



Sustainable Supply Chain Advisory Committee *November Meeting Summary*

Date: November 28th | 11 am – 3 pm

Location: In-person at Port of Los Angeles and via phone conference

Attendees: Attachment A

Meeting Agenda: Attachment B

Key Discussion Items (Action items in green)

1. POLA / POLB Opening Remarks

- Chris and Heather kicked off the meeting by providing an update on the status of the draft assessment of clean truck technology assessment, clean truck rate study and details on the upcoming quarterly CAAP meeting.

2. Review September SSCAC Meeting Summary

- Meeting summary was approved. **See attachment C**

3. CAAP Updates

- CAAP updates were addressed during the opening remarks.

4. Funding Prioritization Presentation & Discussion

- GNA presented a slide deck summarizing work that had been done on a funding prioritization matrix. **See attachment D.**
- Several comments, recommendations and suggested edits to the matrix were provided by members of the committee.
 - **Action item: GNA to update matrix and slides for review during next meeting.**
- A suggestion was made the “prioritization” also suggests “de-prioritization” and words like “roadmap” and “sequencing” may better describe the need to focus on some activities in the near vs long term.
- Several comments raised the issue of time sensitivity: there needs to be a focus on near-term commercially available technologies that can help with near-term (2023) NAAQS attainment deadlines and a cautious approach taken on technologies that may take a decade or more to materialize. It was also suggested that there needs to be near-term and longer-term views on



these issues. Trucks and cargo handling equipment likely fall into the near-term opportunities with OGV falling more into a longer-term opportunity and harbor craft and locomotives falling somewhere in-between.

- Focus on priority emissions was suggested as a way to prioritize forward efforts, however, emission trade off issues was also noted, as were investment trade offs (i.e. if all resources are focused on cleaning up trucks, significant investment in cleaner locomotives cannot also take place at the same time). Trucks were identified as the best place to get both NOx and GHG emissions, thus leading to a prioritization of this application.
- The group discussed key elements to prioritize in the near-term, which include:
 - Trucks are a top priority and the implementation of a clean truck rate should move quickly
 - Aligning funding with regulatory compliance (e.g., upcoming CARB shore power regulation)
 - Capturing as much available grant funding as possible
 - Advocate for more money for ZE infrastructure
 - Ports to focus on ZE infrastructure for terminals, while trucking companies and regional agencies to focus on ZE infrastructure for trucks
 - Provide more funding in the Port Technology Advancement Program (TAP) and focus the TAP on technologies that provide lower emission technologies for locomotives and harbor craft as these are both significant sources of emissions
 - Advocate to the legislature to allow more time than 2 years for complex projects to be completed.
 - Vessels should be a priority given contribution to emissions, however they are difficult to address through funding programs. Possible area for funding advocacy is related to infrastructure for shorepower or at-berth controls.

5. Planning for the 2019 Legislative Session

- The group discussed a number of near-term priorities, which included:
 - Prioritizing funding opportunities for more ZE infrastructure that don't have technology purchase requirements, like the recent CEC grant.
 - Advocating for extended liquidation timelines so there is more time for the ports to install infrastructure.
 - Ensuring the SPBPs are prepared to go after VW settlement funds.
- **Action item: GNA to add this agenda item to a future meeting to continue the discussion**

6. Future Agenda Items

- The group discussed the following agenda items:
 - Follow up discussion on the funding prioritization
 - Update presentation from SCE / DWP

7. Discussion with Electrify America



- Representatives from Electrify America provided a summary of their organization.
 - They will have about \$10 million of funding available in middle of 2019 earmarked for medium- and heavy-duty applications, which could be an opportunity for a POLA/POLB EV charging project. They are currently in the fact-finding stage to determine what project could be the best use of their funds and will make a decision by May of 2019.



Attachment A

Meeting Attendees

SSCAC Committee Members	
Adrian Martinez	Earth Justice
Michele Grubbs	PMSA
Stella Ursua	GRID Alternatives
Marnie Primer	FuturePorts
Cynthia Marvin	CARB
Matt Miyasato	SCAQMD
Zorik Pirveysian	SCAQMD
Michele Grubbs	PMSA
Joe Lyou	CCA and SCAQMD Governing Board
Cody Rosenfield	CCA
Louis Dominguez	San Pedro Neighborhood Council
Steve Cadden	CRT
Los Angeles Port & City Staff	
Chris Cannon	Port of Los Angeles
Tim DeMoss	Port of Los Angeles
Mike DiBernardo	Port of Los Angeles
Erick Martell	Port of Los Angeles
David Libatique	Port of Los Angeles
Michael Samulon	City of LA, Mayors Office
Irene Burga	City of LA, Mayors Office
Max Reyes	City of LA, Mayors Office
Jacob Haik	City of LA
David Reich	City of LA, Mayors Office
Janna Sidley	City of LA, Office of the City Attorney
Long Beach Port & City Staff	
Heather Tomley	Port of Long Beach
Renee Moilanen	Port of Long Beach
Meeting Facilitation Staff	
Erik Neandross	GNA
Lexi Wiley	GNA
Patrick Couch	GNA
Eleanor Johnstone	GNA



Attachment B

Meeting Agenda

1. POLA / POLB Opening Remarks
2. Review & Finalize September Meeting Summary
3. CAAP Updates
4. Funding Prioritization Presentation & Discussion (GNA to present)
5. Lunch
6. Planning for the 2019 Legislative Session
7. Future Agenda Items
8. Discussion with Electrify America
9. Conclusion & Next Steps



Attachment C
September SSCAC Meeting Summary



Sustainable Supply Chain Advisory Committee *September Meeting Summary*

Date:	September 26th 11 am – 3 pm
Location:	In-person at Port of Long Beach and via phone conference
Attendees:	Attachment A
Meeting Agenda:	Attachment B

Key Discussion Items (Action items in green)

1. **Opening Remarks by Lauren Faber O'Connor**

- Lauren kicked off the meeting by summarizing recent announcements and initiatives related to clean goods movement projects, such as the recent CARB ZANZEFF wins that awarded funds to both ports of LA and Long Beach, the US Climate Mayors EV purchasing collaborative, and the Global Climate Action Summit that was co-hosted with the UN and saw a lot of private sector commitments around zero-emission transportation.

2. **Review August SSCAC Meeting Summary**

- Meeting summary was approved. **See attachment C**

3. **Committee Member Updates**

- The group discussed possible replacements now that Peter Peyton has resigned from the Committee. The group agreed that this is an opportunity to invite someone that represents labor in the ports.
 - **Action item: Port and city staff to identify possible candidates, review candidates with each mayor's office and help facilitate a formal invitation letter from the mayors upon approval.**

4. **Marine Emission Reduction Strategies Recommendation**

- The group discussed the increased interest in LNG as a marine fuel with recent announcements from Pasha and Matson. The group also discussed the need to develop supporting LNG fueling infrastructure to support these and potential other LNG vessels call on LA or Long Beach, as none now exists. The opportunity to use renewable natural gas in these ships, in place of fossil natural gas, was also discussed.



- The group discussed the tradeoffs between installing scrubbers and fueling with LNG; however, the based on the emissions profile of each technology-fuel pathway, the group agreed that if NOx is the primary concern, than LNG is the better option.
- While there are new CARB regulations on the horizon, OGVs will be the largest source of NOx emission in the South Coast Air Basin. In an effort to reduce these emissions, the air district and CARB are looking at three main options, including incentives to bring existing Tier 3 vessels to SoCal Ports, incentives for shipping lines with Tier 2 vessels on order to switch them to Tier 3, and researching NOx emission reduction retrofit technology options for existing vessels.
 - Action item: GNA to add this agenda item to a future meeting to continue the discussion around OGV emission reductions (i.e., Tier 3, scrubbers, LNG, etc.)
- The Committee discussed concerns around the lack of available alternatives to shore power / AMP and the lack of testing of these technologies on vessel types other than container vessels. Currently there are only two barge / bonnet vendors, which have deployed two bonnets in So Cal and are building two for the Bay Area. The group agreed that it would be valuable to bring in the vendors who are developing shore power alternatives for a roundtable discussion.
 - Action item: GNA to work with committee members to identify questions and invite vendors to a future committee meeting.

5. Clean Truck Program Update

- Port staff provided a brief update the status of the clean truck program and the 50-100 ZEV demonstration project.
- The group discussed the tradeoffs between prioritizing near-zero trucks and zero emission trucks based on available funding opportunities and cost-effectiveness.

6. Follow up on NZE/ZE Truck Financing Roundtable Discussion

- Erik provided a brief summary of the feedback received from the last meeting's roundtable discussion around clean truck financing. **See attachment D.**
- The group discussed what funding is available to support clean trucks, such as HVIP, VW, etc. In addition, the group discussed what funding is available to support clean trucks, such as HVIP, VW, etc., and what could be done to secure more funding.
 - Based on the discussions the Committee has had in the last several months, additional funding has been a key element; however, while there is a lot of funding available in California, there is ultimately a limited amount of funding given the scale of emission reductions needed from all major source categories in the ports (marine, truck CHE, locomotive). Therefore, the Committee agreed that they needed to prioritize funding for each source categories.
 - The group discussed developing a metric that shows what should be funded based upon cost-effectiveness, regulatory issues (already covered / not), existing programs (capability / need), commercial availability of the technology, near term ability ability and time frame to implement, etc.



- Action item: GNA to work with port staff to develop a draft matrix for the next Committee meeting.

- 7. Follow up on Fueling Infrastructure for Zero Emission Trucks & CHE Discussion**
 - Due to time constraints, this agenda item will be added to a future meeting.
- 8. Planning for the 2019 Legislative Session / Funding Prioritization**
 - This agenda item was discussed during item #6.



Attachment A

Meeting Attendees

SSCAC Committee Members	
Adrian Martinez	Earth Justice
Michele Grubbs	PMSA
Stella Ursua	GRID Alternatives
Jonathan Rosenthal	HPEC
Marnie Primer	FuturePorts
Cynthia Marvin	CARB
Matt Miyasato	SCAQMD
Zorik Pirveysian	SCAQMD
Michele Grubbs	PMSA
Joe Lyou	CCA and SCAQMD Governing Board
Cody Rosenfield	CCA
Louis Dominguez	San Pedro Neighborhood Council
Steve Cadden	CRT
Los Angeles Port & City Staff	
Chris Cannon	Port of Los Angeles
Mike DiBernardo	Port of Los Angeles
Erick Martell	Port of Los Angeles
Michael Samulon	City of LA, Mayors Office
Lauren Faber O'Connor	City of LA, Mayors Office
Jacob Haik	City of LA
Justin Houterman	City of LA, Office of the City Attorney
Long Beach Port & City Staff	
Heather Tomley	Port of Long Beach
Rick Cameron	Port of Long Beach
Meeting Facilitation Staff	
Erik Neandross	GNA
Lexi Wiley	GNA
Patrick Couch	GNA



Attachment B

Meeting Agenda

1. POLA / POLB Opening Remarks
2. Review & Finalize August Meeting Summary
3. Committee Member Updates
4. Marine Emission Reduction Strategies Recommendation
5. Lunch
6. Clean Truck Program Update
7. Follow up on NZE/ZE Truck Financing Roundtable Discussion
8. Follow up on Fueling Infrastructure for Zero Emission Trucks & CHE Discussion
9. Planning for the 2019 Legislative Session / Funding Prioritization
10. Conclusion & Next Steps



Attachment C
August SSCAC Meeting Summary



Sustainable Supply Chain Advisory Committee August Meeting Summary (July Meeting Rescheduled)

Date:	August 6th 11 am – 3 pm
Location:	In-person at Port of Los Angeles and via phone conference
Attendees:	Attachment A
Meeting Agenda:	Attachment B

Key Discussion Items (Action items in green)

- 1. POLA & POLB Opening Remarks**
 - Chris Canon and Heather Tomley provided a brief overview of drayage truck technology demonstration projects that are in discussions and underway, which are crucial in the ongoing implementation of the CAAP. They discussed the need for port staff and other stakeholders to work with OEMs, technology providers and others to ensure they know how to effectively scale the deployments of new technologies. Of course, it was noted that funding support will also be critical, which is the focus of this meeting.
- 2. Review May SSCAC Meeting Summary**
 - Meeting summary was approved. **See attachment C**
- 3. Review & Finalize 2018 Mission & Vision**
 - The Committee approved the Mission and Vision document with one edit; add "to supplement private investment" in second bullet under priorities for 2018. **See attachment D**
- 4. Review & Finalize System of Systems**
 - The Committee approved the Systems of Systems recommendation. **See attachment E**
- 5. Legislative Update/Funding Prioritization**
 - As a follow up to the letter the Committee signed and sent to Sacramento advocating for GGRF funds to go towards port projects, David Libatique provided a brief update on the current discussions in Sacramento about GGRF allocations.
 - The group discussed the need to begin thinking through ways the Committee can support the ports when the 2020 budget is in discussion. The Committee discussed a few ideas and agreed that this would be an agenda item at the next Committee meeting.



6. Roundtable Guests Arrive

7. Update on 2017 CAAP/CTP

- Heather and Chris provided an update on the CAAP and CTP, including the implementation schedule, feasibility assessments, rate study, and related issues. **See attachment F**
- The group discussed the Port's use of CARB's forthcoming definition of low-NOx and zero emission as a mechanism to move forward with the CTP.

8. Overview of Upcoming Available Funding

- GNA provided a high-level summary of the currently and soon-to-be-available funding for drayage trucks. **See attachment G**
- The group discussed the need to streamline funding programs to get more old trucks off the road and cleaner ones on. The SCAQMD's recent \$400 million Carl Moyer Program was mentioned as being approximately 50% subscribed by truck applications, although it is too early to tell how many port drayage trucks were part of the applications vs non-port drayage trucks.

9. Roundtable Discussion

- Several meeting participants discussed the importance of the CTP rate as it will drive decision making for many fleets and independent drivers who are weighing whether or not to buy a new truck. It was noted that many drayage operators have commented that they will wait until they have a clearer vision of the rate and resulting business landscape before making any decisions about investing in new trucks.
- The Committee mentioned that the CTP rate is not the only fee that many cargo owners are looking at with warehouse ISR fees are being considered as well, which compounds the increasing cost of moving cargo through Southern California.
- The Committee discussed the changing nature of the port drayage business in context of various labor issues. Such issues will also impact the ability for licensed motor carriers (LMCs) to guarantee loans for their contracted drivers; thus, the model used in the first CTP will not be applicable going forward.
- While there are large incentive programs available in the market (Carl Moyer, VW, etc.), the group agreed that there are insufficient funds to incentivize the replacement of all trucks operating in the San Pedro Bay Ports. Further, the requirements of many of these traditional funding programs make them a difficult fit for the port drayage market. Therefore, other new funding programs would be needed.
- Market certainty and early action were also noted by the group as key issues to consider.
- Ultimately, the group generally agreed that the "sweet spot" for a monthly truck payment for an operator in the San Pedro Bay Port drayage business is in the \$1,000 per month range.
- The group also agreed that it is critical to include some kind of maintenance plan for new clean trucks to ensure their continued successful operation.
- Financing new advanced technology trucks for port drayage operators has proven to be challenging for a number of reasons, including: high capital costs of the trucks; credit worthiness of the operators; maintenance requirements of new trucks; and residual value and



remarkability of the trucks. The Cal Cap Program has proven to be an effective tool to lenders in this market, although the program is still limited in its capacity.

- The group generally agreed to work with the SSCAC and the Ports to evaluate the potential and potential effectiveness of an incentive program that targeted the following elements.
 - Each OEM would develop a basic truck spec or two (i.e. standard 3-axle day cab), similar to the first CTP where only a limited number of truck models were made available in the CTP.
 - A monthly payment in the \$,1250 range with a 10-year depreciation to \$0 (recognizing that there is likely no secondary market after service in the port drayage market). Payment includes the capital cost of the truck, and a maintenance plan. Both financing and lease models are eligible
 - Some kind of risk pool would be established for lenders (similar to Cal Cap) in order to facilitate financing of advanced technology trucks to drayage operators.
 - Trade in of old truck.
 - A limited pool of funds would be available to motivate the market to respond.

To achieve such a program, it will be required to “back into” the incentive amount that would allow for these program goals to be achieved. The group agreed to work with the SSCAC and Ports to look more closely at these issues to determine if such a program is feasible.

- Action item: GNA to coordinate with trucking industry participants in the meeting to further evaluate the concept discussed.
- Using the above concept, it will likely still be necessary to motivate the market to replace existing older trucks with new near-zero or zero emission models. This mechanism would require further study.
- The tax on grants provided to drayage operators or leasing companies was noted as being a potentially significant issue. The use of a JPA was noted by the Committee as a potential innovative approach.
- It was also noted by the group that BCOs will hopefully want to hire those with near or near-zero emission trucks as there is a market value for using such clean equipment to move their freight.
- Additional funding and financing options were discussed that port staff and the committee are going to continue to flush out in subsequent meetings.



Attachment A

Meeting Attendees

SSCAC Committee Members	
Adrian Martinez	Earth Justice
Stella Ursua	GRID Alternatives
Jonathan Rosenthal	HPEC
Marnie Primer	FuturePorts
Cynthia Marvin	CARB
Barbara Van	CARB
Matt Miyasato	SCAQMD
Michele Grubbs	PMSA
Joe Lyou	CCA and SCAQMD Governing Board
Louis Dominguez	San Pedro Neighborhood Council
Steve Cadden (by phone)	CRT
Los Angeles Port & City Staff	
Chris Cannon	Port of Los Angeles
David Libatique	Port of Los Angeles
Erick Martell	Port of Los Angeles
Michael Samulon	City of LA, Mayors Office
Long Beach Port & City Staff	
Heather Tomley	Port of Long Beach
Meeting Facilitation Staff	
Erik Neandross	GNA
Lexi Wiley	GNA
Patrick Couch	GNA
Brianna Lawrence	GNA
Meeting Guests	
Vincent Pellecchia	BYD
Greg Roche	Clean Energy
Nidia Ramirez	Clean Energy
Roy Rivera	Inland Kenworth
Matt Smith	Navistar
Andrew Keane	PACCAR Finance
Oswaldo Merino	Pacific Enterprise Bank
Drew Cullen	Penske Truck Leasing
Mike Lewis	Penske Area Sales Manager for Southwest Region



Alison Cochran	Peterbilt Product Planning
Lacy V. Buckingham	Rush Peterbilt
Dale Snowden	Rush Peterbilt - Grants
Ann Holder	Rush Peterbilt
Julie C. Johnson	Ryder
Gina Goodhill	Tesla
Howard Shiebler	VVG/Crossroads
Matt Schrap	VVG/Crossroads



Attachment B

Meeting Agenda

1. POLA / POLB Opening Remarks
2. Review & Finalize May Meeting Summary
3. Review & Finalize 2018 Mission & Vision
4. Review & Finalize System of Systems Recommendation
5. Legislative Update/Funding Prioritization
6. Lunch & Roundtable Guests Arrive
7. Update on 2017 CAAP/CTP
8. Overview of Upcoming Available Funding
9. Discussion
10. Conclusion & Next Steps

Next Meeting:

- a. Recommendation on Fueling Infrastructure for Zero Emission Trucks & CHE
- b. Recommendation on Marine Emission Reduction Strategies



Attachment C

Sustainable Supply Chain Advisory Committee

May Meeting Summary

Date:	May 30th 11 am – 3 pm
Location:	In-person at Port of Long Beach and via phone conference
Attendees:	Attachment A
Meeting Agenda:	Attachment B

Key Discussion Items

(Action items in green)

2. POLA & POLB Opening Remarks

- Mario Cordero opened up the meeting by discussing the collaboration between POLB and marine terminal operators in deploying clean equipment. POLB has also moved forward with the GE Portal pilot project, which provides opportunity for maritime stakeholders to share information. Finding ways to continuously improve freight efficiency through this and other means, such as truck appointment systems, will be an ongoing priority for all stakeholders.
- Mike DiBernardo provided an update on the recent CAAP implementation stakeholder meeting that took place on March 29th. Mike also discussed recent developments with fuel cell technology for off-road equipment.

3. Review March Meeting Summary

- Meeting summary was approved (see Attachment C)

4. Review & Finalize 2018 Mission & Vision

- The group discussed edits to the introduction of the mission and vision document and agreed further revisions would be made and reviewed in advance of the next meeting.
 - Action item: GNA to coordinate edits and recirculate before July meeting.

5. Review Draft System of Systems Recommendation

- The group discussed the draft of the System of Systems document that had been developed and circulated in advance of the meeting. There was general agreement on the overall document and concepts, except for the ability to develop a simple analytical tool to measure efficiency improvements. Given time constraints, it was agreed the group would continue



discussing and revising the document until the next meeting where it can be represented to finalize.

- Action item: GNA to coordinate edits and recirculate before July meeting.

6. SCAQMD Summary of May Board Meeting

- Sarah Rees from the SCAQMD provided a short summary of the May AQMD board meeting related to reducing emissions via facility-based measures from freight facilities, including airports, seaports, railyards, warehouses and development projects, as well as the timelines for future activities and reporting by staff back to the AQMD Governing Board.

7. Discussion on Funding Prioritization

- The group discussed the need to line up funding priorities with State emission reduction goals.
- With many major buckets of funding available include VW Settlement funds, PUC, CEC, and others, the group discussed the need for more stakeholders to come together to illustrate the regional need for funding to be prioritized in and around the ports. The group discussed developing a letter to send to Sacramento signed by all of the committee members (except for CARB), advocating for an increased focus of funds for zero and near-zero equipment in the upcoming budget.
 - Action item: GNA to work with the Committee to draft a letter and send it out over the next couple of weeks.
- The group discussed pathways to transition the San Pedro Bay Port drayage truck fleet to near-zero or better, which is approximately 12,500 vehicles. With programs like Prop 1B, which has replaced 7,000 trucks already, members of the group agreed that 12,500 is not unattainable. Other funding measures are being studied by the AQMD and other stakeholders. Funding for zero emission infrastructure is another large aspect of the plan, as are challenging issues with scrappage and stranded assets.

8. 100 Zero-Emission Truck Project Update & Discussion

- POLA staff provided an update that they are meeting with trucking companies who are interested in running a 10+/- vehicle demonstration of electric trucks to test the typical duty cycle. This approach of having several trucking companies run a handful of trucks each is a likely scenario, rather than finding one company to run 100 vehicles. However, they will need to have an infrastructure plan and operate the vehicles for at least one year.
- The group discussed a need to hold workshops with drayage trucking companies, technology providers, port staff and the utilities to talk through of the issues and variables.
- One of the key issues is still funding the demonstration. The VW Settlement funds could be a good pot of money to fund the vehicles for this project and the recent approval of the SCE filing with the PUC could provide an opportunity for infrastructure funding.
- The group discussed if there is a clear picture of the project costs at this stage to ask for funding, or if there needs to be some additional upfront scoping time to better define the



project budget. It was recommended that an RFI be issued by the Ports to better gather such information from the market.

9. Recommendation on Fueling Infrastructure for Zero Emission Trucks & CHE

- Currently there is little to no infrastructure for heavy-duty electric vehicle charging and hydrogen fueling. While there is a good amount of funding becoming available from the CEC and SCE (as approved by the CPUC), there is no clarity on which type of zero emission fueling infrastructure should be pursued: hydrogen or electric recharging. Both types of infrastructure are tremendously expensive, thus driving the need to ensure that investment decisions are well thought through and will not result in stranded assets. The group discussed and agreed that there needs to be more collaboration among all stakeholders to better understand what kind of investment is needed to support the transition to zero emission trucks and CHE.
- Due to time constraints, there was not a full discussion on this agenda item and it will be revisited at the next meeting.

10. Recommendation on Marine Emission Reduction Strategies

- Due to time constraints, this agenda item will be moved to the next meeting.



Attachment D

San Pedro Bay Ports Sustainable Supply Chain Advisory Committee

Mission & Vision

PURPOSE

The Committee's purpose is to evaluate technologies and make advisory recommendations to both ports' executive directors for moving cargo more efficiently and with zero emission technology everywhere feasible, and near-zero emission technology powered by renewable fuels everywhere else. Using innovation, market transformation, and other tools, the Committee will also be tasked to help the San Pedro Bay Ports achieve and exceed the goals set forth in the State's Sustainable Freight Action Plan while addressing economic and commercial needs.

GOALS

The State's **Sustainable Freight Action Plan** goals of note for the Committee include:

- Improve freight system efficiency 25 percent by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030
- Deploy more than 100,000 freight vehicles and equipment capable of zero emission operation and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030
- Foster future economic growth within the freight and goods movement industry by promoting flexibility, efficiency, investment, and best business practices through State policies and programs that create a positive environment for growing freight volumes, while working with industry to lessen immediate potential negative economic impacts

The San Pedro Bay Ports **Clean Air Action Plan** goals of note for the Committee include:

- Reduce population-weighted residential cancer risk of Port-related DPM emissions by 85% by 2020, as compared with 2005 conditions.
- Reduce port-related emissions by 59 percent for NOx, 93 percent for SOx and 77 percent for DPM by 2023, as compared with 2005 conditions.
- Reduce GHGs from port-related sources to 40% below 1990 level by 2030 and 80% below 1990 levels by 2050.

VALUES AND GUIDELINES

As the Committee discusses possible recommendations, the following values and guidelines should be considered:

- Near-term pilots that are scalable, advance zero emissions targets, and help transform markets
- Focus on the largest sources of emissions with near-term and currently available technologies that meet economic and commercial needs
- Cost-effective investments with environmental, economic, and technological sustainability that also drive long-term market transformation



- Protecting human health, especially in port-adjacent communities, by accelerating the deployment of zero and near-zero emission technologies

PRIORITIES FOR 2018

The Committee has identified the following priorities for discussion and possible recommendations in 2018:

- Develop a one-page guiding document that identifies priorities to address and improve the “system of systems” nature of goods movement
- Advocate for local, state and federal funds to supplement private investment and accelerate the deployment of zero and near-zero emission technologies at the ports
- Accelerate technology & efficiency innovation, development and commercial deployments of:
 - On-road trucks (including a 100 zero emission truck demonstration)
 - Container handling equipment
 - Marine
 - Locomotive/rail
- Participate in the development of a multi-port clean tech RFI to accelerate the procurement and deployment of clean technology and vehicles
- Facilitate engagement with the beneficial cargo owners (BCOs) using the San Pedro Bay Ports to explore opportunities to accelerate the use of zero emission technology everywhere feasible, and near-zero emission technology powered by renewable fuels everywhere else.
- Collaborate with the port complex workforce to plan successfully for a zero and near-zero emission technology future



Attachment E

San Pedro Bay Ports Sustainable Supply Chain Advisory Committee

System of Systems Recommendation

The San Pedro Bay Ports SSCAC recognizes that the goods movement system is made up of a series of systems and ultimately, individual freight moves. Congestion and inefficiencies at any point throughout the supply chain will result in immediate incremental costs and emissions at the specific point of friction. Further, because of the connected nature of the goods movement system, each individual impact within the supply chain could potentially have an adverse impact on another part of the goods movement system, and thus result in cascading additional incremental costs and emissions.

The technologies and systems that make up the goods movement system are currently undergoing a radical transformation. New powertrain technologies, fuels, and processes by which to move freight are being developed, tested and deployed on an ongoing basis. The implementation of the San Pedro Bay Ports Clean Air Action Plan will further accelerate such change. While individual systems and goods movement technologies may offer local economic and/or environmental sustainability benefits, it is critical that these new systems and technologies do not have a negative impact on the efficiency of the overall goods movement system.

The SSCAC has a stated goal to work towards solutions and technologies that will "improve freight system efficiency 25 percent by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030." To ensure progress towards such a goal, every member of the goods movement community must accept responsibility for ensuring that their proposed actions, technology deployments and/or other activities do not have an adverse efficiency impact on any other part of the goods movement system.

The SSCAC therefore recommends that as new fuels, technologies and/or system improvements are considered and proposed, analyses should be completed by the San Pedro Bay Ports and other project stakeholders to:

- a. Identify potential areas of benefit and risk to system efficiency from the proposed action, and identify mitigation measures to address the risks, and,
- b. Evaluate how the proposed action will help contribute to the stated goal of improving freight system efficiency by 25 percent by 2030.



Attachment F

SAN PEDRO BAY PORTS | CLEAN AIR ACTION PLAN

SAN PEDRO BAY PORTS
CLEAN AIR ACTION PLAN

UPDATE ON PROGRESS

Chris Cannon
Director of Environmental Management
Port of Los Angeles

Heather Tomley
Director of Environmental Planning
Port of Long Beach

Truck Accomplishments

-
- Tariff Changes for MY 2014 New Registration – Board approved, starts October 1
 - Truck Rate-Setting Study – underway
 - Other – rate collection mechanism and truck reservation system research underway
 - Early Deployments – partnerships underway to hasten near-term action

Feasibility Assessments



- Consultant team has been selected
- Data collection is underway
- Draft expected in fall

Technology Development



- Grant funded demonstrations of Zero Emission Terminal Equipment – applications pending, awarded projects underway
- 50-100 Truck Pilot Deployment – planning underway
- Harbor Craft RFP – contract with vendor approved
- Vessel At-Berth Technologies RFP – proposal evaluation underway
- TAP Call for Projects - complete



Attachment G

gna GLADSTEIN, NEANDROSS & ASSOCIATES
CLEAN TRANSPORTATION & ENERGY CONSULTANTS

FUNDING 360

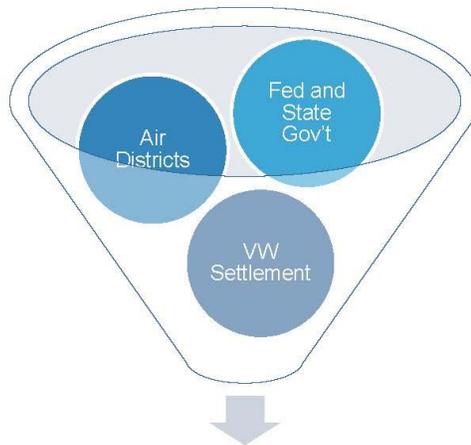
Incentive Opportunities to Support Zero and Near-Zero Emission Port Truck Deployments

Brianna Lawrence
Gladstein, Neandross & Associates

The Funding Landscape

Port truck fleets can avail themselves of funding from multiple sources:

- Federal: EPA's DERA and Targeted Air Shed Grant Programs
- State: HVIP and VW Settlement Programs
- Local: Carl Moyer and Utility Investments



\$1.5 billion in potential funding for port truck projects in next 3 years



Other Key Programs

<p>SCAQMD's Carl Moyer Program</p> <ul style="list-style-type: none"> • Opens annually in summer • Last solicitation: \$75 MM • Max. per vehicle incentive <ul style="list-style-type: none"> – ZE: \$200,000 – NZE: \$100,000 • Requires scrappage • Also funds refueling infrastructure 	<p>EPA's Targeted Air Shed Grant Program</p> <ul style="list-style-type: none"> • Opens annually in spring • Last solicitation: \$20 MM • Does not establish per vehicle incentives • Applicants must propose a comprehensive project, which is then ranked by cost-effectiveness of criteria pollutant reductions
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gna GLADSTEIN, NEANDROSS & ASSOCIATES
CLEAN TRANSPORTATION & ENERGY CONSULTANTS
Santa Monica, CA • New York, NY • Irvine, CA
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Attachment D
Summary of Truck Financing Roundtable Discussion

Aug. 6th Truck Industry Meeting Summary

- How to facilitate \$200K to \$400K near-zero and zero emission trucks in the SPBP
 - What level incentive is needed to make this happen?
 - \$1,250/month was agreed upon “Sweet Spot” for an affordable monthly payment for the drayage truck market (not including maintenance)
- Basic Assumptions
 - Standard 3-axle day cab (“port spec”)
 - 10-year depreciation to \$0 (remove questions re: residual value / secondary market)
 - Financing and lease models are eligible
 - Assume “high,” “mid,” and “low” credit risk

Aug. 6th Truck Industry Meeting Summary

- Other factors
 - Financing / leasing through traditional lenders (banks, dealer financing, leasing companies, etc.) is preferred over LMC-IOO leasing models
 - Need to establish a “Risk Pool” concept similar to CalCAP program
 - Allows lenders to mitigate risk of a default
 - Maintenance of the asset is required and should be “baked in” to the program somehow; need to ensure maintenance is being done regularly as required
 - Must motivate existing truck owners to voluntarily replace old trucks with no payments (9,000 units in DTR are CTP/ CARB compliant through 2023) with new trucks that have a significant monthly payment
 - Use a limited availability, first-come/first-served approach to motivate early action (i.e. only funding for the first 6,000 trucks)

Feedback from Aug. 6th Truck Industry Meeting

- Other feedback received:
 - Truck scrap requirement in Prop 1B, Moyer, VW, etc. presents a significant challenge and impediment to replacing old dirty trucks
 - Recommend a new program optimized for port drayage and the stated goal: early emission reductions via accelerated deployment of clean trucks
 - Provide a \$10K to \$20K bonus if old truck is scrapped or moved out of California
 - Reduce the per truck incentive each year (\$10K - \$20K) to motivate early action
 - Use a voucher-type program; new truck must be deployed within 6-9 mo.
 - Proof of insurance is required for program participation
 - Ensure that leasing is allowed (many programs force retail loans due to restriction on leasing when using public grant funds)

Feedback from Aug. 6th Truck Industry Meeting

- Other feedback (continued)
 - Ports to fund program using “Green Bonds” with repayment by fee collection over longer term
 - Facilitate low-interest loans for truckers; even more “traditional” rates
 - NW Seaport Alliance Clean Truck Fund program: facilitated by the Ports of Seattle and Tacoma and partnered with local/federal community banks
 - Provide incentives to OEMs directly to absorb taxable income (1099) on the incentive and reduce FET/sales tax on delivered cost of the truck
 - Exempt NZE and ZE trucks from container fees for 18 years, per SB1
 - “Green lanes” or other systems to increase gate moves require wholistic industry change and are too complicated to consider for early action efforts

Feedback from Aug. 6th Truck Industry Meeting

- 27 data points received from 9 organizations (2 leasing, 3 OEMs, 3 OEM dealers, 1 independent bank)
 - 17 did not include maintenance, 10 did include maintenance
- All traditional OEMs quoted NZE 12L NG trucks; 3 OEMs quoted BE trucks
- Nearly all organizations quoted 5 and 6 year terms, one quoted 7 years (none would finance on a 10 year schedule)
- Financing rates ranged from 8% - 19% for good to poor credit; average was ~12.5%

Feedback from Aug. 6th Truck Industry Meeting

- Average incentive required was **\$159,500** for both BEV and NZE NG
- Average incentive required was **\$205,000 for BEV**
 - \$130K (\$183K), \$250K (\$305K) and \$331K (\$427K)
- Average incentive required was **\$144,000 for NZE NG**
 - Incremental maintenance cost: \$350-\$550 per month
- “Optimal” package included \$150,000 incentive, 13.5% financing, 5 year term, maintenance included: \$1,500/month payment

Organization	Tech Type	Cost of Truck (incl. FET, sales)	Grant Required	Amount to be financed	Monthly Payment	Rate	Lease / Finance	Includes	Term (years)	Incremental
								Maint? (Y/N)		Cost (per month)
Leasing Co.	NZE NG	\$200,000	\$175,000	\$25,000	\$1,400		Full Service Lease	Y	5	-
Leasing Co.	NZE NG	\$200,000	\$165,000	\$35,000	\$1,600		Full Service Lease	Y	5	-
Leasing Co.	NZE NG	\$200,000	\$155,000	\$45,000	\$1,800		Full Service Lease	Y	5	-
Dealer Finance	NZE NG	\$200,000	\$140,000	\$60,000	\$1,204	12.99%	Finance	N	6	-
Dealer Finance	NZE NG	\$200,000	\$155,000	\$45,000	\$903	12.99%	Finance	Y	6	\$550
Leasing Co.	NZE NG	\$200,000	\$120,000	\$80,000	\$1,482	10.00%	Finance	Y	6	-
Bank	NZE NG	\$200,000	\$135,000	\$65,000	\$1,250		Finance	N		
Dealer Finance	NZE NG	\$200,000	\$138,315	\$61,685	\$1,250	8.00%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$145,675	\$54,325	\$1,250	13.50%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$151,813	\$48,187	\$1,250	19.00%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$126,022	\$73,978	\$1,500	8.00%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$134,810	\$65,190	\$1,500	13.50%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$142,175	\$57,825	\$1,500	19.00%	Finance	N	5	\$350
Dealer Finance	NZE NG	\$200,000	\$143,284	\$56,716	\$1,500	8.00%	Finance	Y	5	-
Dealer Finance	NZE NG	\$200,000	\$150,021	\$49,979	\$1,500	13.50%	Finance	Y	5	-
Dealer Finance	NZE NG	\$200,000	\$155,668	\$44,332	\$1,500	19.00%	Finance	Y	5	-
Dealer Finance	NZE NG	\$195,857	\$120,000	\$75,857	\$1,220	9.00%	Finance	N	7	-
Dealer Finance	NZE NG	\$195,857	\$130,000	\$65,857	\$1,187	9.00%	Finance	N	6	-
OEM	NZE NG	\$180,000	\$125,000	\$55,000	\$1,251	13.00%	Finance	N	5	-
OEM	NZE NG	\$219,600	\$165,000	\$54,600	\$1,242	13.00%	Finance	N	5	
OEM	BEV	\$350,000	\$295,000	\$55,000	\$1,251	12.00%	Finance	N	5	-
OEM	BEV	\$427,000	\$368,000	\$59,000	\$1,250	13.00%	Finance	N	5	
OEM	BEV	\$182,250	\$125,000	\$57,250	\$1,250	8.00%	Asset Lease	N	5	-
OEM	BEV	\$182,250	\$130,000	\$52,250	\$1,250	8.00%	Asset Lease	Y	5	-
OEM	BEV	\$182,250	\$130,000	\$52,250	\$1,250	15.00%	Asset Lease	N	5	-
OEM	BEV	\$182,250	\$135,000	\$47,250	\$1,250	15.00%	Asset Lease	Y	5	-
OEM	BEV	\$305,000	\$250,000	\$55,000			Finance	N		-



Attachment D
Funding Prioritization Presentation

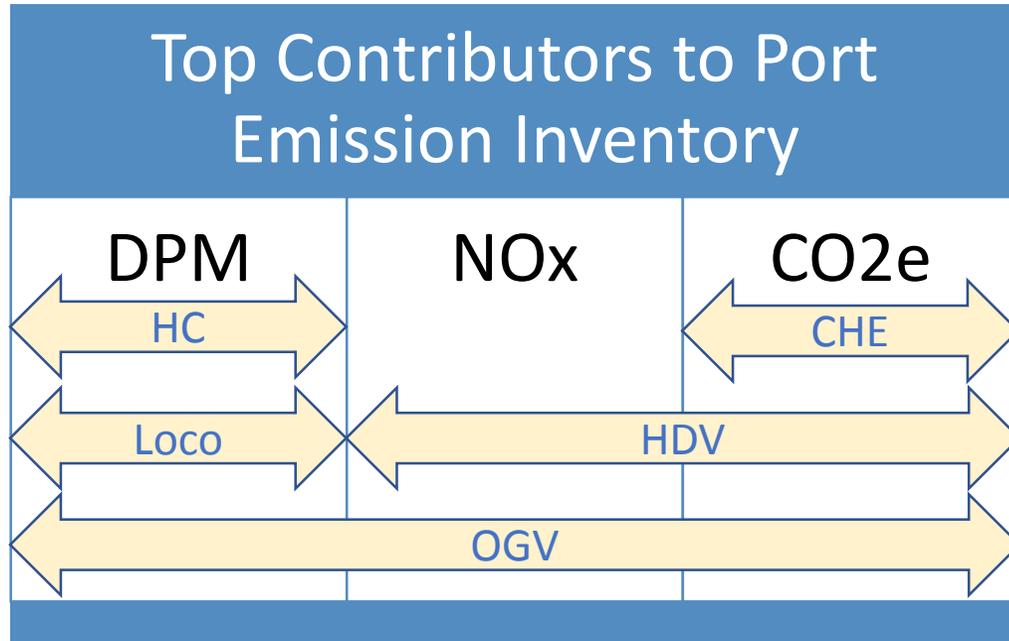
SPBP Needs and Resources Prioritization for Clean Technology Investments

November 28, 2018

Discussion Questions

- How do we weigh/prioritize emissions reductions amongst pollutants? Are NOx, PM, or GHG reductions a higher priority?
- Are there emission tradeoffs?
- Are there co-benefit opportunities?
- What does it mean for a project to be cost effective, recognizing that most projects will be expensive by historic cost effectiveness standards?
- Which technologies are commercially viable today? By 2025? By 2030?
- Are there near term emission reduction opportunities for NOx, PM, and GHGs we should pursue now even though they may not be as high of a priority overall?
- Will regulation drive the same result?
- Where are the potential conflicts/synergies between CAAP goals and new/pending regulations, and how do we resolve the conflicts?
- Will regulation require significant Port investment? If so, how much and will this materially impact the Ports' ability to invest in other measures?
- Are there existing incentive programs that can fund conversion to the goal?
- Can incremental investment drive incremental, near-term and/or cost-effective emission reductions?

Summary of SPBP Emissions Inventories



	DPM	NOx	CO2e
OGV	48%	54%	30%
HC	19%	10%	6%
CHE	4%	6%	17%
Loco	22%	11%	7%
HDV	7%	19%	40%

- Primary contributors to the emissions inventory vary by pollutant
 - OGVs are the single largest source of pollution
 - HDVs are second with respect to NOx and GHGs
 - Locomotives and Harbor craft are second with respect to DPM
- The “most important” equipment types to address depends on your priorities.

Policy Goals and Strategies

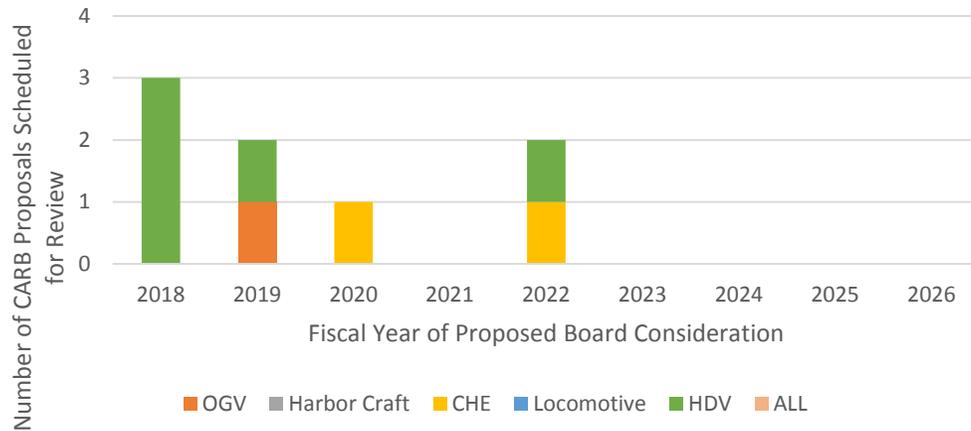
Clean Air Action Plan (SPBP)	State Implementation Plans + AB/SB 32 (CARB)	Sustainable Freight Action Plan (DOT)	Air Quality Management Plan (SCAQMD)
Reduce population-weighted residential cancer risk of port-related DPM emissions by 85% by 2020.	Achieve all NAAQS Standards	Improve freight system efficiency 25% by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030.	Ensure air quality goals will be met while maximizing benefits and minimizing adverse impacts to the regional economy: <ul style="list-style-type: none"> Eliminate reliance on ‘future technologies’ measures to the maximum extent feasible
By 2023, reduce port-related emissions by <ul style="list-style-type: none"> 59% for NOx (56% achieved) 93% for SOx (97% achieved) 77% for DPM (87% achieved) 	Reduce GHG emissions to: <ul style="list-style-type: none"> 1990 levels by 2020 40% below 1990 levels by 2030 80% below 1990 levels by 2050 	Deploy over 100,000 freight vehicles and equipment capable of zero emission operation and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030.	<ul style="list-style-type: none"> Calculate and take credit for co-benefits from other planning efforts Develop a strategy with fair-share emission reductions at the federal, state and local levels Invest in strategies, technologies to meet multiple objectives for air quality, climate change, air toxics exposure, energy, transportation
Reduce GHGs from port-related sources to: <ul style="list-style-type: none"> 40% below 1990 levels by 2030 80% below 1990 levels by 2050 		Increased competitiveness and economic growth.	<ul style="list-style-type: none"> Identify and secure significant funding for incentives to implement early deployment and commercialization of zero and near-zero technologies.

Equipment-specific Commitments to Policy Goals

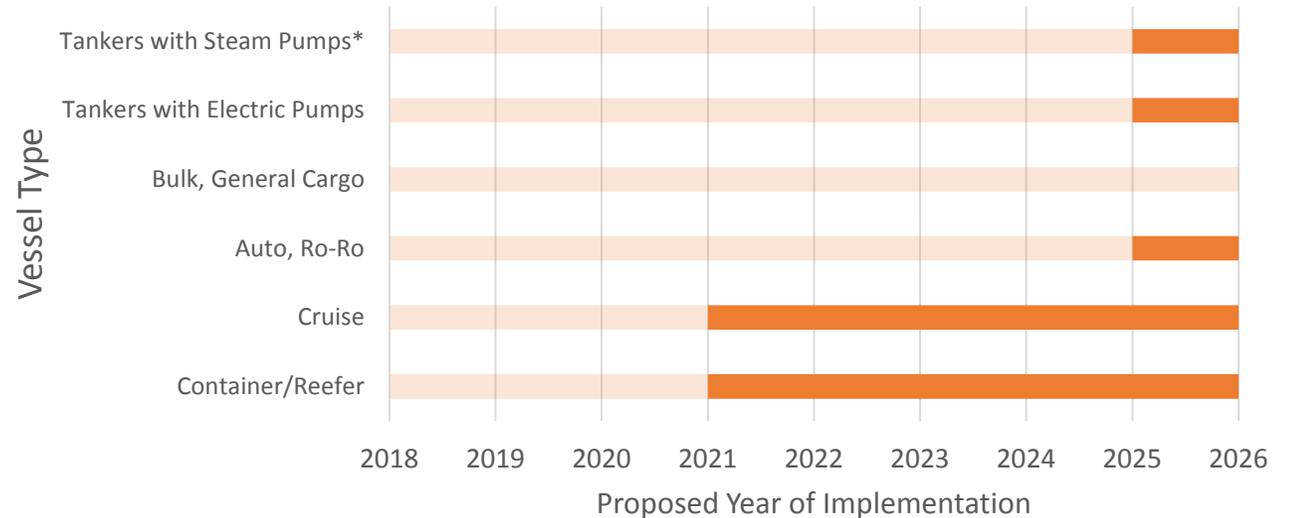
Equipment Type	Clean Air Action Plan (SPBP)	State Implementation Plan (CARB)
OGV	<ul style="list-style-type: none"> • Advocate for Tier 4/PM engine standard • Maximize participation in vessel speed reduction (VSR) for all vessels within 40 nm of Point Fermin • Demonstrate at-berth emission reduction technologies • Accelerate at-berth emissions reduction technology use requirements through leases where possible 	<ul style="list-style-type: none"> • 80% reduction in at-berth emissions required by 2020 • All vessels must comply with at-berth regulations during 100% of visits by 2030.
Harbor Craft	<ul style="list-style-type: none"> • Support new fleet turnover requirements • Incentivize Tier 4 engine upgrades in the short-term • Provide, expand infrastructure to support at-berth shore power use 	<ul style="list-style-type: none"> • Establish zero-emission performance standards, exceeding the LSI regulation requirements for forklifts.
CHE	<ul style="list-style-type: none"> • All new purchases must be ZE and if not feasible, NZE or cleanest-available, effective 2020. • Support idling restrictions and fleet turnover requirements 	<ul style="list-style-type: none"> • Propose regulation requiring transition to 100% zero-emissions equipment beginning in 2026. • Establish zero-emission performance standards, exceeding the LSI regulation requirements for forklifts.
Locomotive	<ul style="list-style-type: none"> • Advocate for Tier 5 engine standard • 50% on-dock rail for cargo transport 	<ul style="list-style-type: none"> • Petition US EPA for more stringent national locomotive (Tier 5) emission standards • Evaluation and potential development of regulation to reduce emissions from locomotives not pre-empted under the Clean Air Act
HDV	<ul style="list-style-type: none"> • Only NZE trucks may enter SPBP without paying a rate effective 2020 or when State NZE standard is defined. Existing trucks in PDTR continue to operate. • Only NZE trucks may enter SPBP effective 2023 or when State NZE standard is defined. Existing trucks in PDTR continue to operate. • Only ZE trucks may enter SPBP without paying a rate, effective 2035. 	<ul style="list-style-type: none"> • All trucks with engine MY2007 or newer are fully compliant until 12/31/2022 for CA ports and rail yards. • All trucks must have engine MY2010 or newer by 2023. • Adopt Low Emission HD Engine Standard by 2022.

Summary of Zero/Near Zero Regulatory Horizon

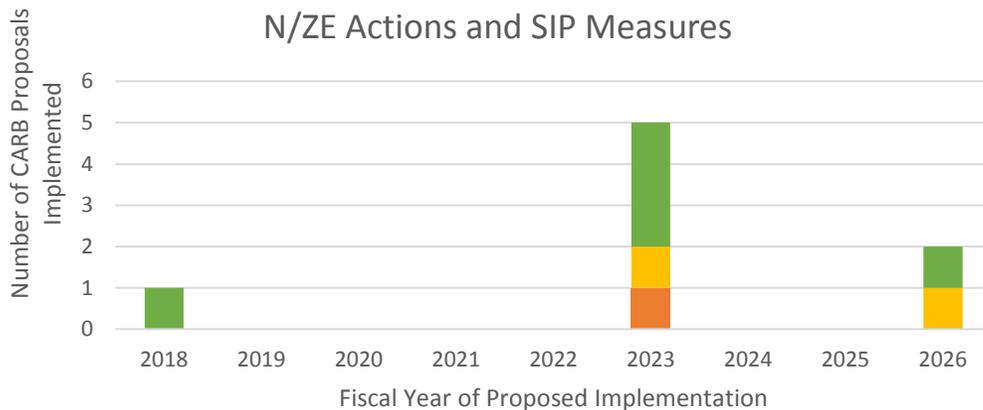
CARB Board Review of Proposed Freight-Related N/ZE Actions and SIP Measures



CARB Proposed Timeline for 100% ShorePower



CARB Proposed Implementation of Freight-Related N/ZE Actions and SIP Measures



- HDVs are the focus of the *greatest number of proposed* regulatory measures in the short term. HDV measures target emissions reductions and commercialization
- OGV measures target at-berth shore power retrofits for most frequent vessels (cruise, container)
- Locomotive measures target pre-commercial R&D

List of regulatory measures

Sector/Facility Type	Action
Ship at-berth Amendments	Requires vessels to comply with shore power and/or alternative control technology requirements during 100% of visits.
Commercial Harbor Craft regulation amendments	Amend existing regulation to increase requirements for in-use and new vessels freight- and passenger- vessels. Includes re-evaluating Tier 4 engine feasibility and advanced retrofit ECDs.
Cargo Handling Equipment regulation to transition to zero emissions	Propose an implementation schedule beginning in 2026 for new equipment and facility requirements. Affects all mobile equipment.
Zero-emission forklift regulation	Establish zero-emission performance standards, exceeding the LSI regulation requirements for forklifts.
Drayage truck regulation to transition to zero emission operation	Establish a schedule to phase-in zero-emission drayage truck technology including zero-emission mile capabilities.
Drayage trucks lower in-use performance level	(Multiple regulations)
Drayage trucks vehicles heavy-duty vehicle zero emission certification procedures	Standardize evaluation criteria to validate zero-emission technology performance.
Advanced local clean trucks regulation (last-mile delivery)	Accelerate penetration of new C3-C7 trucks meeting OLNS or ZE engines in local fleets starting with 2.5% ZEV penetration in 2020, and achieving 10% penetration in 2025.
Low-oxides of nitrogen engine standard	Establish an engine standard that achieves 90% reduction in NOx emissions, and develop regulatory amendments to improve certification requirements for emission control systems operating in low load urban driving conditions.
<i>CARB Proposed Actions Not Incorporated in Critical Regulatory Timeline</i>	
Drayage trucks at seaports and rail yards	Participate in SPBP determination of drayage truck rates to incentivize zero and near-zero emission truck trips
Rail yards, Rail stations, Rail sidings, Seaports, Warehouses, and Other Hubs	Evaluation and potential development of regulation to reduce idling emissions from all rail yard sources and emissions from other stationary locomotive operations
Locomotives	Evaluation and potential development of regulation to reduce emissions from locomotives not pre-empted under the Clean Air Act.
	Petition US EPA for more stringent national locomotive (Tier 5) emission standards
Trucks	Heavy-duty on-board diagnostics amendments
	Innovative truck technology cert flexibility
Off-road equipment	Zero emission off-road emission reduction assessment, and zero emission off-road worksite emission reduction assessment

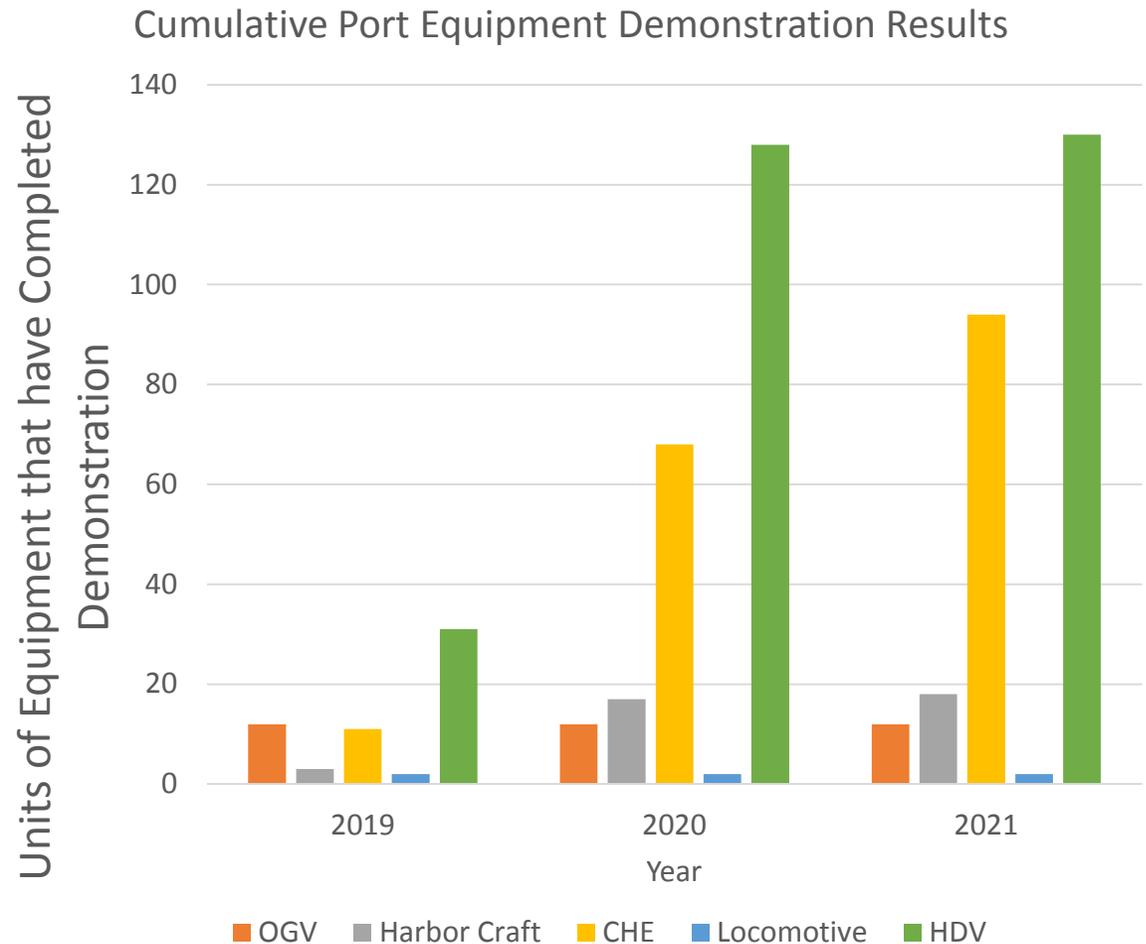
Summary of Near-term Demonstrations

Based on a review of 47 demonstration projects, by 2021:

- CHE and HDV equipment has/will have been extensively tested
→ *Target commercial funding*
- OGV, Harbor Craft and Locomotive are further *behind* in testing
→ *Target demonstration funding*

Project Types by Equipment Category

OGV	Harbor Craft	CHE	Locomotive	HDV
Efficiency, Tier 3 Retrofit	Efficiency, HEV, Fuel Cell	HEV, BEV, NZ NGV, FCV	DPF, BEV/HEV	BEV, NZ NGV, FCV, PHEV, HEV



Examples of Project Cost Ranges

Equipment Type	No. Projects	Project Type(s)	Demo Units	Scope	Range of Project Cost/Unit
OGV	2	Retrofit	14	Engine alterations	\$238K - \$11MM
OGV	2	Shore Power*	2	Berth Infrastructure, Ship Retrofit	\$1.2MM - \$6.5MM
Harbor Craft	4	Retrofit, New Build	5	HEV, PHEV, FCV	\$1.2MM - \$2.5MM
CHE	11	Retrofit, New Build	176	BEV/CNG, BEV	\$232K - \$10MM
Locomotives	3	Retrofit, New Build	3	DPF, CNG	\$700K - \$4.4MM
HDV	12	Retrofit, Repower, New Build	107	PHEV (LNG), CNG, BEV, FCV	\$75K - \$6MM

- Shore Power estimates are based on a September 2018 Draft released by CARB, which is currently under review. Sources indicate that costs are likely to increase in the second round.
- *Note: Infrastructure costs are not included in these project cost estimates, to the best of GNA's knowledge.*

Technology Analysis - Approach

- Questions to answer
 - What are the expected costs of low/zero emission equipment sold at commercial volumes?
 - What would be the total investment to fully deploy these technologies?
 - Which technologies offer the most emissions reduction per project dollar?
- Data sources
 - Port Emissions and Equipment Inventory
 - ZANZEFF Demonstration Project Equipment, Cost, Emissions

Forecasted Equipment Commercial Cost (ZANZEFF)

Equipment	Average Demo Unit Cost	Commercial Unit Cost in 4 years	% Change in Price	
OGV – Container (retro. Tier 3)	\$9.4M	\$9.4M		0%
HC – Tug (Tier 4 HEV)	\$18MM	\$17MM		5%
CHE – Yard Tractor (BEV)	\$320K	\$307K		4%
CHE – Top Handler (BEV)	\$1.87MM	\$1.42MM		24%
CHE – RTG (BEV)	\$600K	\$600K		0%
CHE – Large Forklift (BEV)	\$418K	\$342K		18%
CHE – Small Forklift (BEV)	\$60K	\$53K		12%
HDV (BEV)	\$382K	\$362K		5%
HDV (NZ NGV)	\$165K	\$165K		0%
HDV (FCV)	TBD	TBD		TBD

Forecasted Total Investment by 2030

Equipment	2017 Inventory	Unit Cost	Est. Equipment Cost	Est. Infrastructure Cost	Est. Year of Regulatory Action
OGV – Container (retro. Tier 3)	514	\$9.4 MM	\$4.8 B	N/A	TBD
HC – Tug boat (Tier 4 HEV)	76	\$17 MM	\$1.3 B	N/A	2023
CHE – Yard Tractor (BEV)	1,693	\$307K	\$519 MM	TBD	2026
CHE – Top Handler (BEV)	412	\$1.4 MM	\$602 MM	TBD	2026
CHE – RTG (BEV – Repower)	169	\$600K	\$101 MM	TBD	2026
CHE – Large Forklift (BEV)	221	\$342K	\$76 MM	TBD	2026
CHE – Small Forklift (BEV)	536	\$342K	\$29 MM	TBD	2026
HDV (BEV)	12,989	\$362K	\$4.7 B	TBD	2026
HDV (NG)	12,989	\$165K	\$2.1 B	TBD*	2026
HDV (FCV)	12,989	TBD	TBD	TBD*	2026

\$9.6 to \$12.1 Billion + Infrastructure

Accounts for 75% of NOx, 25% of PM, and 25-65% of GHGs

*Costs likely to be incorporated into fuel pricing

Cost Effectiveness Comparison (ZANZEFF technologies)

Equipment	Est. Total Investment	Emission Reduction Factors			First Year Cost Effectiveness (\$/ton or \$/MT)		
		NOx	PM2.5	GHGs	NOx	PM2.5	GHGs*
OGV – Container (retro. Tier 3)	\$4.8 B	80%	0%	0%	\$2,955,000	N/A	N/A
HC – Tug boat (Tier 4 HEV)	\$1.3 B	91%**	88%**	50%	\$1,941,000	\$60,920,000	\$45,000
CHE – Yard Tractor (BEV)	\$346 MM	100%	100%	100%	\$2,501,000	\$126,562,000	\$4,000
CHE – Top Handler (BEV)	\$1.2 B	100%	100%	100%	\$1,843,000	\$250,977,000	\$7,000
CHE – RTG (BEV - Repower)	\$69 MM	100%	100%	100%	\$612,000	\$48,286,000	\$4,000
CHE – Large Forklift (BEV)	\$253 MM	100%	100%	100%	\$4,934,000	\$382,361,000	\$21,000
CHE – Small Forklift (BEV)	\$253 MM	100%	100%	100%	\$1,195,000	\$72,576,000	\$8,000
HDV (BEV)	\$4.6 B	100%	100%	100%	\$1,796,000	\$295,316,000	\$7,000
HDV (NG)	\$2.1 B	90%	0%	15%	\$911,000	N/A	\$21,000
HDV (FCV)	TBD	100%	100%	100%	TBD	TBD	TBD

*GHG Emissions are direct emissions from equipment only, and do not include upstream emissions **Versus Tier 2 engine standards

Technology Analysis Summary

Equipment	Technology / Strategy	Technical Maturity			Cost Effectiveness			Impact			Can we get Emission Reductions Faster and Cost-Effectively?
		Commercial Availability (2018)	Units in Demonstration	Units in Service (not demos)	Relative Cost Effectiveness			Relative Fraction of SPBP Inventory Reduced			
					NOx	PM2.5	GHGs	NOx	PM2.5	GHGs	
OGVs	Retrofit to Tier 3	Low	Low	None/Low	\$2,955,000	N/A	N/A	44%	0%	0%	1
Harbor Craft	Hybridization	Low	Low	None/Low	\$1,941,000	\$60,920,000	\$45,000	9%	15%	3%	1
CHE - Yard Truck	Electrification	Low/Medium	High	Low	\$2,501,000	\$126,562,000	\$4,000	2%	2%	9%	3
CHE - Top Handler	Electrification	Low	Low	None	\$1,843,000	\$250,977,000	\$7,000	2%	1%	5%	2
CHE - RTG	Electrification	Low	Medium	Low	\$612,000	\$48,286,000	\$4,000	1%	1%	1%	2
CHE - Lg. Forklift	Electrification	Low	None	None	\$4,934,000	\$382,361,000	\$21,000	0.10%	0.10%	0.20%	1
CHE - Sm. Forklift	Electrification	High	None/Low	Medium/High	\$1,195,000	\$72,576,000	\$8,000	0.20%	0.20%	0.20%	4
HDVs	Electrification	Low	High	Low	\$1,796,000	\$295,316,000	\$7,000	19%	6%	40%	3
HDVs	NZ Natural Gas	High	High	Medium	\$911,000	N/A	\$21,000	17%	0%	6%	5
HDVs	Fuel Cell	Low	Medium	Low	TBD	TBD	TBD	19%	6%	40%	2

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