Port of LONG BEACH
The Green Port

THE PORT OF LOS ANGELES

SAN PEDRO BAY PORTS

CLEAN AIR ACTION PLAN 2017

Potential Emission Reductions for Select Clean Air Action Plan Strategies

JULY 2017

Introduction

In an effort to gauge the effectiveness of the proposed CAAP 2017 strategies, the Port of Long Beach and Port of Los Angeles (Ports) have conducted analyses to project the potential emission reductions associated with select CAAP strategies. Specifically, the Ports assessed the following strategies:

- Clean Trucks Program – transition to near-zero emissions and zero-emissions
- Terminal Equipment – transition to zero-emissions

Given the uncertainty of projecting up to 15 years into the future, in developing these emission reduction projections, the Ports made certain assumptions. Those assumptions are defined within the respective sections.

Clean Trucks Program

The proposed Clean Trucks Program (CTP) calls for the following:

- Beginning in early 2018, new trucks, being replaced due to attrition or added due to growth, entering the Port's Drayage Truck Registry (PDTR) must be a 2014 model year (MY) or newer.
- Beginning in 2023, or when the State's near-zero-emission (NZE) heavy-duty engine standard takes effect, new trucks registered in the Ports Drayage Truck Registry must meet this near-zero standard or better
- Starting in 2023, or when the State's near-zero-emission heavy-duty engine standard takes effect, all trucks will be charged a rate to enter the ports, with exemptions for trucks that meet this near-zero standard or better
- Beginning in 2035, only trucks that meet zero-emissions (ZE) or the equivalent will be exempt from the rate. The only exception is scenario 7. In scenario 7, the assumption was that additional influences such as increased funding and other advantages of ZE trucks over non-ZE trucks will compel the trucking industry to purchase only ZE trucks after 2031.

The Ports analyzed the projected emissions benefits of this strategy in 2020, 2024, 2031, and 2036. These years were chosen for the following reasons:

- 2020: To assess the effects of the new registration requirements in 2018
- 2024: To assess the effects of the new registration requirements and truck rate and future near-zero emission standards in 2023
- 2031: To assess the reductions expected in advance of the regional ozone targets
- 2036: To assess the effects of the revised truck rate in 2035

There are many variables to consider when developing potential emission reductions from this strategy, such as:

- The effect of the new registration requirements and proposed rate increases on new trucks entering the PDTR (a combination of turnover due to fees, due to attrition, or added due to growth)
- The projected penetration of ZE trucks
- The engine standard for near-zero-emissions

To account for these variables, the Ports ran multiple scenarios described in more detail below. These scenarios varied the following elements:

- *Assumed different levels of fleet turnover as a result of the rates imposed in 2023 and 2035*. Specifically, the Ports tested scenarios that assumed 25% of the fleet would be replaced with cleaner trucks while 75% of the fleet would choose to pay the rate; 50% of the fleet would be replaced while 50% of the fleet would choose to pay the rate; and 75% of the fleet would be replaced while 25% would pay the rate. Between 2024 and 2034, and 2036+, additional 10% of the fleet would turn over annually except in scenario 7, between 2031 and 2035, all non-ZE trucks will be replaced with ZE such that in 2035, 100% of all trucks would be ZE.
- *Assumed different penetration levels of zero-emissions trucks.* In one set of scenarios, the Ports assumed moderate zero-emissions truck penetration beginning in 2023, 2% (remaining 98% of the trucks are assumed to be near-zero) of the new trucks entering the PDTR fleet each year would be zero emissions until 2030, when that percentage would rise to 20% (remaining 80% of the trucks are assumed to be near-zero) each year until 2035. In the second set of scenarios, the Ports assumed high zero-emissions truck penetration beginning in 2023, 5% (remaining 95% of the trucks are assumed to be near-zero) of the new trucks entering the PDTR fleet each year would be zero emissions until 2030, when that percentage would rise to 20% (remaining 80% of the trucks are assumed to be near-zero) each year until 2035. These percentages are consistent with the California Air Resources Board's (CARB) Vision Model assumption of zero emission truck penetration as well as with CARB's draft proposals for the zero-emissions manufacturing standard for heavy-duty trucks. In the last and most aggressive scenario (Scenario 7), the Ports assumed 20% of the new trucks entering the PDTR fleet between 2023 and 2030 would be zero emissions, and starting in 2031, 100% of all new trucks entering the fleet would be zero emissions.
- *Assumed different emission standards for near-zero emissions trucks.* CARB has not yet set a manufacturing standard for near-zero emissions trucks. To address this uncertainty, the Ports tested scenarios with a NOx standard of .02 gm/bhp-hr and .05 gm/bhp-hr.

The results thus present a range of possible emission reduction scenarios depending on the variables rather than a definitive projection. The range of these scenarios varies from a "Low Rate Effectiveness" to a "High Rate Effectiveness" and one scenario with "Ultra High Rate Effectiveness". The ranges presented in the tables below represent estimates of the potential effects related to the specific details of the Ports' proposed CTP strategies. However, additional state and federal incentive funding may have the effect of accelerating and/or increasing the numbers of NZE and ZE trucks.

The Table below describes Scenario 1 (the Low Rate Effectiveness Scenario). A description of the remaining scenarios is included beneath the table. For more details on the scenarios, please see Appendix A at the end of this document.

YEAR	SCENARIO 1: Low Rate Effectiveness, Moderate Zero Emissions (2%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	● Pre-2010 trucks banned by CARB rule ● Rate takes effect for non-NZE/ZE trucks ● 25% non-NZE trucks are replaced	98% NZE , 2% ZE
2024 to 2029	● Rate in effect for non-NZE/ZE trucks ● Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	98% NZE , 2% ZE
2030 to 2034	● Rate in effect for non-NZE/ZE trucks ● Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	● Rate takes effect for non-ZE trucks ● 25% of Non-ZE trucks are replaced	100% ZE
2036+	● Rate in effect for non-ZE trucks ● Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

Scenario 1: Low Rate Effectiveness, Moderate Zero Emissions (2%) (See Table above)

Scenario 2: Medium Rate Effectiveness, Moderate Zero Emissions (2%)
Same as Scenario 1, except in 2023, 50% of the pre-2023 (Non-NZE) will be replaced, 50% of the pre-2023 (Non-NZE) will pay the rate, in 2035 50% and 2036+ 10% of Non-ZE will be replaced with ZE.

Scenario 3: High Rate Effectiveness, Moderate Zero Emissions (2%)
Same as Scenario 1, except in 2023, 75% of the pre-2023 (Non-NZE) will be replaced, 25% of the pre-2023 (Non-NZE) will pay the rate, in 2035 75% and 2036+ 10% of Non-ZE will be replaced with ZE.

Scenario 4: Low Rate Effectiveness, High Zero Emissions (5%)
Same as Scenario 1, except between 2023 and 2029, 5% of all replaced/new registered trucks in PDTR will be ZE.

Scenario 5: Medium Rate Effectiveness, High Zero Emissions (5%)
Same as Scenario 2, except between 2023 and 2029, 5% of all replaced/new registered trucks in PDTR will be ZE.

Scenario 6: High Rate Effectiveness, High Zero Emissions (5%)
Same as Scenario 3, except between 2023 and 2029, 5% of all replaced/new registered trucks in PDTR will be ZE.

Scenario 7: Ultra High Rate Effectiveness, Ultra High Zero Emissions (20%)
Same as Scenario 6, except between 2023 and 2030, 20% of all replaced/new registered trucks in PDTR will be ZE, and starting in 2031, 100% of replaced/new registered trucks in PDTR will be ZE.

Emission Reductions from all seven scenarios were compared against the "No Action Scenario" of the same year. The "No Action Scenario" assumes a business as usual case under which truck model year distributions for forecast years are developed using a series of adjustments to the 2015 model year distribution to account for changes to the fleet, including current SPBP Clean Truck Program and CARB's drayage truck regulation requiring only 2010+ trucks starting in 2023, fleet attrition or turnover, and growth in activity that would require more trucks and/or higher truck activity.

For all seven scenarios, the 2015 model year is forecasted to future years with same assumptions as the "No Action Scenario" plus the requirements of the individual scenario related to fleet turnover and truck replacement.

Emissions estimates were calculated using speed specific emission factors from CARB's EMFAC2014 model. More details on methodology to estimate truck emissions can be found in both Ports latest 2015 annual emissions inventory reports.[1] In order to model emissions from trucks with the potential ultra-low NOx standard of 0.02 gm/bhp-hr, 90% reduction in NOx emission rates of trucks meeting the current low NOx standard of 0.2 gm/bhp-hr was assumed for all exhaust processes – running, idle and start. Similarly, in order to model emissions from trucks with the potential ultra-low NOx standard of 0.05 gm/bhp-hr, 75% reduction in NOx emission rates of trucks meeting the current low NOx standard of 0.2 gm/bhp-hr was assumed for all exhaust processes – running, idle and start.

[1] POLA, *https://www.portoflosangeles.org/pdf/2015_Air_Emissions_Inventory.pdf,* accessed June 30, 2017; POLB, *http://polb.com/environment/air/emissions.asp*, accessed June 30, 2017

Figures 1 to 4 show the truck model year distribution for 2020, 2024, 2031 and 2036.

Figure 1: Truck model year distribution for CY 2020

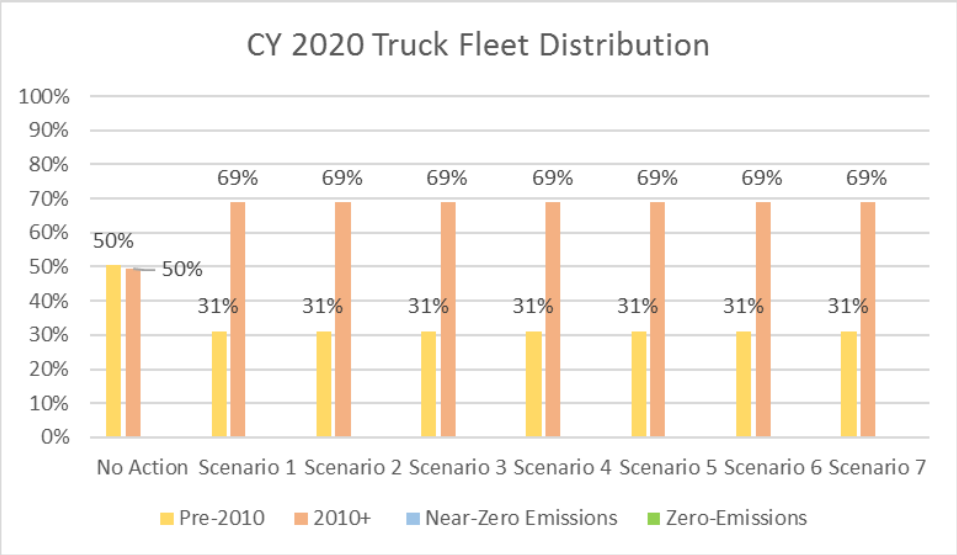


Figure 2: Truck model year distribution for CY 2024

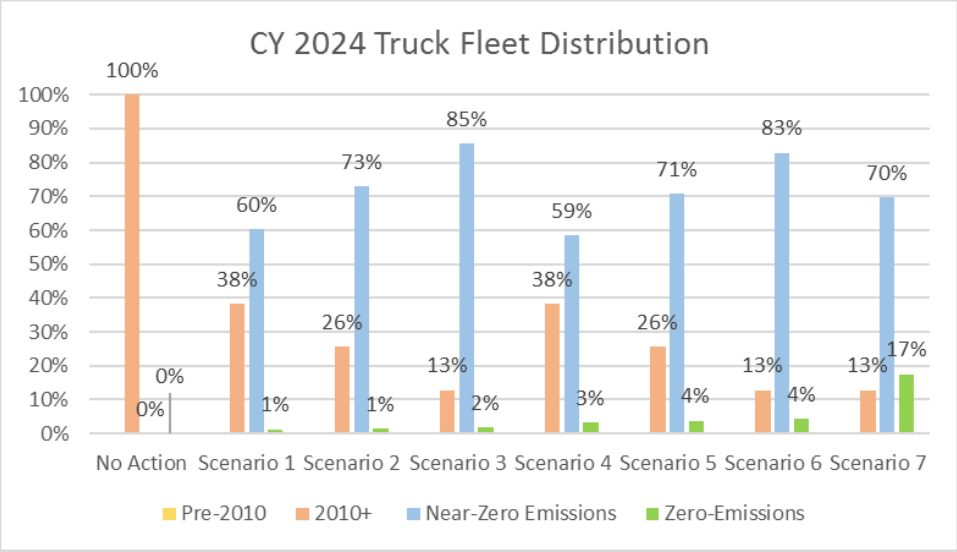


Figure 3: Truck model year distribution for CY 2031

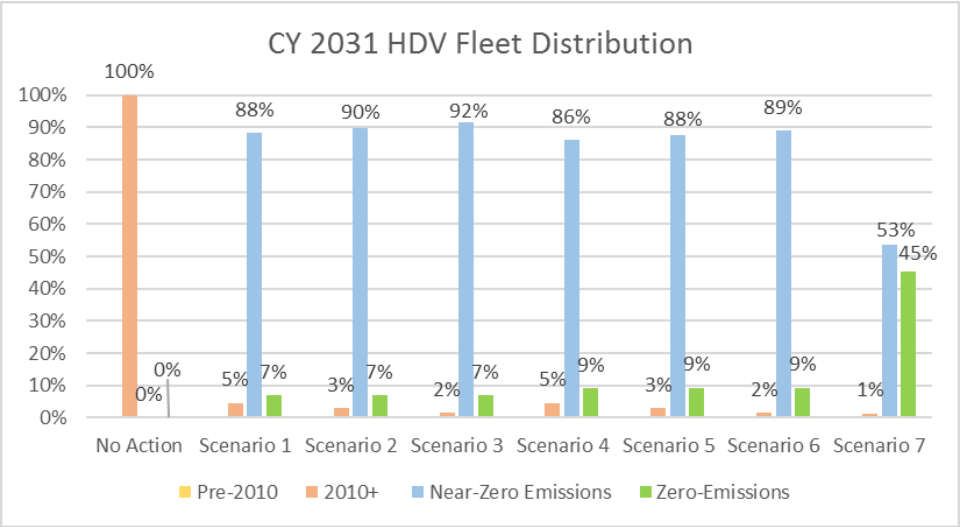
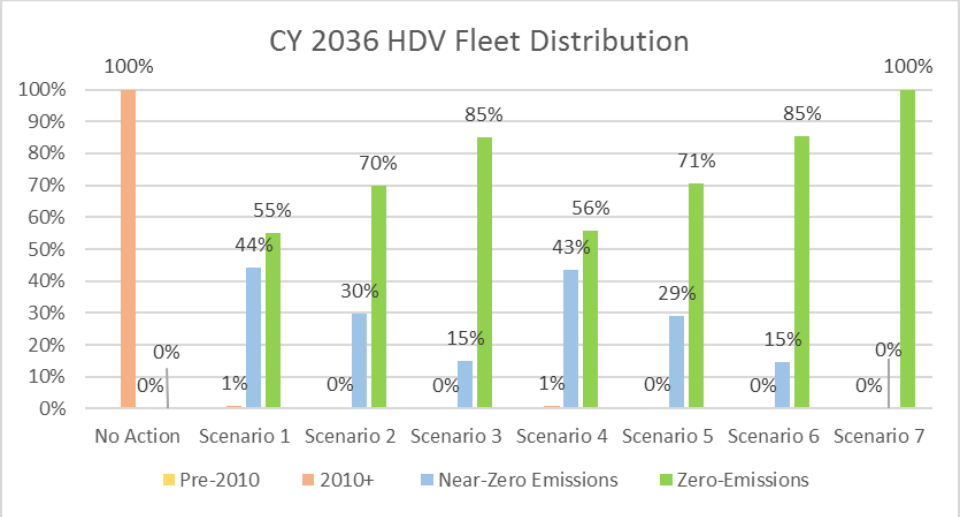


Figure 4: Truck model year distribution for CY 2036



Tables 1 and 2 below present the projected emissions reductions for NOx and CO_2 from all six scenarios in two sets:

1) Table 1 utilizes the assumed NOx standard of 0.02 gm/bhp-hr
2) Table 2 utilizes the assumed NOx standard of 0.05 gm/bhp-hr

Table 1: NOx and CO_2 Emissions Reductions with Near-Zero NOx Standard of 0.02 gm/bhp-hr

NOx Emissions Reductions in % from Baseline

Scenario	ZE truck penetration each year	2023 non-NZE replacement	Calendar Years 2020	2024	2031	2036
Scenario 1	2%	25%	36%	76%	91%	96%
Scenario 2	2%	50%	36%	83%	92%	97%
Scenario 3	2%	75%	36%	90%	93%	99%
Scenario 4	5%	25%	36%	76%	91%	96%
Scenario 5	5%	50%	36%	83%	92%	97%
Scenario 6	5%	75%	36%	90%	94%	99%
Scenario 7	20%	75%	36%	91%	96%	100%

CO_2 Emissions Reductions in % from Baseline

Scenario	ZE truck penetration each year	2023 non-NZE replacement	Calendar Years 2020	2024	2031	2036
Scenario 1	2%	25%	7%	9%	10%	56%
Scenario 2	2%	50%	7%	9%	10%	70%
Scenario 3	2%	75%	7%	10%	10%	85%
Scenario 4	5%	25%	7%	10%	12%	56%
Scenario 5	5%	50%	7%	11%	12%	71%
Scenario 6	5%	75%	7%	12%	12%	85%
Scenario 7	20%	75%	7%	24%	47%	100%

Table 2: NOx and CO_2 Emissions Reductions with Near-Zero NOx Standard of 0.05 gm/bhp-hr

NOx Emissions Reductions in % from Baseline

Scenario	ZE truck penetration each year	2023 non-NZE replacement	Calendar Years 2020	2024	2031	2036
Scenario 1	2%	25%	36%	74%	83%	90%
Scenario 2	2%	50%	36%	81%	85%	94%
Scenario 3	2%	75%	36%	87%	86%	97%
Scenario 4	5%	25%	36%	74%	84%	90%
Scenario 5	5%	50%	36%	81%	85%	94%
Scenario 6	5%	75%	36%	87%	86%	97%
Scenario 7	20%	75%	36%	88%	91%	100%

CO_2 Emissions Reductions in % from Baseline

Scenario	ZE truck penetration each year	2023 non-NZE replacement	Calendar Years 2020	2024	2031	2036
Scenario 1	2%	25%	7%	9%	10%	56%
Scenario 2	2%	50%	7%	9%	10%	70%
Scenario 3	2%	75%	7%	10%	10%	85%
Scenario 4	5%	25%	7%	10%	12%	56%
Scenario 5	5%	50%	7%	11%	12%	71%
Scenario 6	5%	75%	7%	12%	12%	85%
Scenario 7	20%	75%	7%	24%	47%	100%

More details on methodology to estimate truck emissions can be found in Ports latest 2015 annual emissions inventory reports.

Terminal Equipment

The Ports assessed the emission reductions associated with the introduction of near-zero (NZE) emissions and zero-emissions (ZE) terminal equipment in 2020 and 2025 compared to diesel equipment. These estimates are based on projections provided by terminal operators and proposals submitted by Ports for various grants offered by United States Environmental Protection Agency (USEPA), California Energy Commission (CEC), California Air Resources Board (CARB), and the South Coast Air Quality Management District (SCAQMD). As of 2016, 9% of the terminal equipment is electric and projected to grow to 13% in 2020 and 14% in 2025. Additionally, in 2020, Ports are expecting to introduce 20 NZE yard tractors into the fleet.

CARB staff is developing amendments to the cargo handling equipment regulation to achieve up to 100% compliance with zero emissions by 2030 in the San Pedro Bay. The Ports plan to participate in this effort and, where possible, ease barriers to implementation and accelerate emission reduction through securing state and federal funding. For this reason, it is important to note that the estimates provided in the tables below are conservative and do not include the potential increased penetration of NZE and ZE equipment that will likely occur with the provision of grant funding from the agencies.

The following assumptions were made when forecasting emissions to 2020 and 2025:

- NZE and ZE population shown in the tables below are based on various grants that Ports have received and fleet population estimates provided by their terminal operators.
- To calculate the emission reductions, the emissions from each piece of NZE and ZE equipment was compared to an average piece of diesel equipment in 2020 and 2025, i.e., the emissions the Ports would expect to see absent turnover to NZE/ZE ("business as usual").
- The "business as usual" forecast for 2020 and 2025 is calculated by applying growth factors, survival rates, and CARB's in-use cargo handling equipment regulations (the original 2007 regulation, 2009 and 2011 amendments).
- Under the "business as usual" forecast, in 2020, more than 80% of the diesel terminal equipment will meet Tier 4 (interim or final) emissions standards and in 2025, more than 90% of the diesel terminal equipment will meet Tier 4 (interim or final) emissions standards.
- Since NZE and ZE equipment projections are based on what the Ports know now, which could increase or decrease in future, to estimate emissions reductions, the 2020 and 2025 grown population is normalized to 2016 equipment population before calculating emission reductions.

Table 3 provided below shows equipment counts that existed in CY 2016. Tables 4 and 5 show the additional (existing equipment in 2016 are not included) number of NZE and ZE equipment that Ports are expected to see operating at their terminals in 2020 and 2025. These equipment counts are in addition to the ZE equipment that existed in 2016. For completeness, equipment counts in 2016 plus additional equipment since 2016 are shown. These tables also show the emission reductions achieved due to the additional NZE and ZE equipment in comparison to equivalent average diesel equipment in years 2020 and 2025 respectively.

Table 3: SPBP NZE and ZE Equipment as of CY 2016

	Non-NZE/ZE	Near-Zero	Zero	Total
Automated Guided Vehicles	0	0	57	57
Automated Stacking Cranes	0	0	63	63
Forklifts	734	0	17	751
Rail-Mounted Gantry Cranes	0	0	10	10
Rubber-Tired Gantry Cranes/Intermodal Yard Crane	193	0	6	199
Top Handlers/Side Picks	450	0	0	450
Ship-to-Shore Cranes	0	0	153	153
Yard Tractors	1856	0	0	1856
All Other Equipment	200	0	27	227
TOTAL	**3433**	**0**	**333**	**3766**

Table 4: 2020 SPBP Projected NZE and ZE Equipment Population in Addition to 2016 ZE Equipment Population and Associated Emissions Reduction from Diesel Equivalent Equipment

	Non-NZE/ZE	Near-Zero	Zero	Total	NOx % Red	CO_2% Red
Automated Guided Vehicles	0	0	68	68	4%	4%
Automated Stacking Cranes	0	0	47	47	11%	11%
Forklifts	0	0	2	2	1%	1%
Rail-Mounted Gantry Cranes	0	0	0	0	0%	0%
Rubber-Tired Gantry Cranes/Intermodal Yard Crane	0	0	13	13	6%	6%
Top Handlers/Side Picks	0	0	4	4	1%	1%
Ship-to-Shore Cranes	0	0	12	12	0%	0%
Yard Tractors	0	20	40	60	4%	3%
All Other Equipment	0	0	0	0	0%	0%
Total Added After 2016	**0**	**20**	**186**	**206**		
Cumulative Total (2016 to 2020)	**3433**	**20**	**519**	**3972**		
% Reduction from All Terminals Diesel CHE					**8%**	**8%**

Note:
Emission reductions are based on diesel equipment population in 2016 forecasted to 2020 and by applying normal attrition and implementation of CARB's adopted CHE regulation.

Table 5: 2025 SPBP Projected NZE and ZE Equipment Population in Addition to 2016 ZE Equipment Population and Associated Emissions Reduction from Diesel Equivalent Equipment

Equipment	Non-NZE/ZE	Near-Zero	Zero	Total	NOx % Red	CO_2% Red
Automated Guided Vehicles	0	0	72	72	5%	5%
Automated Stacking Cranes	0	0	83	83	20%	20%
Forklifts	0	0	2	2	1%	1%
Rail-Mounted Gantry Cranes	0	0	0	0	0%	0%
Rubber-Tired Gantry Cranes/Intermodal Yard Crane	0	0	18	18	8%	8%
Top Handlers/Side Picks	0	0	6	6	1%	1%
Ship-to-Shore Cranes	0	0	16	16	0%	0%
Yard Tractors	0	20	43	63	4%	3%
All Other Equipment	0	0	0	0	0%	0%
Total Added After 2016	**0**	**20**	**240**	**260**		
Cumulative Total (2016 to 2025)	**3433**	**20**	**573**	**4026**		
% Reduction from All Terminals Diesel CHE					**10%**	**11%**

Note:
Emission reductions are based on diesel equipment population in 2016 forecasted to 2025 and by applying normal attrition and implementation of CARB's adopted CHE regulation.

In addition to the reductions noted above, the Ports will be participating in and supporting CARB's transition to up to 100% zero-emissions terminal equipment by 2030, which will build upon the known equipment deployments that the Ports and terminals operators have already committed to achieve, as listed above. Additional state and federal incentive funding may also have the effect of accelerating and/or increasing the numbers of NZE and ZE equipment.

Appendix A

Clean Trucks Program Scenarios

YEAR	SCENARIO 1: Low Rate Effectiveness, Moderate Zero Emissions (2%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 25% non-NZE trucks are replaced	98% NZE , 2% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	98% NZE , 2% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 25% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 2: Medium Rate Effectiveness, Moderate Zero Emissions (2%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 50% non-NZE trucks are replaced	98% NZE , 2% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	98% NZE , 2% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 50% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 3: High Rate Effectiveness, Moderate Zero Emissions (2%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 75% non-NZE trucks are replaced	98% NZE , 2% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	98% NZE , 2% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 75% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 4: Low Rate Effectiveness, High Zero Emissions (5%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 25% non-NZE trucks are replaced	95% NZE , 5% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	95% NZE , 5% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 25% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 5: Medium Rate Effectiveness, High Zero Emissions (5%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 50% non-NZE trucks are replaced	95% NZE , 5% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	95% NZE , 5% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 50% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 6: High Rate Effectiveness, High Zero Emissions (5%)	
	EXISTING TRUCKS	NEW REGISTERED TRUCKS IN PDTR
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	• Pre-2010 trucks banned by CARB rule • Rate takes effect for non-NZE/ZE trucks • 75% non-NZE trucks are replaced	95% NZE , 5% ZE
2024 to 2029	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	95% NZE , 5% ZE
2030 to 2034	• Rate in effect for non-NZE/ZE trucks • Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2035	• Rate takes effect for non-ZE trucks • 75% of Non-ZE trucks are replaced	100% ZE
2036+	• Rate in effect for non-ZE trucks • Each year, another 10% of non-ZE trucks remaining after attrition are replaced	100% ZE

YEAR	SCENARIO 7: Ultra High Rate Effectiveness, Ultra High Zero Emissions (20%)	
	EXISTING TRUCKS	**NEW REGISTERED TRUCKS IN PDTR**
2018 to 2022	No requirements beyond current Clean Trucks Program	100% Model Year 2014+
2023	● Pre-2010 trucks banned by CARB rule ● Rate takes effect for non-NZE/ZE trucks ● 75% non-NZE trucks are replaced	80% NZE , 20% ZE
2024 to 2030	● Rate in effect for non-NZE/ZE trucks ● Each year, another 10% of non-NZE/ZE trucks remaining after attrition are replaced	80% NZE , 20% ZE
2031+	● Each year, 20% of remaining non-ZE trucks are replaced	100% ZE