PORT OF LOS ANGELES
Inventory of Air Emissions 2021

Highlights | September 2022

THE PORT OF LOS ANGELES

STARCREST CONSULTING GROUP, LLC
ENVIRONMENTAL MANAGEMENT · AIR QUALITY · CLIMATE · SUSTAINABILITY

FOREWORD

This document provides an overview of the air quality improvement efforts associated with the Port of Los Angeles (POLA) in reaching its goals as presented in the San Pedro Bay Ports Clean Air Action Plan (CAAP). This Port of Los Angeles Emissions Inventory Highlights document presents calendar year 2021 inventory findings, trends in emissions and cargo since 2005, CAAP measure progress, and upcoming highlights for 2022 and beyond. This document does not replace the detailed annual emissions report; it complements it by looking into specific topics of interest in greater detail in the context of trends and CAAP goals, in a reader-friendly format.
https://www.portoflosangeles.org/environment/air-quality/air-emissions-inventory

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Please note that due to rounding and decimal places shown in this document, on occasion, the totals and percentages may not add up.

Photos by Port of Los Angeles

Introduction

The Port of Los Angeles (POLA) Emissions Inventory Highlights document is published in conjunction with the annual emissions inventories. This document is intended to provide the key findings of the annual emissions inventory and to track progress with the goals of the San Pedro Bay Ports Clean Air Action Plan (CAAP). The CAAP focuses on emissions of diesel particulate matter (DPM), oxides of nitrogen (NOx), sulfur oxides (SOx), and greenhouse gases (GHG).

In March 2006, a groundbreaking meeting occurred at the highest level between POLA, Port of Long Beach (POLB), and the South Coast Air Quality Management District (SCAQMD) where all parties expressed the need to work jointly toward solutions to reduce emissions from port-related operations. Shortly thereafter, the Ports also engaged the California Air Resources Board (CARB) and the United States Environmental Protection Agency Region 9 (EPA) in the spirit of cooperation to help the Ports develop the original 2006 San Pedro Bay Ports CAAP and the 2010 CAAP Update. The CAAP was last updated in 2017.

As part of the 2010 CAAP Update, the Ports developed mass emissions and health risk reduction standards in coordination with the CARB, EPA, and SCAQMD. These emissions reduction goals set the bar for performance for port-related emissions sources and represent the Ports' "fair share" in reducing emissions in the South Coast Air Basin (the Basin).

THE PORT
OF LOS ANGELES

The **San Pedro Bay Standards** are a statement of the Ports' commitments to significantly reduce the air quality impacts from port operations. Achievement of the goals listed below will require continued coordination with agency partners, diligent pursuit of all of the existing CAAP measures, and aggressive action to seek out further emissions and health risk reductions from port-related sources from strategies that will emerge over time. The standards are relative to 2005 conditions.

Mass Emissions Reduction Standards -
By 2014, reduce emissions by 72% for DPM, 22% for NOx, & 93% for SOx.
By 2023, reduce emissions by 77% for DPM, 59% for NOx, & 93% for SOx.

Health Risk Reduction Standard - By 2020, reduce the population-weighted residential cancer risk of port-related DPM emissions by 85%.

In addition, the CAAP sets out various measures for ocean-going vessels (OGV), harbor craft (HC), cargo handling equipment (CHE), locomotives, and heavy-duty vehicles (HDV). Additional initiatives, such as the Technology Advancement Program (TAP) and the zero emissions effort, support POLA's progress at attaining and maintaining the standards into the future.

Calendar year 2020 was an unprecedented year as the COVID-19 pandemic impacted all sectors of society. Those impacts continued throughout 2021. The logistics chain was fundamentally disrupted, especially for ship operations at berth and at anchorage. Ship disruptions drove annual emissions across the Port to levels not seen in more than a decade and set a new high in GHG emissions compared to 2005.

2017 CAAP Update - GHG Goals

The 2017 CAAP Update introduced two GHG goals that align with state and mayor goals for both cities. The **GHG Goals** include:

By 2030, reduce port-related GHG emissions to 40% below 1990 levels.
By 2050, reduce port-related GHG emissions to 80% below 1990 levels.

https://cleanairactionplan.org/

Report Card

Every year, POLA produces a "Report Card" summary that helps distill each current-year inventory and compare it to 2005, showing progress toward the CAAP goals. The report card has been effective in communicating a high-level understanding of emissions reduction progress to date, describing Port efficiency measured in emissions per twenty-foot equivalent units (TEUs), and showing pollutant emissions for the five emission source categories. Additional relevant information is also provided each year on the report card. The report cards are posted annually on the POLA website. *https://www.portoflosangeles.org/environment/air-quality/air-emissions-inventory*

AIR QUALITY REPORT CARD 2021

SAN PEDRO BAY STANDARDS

The San Pedro Bay Standards establish the long-term emissions-reduction and health risk-reduction goals for the ports of Los Angeles and Long Beach. Emission Reduction Standards for DPM, NOx, and SOx have target years of 2014 and 2023 to support state ambient air quality goals. The Health Risk Reduction Standard has a target year of 2020 to align with California Air Resources Board's Goods Movement Emission Reduction Plan.

All changes shown are compared to 2005 baseline levels.

CLEAN AIR ACTION PLAN (CAAP) GOALS

	2014	2023
DPM	72%	77% ↓
NOx	22%	59% ↓
SOx	93%	93% ↓
	2020	
Health Risk	85% ↓	

OVERALL EMISSIONS REDUCTIONS

Pollutant	%	Tons
DPM	84%	704 ↓
PM2.5	80%	693 ↓
PM10	82%	819 ↓
NOx	44%	6,730 ↓
SOx	95%	4,584 ↓

EMISSIONS REDUCTIONS PER 10,000 TEU HANDLED

Pollutant	%	Tons
DPM	92%	0.99 ↓
PM2.5	91%	0.99 ↓
PM10	91%	1.17 ↓
NOx	60%	12.48 ↓
SOx	96%	6.22 ↓

OCEAN-GOING VESSEL EMISSIONS CHANGES

Pollutant	%	Tons
DPM	81%	366 ↓
PM2.5	76%	372 ↓
PM10	79%	482 ↓
NOx	15%	796 ↑
SOx	95%	4,435 ↓

HEAVY-DUTY VEHICLE/CLEAN TRUCK EMISSIONS REDUCTIONS

Pollutant	%	Tons
DPM	98%	242 ↓
PM2.5	98%	232 ↓
PM10	98%	242 ↓
NOx	83%	5,265 ↓
SOx	91%	41 ↓

HARBOR CRAFT EMISSIONS REDUCTIONS

Pollutant	%	Tons
DPM	54%	18 ↓
PM2.5	54%	17 ↓
PM10	54%	18 ↓
NOx	20%	141 ↓
SOx	88%	3 ↓

RAIL EMISSIONS REDUCTIONS

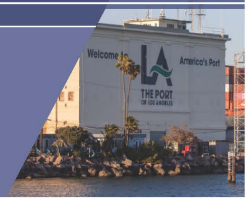
Pollutant	%	Tons
DPM	52%	30 ↓
PM2.5	53%	28 ↓
PM10	52%	30 ↓
NOx	56%	961 ↓
SOx	99%	97 ↓

CARGO-HANDLING EQUIPMENT EMISSIONS REDUCTIONS

Pollutant	%	Tons
DPM	91%	48 ↓
PM2.5	88%	44 ↓
PM10	88%	48 ↓
NOx	74%	1,159 ↓
SOx	78%	7 ↓

CO_2 EQUIVALENT CHANGES BY SOURCE TYPE

Source Type	%	Metric Tons
Ocean-Going Vessels	80%	223,989 ↑
Harbor Craft	19%	8,525 ↑
Cargo-Handling Equip.	37%	50,216 ↑
Rail	21%	16,985 ↓
Heavy-Duty Vehicles	6%	30,063 ↓
TOTAL	**23%**	**235,680** ↑



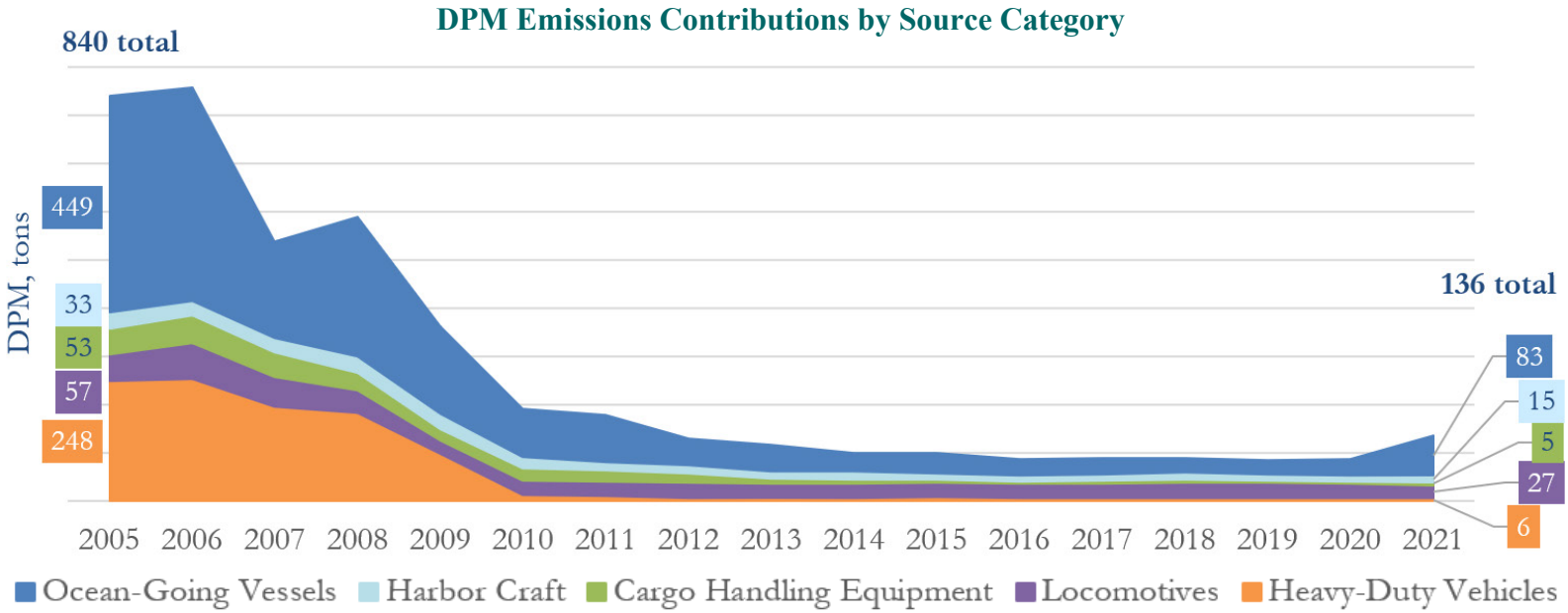
PRIMARY POLLUTANTS DEFINED:

DPM = Diesel Particulate Matter
NO_X = Oxides of Nitrogen
SO_X = Oxides of Sulfur
$PM_{2.5}$ = Particulate Matter less than 2.5 microns in diameter
PM_{10} = Particulate Matter less than 10 microns in diameter
CO_2 = Carbon Dioxide (A greenhouse gas contributor)

portofla.org/emissions-inventory

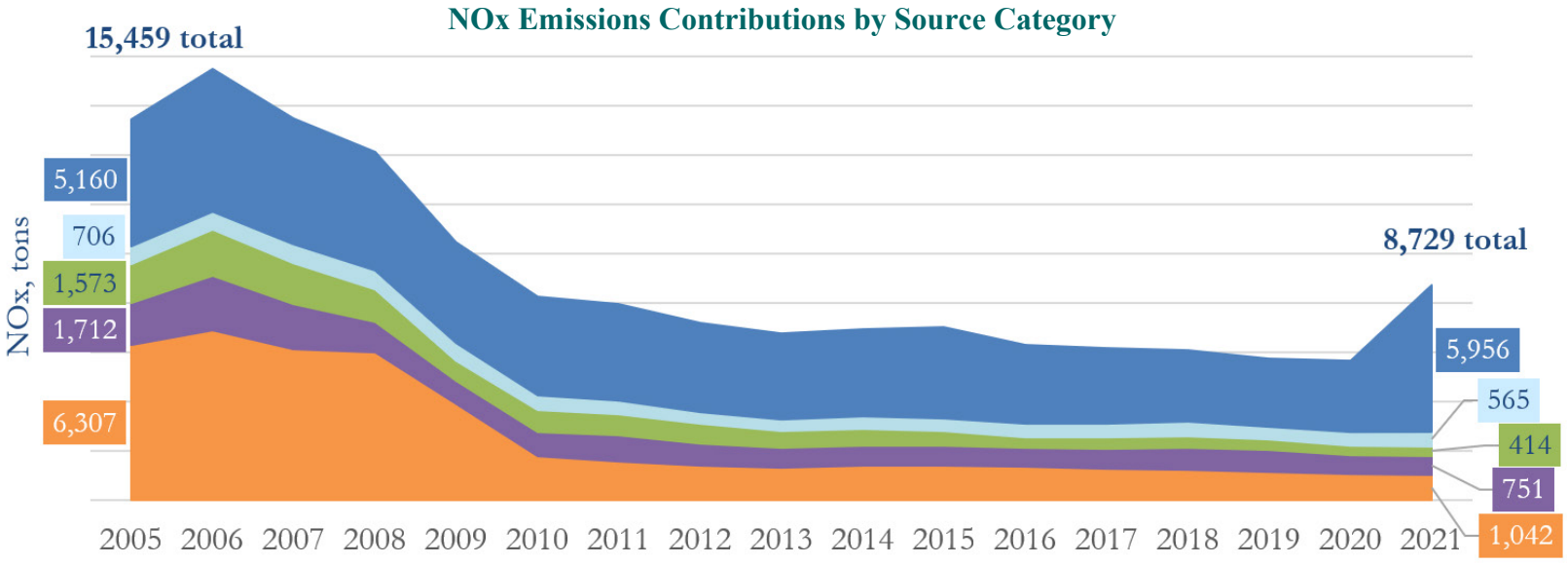
2005-2021 Emissions Inventory Trends

The POLA emissions inventory and CAAP focus on the reduction of DPM, NOx, and SOx as well as GHGs, reported in carbon dioxide equivalents (CO_2e). As highlighted above, operational disruptions that impacted OGV at-berth and at-anchorage activities drove port-wide emissions up across the board. The following figures illustrate the year-over-year emissions by source category. For each figure, note that the 2021 levels represent an unprecedented rise in emissions.

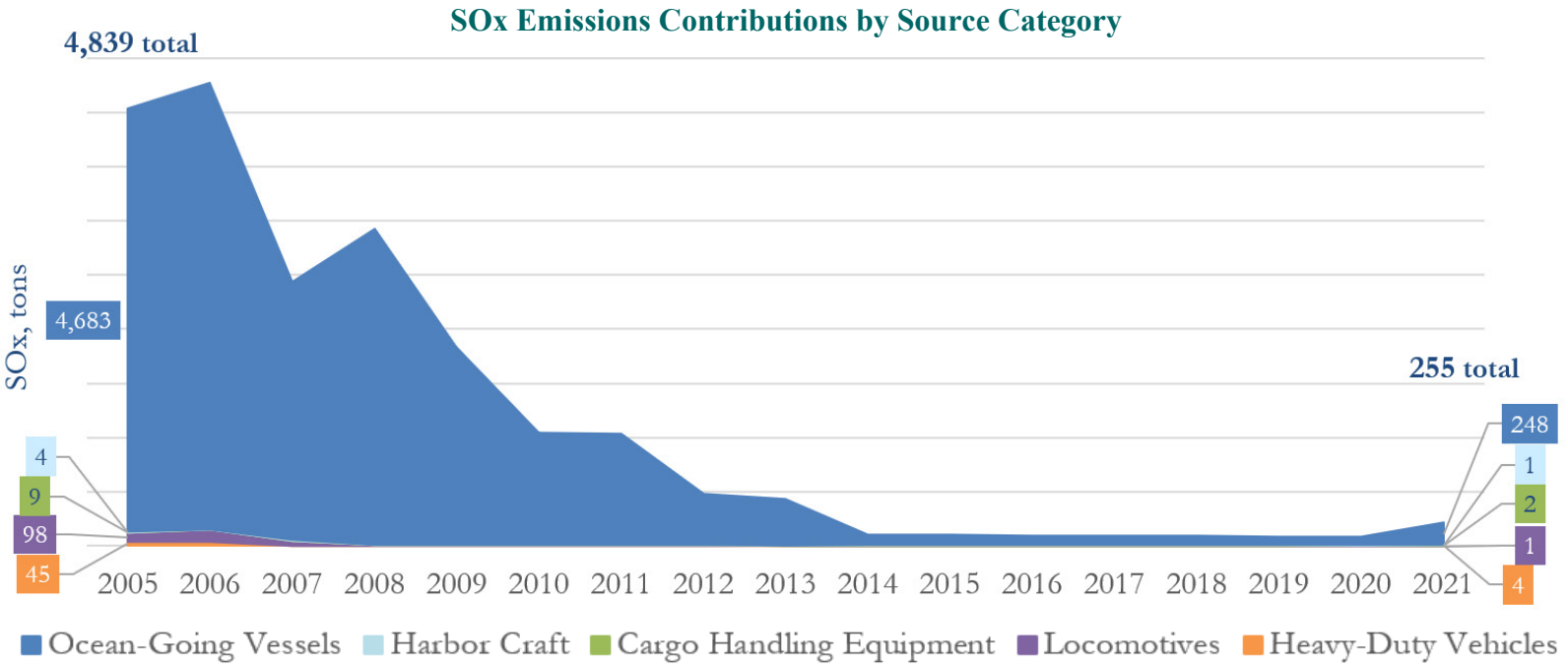


In 2021, overall DPM emissions increased 56% compared to 2020 levels. This was led by OGVs, which had DPM emissions increase from 34 to 83 tons – a 147% increase. DPM emissions from both HC and CHE increased 11%, while DPM emissions from HDV stayed nearly the same and locomotives had a slight decrease.

Similarly, overall NOx emissions increased 54% compared to 2020 levels. This was again led by OGVs, which had NOx emissions increase from 2,879 to 5,956 tons or a 107% increase. NOx emissions from CHE increased 13%, while NOx emissions from HC, locomotives, and HDV stayed nearly the same with slight decreases. More details related to OGV emissions increases are presented later in this document.

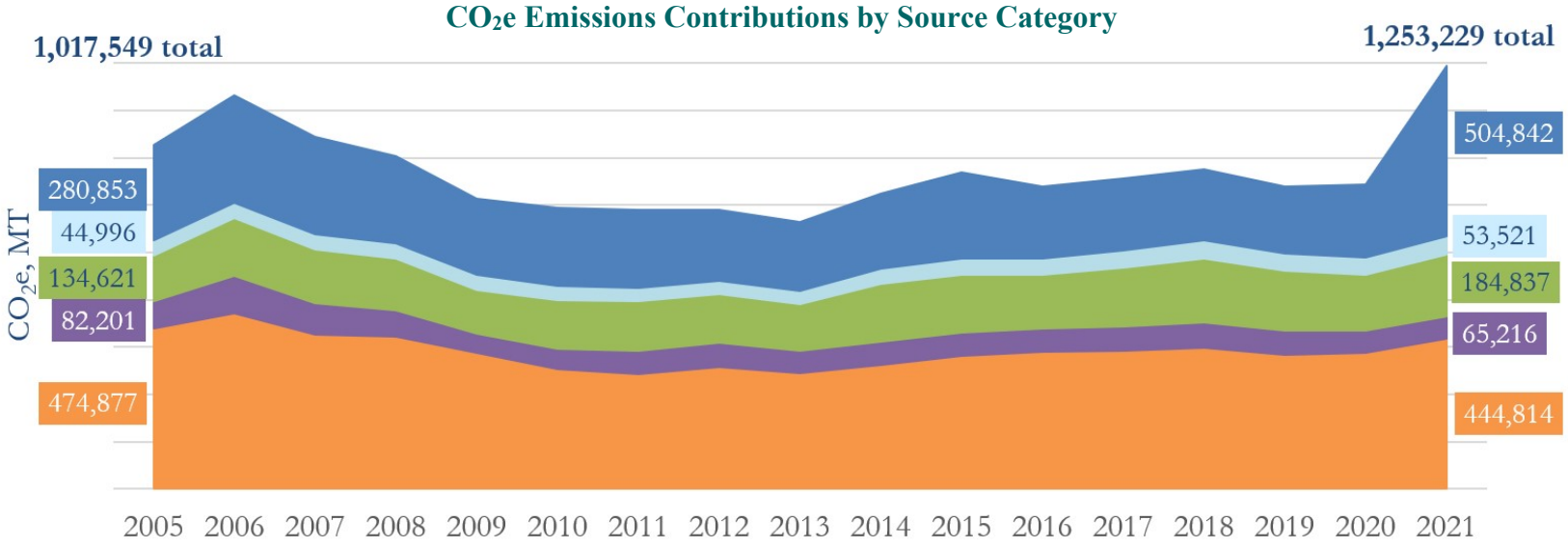


Total emissions for DPM, NOx, and SOx and emissions by source category are presented in the figures in tons. GHGs are reported in metric tons (MT). Additional pollutants are included in the more detailed technical reports located at: *https://www.portoflosangeles.org/environment/air-quality/air-emissions-inventory*.



In 2021, overall SOx emissions increased 145% compared to 2020 levels. This was led by OGVs, which had SOx emissions increase from 97 to 248 tons or a 154% increase. SOx emissions from CHE increased by 12%, HDV increased by 10%, and HC and locomotives stayed nearly the same.

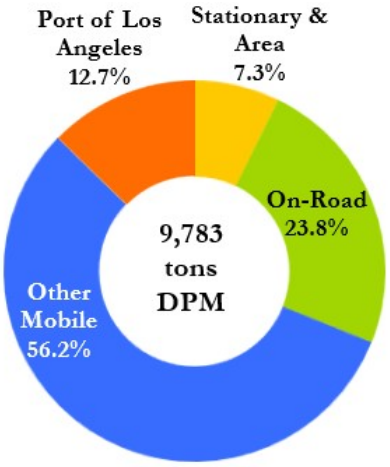
Overall CO_2e emissions increased 39% compared to 2020 levels, which is the highest level recorded since 2005. This was again led by OGVs, which had CO_2e emissions increase from 213,981 to 504,842 metric tons or by 136%. CO_2e emissions from both CHE and HDV increased by 11%, while CO_2e emissions from HC and locomotives stayed nearly the same.

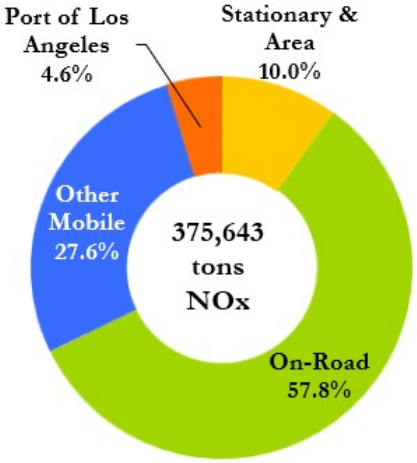


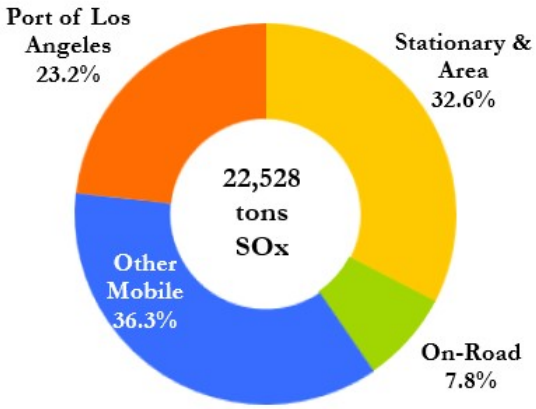
2005 & 2021 Regional Emissions Contributions

Illustrated below are the 2005 and 2021 percent pollutant contributions of port-related emissions relative to the total South Coast Air Basin emissions.

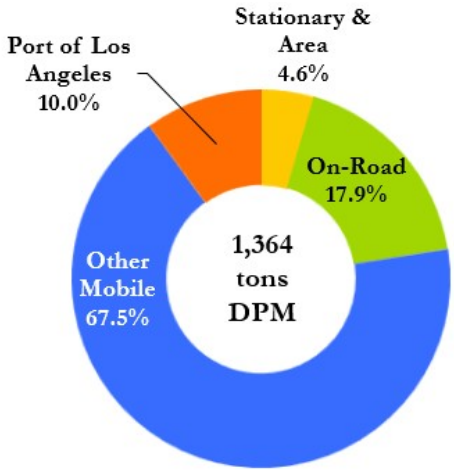
2005

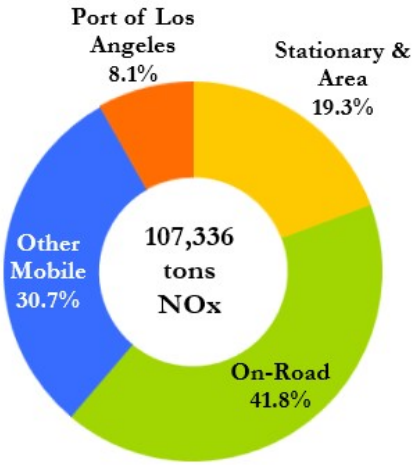


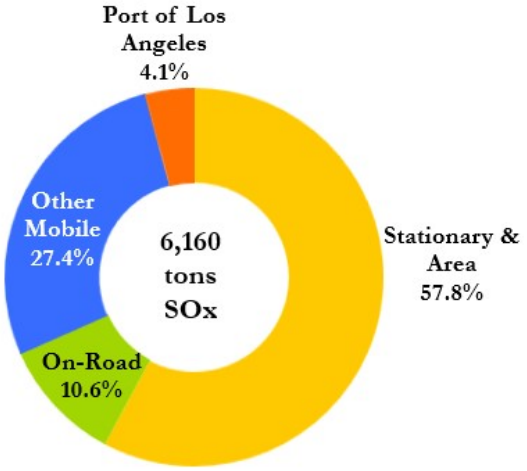




2021





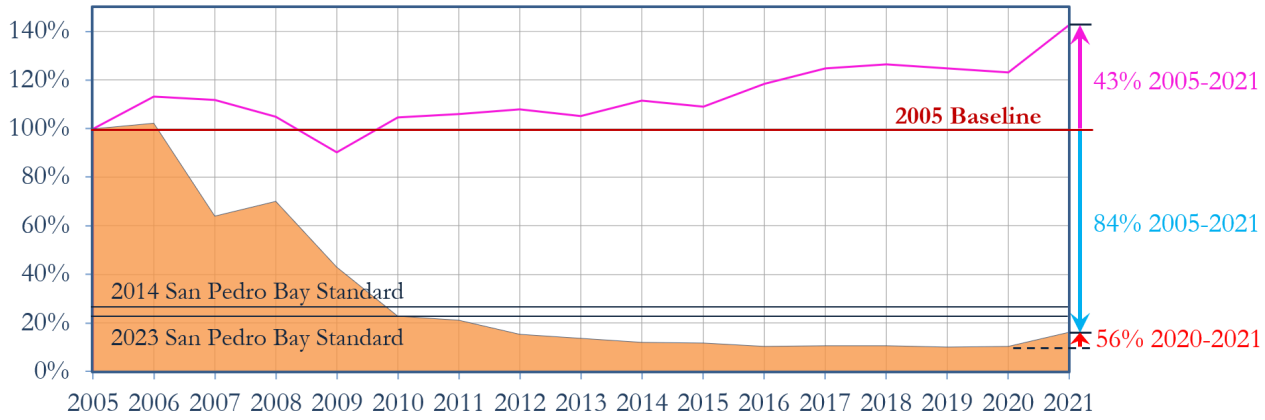


Basin-wide mass emissions have continued to be reduced from 2005 levels with DPM reduced by 86%, NOx reduced by 71%, and SOx reduced by 73%. When considering POLA-related contributions during the COVID-19 pandemic to the total Basin emissions, DPM went from 5.9% in 2020 to 10.0% in 2021. NOx increased from 5.1% in 2020 to 8.1% in 2021 and SOx rose from 1.7% to 4.1%. Again, these increases were driven primarily by emissions associated with OGVs at anchorage.

2005-2021 CAAP Progress

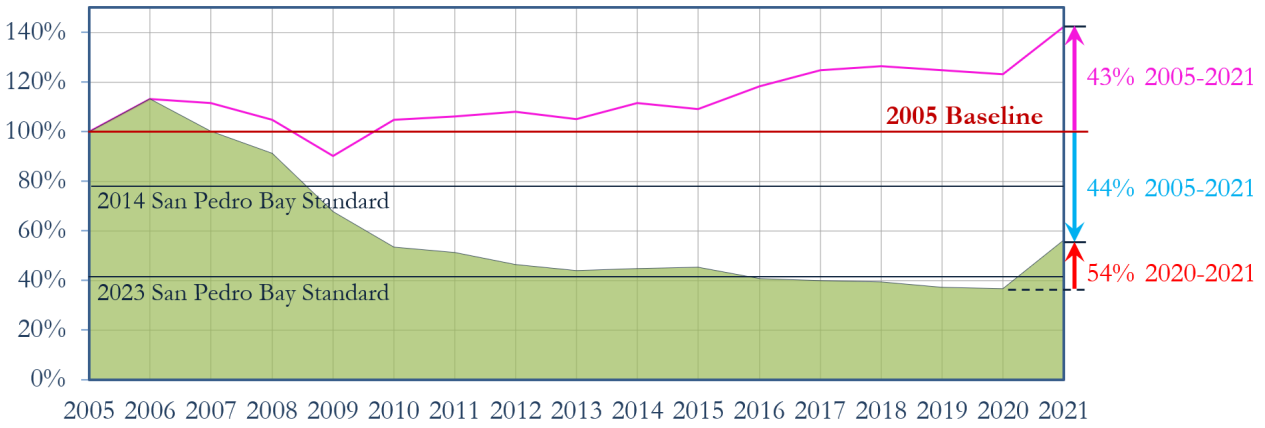
The figures below show the port-related trends for DPM, NOx, SOx, and CO_2e in relation to the CAAP standards and goals, along with cargo throughput measured in TEUs.

Port DPM Emissions



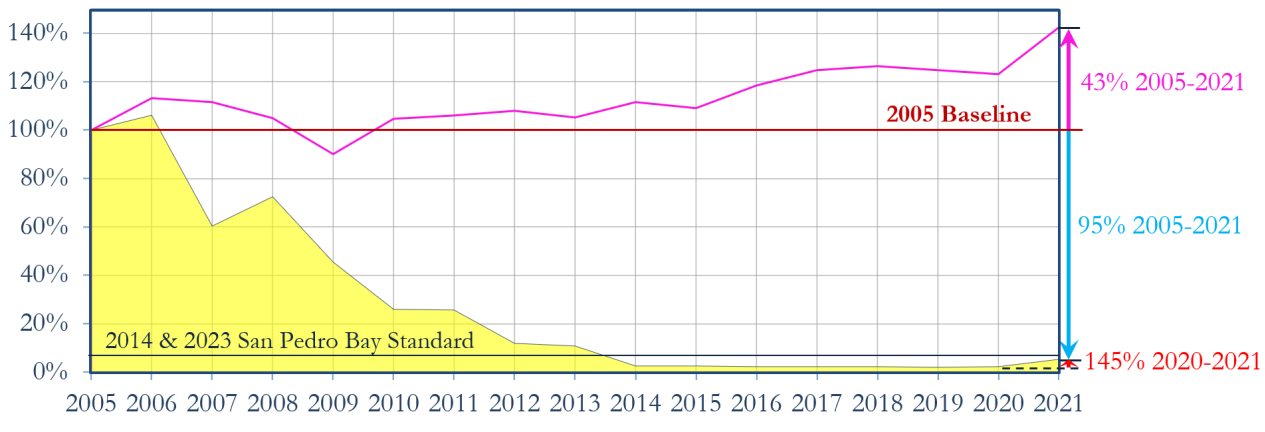
In 2021, emissions increased 56% compared to 2020 levels due to increases at anchorage and at berth. Emissions remained below the 2023 San Pedro Bay Standard and were 84% below 2005 levels.

Port NOx Emissions



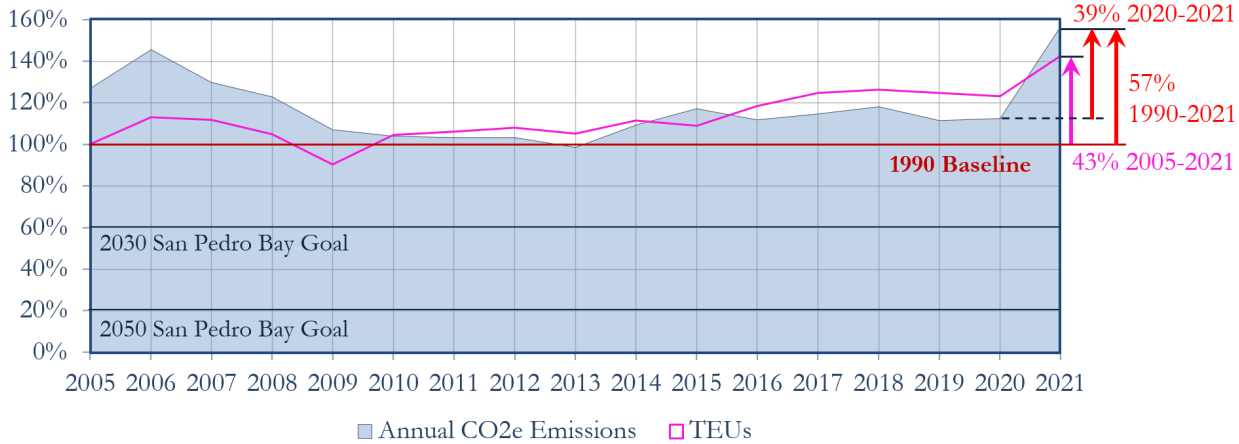
In 2021, emissions increased 54% compared to 2020 levels due to increases at anchorage and at berth. Emissions exceeded the 2023 San Pedro Bay Standard and were 44% below 2005 levels.

Port SOx Emissions



In 2021, emissions increased 145% compared to 2020 levels due to increases at anchorage and at berth. Emissions remained below the 2023 San Pedro Bay Standard and were 95% below 2005 levels.

Port CO_2e Emissions

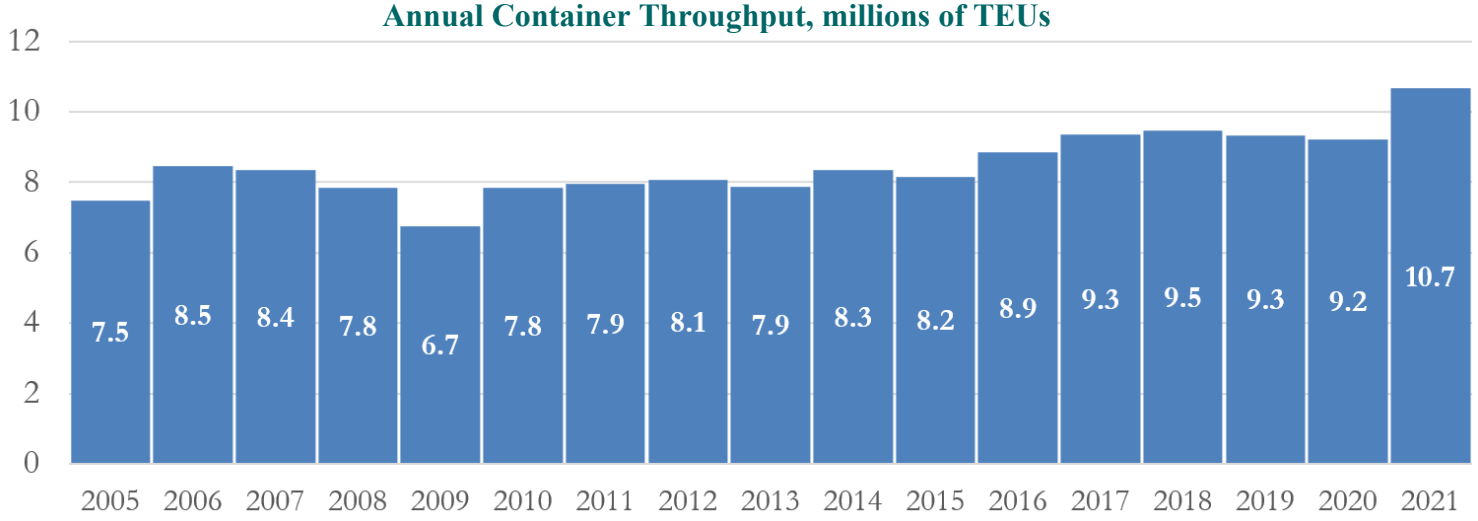


In 2021, emissions increased 39% compared to 2020 levels due to increases at anchorage and at berth. Emissions were 57% above the 1990 baseline level.

2005-2021 Cargo Growth

Cargo growth from 2005 to 2021 provides an overall activity context for the changes in emissions over time. Containers have long been the dominant cargo type at POLA. The following figure presents the changes in annual container cargo-related activity from 2005 to 2021 in millions of twenty-foot equivalent units or TEUs. Container throughput in 2021 reached over 10 million TEUs, the first time in a calendar year.

Annual Container Throughput, millions of TEUs



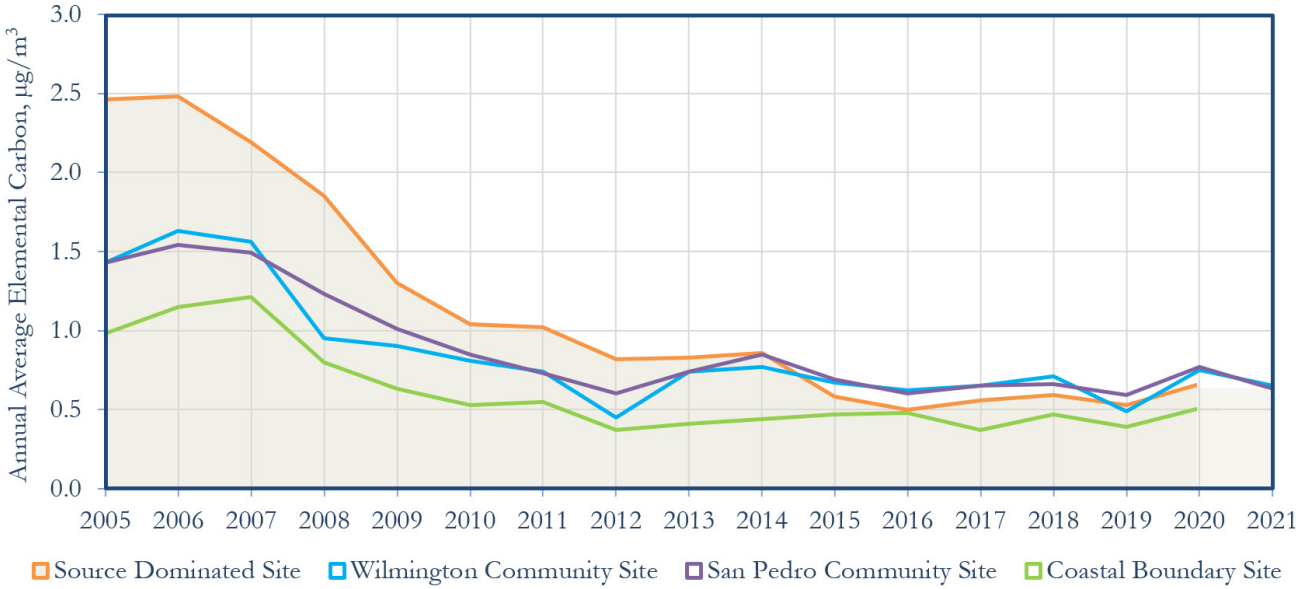
2005-2021 Air Monitoring

In addition to developing and publishing the annual emissions inventory as a means of tracking progress, POLA operates four air monitoring stations at locations around the port. Elemental carbon is monitored as a surrogate for diesel-related emissions. The figure shows how the measured annual average elemental carbon concentration readings have reduced by ~55%. The general shape Is similar to the DPM emissions inventory trends over the same period. The extraordinary wildfires in the Basin were likely responsible for the slight increase in elemental carbon in 2020.

POLA has four monitoring stations that started to collect elemental carbon data in 2005. These stations consist of the Coastal Boundary station, the Wilmington and San Pedro Community stations, and the Source Dominated station on Terminal Island in the middle of port-related operations. Please note that the Coastal Boundary and Source Dominated stations were taken offline in April 2020 and April 2021, respectively, but have since been partially reinstated. All four stations are being upgraded with new equipment in 2022 and 2023. For more information, visit:

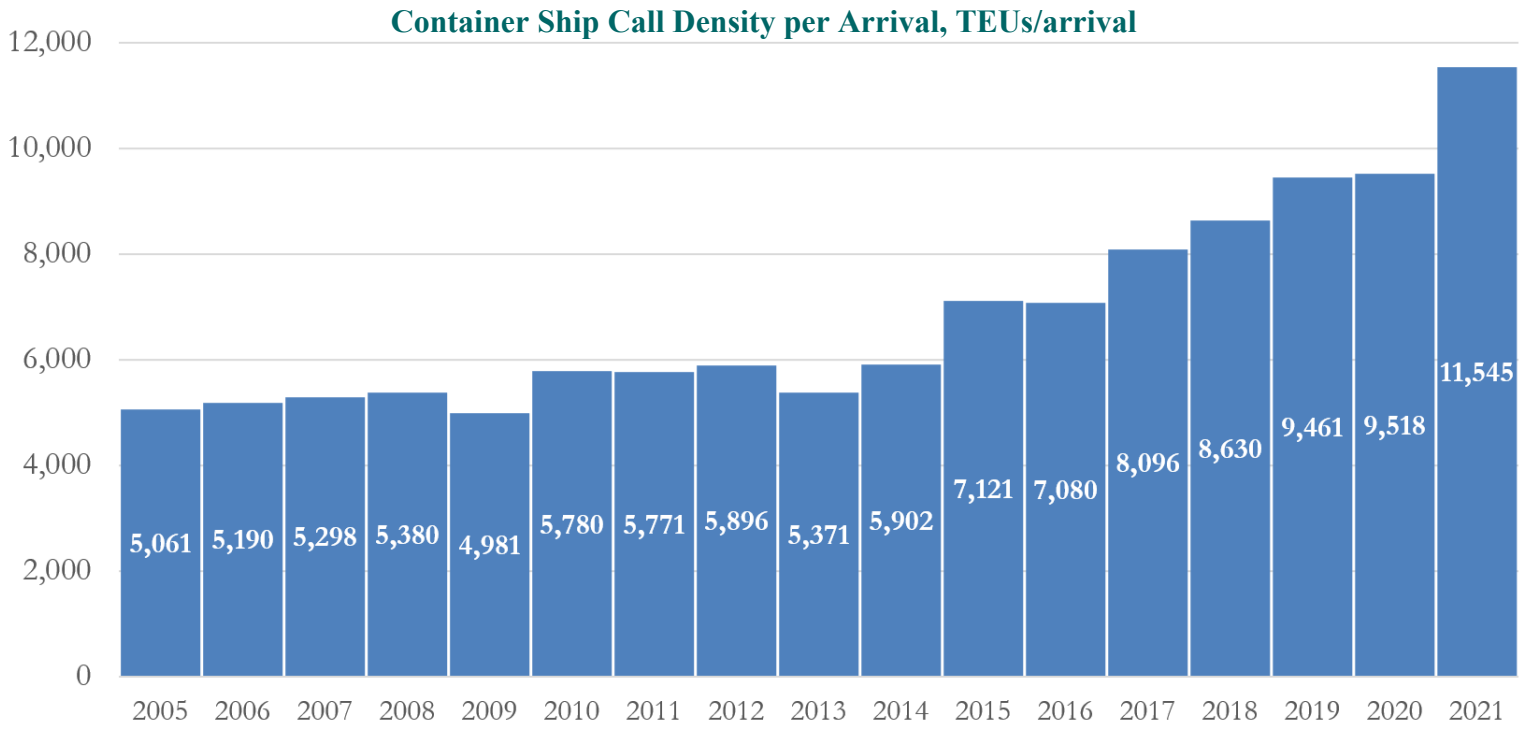
monitoring.cleanairactionplan.org

Port Air Monitoring Network, Elemental Carbon

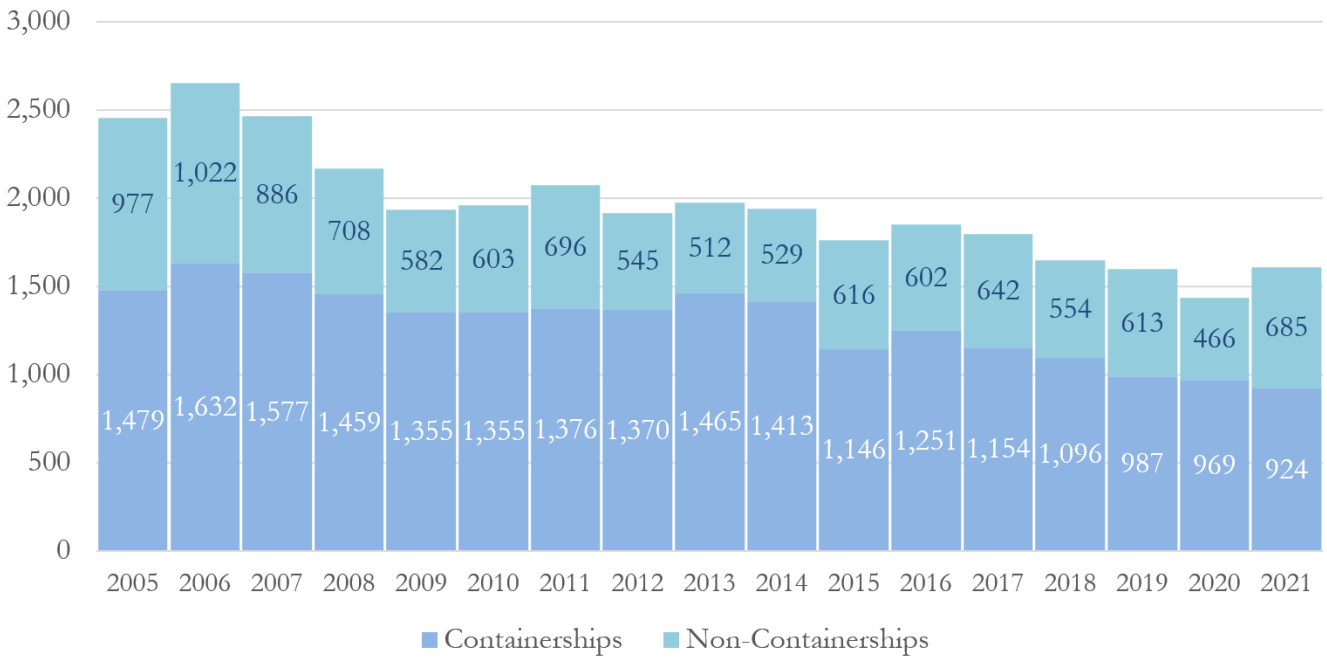


2005-2021 Port-Related Efficiency Trends

The following figure illustrates the ongoing trend of increasing cargo density on arriving container ships. The improvements in container density per arrival (in TEUs per arrival) have allowed for fewer, bigger container ships bringing 1.3 times the amount of cargo per arrival in 2021, compared to 2005. The container density increased by 21% compared to 2020 levels, even with the disruptions caused by the COVID-19 pandemic. Other operational inefficiencies, however, overcame these improvements and emissions jumped in 2021, as discussed in previous sections.



While container volume increased to nearly 1.5 million TEUs, there were 45 ***fewer*** container ship arrivals in 2021 due to the increase in container ship call density. In 2021, non-container ship arrivals increased compared to 2020 primarily from cruise ships which increased by 128 calls, bulk ships which increased by 64 arrivals, and small increases led by tankers, auto carriers, and general cargo vessels. Total arrivals increased by 12% in 2021 compared to 2020 levels.

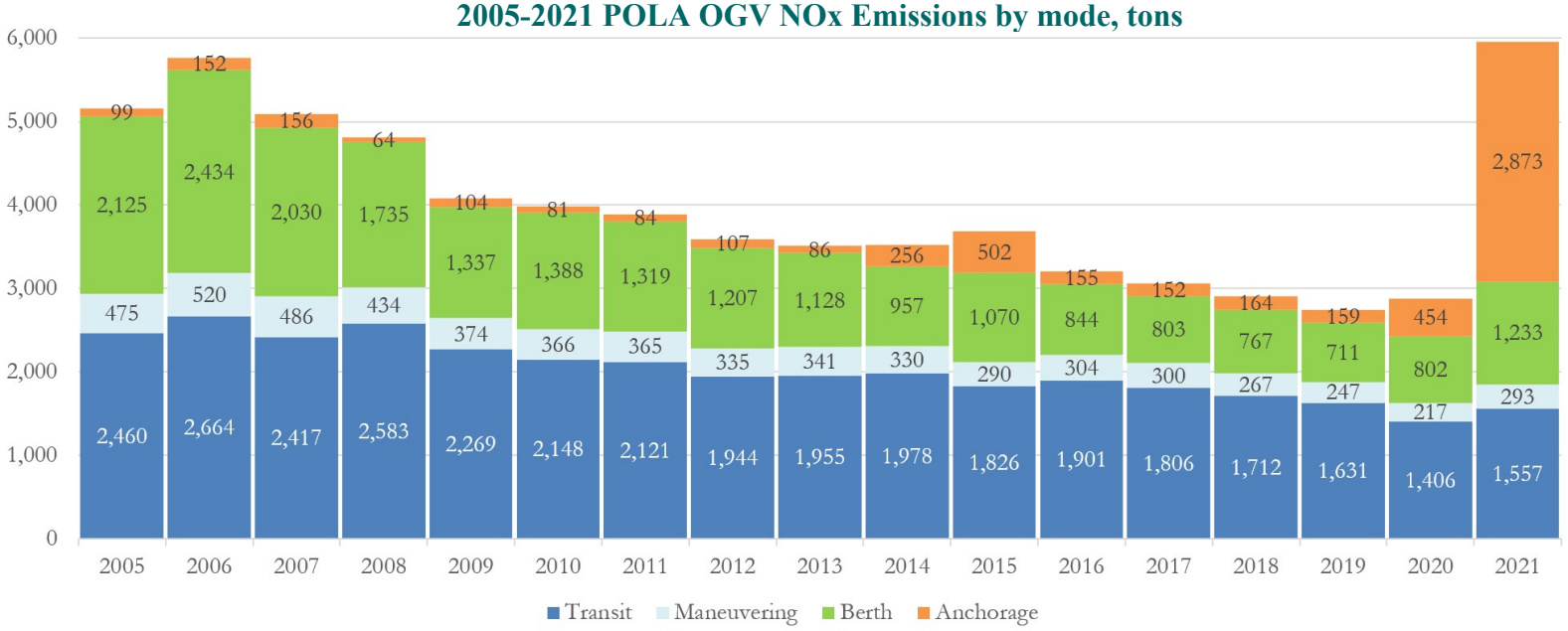


Observed Operational & Emission Impacts During Pandemic Era

Pandemic-related disruptions began in 2020 but were fully realized across all aspects of the logistics chain in 2021. At POLA, these disruptions were seen most acutely through the impacts on OGV operations. While container ship calls were slightly down and non-container ship calls were slightly up, ship activities and related emissions at anchorage and at berth reflect the greater supply chain disruption.

The figure below illustrates total POLA OGV NOx emissions by mode from 2005 to 2021. Generally, anchorage emissions are minimal with respect to the other OGV operational modes with few exceptions. Clearly 2020 and 2021 at-anchorage emissions stand out with significant increases due to ships queueing locally to wait for available berths. NOx emissions in the anchorages increased by more than 6 times compared to 2020 and nearly 18 times compared to 2019. These are by far the highest recorded anchorage activity and NOx emission rates seen in recent times. In 2021, NOx emissions at berth also increased signifcantly – by more than 50% compared to 2020 and more than 70% compared to 2019. Note that maneuvering and transit were not as impacted as the other two modes when compared to pre-pandemic levels.

2005-2021 POLA OGV NOx Emissions by mode, tons

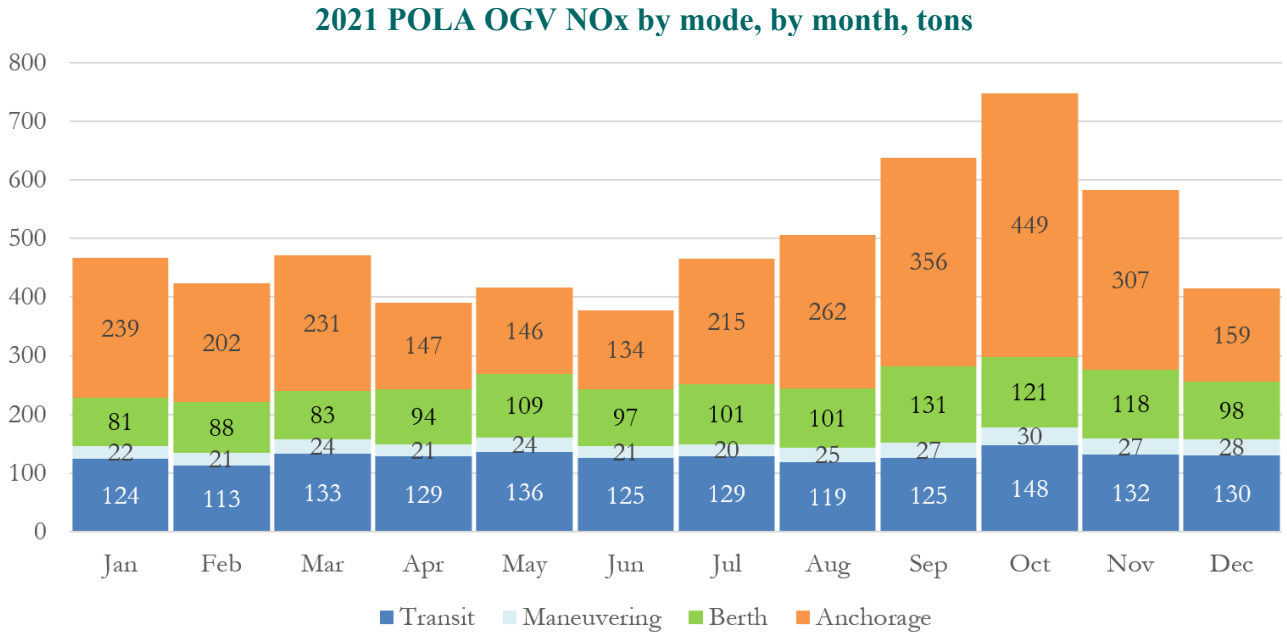


Unprecedented Emissions Levels

In 2021, the at-anchorage and at-berth NOx emissions are estimated to be over 3,000 tons higher than levels seen prior to the COVID-19 pandemic, when the logistics chain was functioning properly. To put that unprecedented level of increase in perspective:

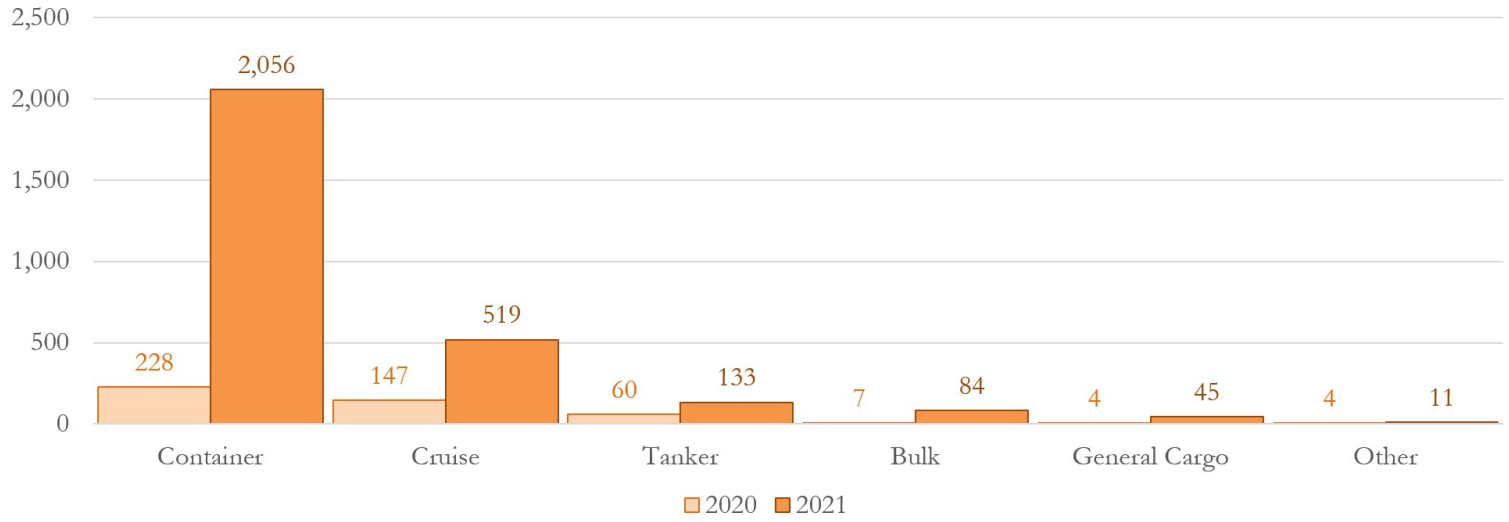
- It is greater than the total OGV NOx emissions for 2017, 2018, 2019, & 2020.
- It results in the highest OGV NOx emissions since 2005, which was historically the highest NOx emissions year since the introduction of the CAAP.
- OGV emissions made up 68% of total POLA NOx emissions compared to 2019 when OGV made up 44% of total POLA NOx emissions.

Looking at 2021 by month, as illustrated below, indicates that OGV at-anchorage and at-berth NOx emissions peaked in September/October and then started to significantly decline in December, though they were still much higher than in the pre-COVID era.



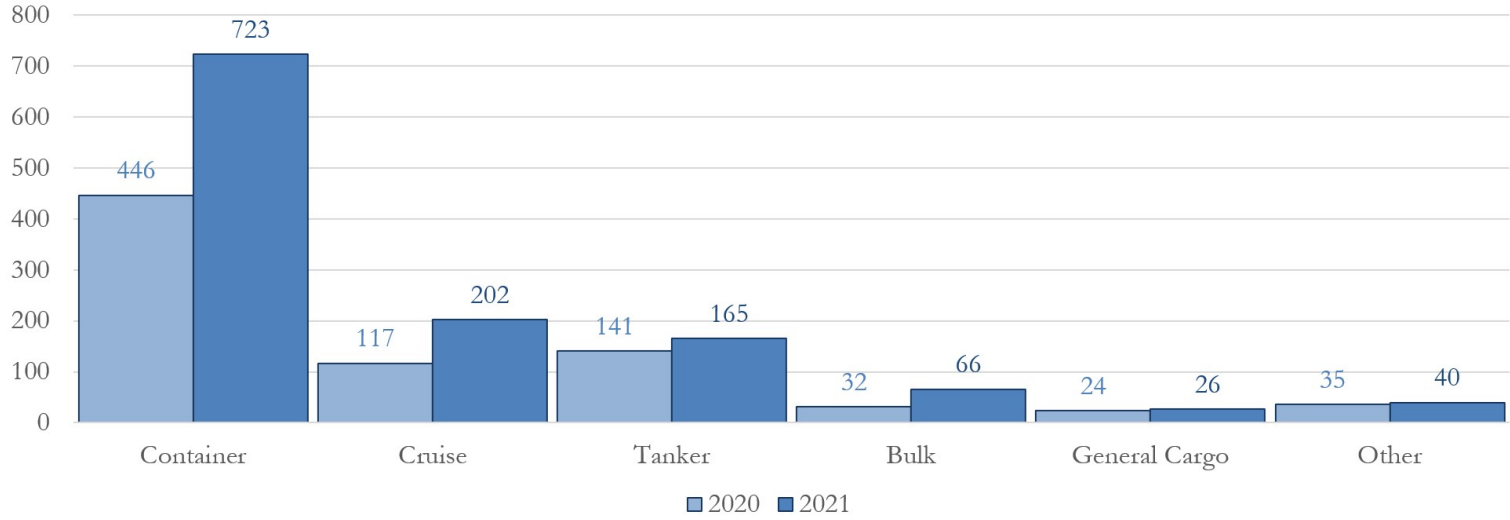
As illustrated below, the main ship types associated with the increased at-anchorage emissions were primarily container, followed by cruise, and then to a much lesser extent tanker, bulk, and general cargo.

2020 & 2021 POLA OGV Anchorage NOx Emissions, tons



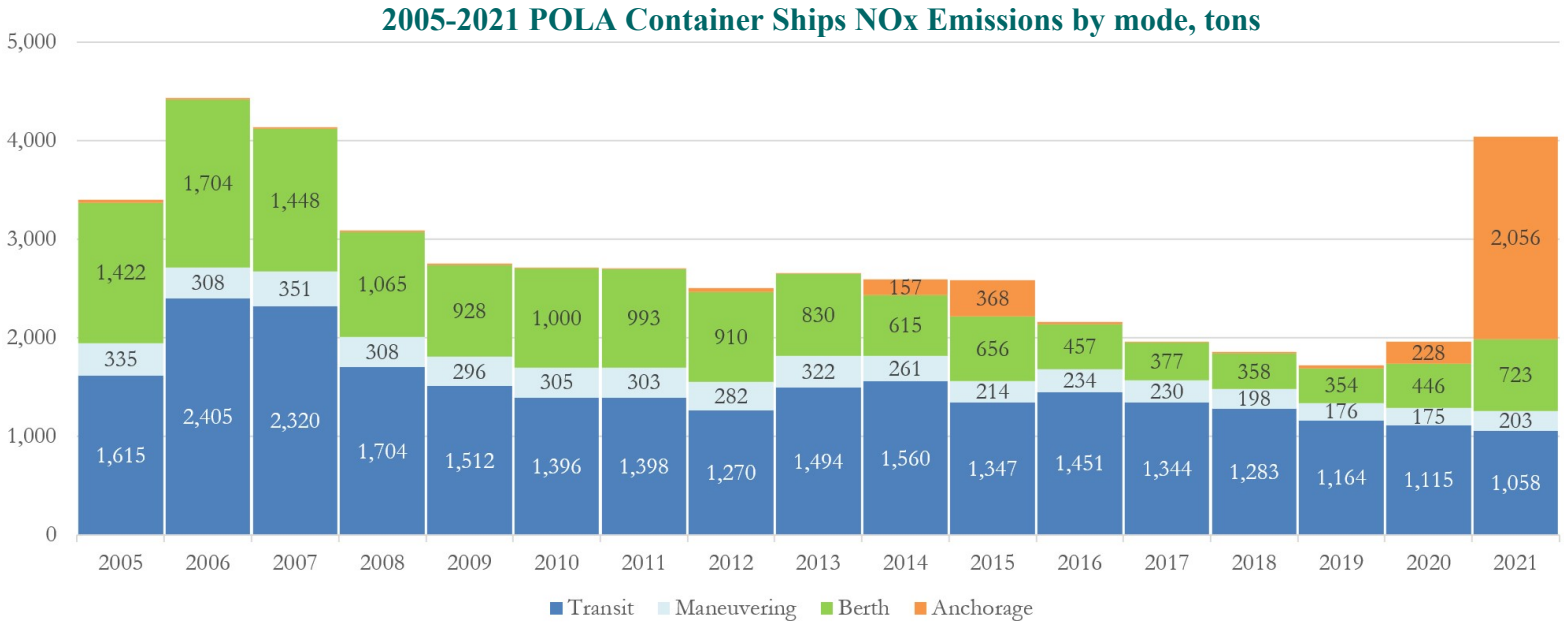
The main ship types associated with the increased at-berth emissions were primarily container, to a much lesser extent cruise, tanker, bulk, and general cargo.

2020 & 2021 POLA OGV At-Berth NOx Emissions, tons

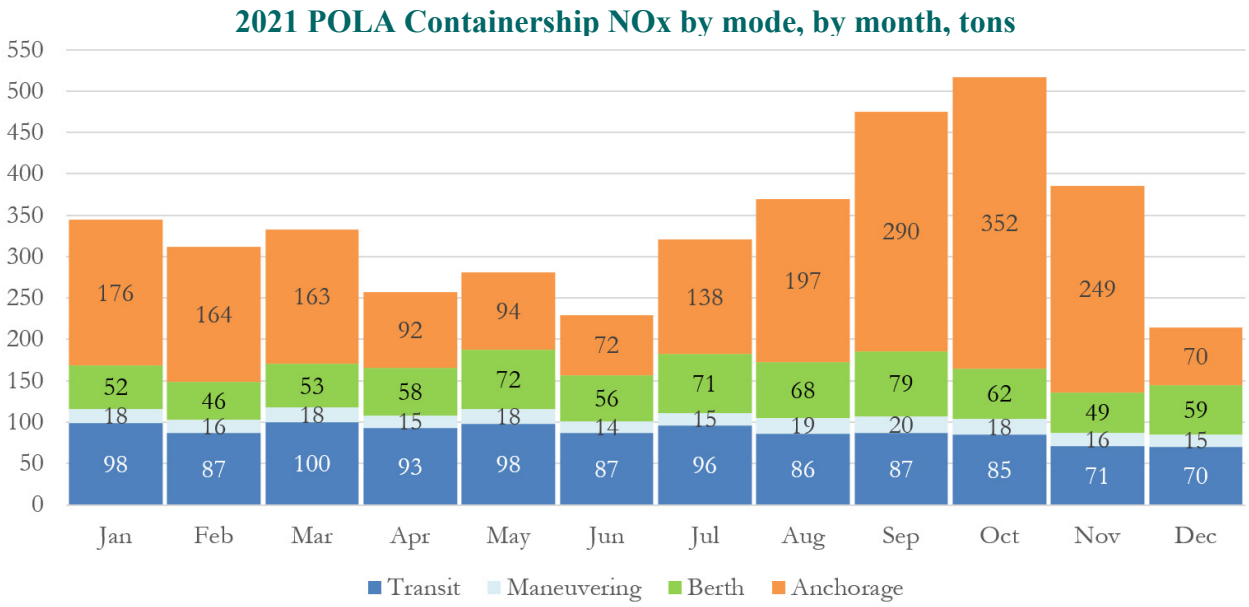


Container Ships

For container ships calling POLA, spending time at anchorage is not traditionally part of their normal business model. Typically, container ships in the anchorages indicate an operational disruption to the system. There have been three disruptions identified at POLA since 2005, which include: 2014-2015 due to the period of temporary congestion, January 2019 due to the lead up to U.S. tariffs on Chinese goods, and 2020-2021 due to the pandemic. As illustrated below, one can see that the resulting disruptions to the logistics chain, from an emissions perspective, acutely manifested in at-anchorage and to a lesser extent at-berth operations for container ships.

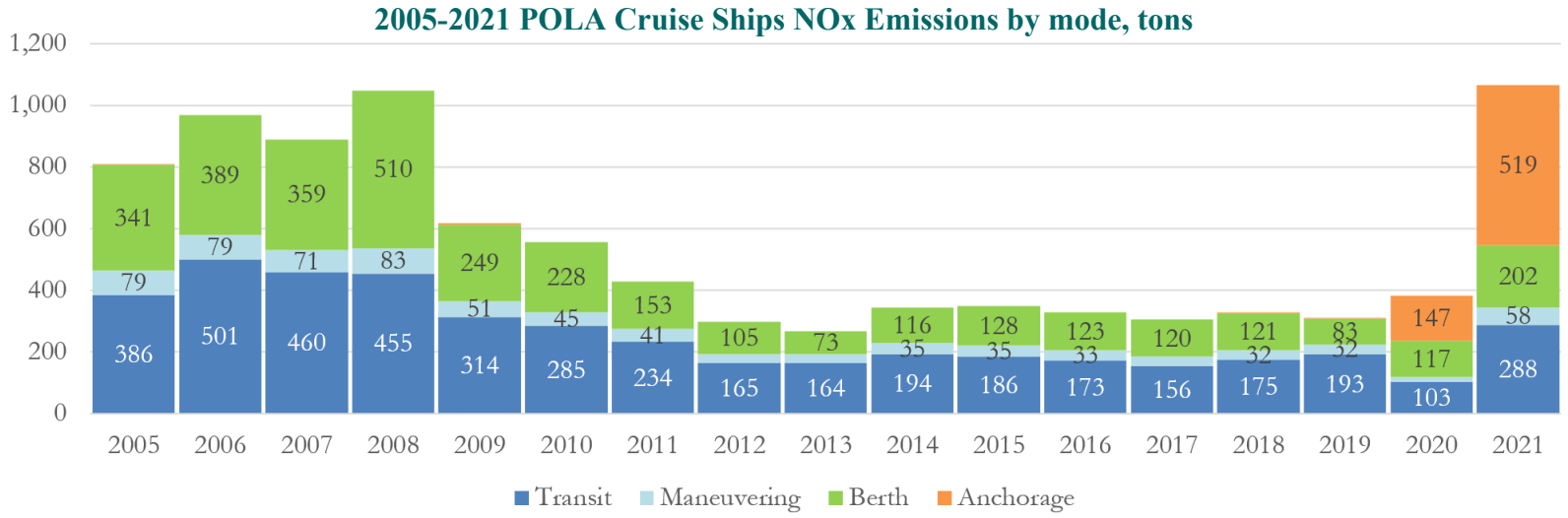


Looking at how container ship NOx emissions progressed by month through 2021, it is noted that emissions at anchorage were high in January, then declined by 44% by June, and then increased through October by 335%. This is associated with a daily average of 33 ships and the peak day being 42 POLA-bound ships at anchorage in October.

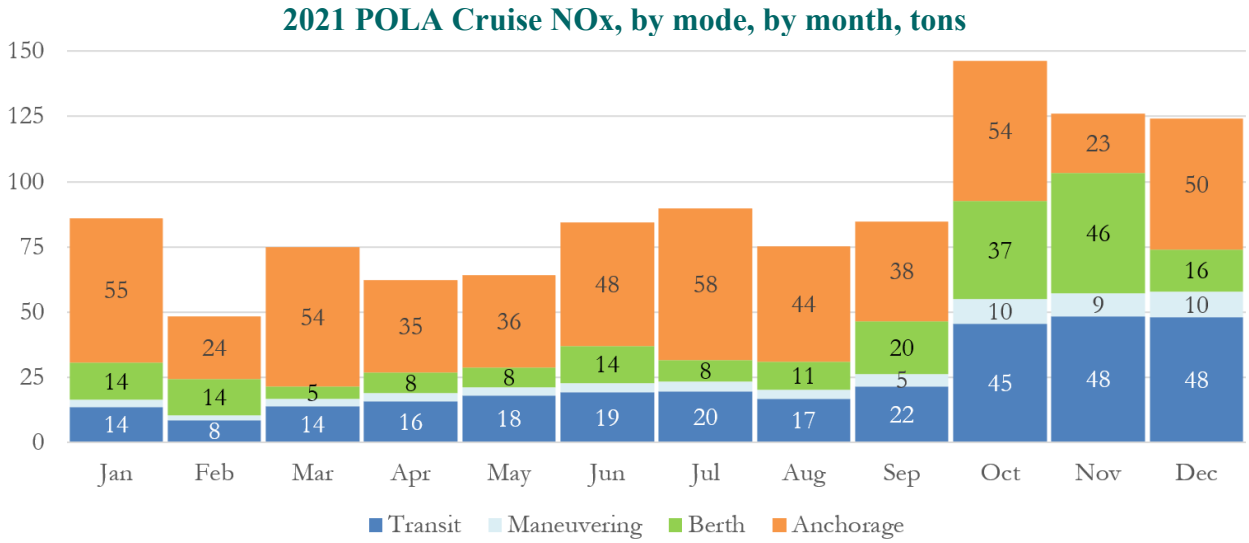


Cruise Ships

Cruise ships were the second most affected ship type after container ships; however, their total emissions were fractional compared to container ships which is the dominant vessel class at POLA. Typically, cruise ships have little to no activity at anchorage as can be seen below in terms of annual NOx emissions. In 2021, cruising started to return with 20 ships making 61 calls with 151,837 passengers embarking from POLA. Of these, 14 ships spent time at anchorage as part of the process of resuming cruise operations resulting in unprecedented emissions at anchorages. Annual cruise NOx emissions increased from 383 tons in 2020 to 1,067 tons or by nearly three times – the highest levels since inventories have been conducted and levels not seen since 2008, which had 265 calls and nearly 1.2 million passengers embarking.



Looking at how cruise ship NOx emissions progressed by month through 2021, it is noted that emissions at anchorage generally ranged from 25 to 55 tons per month. At-berth NOx emissions for cruise peaked from September through November 2021, which is consistent with the cruise season.

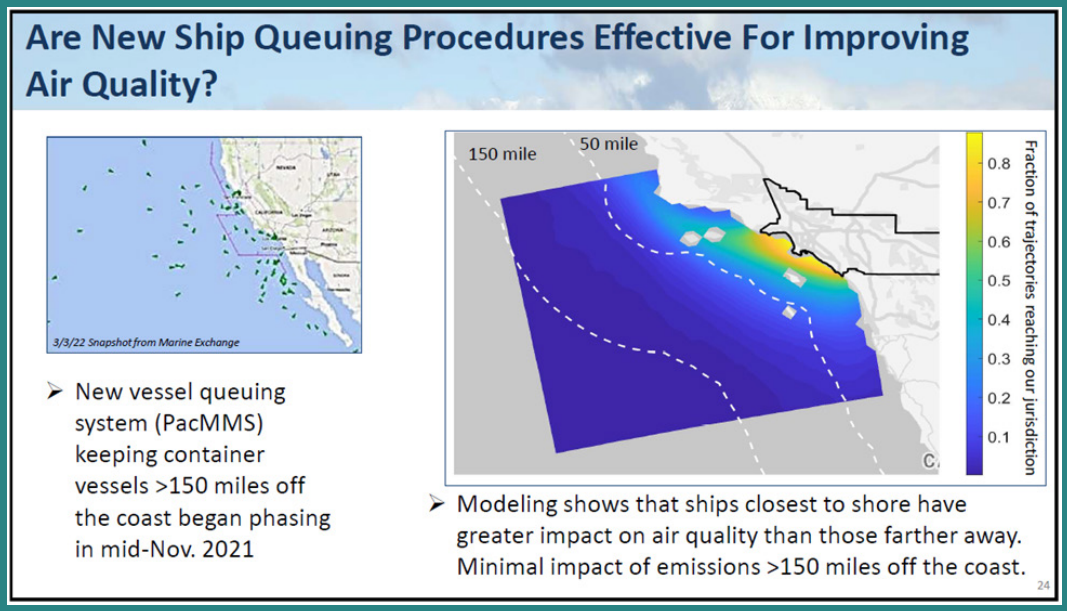


Unprecedented Anchorage Congestion & Unique Solutions

The number of container ships calling POLA that queued at local San Pedro Bay anchorages started with 1 ship on October 7, 2020, and then initially peaked with 22 ships on February 17, 2021 until subsiding to 5 ships on June 24, 2021. From there, the number of ships started increasing again, peaking with 42 ships on October 21, 2021, and again on November 10, 2021. Due to the extensive number of ships the anchorages were extended by the U.S. Coast Guard south along the California coast.

In October 2021, the Marine Exchange of Southern California (MarEx), the Pacific Merchant Shipping Association (PMSA), the Pacific Maritime Association (PMA), as well as individuals from member companies, came together to identify the reasons for the ship queueing in San Pedro Bay and to identify solutions to solve the issue. The primary issue identified was with the queueing system where container vessels were entered into the arrival queue based on when they crossed a line 20 nautical miles (nm) from the San Pedro Bay Port Complex. This resulted in ships coming to the 20 nm line for assignment into the arrival queue and then moving onto anchorages along the coast.

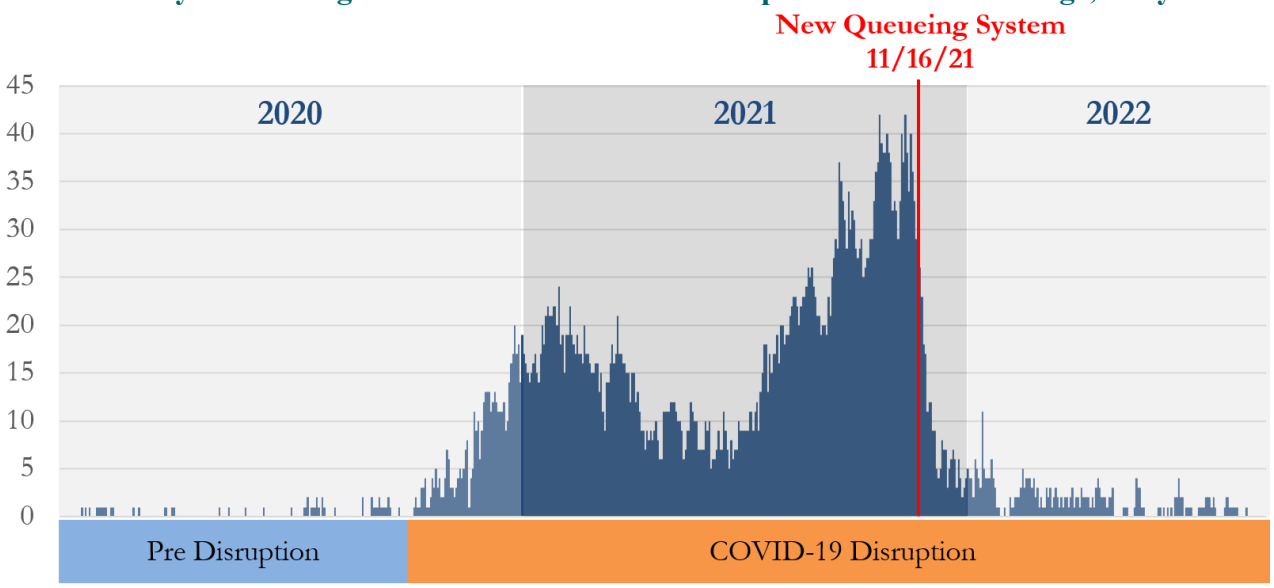
A globally unique solution was identified and implemented within 3 weeks on November 16, 2021. It consisted of the development and implementation of a new queueing system, which calls for each container vessel to be assigned a place in the arrival queue based on their departure time from their last port of call, and requires vessels to wait for an available berth approximately 150 miles off the California coast. A Safety and Air Quality Area (SAQA) was established between 40 nm and 150 miles off the coast where ships are only to transit and not wait for berth. Vessels are expected to wait for their arrival window outside the new SAQA to limit the number of container vessels near the port complex. While awaiting a berth, eastbound ships need to remain 150 miles west of Southern California, while northbound and southbound ships need to remain more than 50 miles from California and Mexico. Vessels may come into the harbor for fuel, crew changes, and regular ship business per normal processes. This new process allows vessels to slow their speed crossing the oceans and for those that arrive early, provides an appropriate waiting area outside the SAQA instead of using anchorages. In March 2022, the SCAQMD presented its findings that indicated "modeling shows that ships closest to the shore have greater impact on air quality than those farther away. Minimal impact of emissions >150 miles off the coast."



Is the new queueing process and SAQA effective?

The best way to evaluate the effectiveness of the new queueing process is to look at container ships calling POLA and their activities at anchorage from January 2020 through August 2022, as illustrated below.

January 2020 – August 2022 POLA Container Ships Counts at Anchorage, daily



Data provide by The Marine Exchange of Southern California, https://mxsocal.org/

Note that in the lead up to the logistics chain disruptions for container ships in 2020, which was roughly the first three quarters, container ships calling POLA had miminal activity at anchorage consistent with previous years. As detailed above, the impacts started to be seen early in the fourth quarter of 2020 and peaked with 22 ships on February 17, 2021. The second peak of activity in the anchorages came between early October 2021 and mid-February 2022 with up to 42 POLA-bound container vessels waiting at anchorages.

The new queueing process started on November 16, 2021, as designated by the red line above. On the commencment date, there were 40 POLA-bound container ships in anchorages. It is apparent that the number of ships in anchorages dramatically dropped from 40 to five by December 2021 or just over three weeks. It has remained less than five per day since February 17 through August 2022, with 41 days of no POLA-bound container ships at anchorage.

Is the new queueing process and SAQA program successful?

Thus far it has dramatically reduced the number of container ships in the anchorages in San Pedro Bay and in doing so has significantly reduced the health risk impacts from those operations. As shown by the SCAQMD analysis highlighted above, the emissions sources are moved out to sea beyond 50 and 150 miles; thus, the amount of pollutants reaching the South Coast Air Basin and the associated risk is significantly reduced. Nonetheless, there is still limited activity in the anchorages from container ships calling POLA and this has not recovered to the pre-disruption activities levels of the early 2020s; however, the results are dramatically reduced from the unprecedented levels observed in 2021.

Looking Ahead

The COVID-19 pandemic has completely disrupted all facets of life in the world, including trade, and it set 2020-2021 and 2021-2022 apart from all previous years considered under the CAAP. In sharp contrast to the global recession in 2009, in which trade significantly slowed leading up to the recession, the effects of the pandemic were abrupt and started in March 2020 and continued through 2021.

The conditions in 2021 formed a 'perfect storm' of unprecedented supply chain disruptions and record cargo volumes. The entire supply chain and federal government continue to work together to better identify and address disruption issues and develop measures to improve freight movement and reduce delays at the ports across all modes of cargo movement, including time at anchorage. Unprecedented federal funding approved in mid-2022 paves the way for further improvements in this area.

From an emissions perspective, the primary source of increased emissions – at-anchorage emissions – appear to have been addressed through the new queueing system and the establishment of the SAQA. The effectiveness of this program will be monitored through 2022 and adjustments will be made to minimize container ships using anchorages.

While there are still disruptions on the land-side operations that need to be addressed and cruise operations have restarted, it is anticipated that 2022 emissions will be significantly lower than 2021, closer to the 2019-2020 levels. This will especially be true if the container call density holds at around 11,000+ TEUs per call.

The busiest seaport in the Western Hemisphere, the Port of Los Angeles is North America's leading trade gateway and has ranked as the number one container port in the United States for 22 consecutive years. In 2021, the Port facilitated $294 billion in trade and handled a total of 10.7 million container units, the busiest calendar year in the Port's 115-year history. San Pedro Bay port complex operations and commerce facilitate one in nine jobs across the Southern California counties of Los Angeles, Orange, Riverside, San Bernardino and Ventura. For more information & the detailed technical report

https://www.portoflosangeles.org/environment/air-quality/air-emissions-inventory