduce their service speed in the range of 30% to 50%. The operators initially adopted these measures in response to severely depressed international trade conditions in the early 2000's. However in the face of a growing global environmental focus, they also recognized that slow steaming is perhaps the principal tool available to them to reduce their carbon footprint. The combinations of cost savings and environmental benefits have compelled the OGV operators to re-design their deployment strategies to accommodate slow steaming.

Data collected during the *Third IMO Greenhouse Gas Study 2014*[28] and again for the *Fourth IMO Greenhouse Gas Study 2020*[29] showed that vessels routinely practice slow steaming while transiting. Based on data presented in the latest IMO study, it was estimated that the majority of ships calling the Port in 2020 practiced slow steaming and reduced speeds were applied accordingly.

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[27] WSPS, *https://sustainableworldports.org/about/*, accessed December 2021

[28] IMO, *Third IMO Greenhouse Gas Study 2014,* 2015

[29] IMO, *Fourth IMO Greenhouse Gas Study 2020*, 2021

Since 2014, a vessel speed reduction (VSR) program has been implemented in the Santa Barbara Channel, an area that experiences a high level of port-related ship traffic. The Protecting Blue Whales and Blue Skies VSR program requests that auto carriers and container ships reduce speed to 10 knots or less while transiting the area between mid-May and mid-November each year. The 2020 VSR Program season attracted a record 495 participating vessels belonging to 16 different shipping companies[30], most of which also visited the Port. One of the criteria of the Protecting Blue Whales and Blue Skies VSR program is that participating vessels must also participate in the VSR Programs administered by the San Pedro Bay Ports. The Ports' long established and highly successful VSR Program asks vessels to slow down when they are within 40 nautical miles of the Ports, an areas that is included in the annual emissions inventory geographic domain.

1.7 GHG Scopes

The 2020 Port-wide GHG emissions are categorized based on the GHG emission scopes as defined under the International Council for Local Environmental Initiatives (ICLEI) Local Government Operations Protocol,[31] as illustrated in Figure 1.2. Scope 1 includes all direct GHG emissions from the Port's municipally-controlled stationary and mobile sources. Examples of Scope 1 sources include Port-owned fleet vehicles, stationary generators, and buildings (i.e., natural gas combustion). Scope 2 consists of indirect GHG emissions associated with the import and consumption of purchased electricity by the Port for its municipally-controlled sources (i.e., electricity used in Port-owned buildings and operations).

Scope 3 emissions include Port tenants' direct emissions from stationary sources (i.e., natural gas combustion in buildings), mobile sources (i.e., ships, trucks, rail, cargo handling equipment, and harbor craft), and indirect source emissions associated with purchased electricity (i.e., buildings, electric wharf cranes, etc.). Scope 3 primarily accounts for emissions associated with the operation of Port tenants. Port employee vehicles are also considered under Scope 3. Scope 3 emissions are significantly higher than Scope 1 and 2 emissions. In fact, within a regional context, Scope 3 emissions are greater than 99 percent of total municipally-related GHG emissions. As geographical extents are expanded, Scope 3 emissions can approach nearly 100 percent of the GHG emissions associated with goods movement through a port. Although inclusion of Scope 3 emissions in the Port's GHG inventory is not mandatory under the Local Government Operations Protocol, the expanded inventory will provide an opportunity for overall understanding, quantification, and context of GHG emissions associated with goods movement operations. In addition, since the Port has the most comprehensive data sets associated with Port tenant operations, it presents the Port with the opportunity to make higher resolution estimates of its related Scope 3 emissions.

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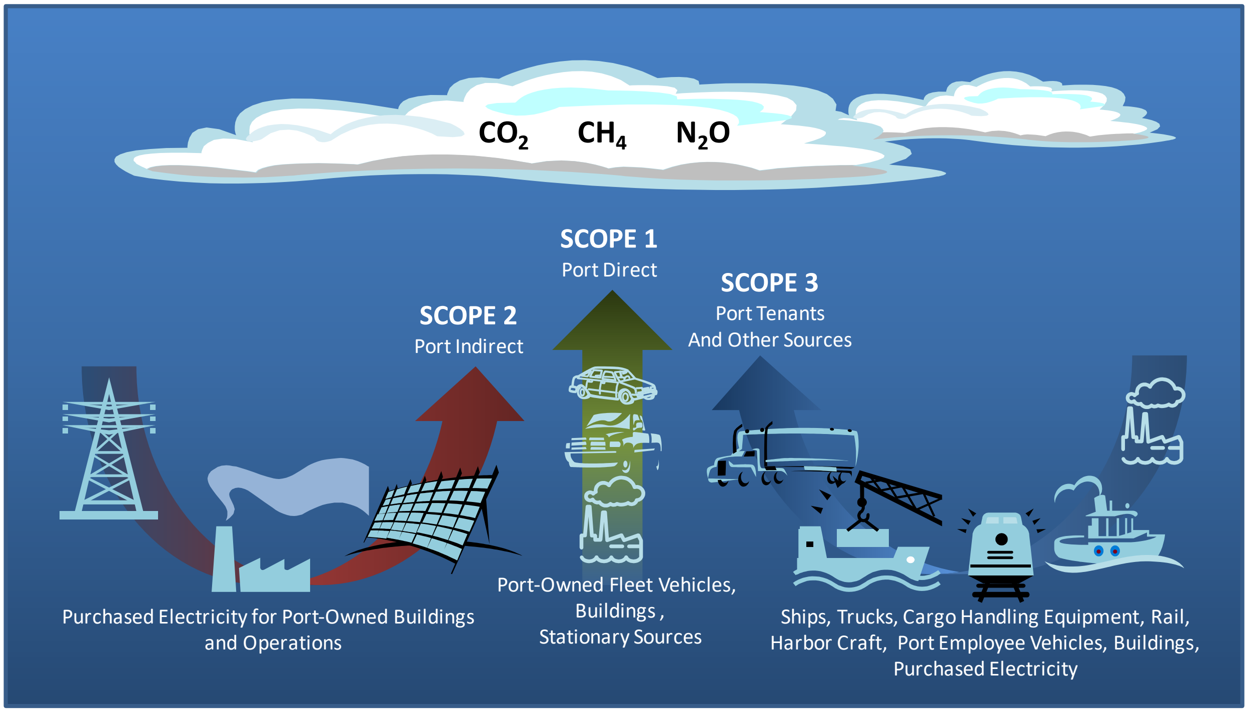
[30] Protection Blue Whales and Blue Skies, *https://www.bluewahlesblueskies.ord/2020results* , accessed November 2021

[31] Local Government Operations Protocol for the quantification and reporting of greenhouse gas emissions inventories, Version 1.0, CARB, September 25, 2008, *https://www.arb.ca.gov/cc/protocols/localgov/pubs/final_lgo_protocol_2008-09-25.pdf*

Figure 1.2: 2020 Port-wide GHG Emission Scopes



It should be noted that emissions associated with the cooling units on refrigerated (reefer) containers have not been estimated. These cooling units, which are used to keep the container contents at required temperatures, are powered by small, intermittently operating, diesel generators. Emissions have not been estimated for these units because data is currently limited to the amount of time the cooling units are actually operated, and because reefers represent a small portion of total containerized throughput, their emissions are anticipated to be significantly less than overall OGVs, trucks, and rail emissions.

1.8 Existing Port Inventories

The Port has developed two inventories covering all three emission source Scopes. Tenants' non-road mobile operational emissions have been quantified starting with calendar year 2001 then annually since 2005, focusing on Scope 3 mobile emissions sources. Also, starting in 2006, the Port started to quantify Scope 1 and 2 emissions (excluding Port tenant's emissions) as part of its joining the California Climate Action Registry (CCAR).

Scope 3 - Annual Tenant Mobile Operations Inventories

The Port began developing inventories for calendar year 2001, with annual updates beginning with the 2005 inventory. The Port completed the 2020 emissions inventory this year. These inventories maximize the use of real and local data to minimize activity assumptions. They involve intensive data collection efforts that include support from the Port tenants, the Southern California Marine Exchange, and numerous other sources. The inventories are coordinated with and reviewed by CARB, SCAQMD, and USEPA to ensure estimating methods are consistent with the latest acceptable practices. Through this process, the Port, the tenants, and the regulatory agencies are better informed on the activities and emissions associated with goods movement.

These annual inventories focus on Scope 3 emission categories including:

- Ocean-Going Vessels (OGVs)
- Harbor Craft (HC)
- Cargo Handling Equipment (CHE)
- Heavy-Duty Vehicles (HDVs)
- Rail Locomotives (RL)

The geographical domain for these source categories is regional and described fully in Section 1.9.

In 2001 and 2005, emission estimates were focused on diesel particulate matter (DPM), particulate matter less than 2.5 and 10 microns (PM2.5 & PM10), oxides of nitrogen (NO_x), oxides of sulfur (SO_x), carbon monoxide (CO), and hydrocarbons. Starting with the 2006 inventories, greenhouse gases were included into the suite of pollutants evaluated due to the rising interest in climate change. The greenhouse gases included are carbon dioxide (CO_2), methane (CH_4), and nitrogen dioxide (N_2O), which are standardized into CO_2 equivalents (CO_2e) and are presented as metric tons, or tonnes.

Because each GHG differs in its effect on the atmosphere, estimates CO_2e weights each gas by its global warming potential (GWP) value. To normalize the GHG pollutants into a common value, GHG emissions estimates are multiplied by the following GWP values[32] and summed:

- CO_2 – 1
- CH_4 – 25
- N_2O – 298

Please note that there may be minor inconsistencies, due to rounding associated with emission estimates, percent distribution, and other calculated numbers between various sections, tables, and figures of this report. All estimates are calculated using more significant figures than presented in various sections.

Scopes 1 & 2 – California Climate Action Registry Inventory

The Port joined the CCAR in 2006 and transitioned to The Climate Registry (TCR) in 2010 as part of that commitment the Port submits annual inventories that cover Scope 1 and 2 emissions. The 2020 TCR inventories include the following emission sources:

- Scope 1: The Port's municipal stationary sources (buildings, stationary generators) and municipal mobile sources (on-road and non-road fleet vehicles)
- Scope 2: The Port's municipal electricity imports

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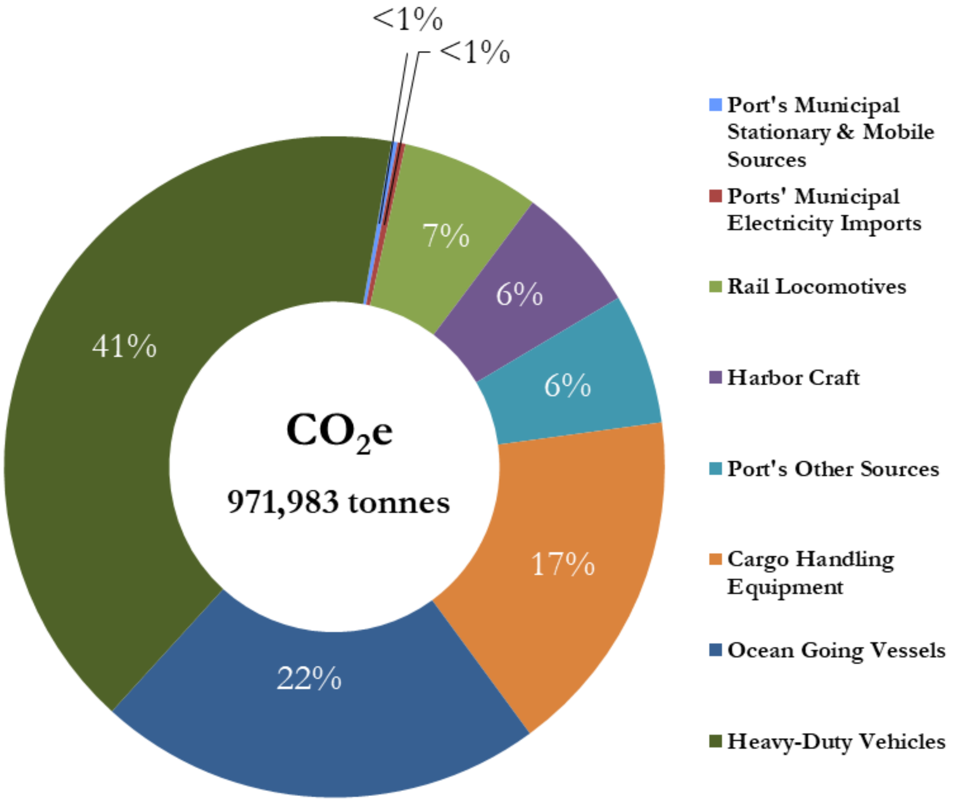
[32] U.S. EPA, *Inventory of U.S Greenhouse Gas Emissions and Sinks: 1990-2014*, April 2016.

The Port's scope 1 and scope 2 emissions have been estimated annually since 2006, and previously submitted to the CCAR and currently submitted to TCR for public posting. The geographical extent is limited to the Port's municipally-controlled property.

In addition to these two 2020 inventories, in order to have a more complete picture of Port-wide emissions, the Port has also prepared GHG emissions estimates of additional Port-related sources including Port tenants indirect source emissions (i.e., purchased electricity for buildings, electric wharf cranes, shore power for ships, etc.) and direct stationary source emissions (i.e., natural gas combustion in buildings) as well as Port employee vehicles (i.e., vehicles operated by employees of the Harbor Department) under Scope 3. These additional GHG emission sources are referenced as the Port's Other Sources.

For 2020, the following figure presents contribution by source category for the entire regional (i.e., within the SoCAB, see Section 1.9 below) Port-related emissions.

Figure 1.3: 2020 Port Regional CO_2e Contributions by Source Category



As shown in Figure 1.3 above, tenant mobile, stationary, and indirect sources make up over 99 percent of the total Port-related regional GHG emission generation.

1.9 Geographical Extents

As part of the implementation of AB 32, CARB has set the "In-State" GHG emission domain to include all operations within state borders as well as maritime operations occurring within 24 nautical miles (nm) of the California coastline. Scope 3 emissions that occur outside of these boundaries are classified as "Out-of-State." There are two different geographical scales that are represented by the existing inventories and the expanded GHG inventory. They are further detailed below.

Existing Inventories - Regional

The annual tenant operations inventories include source category emissions that occur on Port-owned land within the Port boundary/district, and within the SoCAB which is considered a regional domain. The geographical extent within this region varies by source type.

1.9.1 Ocean-Going Vessels & Harbor Craft

The geographical extent for OGVs and commercial harbor craft extend beyond the Port's immediate harbor. The portion of the study area outside the Port's breakwater is four-sided, with the northern and southern boundaries defined by the SoCAB county lines. The area continues approximately 70 nm to the California water boundary to the west, and is on average 70 nm in width.

Figure 1.4 presents the geographical extent of the over-water SoCAB boundary area for marine vessels (dark blue box extending from the coast past San Clemente Island), the CARB 24 nm "In-State" line running along the entire California coast (dark red), and the major routes into and out of the Port.

Figure 1.4: Maritime Sources Geographical Extent

It is important to note that the SoCAB inventory domain for marine vessels is primarily within the CARB "In-State" domain.

1.9.2 Heavy-Duty Vehicles & Rail Locomotives

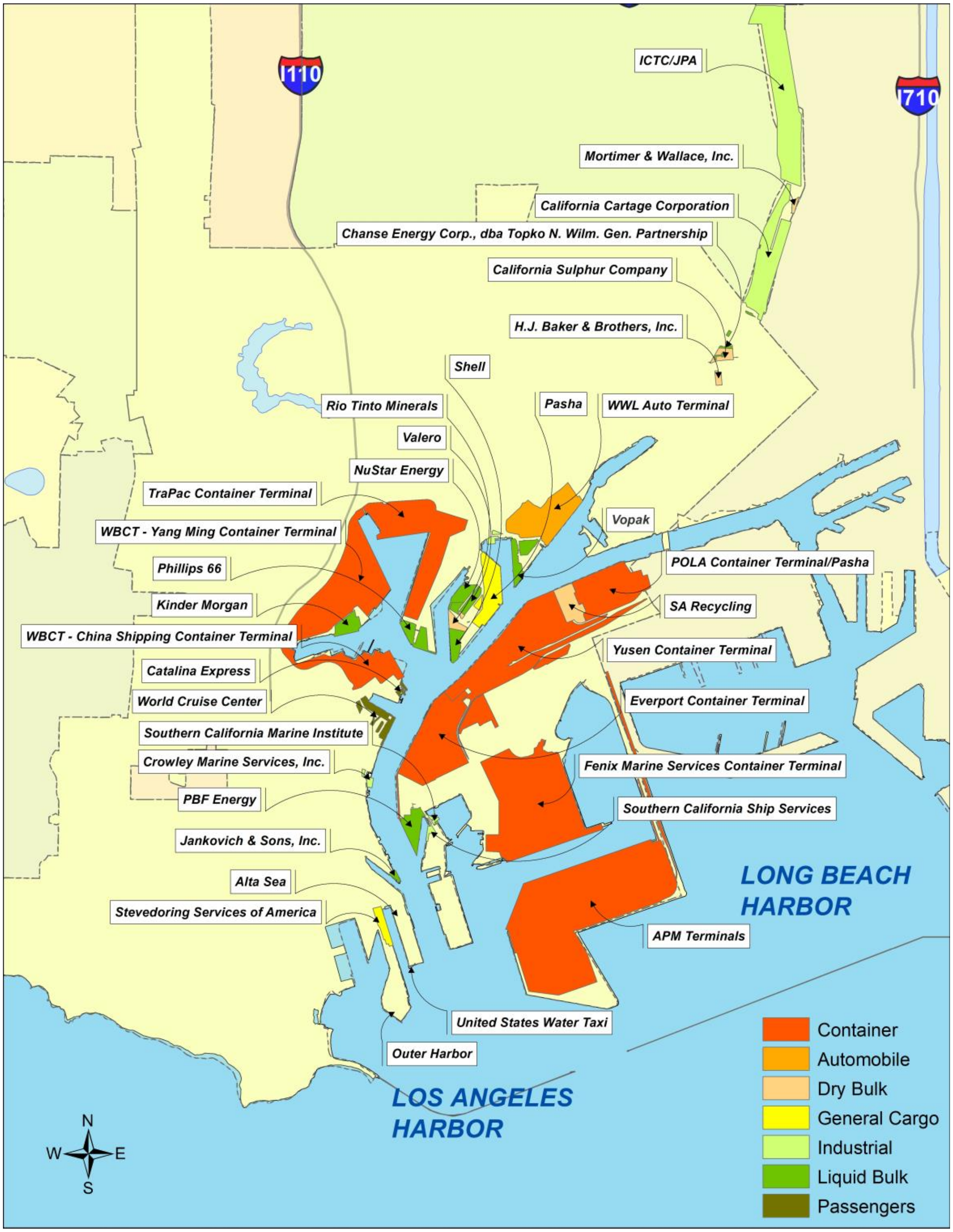
The geographical extent for HDVs or trucks and Class 1 line-haul rail locomotives extends beyond the immediate Port area and includes the entire SoCAB. Truck and rail emissions are estimated on Port terminals, rail lines, rail yards, public roadways, and public highways within the geographical extent of the annual inventories. Figure 1.5 presents the SoCAB or regional boundary of the existing inventories in orange and the location of the Port within the domain. The SoCAB includes all of Los Angeles and Orange Counties, and a portion of Riverside and San Bernardino Counties.

Figure 1.5: South Coast Air Basin Regional Boundary

1.9.3 Cargo Handling Equipment

The geographical extent for CHE is limited locally to the terminals and facilities on which they operate (CHE typically do not leave the terminals and are not registered to drive on public roads). The entire domain of CHE is covered in the annual tenant inventories. Figure 1.6 presents the land area of active Port terminals in 2020.

Figure 1.6: Port Boundary Study Area



Expanded GHG Inventory – Global & National

For the expanded GHG inventory domain, those sources that continue operations outside the existing regional inventory domain were quantified on a global and/or national level. These included OGVs, HDVs, and line-haul locomotives. The geographical extent for these three source categories are detailed below.

1.9.4 Ocean-Going Vessels

OGV GHG emissions are estimated using vessel-specific call information obtained during data collection for the 2020 annual emissions inventory. This data includes the ports that the vessels traveled from and the next port of call and, therefore, the domain is global. The 2020 OGV domain is global as presented in Figure 1.7 below.

Figure 1.7: 2020 Expanded GHG Inventory OGV Domain

1.9.5 On-Road Heavy-Duty Vehicles

Truck transport can typically be cost competitive with rail service up to approximately 600 miles. For the expanded GHG inventory, the geographical domain consists of the major routes beyond the SoCAB that have been identified through a transportation study completed for the two Ports. Figure 1.8 presents the SoCAB boundaries, the major highway routes beyond the SoCAB, and the 600 mile radius arc. It should be noted that it is assumed that population centers in California north of Fresno are most likely served by the Port of Oakland and, therefore, routes from the Port in this direction will be limited to the distance between Los Angeles and Fresno.

Figure 1.8: On-Road Heavy-Duty Major Routes from SoCAB Boundary to 600 Miles

1.9.6 Railroad Locomotives

The Class 1 railroad companies that serve the Port of Los Angeles are BNSF and UP. These two railroads principally serve the western part of the United States, primarily west of Chicago, St. Louis, and Houston. The major routes outside the SoCAB have been identified through previous interviews with the Class 1 railroads and through materials published on their websites. The expanded geographic area encompassing the rail routes to major cities at distances greater than 600 miles is presented in Figure 1.9.

Figure 1.9: Main Railways Traveled by BNSF and UP from the Port of Los Angeles

Methodology Background

GHG emissions were estimated utilizing the methodology used to produce the 2020 Inventory of Air Emissions[33] released October 2021 by the Port of Los Angeles. The methodologies used to estimate emissions in the 2020 report have been reviewed and approved by CARB, SCAQMD, and USEPA. Staff from these agencies and the two San Pedro Bay Ports makes up a standing Technical Working Group that reviews and ensures that all EIs produced by the Ports are consistent with the latest agency-approved methods and data. Further details and enhancements that were made for the expanded GHG inventory are provided for each source category in the following sections.

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[33] POLA, *https://www.kentico.portoflosangeles.ord/getmedia/7cb78c76-3c7b-4b8f-8040-b662f4a992b1/2020_Air_Emissions_Inventory,* accessed November 2021

SECTION 2 OCEAN-GOING VESSELS

This section details the 2020 OGV activity, methodology used to estimate emissions, the resulting emission estimates, and provides facts and findings from the study.

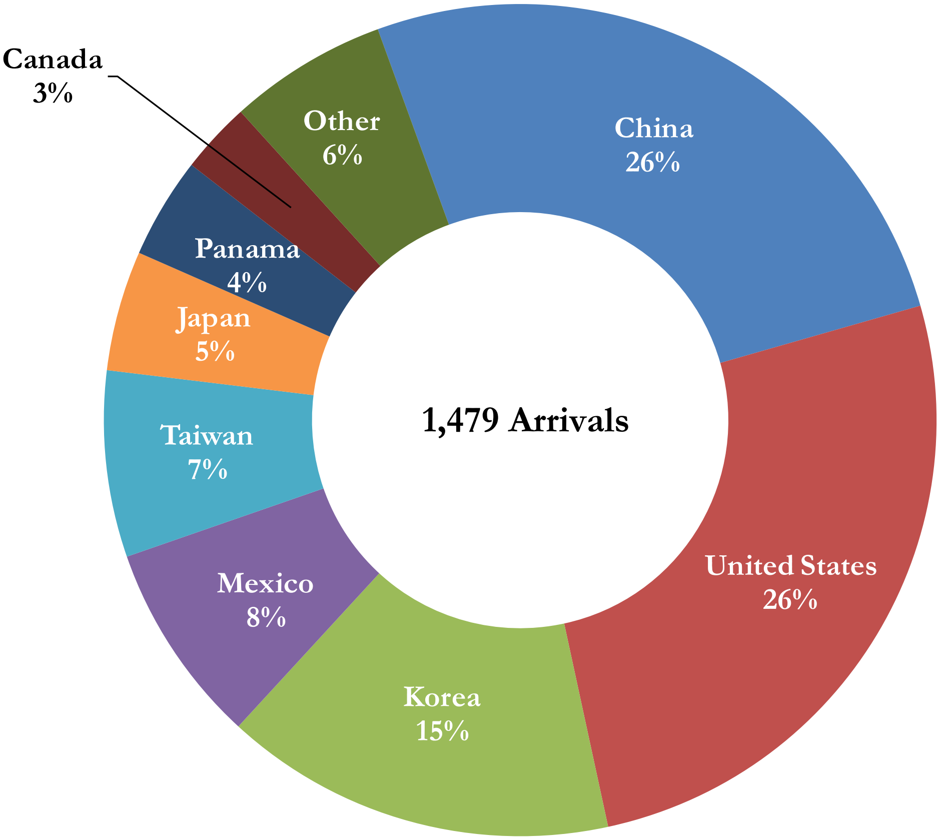
2.1 Activity

Annual Marine Exchange data detailing OGV calls was utilized to determine previous port of call for import cargoes, and next port of call for export cargoes. The Marine Exchange tracks every ship that arrives and departs the Port. This high level of data resolution allows for emissions to be estimated on a vessel-by-vessel and call-by-call basis. This data includes where the ship last stopped prior to the Port and the next port destination for each ship call. The data set does not include a ship's entire voyage (only the previous and next port) and, therefore, the number of arrivals and departures from each port listed will not be the same. It should also be noted that OGV activity levels change each year so the mix of routes associated with the Port will change. The ranking of ports by in-bound calls and their distribution of countries of origin visiting the Port in 2020 are presented in Table 2.1 and Figure 2.1, respectively.

Table 2.1: 2020 Ranking of Ports of Origin by Frequency of Arrivals (In-Bound Activities)

Port	In-Bound Activities
Pusan, KOR	168
Yantian, CHN	155
Oakland, USA	104
Ningbo, CHN	84
San Francisco, USA	70
Xiamen, CHN	69
Shanghai, CHN	60
Manzanillo, MEX	54
Tokyo, JPN	49
Keelung, TWN	45
Taipei, TWN	45
Benicia, USA	41
Rodman, PAN	26
Martinez, USA	25
Ulsan, KOR	23
Balboa, PAN	21
Puerto Vallarta, MEX	21
San Diego, USA	20
Ensenada, MEX	19
Tacoma, USA	19
Cai Mep, VNM	18
Honolulu, USA	17
Kaohsiung, TWN	17
Port Hueneme, USA	17
Vancouver, CAN	17
Yeosu, KOR	16
Prince Rupert, CAN	14
Richmond, USA	14
Valparaiso, CHL	12
Others	219
Total	**1,479**

Figure 2.1: 2020 Distribution of Arrivals by Country of Origin

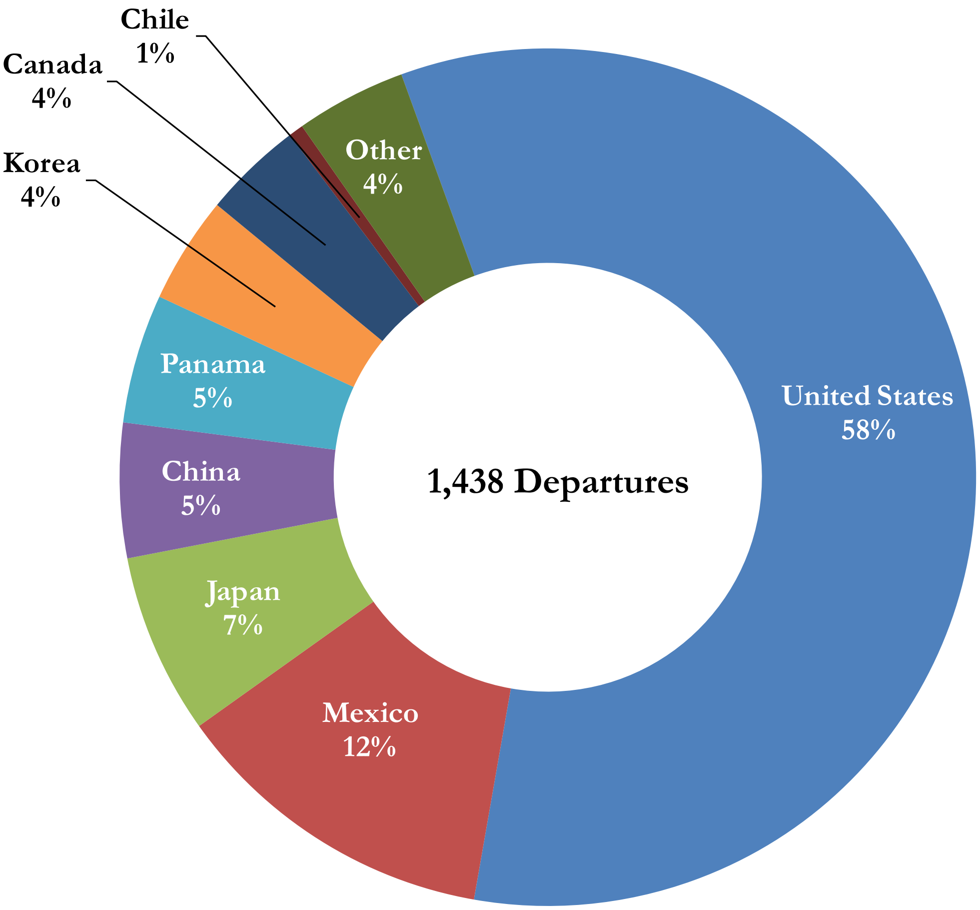


The ranking of destination ports by out-bound call frequencies and distribution of destination countries from the Port in 2020 are presented in Table 2.2 and Figure 2.2, respectively.

Table 2.2: 2020 Ranking of Destination Ports by Frequency of Departures (Out-Bound Activities)

Port	Out-Bound Activities
Oakland, USA	512
San Francisco, USA	81
Yokohama, JPN	73
Honolulu, USA	60
Manzanillo, MEX	46
Balboa, PAN	45
Mazatlan, MEX	44
Vancouver, CAN	43
Pusan, KOR	36
Lazaro Cardenas, MEX	30
Ensenada, MEX	27
Tacoma, USA	22
Rodman, PAN	21
Dutch Harbor, USA	19
Shanghai, CHN	18
Cabo San Lucas, MEX	17
Yantian, CHN	17
Benicia, USA	16
Seattle, USA	15
Richmond, USA	14
Cherry Point, USA	13
Martinez, USA	13
Houston, USA	12
Ningbo, CHN	11
San Diego, USA	11
Ulsan, KOR	9
Yeosu, KOR	8
Chiwan, CHN	7
Portland, USA	7
Others	191
Total	**1,438**

Figure 2.2: 2020 Distribution of Departures by Destination Country



For each route identified for 2020, the distances for each link within a route were developed using Geographical Information System (GIS) and the great circle route method. In keeping with methodology used in the previous expanded GHG inventories, routes were adjusted to ensure that they did not cross over land and used the junction points published in *Distance Between Ports*[34] as guidance. To check for consistency, total route distances were compared to distances published in *Distance Between Ports* as well as online route calculators.

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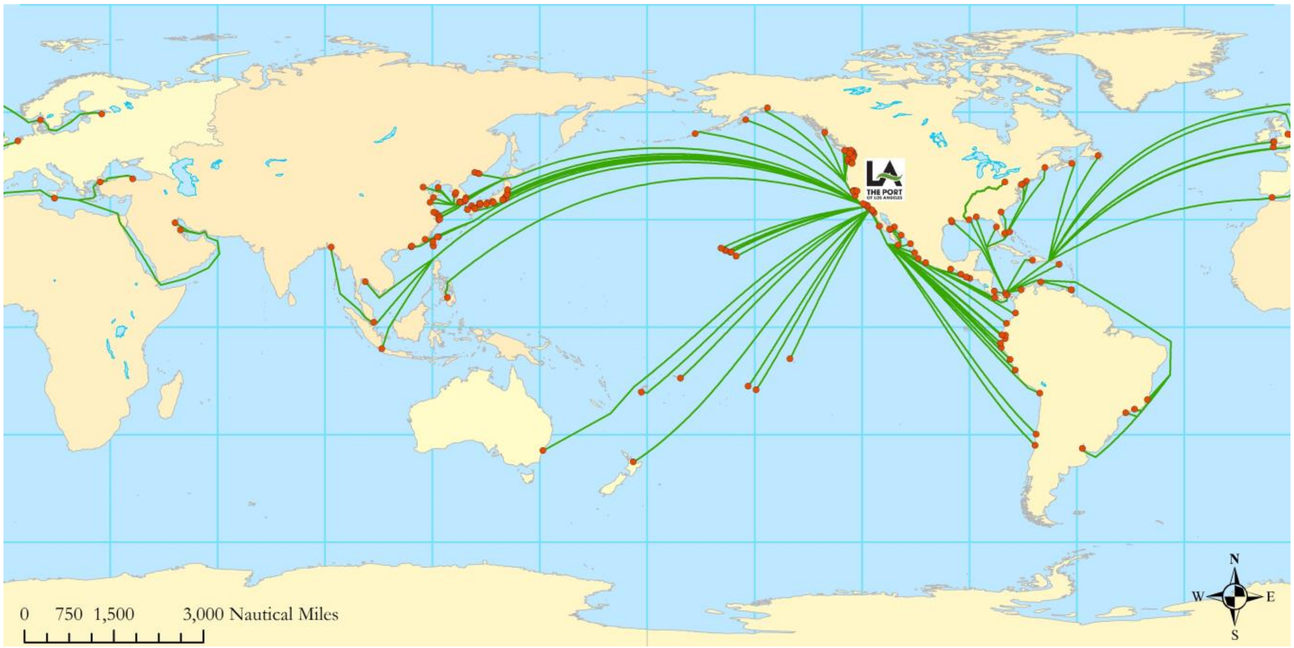
[34] National Imagery and Mapping Agency, *Publication 151 - Distance Between Ports*, 2001

Figure 2.3 illustrates the routes OGVs traveled to and from the Port in 2020. It is important to note that voyage routes may change for each voyage depending on weather, schedule, and many other factors. In 2020, voyages were also impacted by the COVID-19 pandemic and disruptions to the global supply chain due to mandated shut-downs followed by a surge in demand leading to world-wide port congestion. On March 13, 2020, the cruise industry voluntarily suspended cruise ship operations due to the COVID-19 pandemic for the remainder of 2020.

Figure 2.3: 2020 OGV Routes To and From the Port



A wide variety of ship types made up the calls in 2020. This is important because each ship type has its own unique characteristics that impact emissions. OGVs calling only at the Port of Long Beach (POLB) or bypassing the Port without physically stopping at a Port dock have not been included. In addition, vessel voyages that occurred entirely within the boundary of the Port's annual emissions inventory were excluded from this study. Ocean-going vessels are categorized into the following main vessel types:

- Auto carrier
- Bulk carrier
- Container ship
- Passenger cruise vessel
- General cargo
- Ocean-going tugboat (ITB/ATB)
- Miscellaneous vessel (MISC)
- Refrigerated vessel (Reefer)
- Roll-on roll-off vessel (RoRo)
- Tanker

Based on the 2020 Marine Exchange data, there were 1,478 arrivals (in-bound), 1,437 departures (out-bound), for a total of 2,915 distinct OGV activities crossing into or leaving the SoCAB domain. It should be noted that some routes included in the 2020 emissions inventory are contained completely within the SoCAB boundary (Catalina, El Segundo, etc.) and, therefore, are not counted as part of the expanded GHG inventory. Therefore, study excluded routes from 55 calls that were included in the 2020 emissions inventory. Port OGV traffic is dominated by containerships, which made up approximately 65 percent of all arrivals and departures. A full breakout of vessel arrivals and departures to the SoCAB domain is presented in Table 2.3 below.

Table 2.3: Total OGV Movements for 2020

Vessel Type	Arrivals (In-Bound)	Departures (Out-Bound)
Auto Carrier	74	73
Bulk	62	65
Container - 1000	2	3
Container - 2000	144	145
Container - 3000	14	13
Container - 4000	117	113
Container - 5000	61	59
Container - 6000	109	105
Container - 7000	38	38
Container - 8000	227	217
Container - 9000	98	91
Container - 10000	41	34
Container - 11000	18	17
Container - 12000	5	5
Container - 13000	56	57
Container - 14000	18	16
Container - 15000	9	9
Container - 16000	4	3
Container - 17000	1	1
Container - 19000	2	2
Container - 23000	4	2
Cruise	64	49
General Cargo	28	23
ITB	98	100
MISC	3	4
Reefer	16	16
RoRo	5	5
Tanker - Chemical	132	139
Tanker - Handysize	11	14
Tanker - Panamax	18	20
Total	**1,479**	**1,438**

It should be noted that container ships and tankers are subdivided by capacity to provide better resolution on these vessel types. The 2020 number of vessel arrivals and departures include only those activities occurring between January 1 and December 31, 2020. Therefore, the number of arrivals may not match the number of departures. For example, if a vessel arrived on December 31st of 2019 and departed the Port on January 2nd of 2020, only its departure would be included in the tally above. Likewise, if a vessel arrived at the Port on December 31st of 2020 and departed on January 2nd of 2021, only its arrival would be included in the tally above.

2.2 Operational Profiles

Auxiliary engines provide the electricity for equipment used in the operation of ocean-going vessels. Actual Vessel Boarding Program (VBP) data, if available, were used to estimate emissions from auxiliary engines. If actual VBP data were not available, default loads were used. The default loads were consistent with the Port's annual emissions inventory, and were calculated as a call-weighted average of all VBP data points collected from 2005-2020 for each vessel type. Table 2.4 presents the auxiliary engine loads by vessel type except for cruise ships. Cruise ship auxiliary load defaults are listed in Table 2.5.

Table 2.4: 2020 Average Auxiliary Engine Transit Load Defaults by Vessel Type, kW

Vessel Type	Transit
Auto Carrier	527
Bulk	222
Container - 1000	913
Container - 2000	1,287
Container - 3000	920
Container - 4000	1,419
Container - 5000	1,594
Container - 6000	1,558
Container - 7000	1,580
Container - 8000	1,635
Container - 9000	1,634
Container - 10000	1,634
Container - 11000	1,661
Container - 12000	2,048
Container - 13000	1,589
Container - 14000	1,553
Container - 15000	1,850
Container - 16000	1,793
Container - 17000	1,735
Container - 19000	1,950
Container - 23000	2,048
General Cargo	489
ITB	79
MISC	284
Reefer	1,416
RoRo	434
Tanker - Chemical	498
Tanker - Handysize	659
Tanker - Panamax	480

Table 2.5 lists the auxiliary engine defaults for all cruise ships (diesel electric and non-diesel electric). These auxiliary engine defaults were produced by calculating the call-weighted average of all VBP data collected from 2005-2020 for each cruise vessel size group. Cruise ships are classified by passenger capacity range.

Table 2.5: Cruise Ship Average Auxiliary Engine Load Defaults, kW

Passenger Range	Transit
<1,500	3,994
1,500<2,000	7,000
2,000<2,500	11,000
2,500<3,000	9,781
3,000<3,500	8,292
3,500<4,000	9,945
4,000<4,500	12,500
4,500<5,000	13,000

On March 13, 2020, the cruise industry voluntarily suspended cruise ship operations due to the COVID-19 pandemic. This action came just one day before the U.S. Department of Health and Human Service Centers for Disease Control and Prevention (CDC) officially issues a no-sail order on March 14, 2020. Under the no-sail order, cruise ship operations were required to suspend passenger operations. This resulted in a significantly reduced auxiliary engine load requirement due to the reduction in onboard hotel services. Even without passengers on board, transitory cruise vessels were active in the study area during this time. Additionally, cruise ships were participating in activities required by the CDC to develop plans to prevent, mitigate, and respond to the spread of COVID-19 and later, as part of the CDC's Conditional Sailing Order framework, were preparing for the eventual return to passenger operations.

Many cruise lines provided information on vessel operations and auxiliary loads during this time as part of the Port's annual emissions inventory data collection process. The loads provided by cruise lines were used to calculate emissions from March 13- December 31, 2020. Where information was not available directly from the cruise lines, the existing methodology was followed to calculate emissions with a reduction applied for reduced operation loads due to no passengers on board. This reduction was determined to be an average of 27% in kW energy use[35].

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[35] POLA, *https://www.kentico.portoflosangeles.ord/getmedia/7cb78c76-3c7b-4b8f-8040-b662f4a992b1/2020_Air_Emissions_Inventory, pp 16,* accessed November 2021

Auxiliary boiler energy defaults in kilowatts used for each vessel type, except for cruise ships, are presented in Table 2.6. Cruise ship auxiliary boiler default loads are presented in Table 2.7 for diesel electric and non-diesel electric cruise ships. The default load for non-diesel electric cruise ships does not vary by passenger range. There were two non-diesel electric cruise ships that visited the Port in 2020, while the rest were diesel electric.

Table 2.6: Auxiliary Boiler Load Defaults, kW

Vessel Type	Transit
Auto Carrier	82
Bulk	63
Container - 1000	90
Container - 2000	188
Container - 3000	203
Container - 4000	180
Container - 5000	266
Container - 6000	248
Container - 7000	345
Container - 8000	210
Container - 9000	448
Container - 10000	368
Container - 11000	241
Container - 12000	349
Container - 13000	241
Container - 14000	266
Container - 15000	259
Container - 16000	206
Container - 17000	152
Container - 19000	355
Container - 23000	373
General Cargo	77
ITB	0
MISC	54
Reefer	89
RoRo	67
Tanker - Chemical	90
Tanker - Handysize	143
Tanker - Panamax	223

Table 2.7: Cruise Ship Average Auxiliary Boiler Load Defaults, kW

Passenger Range	Transit
<1,500	992
1,500<2,000	1,070
2,000<2,500	1,382
2,500<3,000	596
3,000<3,500	697
3,500<4,000	401
4,000<4,500	0
4,500<5,000	0
Non-diesel electric	282

2.3 Methodology

GHG emissions were estimated using the same methodology used in the Port's 2020 Inventory of Air Emissions which have been reviewed by the Technical Working Group. The methods used for this study are described in Section 2 of the San Pedro Bay Ports Emissions Inventory Methodology Report Version 2[36]. The following improvements for methodology and activity were made since the last expanded GHG inventory:

- Vessel transit speeds were updated based on observed vessel speed averages in the Fourth IMO GHG Study[37].
- Vessel routing was updated to account for foreign ports visited in 2020.
- Emission factors were updated to be consistent with CARB and USEPA's latest methodology.
- The IMO monitors the sulfur content of fuel oil used by ships globally, and the residual fuel oil average sulfur content was determined to be 2.6% in 2018[38], which was used in the 2020 emission estimates. For this inventory, it was assumed that all vessels used HFO 2.6% sulfur fuel when transiting at-sea outside of an Emission Control Area (ECA).
- Updated call-weighted averages of VBP data collected by mode from 2005 to 2020 for auxiliary engine and auxiliary boiler default loads.
- Cruise ship auxiliary engine and boiler loads took into consideration the 2020 COVID-19 pandemic period which resulted in the cruise ship industry suspending operations from March 13, 2020 through the end of the year.

The transit speeds adapted from the IMO Fourth GHG study were applied in this inventory and are shown in Table 2.8 and continued in Table 2.9, as assigned by vessel type and size class.

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[36] San Pedro Bay Ports Emissions Inventory Methodology Report, Version 2, *https://www.polb.com/environment/air/#emissions-inventory,* accessed December 2021

[37] IMO, "MEPC 75-7-15 Fourth IMO GHG Study 2020", 2021, pp 121-123

[38] IMO MEPC 74/5/3, 8 Feb 2019

Table 2.8: Average Transit Speeds, knots

Ship type	Size Range	Units	Speed (knots)
Auto Carrier	0-29,999	GT	13.6
	30,000-49,999	GT	14.7
	50,000+	GT	15.5
Bulk	0-9,999	dwt	9.3
	10,000-34,999	dwt	11.0
	35,000-59,999	dwt	11.4
	60,000-99,999	dwt	11.4
	100,000-199,999	dwt	11.2
	200,000+	dwt	11.8
Container	0-999	TEU	11.8
	1,000-1,999	TEU	13.4
	2,000-2,999	TEU	14.2
	3,000-4,999	TEU	14.7
	5,000-7,999	TEU	15.7
	8,000-11,999	TEU	16.3
	12,000-14,499	TEU	16.3
	14,500-19,999	TEU	16.5
	20,000+	TEU	16.3
Cruise	0-1,999	GT	8.1
	2,000-9,999	GT	9.2
	10,000-59,999	GT	13.4
	60,000-99,999	GT	15.3
	100,000-149,999	GT	16.0
	150,000+	GT	16.4
General Cargo	0-4,999	dwt	8.8
	5,000-9,999	dwt	9.8
	10,000-19,999	dwt	11.4
	20,000+	dwt	11.9
ITB	All	All	6.6
Reefer	0-1,999	dwt	9.1
	2,000-5,999	dwt	11.1
	6,000-9,999	dwt	13.6
	10,000+	dwt	16.3
RoRo	0-4,999	dwt	8.1
	5,000-9,999	dwt	14.2
	10,000-14,999	dwt	15.5
	15000+	dwt	15.2

Table 2.9: Average Transit Speeds, knots Continued.

Ship type	Size Range	Units	Speed (knots)
Chemical Tanker	0-4,999	dwt	9.6
	5,000-9,999	dwt	10.3
	10,000-19,999	dwt	11.4
	20,000-39,999	dwt	12.1
	40,000+	dwt	11.9
Oil Tanker	0-4,999	dwt	8.7
	5,000-9,999	dwt	9.1
	10,000-19,999	dwt	9.6
	20,000-59,999	dwt	11.7
	60,000-79,999	dwt	12.2
	80,000-119,999	dwt	11.6
	120,000-199,999	dwt	11.7
	200,000+	dwt	12.5

The updated emission factors are per USEPA's Ports Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions (September 2020)[39]. The North American Emissions Control Area (ECA) continued to be in effect in 2020. It was assumed that except for those vessels that participated in the Port's Environmental Ship Index (ESI) program, all vessels used 0.1% sulfur distillate fuel (MGO) while operating within an ECA. Table 2.6 lists the emission factors for propulsion engines using HFO 2.6 % and MGO 0.1% sulfur fuels. Auxiliary boilers use the emission factors listed for steamships in Table 2.10.

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[39] USEPA, *https://www.epa.gov/state-and-local-transportation/port-emissions-inventory-guidance*, accessed December 2021

Table 2.10: GHG Emission Factors for Diesel Propulsion, Steamship Propulsion and Gas Turbine Engines, g/kW-hr

Engine	IMO Tier	Model Year	CO_2	N_2O	CH_4
HFO 2.6% Sulfur					
Slow speed diesel	Tier 0	≤ 1999	607	0.031	0.012
Medium speed diesel	Tier 0	≤ 1999	670	0.031	0.010
Slow speed diesel	Tier 1	2000 – 2010	607	0.031	0.012
Medium speed diesel	Tier 1	2000 – 2010	670	0.031	0.010
Slow speed diesel	Tier 2	2011 – 2015	607	0.031	0.012
Medium speed diesel	Tier 2	2011 – 2015	670	0.031	0.010
Gas turbine	na	all	950	0.08	0.002
Steamship	na	all	950	0.08	0.002
MGO 0.1% Sulfur					
Slow speed diesel	Tier 0	≤ 1999	593	0.029	0.012
Medium speed diesel	Tier 0	≤ 1999	657	0.029	0.010
Slow speed diesel	Tier 1	2000 – 2010	593	0.029	0.012
Medium speed diesel	Tier 1	2000 – 2010	657	0.029	0.010
Slow speed diesel	Tier 2	2011 – 2015	593	0.029	0.012
Medium speed diesel	Tier 2	2011 – 2015	657	0.029	0.010
Gas turbine	na	all	962	0.075	0.002
Steamship	na	all	962	0.075	0.002

Table 2.11 lists the emission factors for auxiliary engines using HFO 2.6% and MGO 0.1% sulfur fuels.

Table 2.11: GHG Emission Factors for Auxiliary Engines, g/kW-hr

Engine	IMO Tier	Model Year	CO_2	N_2O	CH_4
HFO 2.6% Sulfur					
Medium speed auxiliary	Tier 0	≤ 1999	707	0.031	0.008
Medium speed auxiliary	Tier 1	2000 – 2010	707	0.031	0.008
Medium speed auxiliary	Tier 2	2011 – 2015	707	0.031	0.008
MGO 0.1% Sulfur					
Medium speed auxiliary	Tier 0	≤ 1999	696	0.029	0.008
Medium speed auxiliary	Tier 1	2000 – 2010	696	0.029	0.008
Medium speed auxiliary	Tier 2	2011 – 2015	696	0.029	0.008

Alternative Maritime Power Usage
Power generation associated with Alternative Maritime Power (AMP) for containerships, cruise and reefer vessels at-berth per CARB's Shore Power Regulation[40] are considered Scope 3 emissions, which were estimated based on the power consumption used by the program in 2020. There were 724 calls that utilized the AMP system which transferred a total of 51,098 megawatt-hours (MW-hrs) to grid-supplied vessel power instead of generating the same energy on-board with auxiliary engines. In addition, tenant operations include power consumption for the electric wharf cranes and building electrical needs.

To estimate the emissions associated with the grid-supplied power, the following emission factors[41] were used:

- CO_2 – 687.2 lbs/MW-hr
- CH_4 – 0.033lbs/MW-hr
- N_2O – 0.004 lbs/MW-hr

These are the same emission factors that were used to estimate Port's Harbor Department's 2020 GHG emissions for the Climate Registry. Grid power is supplied by the City of Los Angeles' Department of Water and Power (LADWP). Based on the latest information provided by the LADWP in 2019, LADWP's power supply profile included 34 percent of the power supply from renewal sources. Based on LADWP's 2017 Power Strategic Long-Term Resource Plan[42], it was assumed that 53 percent is emitted outside of the SoCAB and 47 percent is emitted in the SoCAB.

2.4 Emissions Estimates

The total expanded (outside SoCAB domain) OGV emissions by port route with the highest number of arrivals and departures are presented in Table 2.12. The top 29 routes with the highest number of Port calls are listed in the table and "Others" includes all other routes. As shown in the table, the total number of calls is not the dominant variable with regards to GHG emissions, but rather a combination of route length, type of ship, and number of calls.

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[40] CARB, *https://www.arb.ca.gov/ports/shorepower/shorepower.htm,* accessed December 2021

[41] TCR, *https://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/*, accessed December 2021

[42] LADWP*,https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-power/a-p-integratedresourceplanning/a-p-irp-documents?_adf.ctrl-state=10jlvyugj5_101&_afrLoop=1153024641101627*, Table 2.5, "accessed December 2021"

Table 2.12: 2020 Total Expanded OGV GHG Emissions by Total Number of Port Calls

Port	In-Bound & Out-Bound	CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
Oakland, USA	616	131,889	7.07	1.53	134,033
Pusan, KOR	204	666,435	36.12	9.22	677,428
Yantian, CHN	172	646,853	35.84	7.94	657,732
San Francisco, USA	151	6,572	0.33	0.09	6,671
Manzanillo, MEX	100	37,671	2.04	0.52	38,290
Ningbo, CHN	95	362,061	19.54	4.69	368,001
Shanghai, CHN	78	248,519	13.29	3.51	252,567
Honolulu, USA	77	87,430	5.62	0.71	89,122
Yokohama, JPN	74	195,302	10.41	2.80	198,475
Xiamen, CHN	70	304,622	16.51	3.78	309,635
Balboa, PAN	66	62,665	3.44	0.59	63,705
Vancouver, CAN	60	21,785	1.14	0.26	22,131
Benicia, USA	57	3,265	0.16	0.05	3,314
Tokyo, JPN	49	200,130	10.87	2.08	203,421
Rodman, PAN	47	80,547	4.70	0.65	81,964
Ensenada, MEX	46	2,166	0.10	0.03	2,198
Keelung, TWN	45	179,103	10.24	1.42	182,188
Mazatlan, MEX	45	12,880	0.75	0.13	13,107
Taipei, TWN	45	159,620	8.62	2.27	162,244
Tacoma, USA	41	19,224	0.97	0.30	19,521
Martinez, USA	38	1,282	0.06	0.03	1,301
Lazaro Cardenas, MEX	33	14,414	0.73	0.23	14,637
Ulsan, KOR	32	35,806	1.86	0.41	36,371
San Diego, USA	31	487	0.02	0.01	494
Cabo San Lucas, MEX	28	21,451	0.98	0.25	21,749
Richmond, USA	28	1,532	0.07	0.02	1,555
Puerto Vallarta, MEX	26	26,176	1.22	0.30	26,546
Yeosu, KOR	24	26,364	1.42	0.26	26,793
Cherry Point, USA	23	4,191	0.21	0.04	4,253
Others	516	704,390	37.47	8.56	715,770
Total	**2,917**	**4,264,833**	**231.77**	**52.65**	**4,335,217**

Total 2020 expanded OGV routes ranked by GHG emissions are presented in Table 2.13. The top 29 routes with the highest GHG emissions are listed while "Others" includes all other routes. The top nine routes with respect to CO_2e emissions are Asian routes, even though there are other routes that have more calls.

Table 2.13: 2020 Total Expanded OGV Routes Ranked by GHG Emissions

Port	**In-Bound & Out-Bound**	**CO_2** tonnes	**N_2O** tonnes	**CH_4** tonnes	**CO_2e** tonnes
Pusan, KOR	204	666,435	36.12	9.22	677,428
Yantian, CHN	172	646,853	35.84	7.94	657,732
Ningbo, CHN	95	362,061	19.54	4.69	368,001
Xiamen, CHN	70	304,622	16.51	3.78	309,635
Shanghai, CHN	78	248,519	13.29	3.51	252,567
Tokyo, JPN	49	200,130	10.87	2.08	203,421
Yokohama, JPN	74	195,302	10.41	2.80	198,475
Keelung, TWN	45	179,103	10.24	1.42	182,188
Taipei, TWN	45	159,620	8.62	2.27	162,244
Oakland, USA	616	131,889	7.07	1.53	134,033
Honolulu, USA	77	87,430	5.62	0.71	89,122
Cai Mep, VNM	18	87,522	4.93	0.98	89,016
Kaohsiung, TWN	22	85,130	4.49	1.30	86,501
Rodman, PAN	47	80,547	4.70	0.65	81,964
Balboa, PAN	66	62,665	3.44	0.59	63,705
Manzanillo, MEX	100	37,671	2.04	0.52	38,290
Ulsan, KOR	32	35,806	1.86	0.41	36,371
Fuqing, CHN	7	28,904	1.51	0.34	29,361
Yeosu, KOR	24	26,364	1.42	0.26	26,793
Puerto Vallarta, MEX	26	26,176	1.22	0.30	26,546
Dutch Harbor, USA	19	25,179	1.33	0.33	25,583
Valparaiso, CHL	18	22,743	1.12	0.42	23,086
Houston, USA	12	22,021	1.30	0.21	22,415
Vancouver, CAN	60	21,785	1.14	0.26	22,131
Cabo San Lucas, MEX	28	21,451	0.98	0.25	21,749
Cartagena, COL	11	19,755	1.14	0.16	20,100
Tacoma, USA	41	19,224	0.97	0.30	19,521
Chiwan, CHN	8	18,546	1.03	0.28	18,860
Qingdao, CHN	6	17,492	0.94	0.24	17,778
Others	847	423,888	22.11	4.91	430,600
	2,917	**4,264,833**	**231.77**	**52.65**	**4,335,217**

Tables 2.14 and 2.15 show emissions by emission source type and by vessel type category, respectively.

Table 2.14: 2020 Total Expanded OGV GHG Emissions by Emission Source Type

Emission Source	CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
Main Engine	3,635,144	202.82	45.85	3,696,731
Auxiliary Engine	592,212	25.82	6.72	600,075
Auxiliary Boiler	37,477	3.13	0.08	38,411
Total	**4,264,833**	**231.77**	**52.65**	**4,335,217**

Table 2.15: 2020 Total Expanded OGV GHG Emissions by Vessel Type Category

Vessel Type	CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
Auto Carrier	77,565	4.01	1.04	78,787
Bulk	80,436	4.25	0.85	81,724
Container - 1000	2,977	0.15	0.03	3,024
Container - 2000	121,510	7.70	1.12	123,831
Container - 3000	38,078	2.24	0.30	38,752
Container - 4000	306,951	17.56	3.48	312,271
Container - 5000	276,877	14.20	4.74	281,227
Container - 6000	431,457	23.49	5.81	438,604
Container - 7000	154,890	8.19	1.92	157,378
Container - 8000	1,076,404	58.76	12.54	1,094,229
Container - 9000	461,235	25.12	5.65	468,863
Container - 10000	136,544	7.94	1.17	138,940
Container - 11000	95,327	5.11	1.24	96,882
Container - 12000	38,388	2.03	0.24	39,001
Container - 13000	352,824	19.10	4.97	358,640
Container - 14000	81,836	4.24	1.51	83,136
Container - 15000	35,204	1.98	0.52	35,808
Container - 16000	26,876	1.59	0.34	27,357
Container - 17000	6,514	0.43	0.05	6,645
Container - 19000	19,671	1.15	0.14	20,017
Container - 23000	39,399	2.27	0.27	40,083
Cruise	105,453	4.88	1.23	106,938
General Cargo	39,456	1.95	0.57	40,053
ITB	7,124	0.32	0.14	7,222
MISC	196	0.01	0.00	199
Reefer	40,419	1.99	0.75	41,030
RoRo	3,971	0.20	0.02	4,031
Tanker - Chemical	156,261	8.16	1.52	158,731
Tanker - Handysize	14,642	0.75	0.18	14,870
Tanker - Panamax	36,348	1.97	0.30	36,943
Total	**4,264,833**	**231.77**	**52.65**	**4,335,217**

The total 2020 tenant operational energy consumption associated with electric wharf cranes, building electricity, AMP, and natural gas usage is considered Scope 3 GHG emissions. In addition, Port employee vehicles are also considered under Scope 3. Total emissions by domain are presented in Table 2.16.

Table 2.16: 2020 Port's Other Sources GHG Emissions by Domain

Scope	Domain	2020 Other Port-Related GHG Emissions			
		CO_2	N_2O	CH_4	CO_2e
		tonnes	tonnes	tonnes	tonnes
3	Expanded Inventory (SoCAB)	32,358	0.18	1.79	32,455
3	Expanded Inventory (Out-of-State)	29,573	0.17	1.42	29,660
Total		**61,931**	**0.35**	**3.21**	**62,115**

Note: The blue highlight represents emissions within the CARB "In-State" domain definition.

The total expanded and annual inventory Port-related OGV GHG emissions by domain are presented in Table 2.17.

Table 2.17: 2020 Total Port-Related OGV GHG Emissions by Domain

Scope	Domain	2020 Port-Related OGV GHG Emissions			
		CO_2	N_2O	CH_4	CO_2e
		tonnes	tonnes	tonnes	tonnes
3	Annual Inventory (Within 24 nm/Inside SoCAB)	208,486	12.40	2.30	212,248
3	Expanded Inventory (Within 24 nm/Outside SoCAB)	271,555	14.51	3.28	275,960
3	Annual Inventory (Outside 24 nm/Inside SoCAB)	0	0.00	0.00	0
3	Expanded Inventory (Outside 24 nm & SoCAB)	3,993,278	217.26	49.37	4,059,257
Total		**4,473,319**	**244.17**	**54.95**	**4,547,465**

Note: The blue highlight represents emissions within the CARB "In-State" domain definition.

2.5 Facts & Findings

Figure 2.4 illustrates the distribution of total Port-related OGV emissions between the SoCAB domain (extends beyond the 24 nm "In-State" line), in-state (within 24 nm of California Coast, outside the SoCAB boundary), and out-of-state (as presented in Figure 1.4). The total 2020 in-state Port-related (SoCAB within 24 nm plus in-state) OGV emissions were estimated at 488,145 metric tons CO_2e. These emissions are represented by the red and blue pie slices in the figure.

Figure 2.4: 2020 OGV Emissions Distribution by Domain

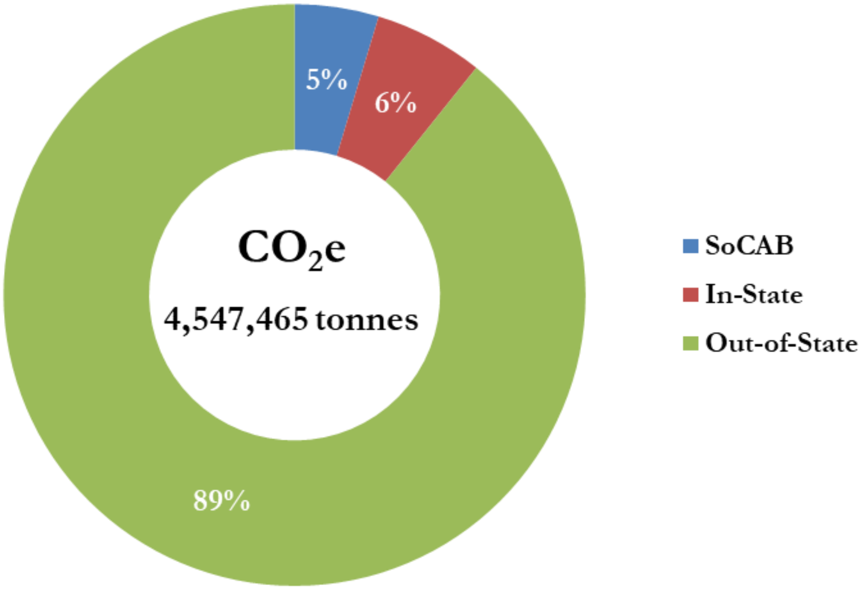

Table 2.18 shows the electricity usage during 2015 and 2020 by ships that utilized shore side power during hotelling at the Port. While CARB's Shore Power Regulation was in effect in both 2015 and 2020, there was a decrease in electricity usage in 2020 due to a decrease in cruise ship calls and reduced cruise ship hotelling loads during the COVID-19 pandemic.

Table 2.18: AMP Related Electricity Usage in MW-hrs

Calendar Year	MWhr
2015	60,252
2020	51,098

SECTION 3 HEAVY-DUTY VEHICLES

3.1 Activity

This evaluation includes three types of truck trips to and from the Port:

- Direct – Truck trips that start or end at a Port facility and travel is directly between the Port and the shipper (origin) or recipient (destination) of the goods.
- Rail Drayage – Truck trips that start or end at a Port facility and travel is between the Port and an off-dock rail yard. This includes trips between Port terminals and the ICTF operated by UP on Port property.
- Transloading – Truck trips that start at a Port facility and end at a warehouse or loading facility where freight is removed from its overseas shipping container and re-packaged for overland shipment to its destination for distribution to their final destination.

All mileage associated with direct, rail drayage, and transloading truck trips, within the SoCAB is included in the annual EIs. This includes the portions of trips that have origin or destination outside the SoCAB that have mileage within the SoCAB (i.e., mileage is included that occurs within the SoCAB for trips from the Port to destinations outside the SoCAB).

To estimate the emissions from truck trips outside the SoCAB, the Port utilized information that was developed for the 2020 Inventory of Air Emissions within the SoCAB. This includes the annual number of truck trips to and from the Port and the percentage that travel outside the SoCAB, based on origin/destination (O/D) data collected in the early part of 2010 by a Port transportation consultant in support of Port transportation planning assignments. The most recent available data of its kind, the 2010 O/D data provide the approximate percentages of trucks that travel to and from various locations within the SoCAB and to and from cities outside the SoCAB. The origin and destination information is specific to the three general configurations of container trucks: trucks carrying a container, trucks carrying a bare chassis (no container), and trucks traveling with no trailer (bobtails).

The O/D data was used to estimate the percentages of trips that travel the major highways into and out of the SoCAB. These percentages were then used to develop a statistical distribution that could be applied to the total number of truck trips in 2020 to determine the number of trips that traveled beyond the SoCAB boundary and to distribute the trips along the major highway routes. Figure 3.1 illustrates these routes, while Table 3.1 lists the routes, the major cities to and from which the routes travel, and the distances to those cities. Table 3.2 lists the distribution percentages that have been applied to the total number of truck trips to estimate the number of container, chassis, and bobtail trucks on each route, inbound and outbound, while Table 3.3 lists the estimated number of each type of truck, based on these percentages and the total number of truck trips to and from the Port in 2020; equivalent to approximately 4.11 million trips.

Figure 3.1: Population Centers along Major Routes Beyond SoCAB

Table 3.1: Routes, Major Origins/Destinations, and Maximum Distances

Route	Major City	Maximum Distance
US 101 N	San Jose	315
I-5 N	Oakland	197
SR 99 N	Sacramento	245
I-10 E	El Paso	585
I-5 S	San Diego	71
I-15 S	San Diego	48
I-15 N	Salt Lake City	626
I-15 to I-40	Albuquerque	643

Table 3.2: Route Distribution Percentages Based on O/D Survey

Route	Inbound Trips			Outbound Trips		
	Containers	Chassis	Bobtails	Containers	Chassis	Bobtails
US 101 N	0.0041	0.0000	0.0007	0.0023	0.0000	0.0008
I-5 N	0.0075	0.0014	0.0000	0.0023	0.0000	0.0023
SR 99 N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
I-10 E	0.0062	0.0007	0.0014	0.0101	0.0008	0.0008
I-5 S	0.0178	0.0021	0.0069	0.0249	0.0000	0.0055
I-15 S	0.0021	0.0014	0.0007	0.0016	0.0000	0.0008
I-15 N	0.0055	0.0007	0.0021	0.0039	0.0000	0.0008
I-15 to I-40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 3.3: Route Distribution – Number of Trips

Route	Inbound Trips			Outbound Trips		
	Containers	Chassis	Bobtails	Containers	Chassis	Bobtails
US 101 N	16,854	0	2,878	9,455	0	3,289
I-5 N	30,830	5,755	0	9,455	0	9,455
SR 99 N	0	0	0	0	0	0
I-10 E	25,486	2,878	5,755	41,518	3,289	3,289
I-5 S	73,171	8,633	28,364	102,357	0	22,609
I-15 S	8,633	5,755	2,878	6,577	0	3,289
I-15 N	22,609	2,878	8,633	16,032	0	3,289
I-15 to I-40	0	0	0	0	0	0

The total truck miles along each route have been calculated by distributing the total trips on each route to the population centers along each route, out to 600 miles, as illustrated in Figure 3.1. The distributions were made on the basis of the populations along the routes, assuming that truck trips originated or terminated along the routes in proportion to the populations. The routes have been divided into segments, each segment having a defined length – the total distance of each route as shown in Table 3.1 is the sum of the lengths of all the segments in that route. At the boundary of the SoCAB, the number of truck trips on each route is equal to the total number of trips for the year multiplied by the relevant percentage shown in Table 3.2. As the distance from the SoCAB boundary increases, the number of truck trips on each route is decreased by a "decay factor" that is based on the population along the route to that point, based on population figures originally obtained from 2000 Census data. Population information based on 2010 and 2020 Census data[43] was reviewed for the cities listed in Table 3.1 above and no significant differences occurred in the population growth of these cities – all of them increased modestly in population. Therefore, the decay factors were not revised from

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[43] US Census Bureau, *https://www.census.gov/quickfacts/fact/table*, accessed December 2021

those used in earlier inventories. For each segment, the vehicle miles travelled (VMT) has been calculated by multiplying the number of truck trips remaining in the route (after application of the decay factor) by the length of the segment. The segments in each route are summed to calculate the total VMT over each segment. In this way, a total of 74.9 million travel miles has been estimated.

It should be noted that emissions associated with the cooling units on refrigerated (reefer) containers have not been estimated. These cooling units, which are used to keep the container contents at required temperatures, are powered by small, intermittently operating, diesel generators. Emissions have not been estimated for these units because data related to the amount of time the cooling units are actually operated is very limited. Additionally, since reefers represent a small portion of total containerized throughput, their emissions are anticipated to be significantly less than overall truck emissions.

3.2 Methodology

Emissions have been estimated using emission factors expressed as grams per mile, using the vehicle mileage activity discussed in the previous section. The emission factors are the same as those used for estimating greenhouse gases for the 2020 Port emissions inventory covering activities within the SoCAB, obtained from CARB's EMFAC2021 model. Because specific speeds are not known, the emission factors used in the 2020 emissions inventory for travel at an average 50 miles per hour (mph) were used for highway segments that are within municipal limits while emission factors used for travel at an average 60 mph were used for highway segments outside municipalities. The emission factors used for these two speeds are presented in Table 3.4.

Table 3.4: HDV Greenhouse Gas Emission Factors, g/mile

Speed mph	CO_2 g/mi	N_2O g/mi	CH_4 g/mi
50	1,539	0.245	0.044
60	1,549	0.247	0.039

The emission factors for CO_2 are many orders of magnitude larger than those for N_2O and CH_4 because carbon is the main constituent of diesel fuel and combustion of fuel leads to the formation of CO_2 from the carbon in the fuel. The other compounds are formed incidentally from nitrogen in the air that enters the engine to support combustion or in the fuel (N_2O) or as a product of incomplete combustion (CH_4).

Emissions were estimated for each road segment by multiplying the length of the segment in miles by the g/mile emission factor for the assumed speed over the segment.

Equation 3.1

$$\frac{miles/year \times g/mile}{1{,}000{,}000g/metric\ ton} = metric\ tons/year$$

3.3 Emissions Estimates

The estimated emissions from HDVs operating outside the SoCAB domain, on trips between the Port and locations outside the SoCAB, are presented by route in Table 3.5.

Table 3.5: 2020 Total Expanded HDV Emissions by Route

	Total Emissions (In-Bound and Out-Bound)			
Route	**CO_2**	**N_2O**	**CH_4**	**CO_2e**
	tonnes	**tonnes**	**tonnes**	**tonnes**
US 101 N	6,696	1.07	0.18	7,018
I-5 N	6,527	1.04	0.17	6,840
SR 99 N	0	0.00	0.00	0
I-10 E	44,043	7.01	1.17	46,162
I-5 S	20,268	3.23	0.57	21,245
I-15 S	1,801	0.29	0.05	1,887
I-15 N	36,412	5.80	0.95	38,164
I-15 to I-40	0	0.00	0.00	0
Total	**115,746**	**18.44**	**3.08**	**121,317**

Tables 3.6 and 3.7 present the in-bound and out-bound components of the out-of-basin emissions, respectively. The emissions from in-bound trucks exceed those from out-bound trucks because these emissions are from trucks that travel from locations outside the SoCAB directly to the Port. Out-bound trucks that leave intermodal cargo transloading facilities within the SoCAB are not included in the expanded GHG domain as these movements are not directly related to the Port.

Table 3.6: 2020 Total In-Bound Expanded HDV Emissions by Route

	Total Emissions (In-Bound)			
Route	**CO_2**	**N_2O**	**CH_4**	**CO_2e**
	tonnes	**tonnes**	**tonnes**	**tonnes**
US 101 N	4,068	0.65	0.11	4,264
I-5 N	4,303	0.69	0.11	4,510
SR 99 N	0	0.00	0.00	0
I-10 E	18,278	2.91	0.48	19,157
I-5 S	9,496	1.51	0.27	9,954
I-15 S	1,146	0.18	0.03	1,201
I-15 N	23,247	3.70	0.61	24,366
I-15 to I-40	0	0.00	0.00	0
Total	**60,538**	**9.64**	**1.61**	**63,452**

Table 3.7: 2020 Total Out-Bound Expanded HDV Emissions by Route

	Total Emissions (Out-Bound)			
Route	**CO_2**	**N_2O**	**CH_4**	**CO_2e**
	tonnes	**tonnes**	**tonnes**	**tonnes**
US 101 N	2,628	0.42	0.07	2,754
I-5 N	2,224	0.35	0.06	2,331
SR 99 N	0	0.00	0.00	0
I-10 E	25,765	4.10	0.68	27,005
I-5 S	10,772	1.72	0.30	11,291
I-15 S	655	0.10	0.02	686
I-15 N	13,164	2.10	0.34	13,798
I-15 to I-40	0	0.00	0.00	0
Total	**55,207**	**8.79**	**1.47**	**57,865**

The total expanded and annual inventory Port-related HDV GHG emissions by domain are presented in Table 3.8.

Table 3.8: 2020 Total Port-Related HDV GHG Emissions by Domain

Domain	2020 Port-Related HDV GHG Emissions			
	CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
Annual Inventory (Within SoCAB)	380,331	60.36	14.45	398,679
Expanded - In-State (Outside SoCAB)	64,445	10.27	1.73	67,547
Expanded - Out-of-State	51,301	8.17	1.36	53,770
Total Port-Related	**496,077**	**78.80**	**17.53**	**519,996**

Note: The blue highlight represents emissions within the CARB "In-State" domain definition.

3.4 Facts & Findings

The distribution of total Port-related HDV emissions between the SoCAB (regional), in-state (rest of California outside of SoCAB), and out-of-state are presented in Figure 3.2. The total 2020 in-state Port-related (in-state plus the SoCAB) HDV emissions were estimated to be 466,266 metric tons CO_2e. HDV emissions by route (outside the SoCAB), in-bound and out-bound are presented in Figure 3.3.

Figure 3.2: 2020 HDV Emissions Distribution by Domain

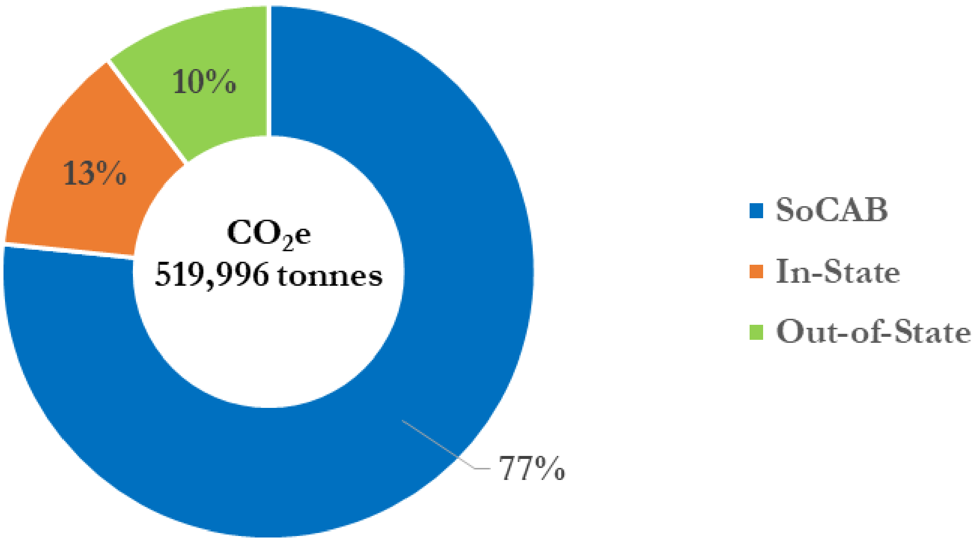
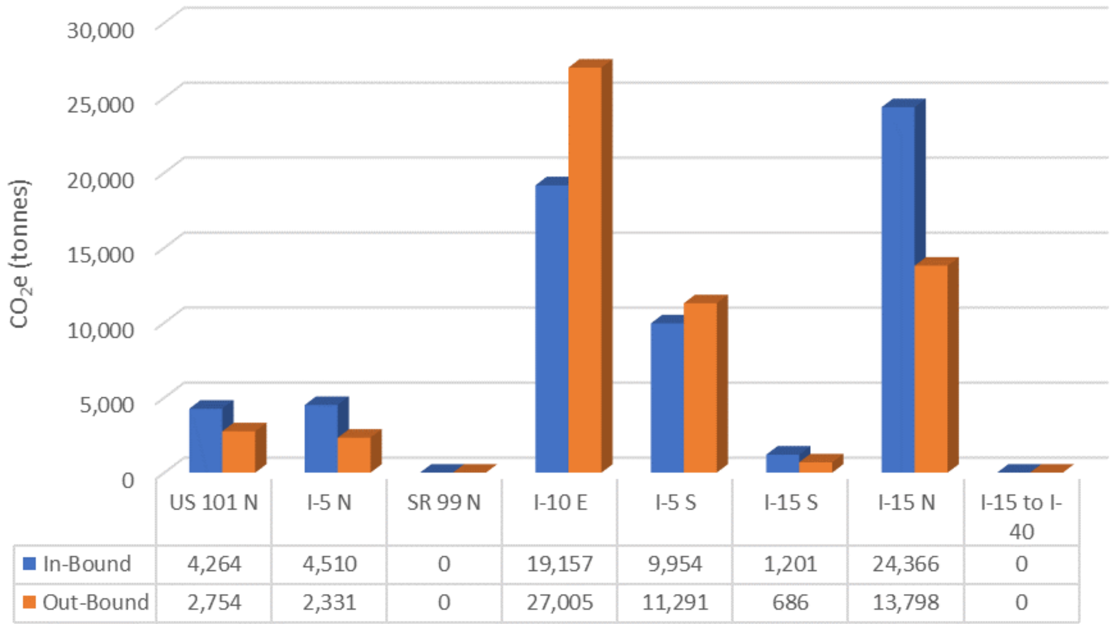


Figure 3.3: 2020 Total Expanded HDV Emissions by Route, In-Bound & Out-Bound



	US 101 N	I-5 N	SR 99 N	I-10 E	I-5 S	I-15 S	I-15 N	I-15 to I-40
🟦 In-Bound	4,264	4,510	0	19,157	9,954	1,201	24,366	0
🟧 Out-Bound	2,754	2,331	0	27,005	11,291	686	13,798	0

SECTION 4 RAIL LOCOMOTIVES

4.1 Activity

The Port collects annual data on the number of Port-related containers that are moved by on-dock and near-dock rail facilities. The Port also collects cargo throughput data that can be used to estimate the distribution of cargo between the two railroads.

Two types of locomotive are associated with Port operations: switching locomotives and Class 1 line haul locomotives. Switching locomotives operate fully within the SoCAB and are currently estimated and reported in the annual emissions inventories. Class 1 line haul locomotives transit in and out of the SoCAB to and from points across the country. Emissions from Class 1 line haul locomotives operating within the SoCAB are currently estimated and reported in the annual emissions inventories. Information provided by the two Class 1 railroads has been used to characterize the rail routes with the highest volumes of travel to and from the Port, as discussed below.

The Class 1 railroads UP and BNSF have previously provided the approximate percentage breakdowns of the routes their cargo takes into and out of the SoCAB (primarily east/west, either through Yuma, Arizona or over the Cajon Pass) as part of emissions inventory development. These percentages have been used to apportion UP and BNSF rail emissions to specific routes. Note that the total amount of rail cargo to and from the Ports has been obtained from Port records –the railroads' percentage data have been used to apportion this cargo to various routes for the purpose of estimating the distances the cargo is transported.

Key routes have been identified to the major cities served from the Los Angeles area by each of the Class 1 railroads. Distribution of cargo has been estimated from the sources presented above and from other sources to determine the likely freight distribution by route for each railroad. Table 4.1 presents the main intermodal routes for each Class 1 railroad, the distance of the route, and the estimated percentage of each railroad's total cargo that is moved on each route. The distances and approximate percentages of freight are the same as in the previous expanded GHG inventory. Note that the railroads generally travel on their own tracks over different routes so the distance to each destination city is different for the two railroads.

Table 4.1: Estimated Distance and Percentage of Cargo Moved by Rail in 2020

Railroad	Destination City	Distance (miles)	Approx. % Freight
BNSF	Chicago	2,065	20.3%
BNSF	Dallas	1,415	5.1%
BNSF	Houston	1,580	3.6%
BNSF	Kansas City	1,625	20.3%
BNSF	St. Louis	1,920	1.5%
UP	Chicago	2,031	11.8%
UP	Dallas	1,403	18.7%
UP	Houston	1,526	12.8%
UP	Kansas City	1,580	2.5%
UP	Salt Lake City	708	2.0%
UP	Seattle	1,156	1.2%
UP	St. Louis	1,816	0.2%

The Port will continue its data discovery efforts and utilize published materials from the railroads to further improve assumptions of route distribution and train characteristics. Confidentiality concerns prevent the railroads from readily disseminating current route percentage information.

4.2 Methodology

Emissions from line haul locomotives operating outside of the SoCAB have been estimated on an activity basis, i.e., based on estimates of the number and characteristics of locomotives that arrive and depart with cargo. The information used in developing these estimates has been obtained from the Port and Port terminals.

Line haul locomotive activity outside the SoCAB boundary has been estimated through an evaluation of the amount of Port cargo transported by rail and average or typical train characteristics such as number of containers and number of gross tons per train. In this way, estimates have been prepared of gross tonnage and transport distances, similar to the methodology used for the Port emissions inventories. The activity information has been used to develop an estimate of overall horsepower-hours expended on each rail route outside of the SoCAB. Emissions have been estimated by multiplying the horsepower- hour estimates by greenhouse gas emission factors derived from an annual USEPA greenhouse gas emissions inventory[44] converted to terms of grams per horsepower-hour (g/hp-hr). The CO_2 emission factor was developed using a mass balance approach based on the typical amount of carbon in diesel fuel reported in the USEPA inventory, assuming essentially all carbon in the fuel is converted to CO_2, and using a fuel consumption factor (horsepower- hours per gallon of fuel,

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[44] USEPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, April 2021.

hp-hr/gal) from another USEPA publication.[45] The N_2O and CH_4 emission factors were converted from units of grams per kilogram of fuel as reported by USEPA to grams per horsepower-hour using the hp-hr/gal fuel consumption factor. Table 4.2 lists the emission factors.

Table 4.2: GHG Emission Factors for Line Haul Locomotives, g/hp-hr

Emission Factors	CO_2	N_2O	CH_4
EF, g/hp-hr	489	0.013	0.040

The four components to locomotive activity that were estimated to develop the out-of-basin emission estimates are the number of trains, the average weight of each train, the distances traveled on each route outside of the basin, and the amount of fuel used per ton-mile of train activity. Using the average train capacity on which the 2020 Port emissions inventory was based (average 283 containers per train) and the Port's 2020 intermodal throughputs, a total of 5,100 trains were estimated to have been associated with Port rail cargo movements in 2020.

The gross weight (including locomotives, railcars, and freight) of a typical train was estimated to be 7,402 tons, consistent with the value calculated for the Port's 2020 emissions inventory. The distances over each route between the Port and major rail destinations were calculated by dividing the routes into discrete segments and summing the lengths of each segment over each route. These estimated distances are presented above in Table 4.1.

Gross ton-miles were calculated by multiplying together the number of trains, the gross weight per train, and the miles traveled. The results of this calculation for each route are shown in Table 4.3 as million gross ton-miles (MMGT-miles) per year. This table also shows the estimated total fuel usage, estimated by multiplying the gross tons by the average fuel consumption for the two line haul railroads in 2020. This average was derived from information reported by the railroads to the U.S. Surface Transportation Board in an annual report known as the "R-1."[46] Among the details in this report are the total gallons of diesel fuel used in freight service and the total freight moved in thousand gross ton-miles. The total fuel reported by both railroads was divided by the total gross ton-miles to derive the average factor of 0.965 gallons of fuel per thousand gross ton-miles.

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[45] Office of Transportation and Air Quality, "Emission Factors for Locomotives," EPA-420-F-09-025, April 2009

[46] *Class I Railroad Annual Report R-1 to the Surface Transportation Board for the Year Ending Dec. 31, 2020* (Union Pacific Railroad) and *Class I Railroad Annual Report R-1 to the Surface Transportation Board for the Year Ending Dec. 31, 2020* (BNSF Railway). *https://www.stb.dot.gov/econdata.nsf/FinancialData?OpenView* , accessed December 2021

The 2020 annual R-1 reports have been used as the basis of the 2020 fuel consumption factor. Also listed in Table 4.3 is the estimated total of out-of-basin horsepower-hours, calculated by dividing the fuel use by the fuel use factor of 0.048 gal/hp-hr.

Table 4.3: 2020 Gross Ton-Mile, Fuel Use, and Horsepower-hour Estimates (per year)

Destination City	Average Distance (miles)	Trains per year	MMGT per year	MMGT-miles per year
Chicago	2,048	1,637	12.1	24,816
Dallas	1,409	1,214	9.0	12,661
Houston	1,553	837	6.2	9,622
Kansas City	1,603	1,163	8.6	13,795
Salt Lake City	708	102	0.8	535
Seattle	1,156	61	0.5	522
St. Louis	1,868	87	0.6	1,203
Total million gross ton-miles				**63,153**
Estimated gallons of fuel (millions)				**61**
Estimated horsepower-hours (milions)				**1,270**

Emission estimates for line haul locomotive activity outside the SoCAB originating or terminating at the Port were calculated by multiplying this estimate of overall horsepower-hours by the emission factors in terms of g/hp-hr.

Equation 4.1

$$\frac{hp - hr/year \times g/hp - hr}{1{,}000{,}000 g/metric\ ton} = metric\ tons/year$$

4.3 Emissions Estimates

The 2020 expanded domain Class 1 line-haul emission results are presented in the following tables by destination city and total emissions, in-state emissions, and out-of-state emissions. Table 4.4 presents the total expanded (outside the SoCAB domain) Class 1 line-haul emissions.

Table 4.4: 2020 Total Expanded Class 1 Line-Haul Emissions

Destination	Tonnes/year			
City	CO_2	N_2O	CH_4	CO_2e
Chicago	240,340	6.39	19.66	242,736
Dallas	122,058	3.24	9.98	123,275
Houston	92,075	2.45	7.53	92,992
Kansas City	134,773	3.58	11.02	136,116
Salt Lake City	5,166	0.14	0.42	5,217
Seattle	5,044	0.13	0.41	5,094
St. Louis	11,874	0.32	0.97	11,993
Totals	**611,329**	**16.25**	**50.01**	**617,423**

Table 4.5 presents the "in-state" (outside the SoCAB domain) Class 1 line-haul emissions. Table 4.6 presents the "out-of-state" Class 1 line-haul emissions.

Table 4.5: 2020 Expanded In-State Class 1 Line-Haul Emissions

Destination	Tonnes/year			
City	CO_2	N_2O	CH_4	CO_2e
Chicago	38,493	1.02	3.15	38,877
Dallas	27,891	0.74	2.28	28,169
Houston	16,968	0.45	1.39	17,137
Kansas City	29,234	0.78	2.39	29,526
Salt Lake City	3,378	0.09	0.28	3,412
Seattle	2,195	0.06	0.18	2,217
St. Louis	2,160	0.06	0.18	2,181
Totals	**120,320**	**3.20**	**9.84**	**121,519**

Table 4.6: 2020 Expanded Out-of-State Class 1 Line-Haul Emissions

Destination City	Tonnes/year CO_2	N_2O	CH_4	CO_2e
Chicago	201,847	5.37	16.51	203,859
Dallas	94,167	2.50	7.70	95,105
Houston	75,107	2.00	6.14	75,855
Kansas City	105,538	2.81	8.63	106,590
Salt Lake City	1,788	0.05	0.15	1,805
Seattle	2,849	0.08	0.23	2,878
St. Louis	9,714	0.26	0.79	9,811
Totals	**491,010**	**13.05**	**40.16**	**495,904**

The total expanded and annual inventory Port-related rail locomotive GHG emissions by domain are presented in Table 4.7.

Table 4.7: 2020 Total Port-Related Rail GHG Emissions by Domain

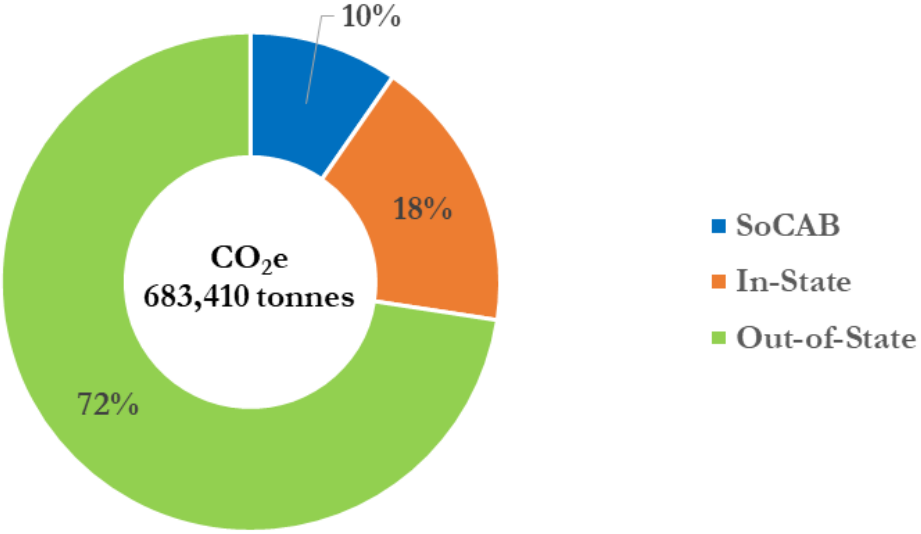
Domain	2020 Port-Related Locomotive GHG Emissions CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
Annual Inventory (Within SoCAB)	65,339	1.73	5.31	65,987
Expanded - In-State (Outside SoCAB)	120,320	3.20	9.84	121,519
Expanded - Out-of-State	491,010	13.05	40.16	495,904
Total Port-Related	**676,668**	**17.98**	**55.32**	**683,410**

Note: The blue highlight represents emissions within the CARB "In-State" domain definition.

4.4 Facts & Findings

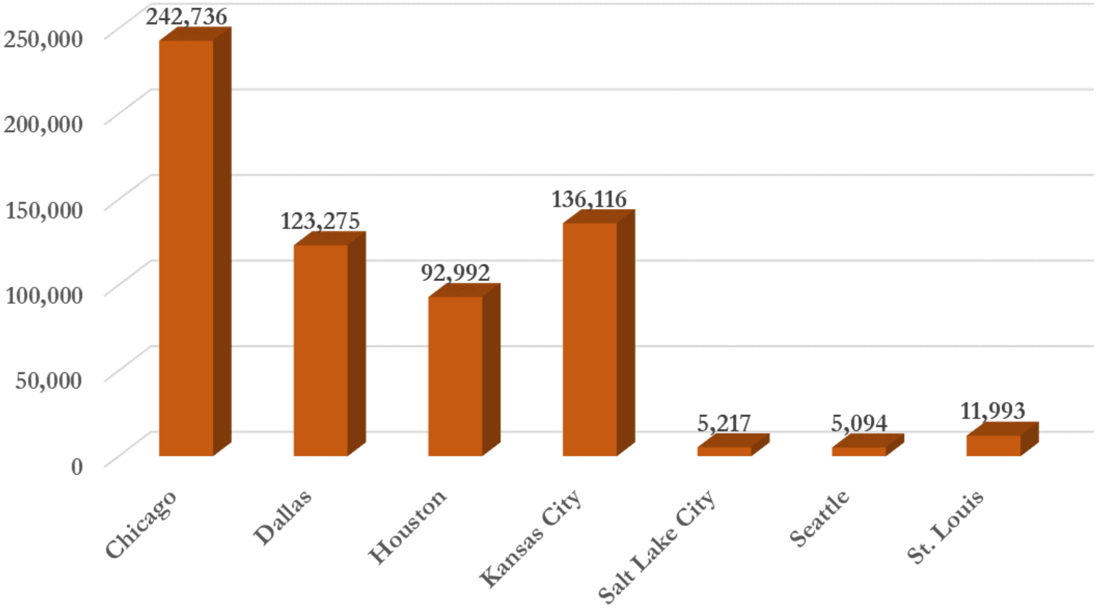
The distribution of total Port-related rail locomotive emissions (including switch and Class 1 line-haul) between the SoCAB (regional), in-state (rest of California outside of SoCAB), and out-of-state are presented in Figure 4.1. Total 2020 in-state (SoCAB plus in-state) rail emissions were estimated to be 185,659 metric tons CO_2e.

Figure 4.1: 2020 Rail Emissions Distribution by Domain



The total 2020 Class 1 line-haul emissions in the expanded domain, by railroad and destination are presented in Figure 4.2.

Figure 4.2: 2020 Total Class 1 Line-Haul Expanded CO_2e Emission by Destination, metric tons



SECTION 5 PORT-RELATED DIRECT FOOTPRINT

This section summarizes the total GHG emissions that have a direct connection to and/or through the Port. This section presents the 2020 findings and compares the 2020 results with emissions in 2015.

5.1 2020 Findings

Table 5.1: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Emissions

Scope	2020 Inventory Study	2020 Port-Related GHG Emissions CO_2 tonnes	N_2O tonnes	CH_4 tonnes	CO_2e tonnes
1&2	Annual Municipal GHG Inventory	6,577	0.04	0.39	6,618
3	Electric Wharf Cranes	31,166	0.18	1.50	31,258
3	Buildings Electricity	8,743	0.05	0.42	8,769
3	AMP	15,890	0.09	0.76	15,936
3	Buildings Natural Gas	5,832	0.01	0.52	5,848
3	Port Employee Vehicles	301	0.01	0.02	305
3	Expanded GHG Inventory	5,870,487	346.85	134.50	5,977,206
Total		**5,938,996**	**347.23**	**138.10**	**6,045,939**

The 2020 combined emissions footprint for Port-related emissions for all three Scopes is presented in detail in Table 5.2.

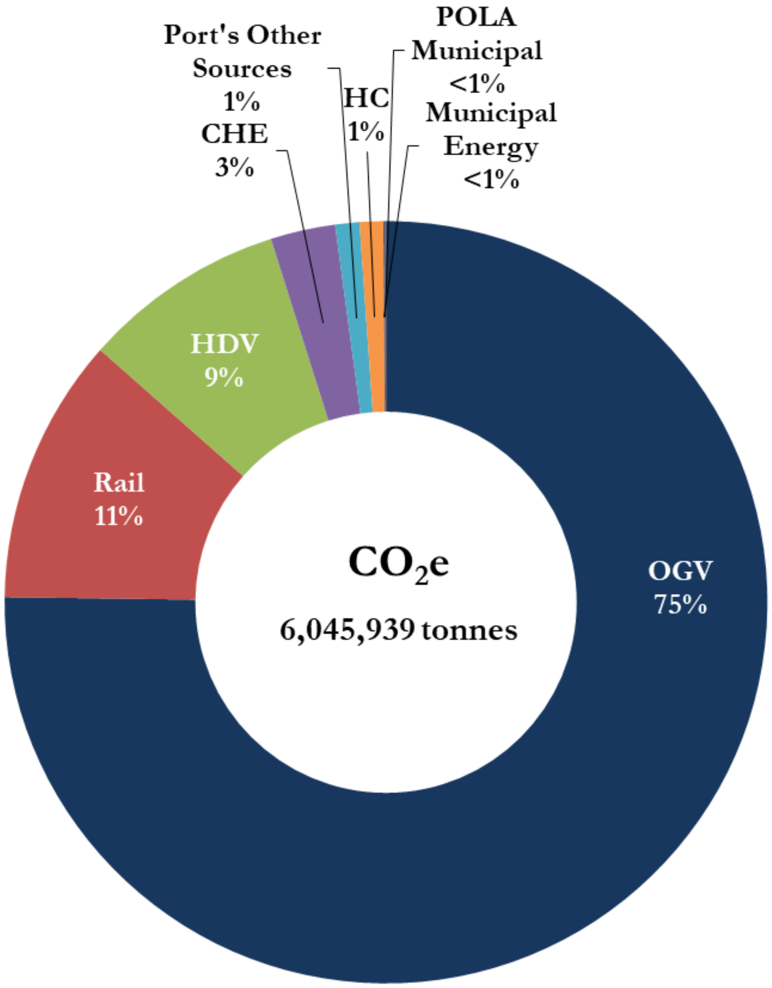
Table 5.2: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Expanded Domain Emissions

Scope	Domain	2020 Port-Related GHG Emissions			
		CO_2	N_2O	CH_4	CO_2e
		tonnes	tonnes	tonnes	tonnes
POLA Municipal Operations					
1	Annual GHG Inventory	2,755	0.01	0.21	2,785
Municipal Energy Consumption					
2	Annual Municipal GHG Inventory (SoCAB)	1,796	0.01	0.09	1,802
2	Annual Municipal GHG Inventory (Out-of-State)	2,026	0.01	0.10	2,032
	Subtotal	**3,822**	**0.02**	**0.18**	**3,833**
Port's Other Sources					
3	Expanded Inventory (SoCAB)	32,358	0.18	1.79	32,455
3	Expanded Inventory (Out-of-State)	29,573	0.17	1.42	29,660
	Subtotal	**61,931**	**0.35**	**3.21**	**62,115**
Ocean-Going Vessel Operations					
3	Annual Inventory (Within 24 nm/Inside SoCAB)	208,486	12.40	2.30	212,248
3	Expanded Inventory (Within 24 nm/Outside SoCAB)	271,555	14.51	3.28	275,960
3	Annual Inventory (Outside 24 nm/Inside SoCAB)	0	0.00	0.00	0
3	Expanded Inventory (Outside 24 nm & SoCAB)	3,993,278	217.26	49.37	4,059,257
	Subtotal	**4,473,319**	**244.17**	**54.95**	**4,547,465**
Heavy-Duty Vehicle Operations					
3	Annual Inventory (Within SoCAB)	380,331	60.36	14.45	398,679
3	Expanded - In-State (Outside SoCAB)	64,445	10.27	1.73	67,547
3	Expanded - Out-of-State	51,301	8.17	1.36	53,770
	Subtotal	**496,077**	**78.80**	**17.53**	**519,996**
Rail Locomotive Operations					
3	Annual Inventory (SoCAB)	65,339	1.73	5.31	65,987
3	Expanded - (In-State Outside SoCAB)	120,320	3.20	9.84	121,519
3	Expanded - Out-of-State	491,010	13.05	40.16	495,904
	Subtotal	**676,668**	**17.98**	**55.32**	**683,410**
Cargo Handling Equipment Operations					
3	Annual Inventory	164,881	3.20	5.50	165,961
Harbor Craft Operations					
3	Annual Inventory	59,543	2.70	1.20	60,374
TOTAL		**5,938,996**	**347.23**	**138.10**	**6,045,939**

Note: The blue highlights represent emissions within the CARB "In-State" domain definition.

The distribution of Scopes 1, 2, & 3 emissions by source category is presented in Figure 5.1.

Figure 5.1: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Expanded Domain Emissions Distribution by Source Category



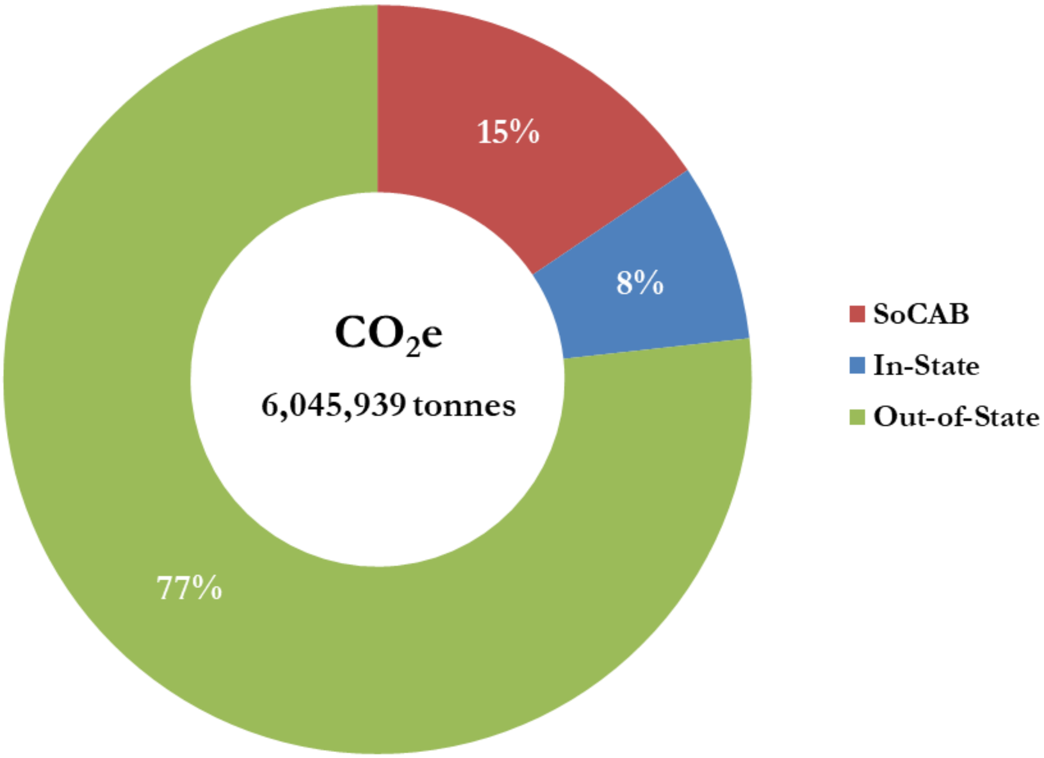
Emissions by domain (SoCAB, In-State, Out-of-State) are presented in Table 5.3 and the distribution by geographic domain is illustrated in Figure 5.2.

Table 5.3: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Emissions by Domain

Domain	2020 Port-Related GHG Emissions			
	CO_2	N_2O	CH_4	CO_2e
	tonnes	tonnes	tonnes	tonnes
SoCAB (Including entire over water boundary)	915,489	80.59	30.85	940,291
In-State (Outside SoCAB & w/in 24 nm of CA Coast)	456,319	27.97	14.85	465,026
Out-of-State (Outside California)	4,567,188	238.67	92.41	4,640,622
TOTAL	**5,938,996**	**347.23**	**138.10**	**6,045,939**

Note: The blue highlight represents emissions within the CARB "In-State" domain definition. Totals may differ slightly due to rounding.

Figure 5.2: 2020 Total Port-Related Scopes 1, 2, & 3 GHG Emissions Domain Distribution



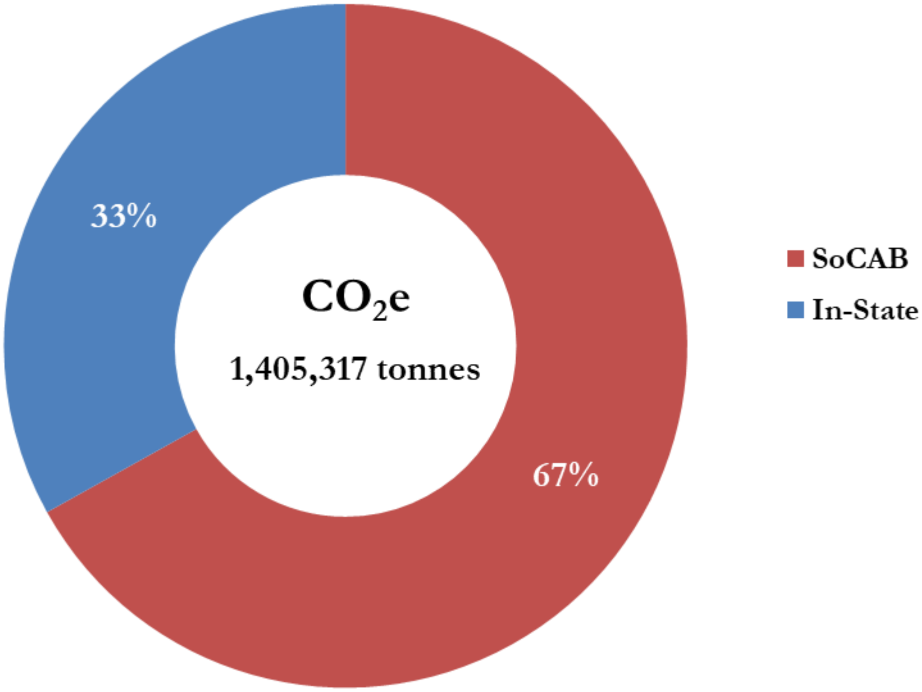
The California State domain is equal to the SoCAB emissions (all land and out to 24-nm from the California Coast) plus the in-state domain outside of the SoCAB. It should be noted that the majority of the emissions in the annual tenant inventories fall within the 24-nm line off the California Coast. The 2020 Port-related Scopes 1, 2, & 3 for the State of California are presented in Table 5.4 and the distribution by SoCAB and in-state domains is illustrated in Figure 5.3.

Table 5.4: 2020 Total California Port-Related Scopes 1, 2, & 3 GHG Emissions

Domain	2020 Port-Related GHG Emissions			
	CO_2	N_2O	CH_4	CO_2e
	tonnes	tonnes	tonnes	tonnes
SoCAB (Inside SoCAB w/in 24 nm)	915,489	80.59	30.85	940,291
In-State (Outside SoCAB w/in 24nm)	456,319	27.97	14.85	465,026
CALIFORNIA STATE TOTAL	**1,371,808**	**108.56**	**45.69**	**1,405,317**

Note: The blue highlights represent emissions within the CARB “In-State” domain definition.

Figure 5.3: 2020 Total California Port-Related Scopes 1, 2, & 3 GHG Emissions Domain Distribution



5.2 Comparison of Previous Year Emissions

In comparing the 2020 emissions estimates with previous years, estimates for each year have been prepared using the latest methodology so that the estimates are comparable.

In order to provide context to the emission comparisons between 2020 and 2015, it is important to understand the activity levels of the Port's sources in both years. The Port typically tracks vessel call numbers, container ship call numbers, throughput in twenty-foot equivalent unit (TEUs) volumes, and average TEUs per call. Since containerized cargo dominates port activity, TEU changes, along with changes in container ship calls and call-density (TEUs/call) are typically the most informative indicators for evaluating activity changes. Table 5.5 presents the above activity level indicators for 2015 and 2020 along with their relative change.

Table 5.5: Port OGV Activity Comparisons

Year	All Calls	Container ship Calls	TEUs	Average TEUs/Container ship Call	Total Distance Traveled in Expanded Area (nm)
2015	1,774	1,146	8,160,458	7,121	9,253,659
2020	1,533	968	9,213,396	9,518	8,233,630
Comparison 2020-2015	**-14%**	**-16%**	**13%**	**34%**	**-11%**

As shown above, the number of vessel calls has decreased by 14% between 2015 and 2020, while the number of TEUs has increased by 13% and the average number of TEUs per call has increased by 34% over the same period.

The emission changes between each year track fairly closely with the change in activity. The emissions in each year are presented by domain in Table 5.6. The emissions in the first three domains presented in the table are not primarily affected by changes in cargo activity. The decrease in GHG emissions intensity of LADWP power generation due to increased use of renewal energy in LADWP's power sources portfolio and use of Green Power program energy and decrease in AMP usage in 2020 caused a decrease in emissions associated with the Port's Municipal Energy Consumption and Other Sources category. OGV emissions tracked fairly closely with all calls and container ship calls. Between 2015 and 2020, there was an increase in TEU throughput and a decrease in container ship calls, indicating that larger container vessels visited the Port in 2020. The increase in TEU throughput caused an increase in HDV emissions in 2020 when compared to 2015, resulting from handling the increased number of TEUs. However, CHE emissions decreased in 2020 due to an increase in the number of electric and hybrid equipment in 2020 compared to CHE fleet in 2015. There was a decrease in rail emissions in 2020 when compared to 2015 due to an overall decrease in rail transport (especially through the Intermodal Container Transport Facility (ICTF) and possibly to improved rail transport efficiency. The harbor craft emissions trend does not correspond closely with the vessel call trend because emissions trend from this emission source category are also influenced by harbor vessel types that are not associated with cargo throughput, such as commercial fishing, ferries, tug, crew, and work boats.

Table 5.6: Port Emissions Comparison

	Port-Related GHG Emissions Comparison, CO_2e		
Activity Domain	**2020** tonnes	**2015** tonnes	**% Change** **2020-2015**
POLA Municipal Operations	2,785	3,299	-16%
Municipal Energy Consumption	3,833	7,237	-47%
Port's Other Sources	62,115	121,195	-49%
Ocean-Going Vessel Operations	4,547,465	5,420,917	-16%
Heavy-Duty Vehicle Operations	519,996	509,727	2%
Rail Locomotive Operations	683,410	743,025	-8%
Cargo Handling Equipment Operations	165,961	170,780	-3%
Harbor Craft Operations	60,374	61,013	-1%
Totals	**6,045,939**	**7,037,195**	**-14%**

Appendix A - OGV ROUTE DISTANCES

Port	Latitude	Longitude	Arrival Distance (nm)	Departure Distance (nm)
Acapulco, MEX	16.84	-99.91	1,494	1,493
Amsterdam, NLD	52.41	4.83	7,802	7,801
Anacortes, USA	48.52	-122.61	1,085	1,085
Astoria, USA	46.19	-123.86	857	857
Auckland, NZL	-36.84	174.77	5,482	5,660
Balboa, PAN	8.96	-79.57	2,930	2,929
Barbers Point, USA	21.32	-158.12	2,192	2,192
Baytown, USA	29.70	-94.97	4,465	4,464
Benicia, USA	38.04	-122.13	368	369
Blaine, USA	48.99	-122.75	1,107	1,107
Brisbane, AUS	-27.38	153.17	6,289	6,288
Cabo San Lucas, MEX	22.88	-109.91	822	820
Cai Mep, VNM	10.39	107.08	7,129	7,129
Callao, PER	-12.05	-77.15	3,632	3,630
Cartagena, COL	10.40	-75.53	3,243	3,242
Cedros Island, MEX	28.10	-115.19	340	339
Changshu, CHN	31.76	120.96	5,670	5,671
Cherry Point, USA	48.86	-122.76	1,099	1,099
Chiba, JPN	35.56	140.06	5,148	5,149
Chimbote, PER	-9.08	-78.61	3,445	3,444
Chittagong, BGD	22.27	91.83	9,181	9,181
Chiwan, CHN	22.47	113.87	6,386	6,386
Clatskanie, USA	46.18	-123.18	886	893
Coloso, CHL	-23.76	-70.47	4,400	4,399
Coquimbo, CHL	-29.95	-71.33	4,639	4,638
Corinto, NIC	12.47	-87.17	2,269	2,268
Coronel, CHL	-37.03	-73.16	4,905	4,904
Cristobal, PAN	9.35	-79.91	2,976	2,975
Daesan, KOR	37.01	126.38	5,537	5,538
Dalian, CHN	38.93	121.65	5,707	5,708
Dumai, IDN	1.69	101.46	7,770	7,770
Dung Quat, VNM	15.39	108.79	6,863	6,863
Dutch Harbor, USA	53.90	-166.52	2,355	2,356
Ensenada, MEX	31.85	-116.63	100	100
Esmeraldas, ECU	0.99	-79.65	3,003	3,002
Etajima, JPN	34.24	132.46	5,419	5,420
Ferndale, USA	48.83	-122.72	1,097	1,097
Freeport, BHS	26.52	-78.77	4,255	4,254
Fukuyama, JPN	34.46	133.43	5,283	5,283
Fuqing, CHN	26.01	119.48	5,866	5,866
Fuzhou, CHN	26.04	119.30	5,876	5,876
Geismar, USA	30.19	-91.02	4,413	4,411
Geoje, KOR	34.88	128.71	5,237	5,238
Georgetown, GUY	6.82	-58.17	4,536	4,535
Guayaquil, ECU	-2.28	-79.90	3,197	3,196
Guaymas, MEX	27.92	-110.87	1,217	1,216
Gwangyang, KOR	34.89	127.68	5,281	5,281
Hilo, USA	19.73	-155.07	2,082	2,082
Hiroshima, JPN	34.37	132.42	5,427	5,427

Port	Latitude	Longitude	Arrival Distance (nm)	Departure Distance (nm)
Hitachanaka, JPN	36.41	140.61	4,682	4,682
Hitachi, JPN	36.49	140.62	4,679	4,679
Honolulu, USA	21.30	-157.87	2,178	2,178
Houston, USA	29.71	-95.06	4,468	4,467
Huanghua, CHN	38.49	117.62	5,857	5,858
Incheon, KOR	37.47	126.62	5,564	5,564
Innoshima, JPN	34.28	133.19	5,295	5,295
Irago, JPN	34.58	137.02	5,034	5,034
Itaguai, BRA	-22.93	-43.83	7,490	7,489
Japan	38.00	141.00	4,615	4,615
Jiangyin, CHN	31.93	120.22	5,718	5,718
Jubail, SAU	27.03	49.67	12,566	12,565
Kalama, USA	46.01	-122.85	904	904
Kanda, JPN	33.79	131.01	5,415	5,415
Kaohsiung, TWN	22.57	120.31	6,131	6,131
Kashima, JPN	35.93	140.69	4,694	4,695
Keelung, TWN	25.15	121.76	5,876	5,876
Kitimat, CAN	54.00	-128.69	1,353	1,353
Kobe, JPN	34.68	135.24	5,222	5,223
La Pampilla, PER	-11.96	-77.13	3,628	3,627
La Paz, MEX	24.17	-110.32	1,024	1,023
Lazaro Cardenas, MEX	17.93	-102.18	1,347	1,345
Longview, USA	46.11	-122.97	896	896
Manila, PHL	14.52	120.95	6,511	6,511
Manzanillo, MEX	19.07	-104.30	1,200	1,199
Manzanillo, PAN	9.36	-79.89	2,977	2,976
Marquesas Islands, PYF	-9.81	-139.04	2,847	2,846
Martinez, USA	38.03	-122.13	369	369
Mazatlan, MEX	23.19	-106.40	1,025	1,024
Milford Haven, GBR	51.71	-5.04	7,395	7,394
Moorea, PYF	-17.51	-149.82	3,550	3,549
Muara Pantai, IDN	-3.21	116.28	7,587	7,587
Muara, BRN	5.03	115.07	7,063	7,063
Moruran, JPN	42.34	140.96	4,511	4,511
Nagoya, JPN	35.05	136.85	5,067	5,067
Nakhodka, RUS	42.80	132.89	4,892	4,892
Nansha, CHN	23.01	112.99	6,450	6,450
Nantong, CHN	32.02	120.77	5,688	5,688
New Orleans, USA	29.91	-90.09	4,355	4,354
New Westminster, CAN	49.19	-122.92	1,105	1,105
New York, USA	40.69	-74.03	5,147	5,146
Nghi Son, VNM	19.31	105.82	6,838	6,838
Niigata, JPN	37.99	139.22	4,754	4,754
Ningbo, CHN	29.94	121.85	5,684	5,685
Ningde, CHN	26.76	119.67	5,856	5,857
Nueva Palmira, URY	-33.88	-58.42	8,607	8,606
Nuku Hiva, PYF	-8.87	-140.10	2,823	2,822
Oakland, USA	37.80	-122.30	349	350
Onsan, KOR	35.32	129.29	5,174	5,174

Port	Latitude	Longitude	Arrival Distance (nm)	Departure Distance (nm)
Osaka, JPN	34.64	135.43	5,226	5,226
Panama, PAN	8.96	-79.53	2,930	2,929
Pecem, BRA	-3.55	-38.81	5,782	5,782
Pisco, PER	-13.71	-76.20	3,741	3,740
Pittsburgh, USA	40.45	-80.01	5,760	5,759
Point Tupper, CAN	45.60	-61.37	5,552	5,550
Port Angeles, USA	48.13	-123.44	1,042	1,043
Port Hueneme, USA	34.15	-119.21	24	24
Port Kembla, AUS	-34.46	150.90	6,569	6,567
Port Klang, MYS	3.00	101.38	7,836	7,837
Portland, USA	45.61	-122.78	929	929
Praia Mole, BRA	-20.28	-40.23	7,149	7,148
Prince Rupert, CAN	54.29	-130.36	1,375	1,376
Puerto Bolivar, ECU	-3.26	-80.00	3,148	3,146
Puerto Quetzal, GTM	13.92	-90.79	2,049	2,048
Puerto Vallarta, MEX	20.66	-105.25	1,107	1,106
Punta Arenas, CRI	9.98	-84.81	2,503	2,502
Pusan, KOR	35.11	129.06	5,193	5,193
Pyeongtaek, KOR	36.99	126.79	5,560	5,560
Qingdao, CHN	36.10	120.32	5,656	5,656
Redwood City, USA	37.51	-122.21	367	367
Richmond, USA	37.91	-122.36	347	348
Rio de Janeiro, BRA	-22.88	-43.20	7,429	7,428
Rodeo, USA	38.04	-122.27	360	360
Rodman, PAN	8.96	-79.58	2,930	2,929
Rotterdam, NLD	51.93	4.30	7,773	7,772
Sacramento, USA	38.56	-121.56	422	423
Sakai, JPN	32.98	131.92	5,333	5,333
Salina Cruz, MEX	16.16	-95.20	1,799	1,798
San Diego, USA	32.68	-117.16	52	52
San Francisco, USA	37.79	-122.40	342	342
San Lorenzo, HND	13.40	-87.43	2,274	2,273
Santa Barbara, USA	34.41	-119.69	46	44
Santa Rosalia, MEX	27.34	-112.26	1,210	1,209
Santo Tomas de Castilla, GTM	15.69	-88.62	3,106	4,344
Santos, BRA	-23.97	-46.30	7,651	7,650
Seattle, USA	47.58	-122.35	1,111	1,111
Selby, GBR	53.79	-1.07	8,026	8,025
Shanghai, CHN	31.39	121.52	5,635	5,635
Shimotsu, JPN	34.12	135.13	5,191	5,191
Singapore, SGP	1.29	103.73	7,633	7,634
St. Eustatius, ANT	17.48	-64.89	3,976	3,975
Stockton, USA	37.95	-121.33	413	413
Taboguilla Island, PAN	8.81	-79.52	2,920	2,919
Tacoma, USA	47.27	-122.41	1,128	1,128
Taicang, CHN	31.65	121.20	5,656	5,656
Taipei, TWN	25.18	121.41	5,891	5,891
Tanjung Pelepas, MYS	1.36	103.55	7,644	7,644
Tauranga, NZL	-37.66	176.18	5,812	5,631

Port	Latitude	Longitude	Arrival Distance (nm)	Departure Distance (nm)
Tianjin, CHN	39.01	117.46	5,873	5,873
Tokyo, JPN	35.62	139.79	5,148	5,148
Tonga, JPN	34.06	131.75	5,392	5,392
Topolobampo, MEX	25.59	-109.05	1,055	1,054
Ulsan, KOR	35.49	129.39	5,164	5,164
Valparaiso, CHL	-33.04	-71.62	4,768	4,767
Vancouver, CAN	49.30	-123.07	1,119	1,119
Vancouver, USA	45.63	-122.71	928	928
Vanino, RUS	49.09	140.27	4,620	4,620
Veracruz, MEX	19.21	-96.13	4,374	4,372
Victoria, CAN	48.43	-123.41	1,048	1,048
Vung Tau, VNM	10.39	107.10	7,129	7,130
Xiamen, CHN	24.45	118.02	5,966	5,966
Yangshan, CHN	30.62	122.07	5,638	5,638
Yantian, CHN	22.57	114.27	6,331	6,332
Yeosu, KOR	34.75	127.76	5,269	5,269
Yokohama, JPN	35.44	139.67	5,139	5,139
Zhangjiagang, CHN	31.98	120.42	5,708	5,709
Zhoushan, CHN	30.00	122.10	5,686	5,686
Zhuhai, CHN	22.24	113.59	6,372	6,372