Environmental Plans and Freight Movement at the San Pedro Bay Ports: A Quick Strike Analysis

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A White Paper from the National Center for Sustainable Transportation

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16. Abstract
Critical to freight movement in Southern California are environmental plans at the Port of Los Angeles (POLA) and Port of Long Beach (POLB). The combined port complex is the single largest fixed source of air pollution in the South Coast Air Basin. This white paper presents three case studies from the San Pedro Bay Ports Clean Air Action Plan (CAAP), including brief analyses of their effects on freight movement in the region. This research also includes a case study of a private-sector, yet-to-be-built infrastructure project designed to support the faster movement of freight out of the San Pedro Bay Ports called the Southern California International Gateway (SCIG). The case studies are provided to elucidate how self-regulating agreements and operator-led programs contribute to regional environmental goals for freight operations. The findings indicate in part that stakeholder power relationships influence the ability to both develop environmental strategies and determine their outcomes. They also indicate that port-focused plans are more effective when their impact on the entire supply chain is considered. The research also helps to illustrate examples of unintended consequences of freight-related environmental measures which will prove useful to policymakers and operators alike.

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Disclaimer

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Acronyms

APCD	Air Pollution Control District
ACMD	Air Quality Management District
AQMP	Air Quality Management Plan
BNSF	Burlington Northern and Santa Fe Railways
CAAP	Clean Air Action Plan
CAA	Clean Air Act
CARB	California Air Resources Board
CEQA	California Environmental Quality Act
CHE	Cargo Handling Equipment
CTP	Clean Truck Program
CO	Carbon Monoxide
DPM	Diesel Particulate Matter
DOCs	Diesel Oxidation Catalysts
DPF	Diesel Particulate Filters
EIR	Environmental Impact Report
EJ	Environmental Justice
EPA	Environmental Protection Agency
GHG	Greenhouse Gas
HDV	Heavy-duty Vehicle
HTA	Harbor Trucking Association
ILWU	International Longshore and Warehouse Union
LNG	Liquefied Natural Gas
MOU	Memorandum of Understanding
NOx	Nitrogen Oxide
NRDC	National Resources Defense Council, Inc.
OGVs	Ocean-Going Vessels
PCMTF	Port Community Mitigation Trust Fund
PM	Particulate Matter
SCAQMD	South Coast Air Quality Management District
VSR	Vessel Speed Reduction

Glossary

Some terms are adapted from the Energy Glossary of the California Energy Commission

AIR QUALITY MANAGEMENT DISTRICT (AQMD) – A group of counties or portions of counties, or an individual county specified in law with authority to regulate stationary, indirect and area sources of air pollution within the region and governed by a regional air pollution control board comprised mostly of elected officials from within the region.

AIR QUALITY MANAGEMENT PLAN (AQMP) – A plan prepared by an APCD/AQMD, for a county or region designated as a non-attainment area, for the purpose of bringing the area into compliance with the requirements of the national and/or California ambient air quality standards. AQMPs are incorporated into the State Implementation Plan (SIP).

CALIFORNIA AIR RESOURCES BOARD (CARB) – The "clean air agency" in the government of California, whose main goals include attaining and maintaining healthy air quality; protecting the public from exposure to toxic air contaminants; and providing innovative approaches for complying with air pollution rules and regulations. CARB is responsible for controlling emissions mainly from mobile sources.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) – Enacted in 1970 and amended through 1983, established state policy to maintain a high-quality environment in California and set up regulations to inhibit degradation of the environment.

CARBON MONOXIDE (CO) – A colorless, odorless, highly poisonous gas made up of carbon and oxygen molecules formed by the incomplete combustion of carbon or carbonaceous material, including gasoline. It is a major air pollutant on the basis of weight.

COLD IRONING – Cold ironing or Shore power refers to providing electrical power to a vessel that is docked. The purpose of shore power is to allow the vessel operator to turn off the vessel's auxiliary engines, which would normally be providing the necessary electricity. Although there are emissions associated with the generation of electricity used for shore power, those emissions are much lower than those from the auxiliary engines, which burn diesel fuel. This all having been said, it is important to note that some auxiliary engines cannot be turned off when a ship is plugged in at berth. Boilers that heat water and fuel must operate the entire time. If temperatures drop, fuel will congeal and clog the entire mechanism. Furthermore, emissions at berth are generated during the connection and disconnection of vessels, which can take anywhere from forty-five minutes to three hours.

DIESEL OIL – Fuel for diesel engines obtained from the distillation of petroleum. It is composed chiefly of aliphatic hydrocarbons. Its volatility is similar to that of gas oil. Its efficiency is measured by cetane number.

DISADVANTAGED COMMUNITY – These are communities in the top 25% scoring areas census tracts from CalEnviroScreen 3.0 along with other areas with high amounts of pollution and low populations.

DRAYAGE – The short-distance cargo movement within and out of the ports by ground freight (usually heavy duty trucks) to intermodal yards or distribution and warehousing centers.

ENVIRONMENTAL JUSTICE (EJ) – The fair treatment and meaningful involvement of all people regardless of race, color, culture, national origin, income, and educational levels with respect to the development, implementation, and enforcement of protective environmental laws, regulations, and policies.

EPA – The Environmental Protection Agency. A federal agency charged with protecting the environment. Note: This should not be confused with CalEPA, a California state agency charged with protecting the environment and human health.

EXHAUST – Air removed deliberately from a space, by a fan or other means, usually to remove contaminants from a location near their source.

HYDROCARBONS – Compounds containing various combinations of hydrogen and carbon atoms. They may be emitted into the air by natural sources (e.g., trees) and as a result of fossil and vegetative fuel combustion, fuel volatilization and solvent use. Hydrocarbons are a major contributor to smog.

LIQUEFIED NATURAL GAS – Natural gas that has been condensed to a liquid, typically by cryogenically cooling the gas to minus 260 degrees Fahrenheit (below zero).

MEMORANDUM of UNDERSTANDING – An agreement between two or more parties outlined in a formal document. The MOU can be the starting point for negotiations as it defines the scope and purpose of the talks. A MOU is not a legal commitment; it expresses parties' willingness to cooperate.

MOBILE SOURCES – Sources of air pollution such as automobiles, motorcycles, trucks, off-road vehicles, vessels, and airplanes.

NITRIC OXIDE (NO) – A Precursor of ozone, NO2 and nitrate; nitric oxide is usually emitted from combustion processes. Nitric oxide is converted to nitrogen dioxide (NO2) in the atmosphere and then becomes involved in the photochemical processes and/or particulate formation.

NITROGEN OXIDES (OXIDES OF NITROGEN, NOx) – A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO2 is a criteria air pollutant and may result in numerous adverse health effects.

PARTICULATE MATTER (PM) – A blend of solid particles and liquid droplets that remain suspended in the air for a long time. PMs range from visual macroscopic particles (such as dust, soot, and metal specks) to invisible nanoparticles. The category of PM includes, but is not limited to, unburned fuel particles that form smoke or soot and stick to lung tissue when inhaled. PM is a chief component of exhaust emissions from heavy-duty diesel engines.

SHORE POWER – "Shore power," also known as Cold Ironing, refers to providing electrical power to a vessel that is docked. The purpose of shore power is to allow the vessel operator to turn off the vessel's auxiliary engines, which would normally be providing the necessary electricity. Although there are emissions associated with the generation of electricity used for shore power, those emissions are much less than those from the auxiliary engines, which burn diesel fuel.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD) – the air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. This area of 10,743 square miles is home to over 16.8 million people—more than one-third of the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. SCAQMD's mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies. SCAQMD is responsible for controlling emissions mainly from stationary sources.

VESSEL SPEED REDUCTION (VSR) – A way to reduce emissions of NOx, SOx, diesel PM and CO2 from oceangoing vessels. Speaking generally, emissions are decreased when vessels slow their speeds, thereby reducing the energy requirements of the main engine. Ports typically offer incentives for complying. The emissions reduction due to VSR vary and depend on many factors, like the type of engine and fuel, or ocean current. VSR significantly reduces NOx but not PM or SOx. VSR also reduces the risk of whale strikes.

Environmental Plans and Freight Movement at the San Pedro Bay Ports: A Quick Strike Analysis

EXECUTIVE SUMMARY

Critical to freight movement in Southern California are environmental plans at the Port of Los Angeles (POLA) and Port of Long Beach (POLB), commonly referred to as the San Pedro Bay Ports (SPBP). The SPBP complex is a notably large fixed source of air pollution in the South Coast Air Basin (SCAB) (Wallerstein, Chang, and Tisopulos 2013). SCAB is in non-attainment of federal air quality standards pertaining to ground-level ozone and particulate matter smaller than 2.5 microns (PM2.5) due in part to heavy duty trucks[1] that move containers from the SPBP to intermodal railyards and distribution and warehousing facilities ("CAAP Final Update 2017" 2017). Ocean-Going Vessels (OGVs) also produce a large share of greenhouse gas emissions (GHGs) in the region.

Researchers at the Center for International Trade and Transportation (CITT) at California State University, Long Beach (CSULB) present three case studies from the SPBP Clean Air Action Plan (CAAP), including brief analyses of their effects on freight movement in the region. This research also includes a case study of a private-sector, yet-to-be-built infrastructure project designed to support the faster movement of freight out of the SPBP called the Southern California International Gateway (SCIG). This quick strike analysis builds upon METRANS policy evaluations of port-related strategies to reduce congestion, such as gate appointment systems to increase efficiency within the port complex.

The CAAP case studies focus on three intermodal freight transportation systems: truck, rail, and Ocean-Going Vessels (OGVs). These air quality action plans include the government-subsidized Clean Truck Program (CTP), and the voluntary Vessel Speed Reduction (VSR) and Technology Advancement Program (TAP). The fourth and final case focuses on environmental policies regarding rail. At the start of the CAAP in 2006, policies regarding rail focused on lowering locomotive emissions in line with Environmental Protection Agency (EPA) and California Air Resources Board (CARB) standards. Within the past 15 years, however, the environmental strategies have shifted to prioritize moving more cargo by rail, as opposed to the use of drayage[2] trucks within the complex. The Burlington Northern Santa Fe Railway (BNSF) proposed the SCIG, an intermodal rail yard four miles from the port complex, to improve freight congestion and air quality in the region. This infrastructure project has been blocked from development largely from opposition by port and port-adjacent community stakeholders including the City of Long Beach, Long Beach Unified School District, Environmental Justice organizations, and health and civil rights organizations. The latter organizations were backed

[1] These trucks are referred to as drayage trucks.

[2] The short-distance cargo movement within and out of the ports by ground freight (usually heavy-duty trucks) to intermodal yards or distribution and warehousing centers.

with technical support from the National Resources Defense Council (NRDC), a U.S.-based international nonprofit environmental advocacy organization.

CITT further explored the institutional challenges the twin ports face while working with a multitude of stakeholders and regulatory bodies to address both environmental sustainability and economic competitiveness. This report identifies stakeholders, sources of influence, appropriate terminology, and collaborative strategies to reach air emission objectives. CITT's investigative framework also examines five levels of environmental policy jurisdiction including the International Maritime Organization (IMO), the federal U.S. Environmental Protection Agency (EPA), the California Air Resources Board (CARB) and California Energy Commission (CEC), the regional South Coast Air Quality Management District (SCAQMD), and the SPB ports' Clean Air Action Plan. The case studies are provided to elucidate how self-regulating agreements are arranged with multiple parties and interests and the extent to which relationships and objectives change over time. What have been the unintended consequences affecting freight? How has the COVID-19 pandemic affected these air action plans? It is important to note that the CAAP is a product of continual stakeholder collaboration and can be analyzed as a living, malleable document. CAAP 1.0 in 2006, for example, is far different in scope and objectives from the subsequent CAAP Updates in 2010 and 2017. These air action plans currently serve as prototypes for other ports to potentially replicate ("EPA Case Study CAAP Best Practices Lesson Learned" n.d.).

The findings indicate in part that stakeholder power relationships influence the ability to both develop environmental strategies and determine their outcomes. They also indicate that port-focused plans are more effective when their impact on the entire supply chain is considered. The research also helps to illustrate examples of unintended consequences of freight-related environmental measures which will prove useful to policymakers and operators alike.

CITT developed these case studies for secondary, post-secondary, and graduate students as the intended audience. CSULB's Advanced Media Productions (AMP) will produce a video highlighting main points of this research as a further resource for students.

Introduction

The Need for Air Action Plans in Southern California

South Coast Air Quality Management District (SCAQMD) as an EPA-designated Extreme Nonattainment District

Based on national ambient air quality standards (NAAQS), the South Coast Air Quality Management District (SCAQMD)[3] is a designated "extreme" nonattainment region ("Revisions to California State Implementation Plan; South Coast Air Quality Management District, San Joaquin Valley Air Pollution Control District and Yolo-Solano Air Quality Management; Nonattainment New Source Review Requirements for the 2008 8-Hour Ozone Standard" 2018). Furthermore, according to the SCAQMD, the SPBP Complex is the single largest fixed source of air pollution in the South Coast Air Basin (SCAB) (Wallerstein, Chang, and Tisopulos 2013). SCAB is in non-attainment of federal air quality standards largely due to heavy duty trucks[4] that move containers from the SPBP to intermodal railyards and distribution and warehousing facilities ("CAAP Final Update 2017" 2017). Moreover, SCAQMD released the widely-circulated Multiple Air Toxics Exposure Study (MATES II) in 2000. MATES II assessed disproportionate cancer burdens from diesel exhaust, showing high cancer risks among those living near freight corridors, which would include near-port communities associated with the SPBP ("MATES II" n.d.). SCAQMD followed up MATES II with MATES III in 2008 which included PM emissions for the first time (though it did not estimate mortality or other health effects from particulate exposures). Among the goals established in the CAAP 2.0 (CAAP 2010 update) is the reduction of cancer risk. In the document itself, this goal is defined specifically as: "Reduce population-weighted residential cancer risk of Port-related DPM emissions by 85% by 2020."

Environmental Justice (EJ) Communities in Freight Corridors

The near-port SPBP communities of Wilmington, West Long Beach, and Carson are designated as Air Monitoring Communities by CARB through Assembly Bill 617 passed in 2017. AB 617 is a law that focuses on reducing air pollution in Environmental Justice (EJ) communities statewide. Environmental Justice (EJ), as defined by the EPA, focuses on "the fair treatment and meaningful involvement of all people regardless of race, color, culture, national origin, income, and educational levels with respect to the development, implementation, and enforcement of protective environmental laws, regulations, and policies"(US EPA 2016). Other terminology related to concerns of EJ communities are defined in the following section and include the terms disproportionate effects, overburdened community, and meaningful involvement. The EPA identifies collaboration and meaningful communication with community organizations as key to successful implementation of the CAAP measures, so using the accepted terminology is

[3] SCAQMD is the air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside and San Bernardino counties. This area of 10,743 square miles is home to over 16.8 million people–about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

[4] These trucks are referred to as drayage trucks.

imperative ("EPA Case Study ENVIRONMENTAL JUSTICE AND LEVERS OF COMMUNITY INFLUENCE" n.d.). CARB, SCAQMD, and local agencies work with AB 617 Air Monitoring Communities to reduce emissions and exposure within these areas that are disproportionally affected by air pollution. The CAAP and the SCIG project both require close collaboration with these AB 617 Communities.

Methodology

CITT researchers used a framework of case studies for analysis. By using case studies, this research provides an in-depth, multilevel analysis of the motivations and expectations behind environmental action plan development. These case studies illuminate the complexities of air quality action plans to provide a basis for better understanding the multifaceted framework for developing and implementing future freight projects.

CITT researchers conducted a literature review to build a historical framework of the development, implementation, and updates of the CAAP and the SCIG project. Researchers reviewed online resources from the SPBP, CAAP websites and webinars, industry association websites, journal publications, news articles, industry blogs and resources, and EPA, CARB, and CEC documents related to freight and air quality action plans. CITT also included research from the METRANS Transportation Consortium. CITT has historically offered a neutral ground for various port stakeholders to openly discuss areas of concern and to exchange information that contributes positively to solutions and conflict resolution. These port, government, and industry partnerships developed over CITT's 24-year history have provided a varied and in-depth context to analyzing the complexities of developing environmental action plans in port communities.

Background

The Global Supply Chain: Key Stakeholders

The global supply chain is an international network of multimodal freight driven by population supply and demand and guided by regulations and economic relationships between nations. Ports around the globe consist of a complex framework where different modes of transportation interact to connect international as well as regional suppliers and consumers. This involves the transfer of containerized goods from Ocean-Going Vessels (OGVs) to trucking and rail. Each can be managed by multiple entities bound by different regulatory frameworks from local to international levels within the port environment. This port environment is dynamic, involving freight-driven interactions between ocean vessels, locomotives, cargo and material handling equipment, and trucks. Historically, the vehicles and equipment used were diesel-powered with significant impacts on harmful atmospheric emissions. A high concentration of these vehicles and equipment in a fixed, constantly operational environment characteristic of ports, has external implications for environmental and community health.

The state's stance on reducing greenhouse gas (GHG) emissions and combustion-powered operations at the SPBP have had to constantly evolve so that the ports remain competitive. Giuliano and O'Brien (2008) argue that port-related trade is significantly influenced by institutional relationships and market power (Giuliano et al., n.d.). Dominant actors influence

port operations, relations, and responses with a common interest in remaining competitive and operating efficiently. Many of these entities—shipping lines and terminal operators within the Pacific Maritime Association (PMA), major retailers and the ports—will be natural allies. The International Longshore and Warehouse Union (ILWU) stands apart as a dominant actor with focused labor interests. Distribution and warehouse establishments and freight forwarders react to decisions made by the dominant actors. Uncovering the complexity of these relations will be important for understanding the successes and failures in meeting the expected outcomes of environmental programs within the port system.

CAAP Stakeholders

Many of these entities will be allied given a common interest in economic growth. However, their participation in the CAAP's development and implementation, and the extent to which they are affected by CAAP policies, varies. It is important to recognize that POLB and POLA are the Harbor Departments of the respective cities of Long Beach and Los Angeles. They are landlord ports that administer facilities and lease terminal lands to tenant operators who move cargo. The SPB ports do not own the land they lease. While the ports manage the land on behalf of the people of California, not all of facilities themselves on the port terminals are public. This research explores some of the relevant partnerships involved in economic activity and administration. Table 1 below represents CAAP stakeholders with a brief description of stakeholders that may be less familiar to those outside of the port community.

Table 1. CAAP Stakeholders

LEVEL of JURISDICTION	CAAP STAKEHOLDERS
Local	Beneficial Cargo Owners (BCOs)*
	Contractors*
	Industry Associations*
Local/Port	City of Los Angeles
	City of Long Beach
	Terminal Operators*
	Environmental Justice Communities (AB 617)*
	Community-Based Organizations
	Near-Port Communities
	Port of Los Angeles (POLA)
	Port of Long Beach (POLB)
	POLA Harbor Commissioners
	POLB Harbor Commissioners
	Freight Forwarders (and other small- and medium-sized companies involved in goods movement)
	Drayage/Trucking
	Labor
	Original Equipment Manufacturers (OEMs)
	Public Health Organizations
	Maritime Transport

LEVEL of JURISDICTION	CAAP STAKEHOLDERS
Regional	Industry Associations South Coast Air Quality Management District (SCAQMD) Marine Exchange of Southern California Beneficial Cargo Owners (BCOs) Original Equipment Manufacturers (OEMs) Freight Forwarders Public Health Organizations Maritime Transport
State	California Air Resources Board (CARB) Beneficial Cargo Owners (BCOs) California Energy Commission (CEC) Maritime Transport
Federal/National	United Stated Environmental Protection Agency (US EPA) Beneficial Cargo Owners (BCOs) Original Equipment Manufacturers (OEMs) Freight Forwarders National Environmental Rights Organizations Public Health Organizations Railways Maritime Transport
International	International Maritime Organization (IMO) Vessel Fleets/Steamship Lines Original Equipment Manufacturers (OEMs)

**Note: Beneficial Cargo Owners (BCOs) are defined as the party that owns and takes control of the cargo being shipped. Terminal operators contract with the ports to provide facilities and cargo handling services at the port. Environmental Justice Communities are those organizations aimed at addressing negative impacts on air quality. Industry Associations advocate for baseline rules for engagement that benefits the industry. Drayage trucks are on-road, diesel-fueled, heavy-duty trucks that transport containers and bulk to and from the ports and intermodal railyards, as well as to many other locations. While drayage is often understood as short-distance cargo movement by ground freight, it is worth noting that ground freight may travel to locations that are many miles away from the ports.*

Roles of Regulatory Agencies for the CAAP

Local, regional, state, federal, and international regulatory agencies have roles associated with the CAAP (Table 2). Their agreements are in the form of Memoranda of Understanding (MOUs), which are agreements between two or more parties that can be the starting point for negotiations to define the scope and purpose of discussions. In essence, the port stakeholders have agreed to voluntarily self-regulate while working with the various regulatory agencies to develop the CAAP measures (Genevieve Giuliano, Principal Investigator and Alison Linder, PhD 2013). Regulatory agencies also allocate and administer funds associated with the CAAP measures. Further, these agencies can develop regulations and standards based on data collected from these CAAP measures.

Table 2. Regulatory Agencies involved with CAAP

Agency	Jurisdiction	Purpose	Research Case Study Involvement
International Maritime Organization (IMO)	International	• A United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships	Vessel Speed Reduction (VSR) Program
U.S. Environmental Protection Agency (EPA)	Federal	• Oversees the Clean Air Act (1970) which requires a time-sensitive reduction in emissions from motor vehicles • Regulates locomotive emissions	VSR Technology Advancement Program (TAP) Clean Truck Program (CTP) Southern California International Gateway (SCIG)
California Air Resources Board (CARB)	State	• Oversees mobile sources of emissions such as trucks	Clean Truck Program (CTP) TAP VSR SCIG
California Energy Commission (CEC)	State	• Serves as the State's primary energy and policy planning agency	TAP
South Coast Air Quality Management District (SCAQMD)	Regional	• Responsible for air pollution control • SCAQMD regulations must be approved by CARB and the U.S. EPA • Oversees stationary sources of emissions such as distribution and warehousing facilities	TAP CTP VSR SCIG

Terminology Involving Environmental Justice Issues

For critical discourse on freight-related environmental concerns of port and near-port communities and the development of air quality action plans, terminology defined by working groups comprised of regulatory agencies and community and environmental advocacy groups is essential ("Team-Ej-Lexicon.Pdf" n.d.). Key issues precipitating the CAAP include the *fair treatment* of communities flanking the freight corridors which face *disproportionate health and environmental effects* from proximity to the ports. Many of these communities can be defined as *overburdened communities.* CAAP best practices include the *meaningful involvement* of

affected community residents. These italicized terms, as defined by the EPA, are provided below (US EPA 2016):

Disproportionate Effects – Term used in Executive Order 12898 to describe situations of concern where there exists significantly higher and more adverse health and environmental effects on minority populations, low-income populations or indigenous peoples.

Fair Treatment – The principle that no group of people, including a racial, ethnic or a socioeconomic group, should bear a disproportionate share of the negative environmental consequences from industrial, municipal and commercial operations or the execution of federal, state, local and tribal programs and policies. In implementing its programs, EPA has expanded the concept of fair treatment to include not only consideration of how burdens are distributed across all populations, but the distribution of benefits as well.

Low-Income – A reference to populations characterized by limited economic resources. The US Office of Management and Budget has designated the Census Bureau's annual poverty measure as the official metric for program planning and analysis, although other definitions exist.

Meaningful Involvement – Potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; the public's contribution can influence the regulatory agency's decision; the concerns of all participants involved will be considered in the decision-making process; the decision makers seek out and facilitate the involvement of those potentially affected.

Minority Populations – According to the U.S. Census Bureau, population of people who are not single-race white and not Hispanic. Populations of individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

Overburdened Community – Minority, low-income, tribal, or indigenous populations or geographic locations in the United States that potentially experience disproportionate environmental harms and risks. This disproportionality can be as a result of greater vulnerability to environmental hazards, lack of opportunity for public participation, or other factors. Increased vulnerability may be attributable to an accumulation of negative or lack of positive environmental, health, economic, or social conditions within these populations or places. The term describes situations where multiple factors, including both environmental and socio-economic stressors, may act cumulatively to affect health and the environment and contribute to persistent environmental health disparities.

Near Port Communities – Ports and near-port communities share infrastructure, regulatory jurisdictions, local governments, and climate-related risks

Overview of the CAAP

The CAAP serves as a living document and involves a complicated mix of incentives, voluntary measures, tariff charges, technology demonstrations and assessments, lease requirements, public sector funding, and mitigation requirements. The CAAP measures work in tandem with not only various levels of regulatory agencies as previously presented, but with freight action plans (such as the California Sustainable Freight Action Plan) and Executive Orders (E.O.). For example, Governor's Newsom's E.O. N-79-20 calls for statewide carbon neutrality by 2045.

The SPBP as the largest U.S. Port Complex

The SPBP is the United States' largest container port complex and is also among the top ten ports in the entire world. This port complex generates approximately $312 billion in annual trade combined (Dean 2019). Forty percent (40%) of the nation's containerized cargo enters the SPBP. The ports are technically landlord operated, meaning that the port manages the leasing of public land to interested companies which then manage day-to-day operations.[5] Terminal development is mainly managed and financed by the ports (funding may include federal and state sources). Port tenants typically pay for the terminal cargo handling equipment. The cargo movement carried out by the terminals, vessels, rail, and trucks on a day-to-day basis is not an operation of the SPBP ("Final SPBP CAAP Overview" 2006). However, the ports have an incentive to persuade their tenants to follow air quality action regulations because they allow for the potential for reduced health risks and increased access to trade.

Rise of International Trade and Increased Diesel Emissions

The sharp rise in international trade in the 1990s and 2000s brought port expansion plans and increased diesel emissions associated with freight movement:

> In 2000, the South Coast Air Quality Management District (SCAQMD) published a study that reported a high risk of cancer resulted from air pollution from diesel exhaust [*MATES II, described previously in this report*]. The study raised public awareness of the health effects of air pollution, and near-port communities began mobilizing to oppose the Ports' expansion and demanded action to improve air quality. SPBP leaders were also becoming increasingly aware of a trend toward stricter environmental regulations and saw potential cost savings in taking pre-emptive environmental action. In response, the ports and partners developed the CAAP in 2006, with subsequent revisions in 2010 and 2017 ("EPA Case Study HIGHLIGHTS AND KEY CONCLUSIONS" n.d.).

The Threat of Cargo Diversion

The groundwork for California's intermodal environmental policies was developed in the late 1990s and early 2000s through a series of Memoranda of Understanding (MOUs) and statewide

[5] For clarity's sake, it is worth emphasizing that the SPB ports do not own the land they lease. Rather, the ports manage the land on behalf of the people of California.

incentive programs. Giuliano and Linder provide a succinct summary of the economic and environmental regulatory landscape of the SPBP prior to the development of the CAAP:

> Economic growth is a powerful incentive for cities and regions to support the port. Indeed, many U.S. ports are subsidized via infrastructure investment, reduced service fees, and other means as regions compete for port-related growth. Because of these competitive pressures (or the threat of such pressures), the ports have been able to resist and even bypass environmental requirements. For example, the SPBP faced regulatory pressures in the 1980s when state plans were not in compliance with National Ambient Air Quality Standards. The EPA created a Federal Implementation Plan that focused on the shipping industry. In response, an economic impact study was commissioned which showed that coercive regulation might lead to diversions and therefore negative economic consequences. Eventually, lobbying from elected officials and business groups resulted in an amendment to the 1990 Clean Air Act allowing a smog exemption for California (Erie, 2004). It was not until the rapid port growth of the late 1990s that the long history of isolation from environmental pressures came to an end (Giuliano and Linder 2013).

The SPBP was incentivized to develop the CAAP in part because both ports faced challenges to port expansion from environmental groups. This included challenges to often lengthy environmental review processes. The principles setting the standards for CAAP were multilevel: public health risks; reducing emissions to the ports' "fair share;" and meeting state and federal standards. These standards contain both project-specific and source-specific standards ("CAAP_Overview_Final_2.Pdf" 2006). To address these environmental concerns, the SPBP worked with the regulatory agencies of SCAQMD, CARB, EPA, and other stakeholders to develop the CAAP 1.0. It is important to note here that there were port stakeholders, including community-based and industry organizations, that stated they were initially excluded from discussions regarding CAAP 1.0. Some of these organizations will be discussed later in the report.

CAAP requires the consideration of economic sustainability, as some port stakeholders feared (and continue to fear) that sustainability measures may deter the SPBP from retaining customers. Less cargo would move through the ports, thereby affecting income. An unintended consequence of this is that cargo, particularly goods destined for consumption outside of Southern California, would be diverted to ports that may not have environmental initiatives as rigorous as those of the SPBP. Cargo diversion to the Southeastern ports of the U.S. is a major consideration in environmental policy development at the SPBP, as evidenced from the 2014/15 cargo congestion event at the SPBP when major shippers sent cargo to other gateways and did not return to the SPBP.

Backstop Regulations

The SPBP were able to enter into MOUs with CARB and SCAQMD, rather than being directly regulated by them. This is because CARB and SCAQMD authority is limited in this area. Depending on the definition of the ports, the local or state regulators do not have jurisdiction to impose regulations on interstate commerce (rail and trucks), and even federal laws cannot

apply to internationally regulated OGVs. The SPBP worked with regulators and the industry, not only to set emissions goals, but also to develop these regulations and standards. Both CARB and SCAQMD have concurrent authority to establish regulatory standards in compliance with the CAAP. Since CAAP 1.0, CARB has developed a few "backstop" environmental policies that enforce CAAP policies in the event the SPBP fail to enforce the CAAP. CARB enforces its mandates across the entire state of California, supporting environmental progress at all ports. Additionally, as CAAP 2.0 and 3.0 have updated the original CAAP policies, CARB has continued to update its policies to lower emissions. The TAP, VSR, and CTP CAAP air quality action plans that helped to shape these CARB regulations are discussed in this research. Giuliano and Linder note that:

> According to the POLA representative, one of the most beneficial results of the [CAAP] was that the "ARB has aligned their regulatory strategies with the CAAP." The respondent noted that all marine vessel rules were aligned with CAAP, and that the state-wide vessel fuel rule and the Shore Side Power 59 rule stemmed from the CAAP. This happened because industry representatives discussed their position at various meetings: "when the industry agreed to do something for the CAAP, the ARB saw that the industry thought this was feasible and built this into the rules. They gave the state the information needed to support statewide rule making" (Giuliano and Linder, 2013).

CAAP Emission Inventories and Metrics

Air emission inventories began with CAAP 1.0. In addition, prior to CAAP, the ports installed their air monitoring stations.[6] These activity-based emissions inventories, as an effective tool to track air emission improvements over the past several years, serve as a model for other ports to replicate nationally in developing freight-related air quality action plans. According to the EPA, this was the first U.S. port air quality program to include emission targets:

> Beyond characterizing the overall scope of the air quality challenge, inventories can identify significant sources of emissions (perhaps resulting in surprises and changes in emphasis for community advocates and port managers), point toward the best solutions for reducing pollution levels, and enable informed decision-making. When combined with equipment replacement and/or remediation cost information, inventory data—or alternative metrics such as vessel and truck counts, vessel speeds, and gate management system data—can point toward cost-effective emission reductions ("EPA Case Study CAAP Best Practices Lesson Learned" n.d.).

Though SCAQMD does not directly regulate the ports, it does control mobile sources of emissions via control of stationary sources—such as facilities. SCAQMD's 2016 Air Quality Management Plan's (AQMP) Facility-Based Mobile Source Measures implemented a Commercial Marine Ports Working Group that continues to pursue MOUs with the SPBP to achieve emission reductions based on the 2017 CAAP ("Commercial Marine Ports Working

[6] The goals of CAAP 2.0 were to further cut the emissions of DPM, NOx, and SOx, and reduce health-risk. By the time the update was adopted, the ports have already achieved the emission reduction goals.

Group" n.d.). This MOU approach allows SCAQMD to get State Implementation Plan (SIP) credits through the EPA. However, not all SIPs are approved by the U.S. EPA in a timely fashion, which sometimes leads to the process called "overfilling"—and even lawsuits.

Case Study 1: Technology Advancement Program (TAP)

Testbed for Emerging Technologies Leveraging Public Agencies, Industry, Port Stakeholders, and the Ports

The Technology Advancement Program (TAP) was initiated in 2007 to support CAAP 1.0 goals of developing clean technologies at the SPBP. TAP's technology demonstrations provide a platform for the SPBP to test, evaluate, and invest in emerging technologies that reduce GHG and common, or criteria, pollutants in an effort to support the adoption of zero-emission goods movement equipment[7] and vehicles and required infrastructure at SPBP marine terminals. Since its inception, TAP has tested more than 40 projects including hybrid and alternative fuel demonstrations and zero-emission equipment deployment. Zero-emission refers to the tailpipe emissions, and measures that are taken up in an effort to reach zero tailpipe emissions predominantly address air quality from the public health perspective. To address GHGs, the lifecycle emissions should be considered, not just those coming from the tailpipes. TAP involves local, state, and federal funding and regulatory agencies, terminal operators, and original equipment manufacturers (OEMs) as stakeholders, though not all stakeholders comprise the TAP Advisory Committee.

The CEC and CARB are major funding and regulatory partners in this program, though the private sector provides the match funding in most cases. This TAP Advisory Committee, including the subject matter expertise of port terminal operators and equipment manufacturers, evaluates the commercial deployment of new freight technologies involving cargo handling equipment, trucks, harbor craft, OGVs, and rail. This Committee also evaluates new sources of energy and alternative fuels. Governor Newsom's E.O. N-79-20 calls for carbon neutrality in California by 2045 and the acceleration of electric vehicle (EV) deployment and cargo handling equipment (CHE) to reach these goals. The SPBP are committed to using ZE CHE by 2030 and ZE trucks by 2035.

Combined with CARB's CHE Regulation to transition all CHE to zero-emission, TAP expedites the replacement of older, more polluting equipment with cleaner units and retrofits to lower emissions in the SPBP. These TAP technology demonstrations also focus on drayage trucks and harbor craft. With the TAP, OEMs and other project partners (including engineers, contractors, utilities, and users of these technologies) are provided data to show the efficacy of equipment, supporting manufacturing to scale.

[7] Goods movement equipment refers to loading and unloading cargo equipment that is used throughout a terminal and includes RTG cranes, top handlers, and yard tractors.

Data Inventories from Technology Demonstrations Developed

Since CAAP 2.0 in 2010, the SPBP have collected data on vessel, terminal, truck, and train operations working closely with industry. This data is crucial in informing the development of future technologies that have the potential to improve air quality in the region. The SPBP have partnered with other agencies to leverage resources and to support regional efforts—outside of the ports—to reduce port-related emissions. These regional initiatives include truck demonstrations. In the 2017 CAAP update, TAP began implementation of a new project, the SPBP Drayage Truck Demonstration of a Near-Zero Ultra-Low NOx Natural Gas Engine Operating on Renewable Natural Gas. Data was collected on the demonstration vehicle, a 2014 Freightliner equipped with a pre-commercial engine that is fueled with renewable natural gas. This data quantified routes, miles traveled, and number of deliveries using GPS technology, and served as an example and testbed for quantifying metrics. The TAP truck demonstrations support CARB's 2020 Advanced Clean Trucks (ACT) Regulation that requires manufacturers to produce Class 8[8] zero-emission trucks at increasing percentages beginning in 2024 through 2035. According to the EPA,

> The CAAP (as of the 2010 update) was the first U.S. port air quality program to include quantitative air emission reduction targets. The adoption of these quantitative targets was possible because the SPBP instituted annual emission inventories several years prior. The inventory data enabled the Ports to determine where they needed to reduce emissions and to develop quantitative targets to address those needs. Beyond characterizing the overall scope of the air quality challenge, inventories can identify significant sources of emissions (perhaps resulting in surprises and changes in emphasis for community advocates and port managers), point toward the best solutions for reducing pollution levels, and enable informed decision-making. When combined with equipment replacement and/or remediation cost information, inventory data—or alternative metrics such as vessel and truck counts, vessel speeds, and gate management system data—can point toward cost-effective emission reductions. Ports and communities nationwide can also use the SPBP assessments of trucking and cargo handling equipment (CHE) technologies, as well as technical resources available through the EPA Ports Initiative ("EPA Case Study CAAP Best Practices Lesson Learned" n.d.).

Another example of a TAP objective documenting metrics was data collection on operational conditions using a new meter system and sensors that allow real-time data transmission to shore-side operators.

Barriers to Implementation: Unintended Consequences of Costs, Stranded Assets, and COVID-19 Impacts

Some terminal operators were concerned that zero-emission or near zero-emission requirements would raise operating costs because early adoption involves higher technology

[8] Class 8 trucks refer to those heavy-duty trucks with Gross Vehicle Weight Ratings (GVWR) of 33,001 pounds or more. These are commonly referred to as "big rigs."

costs. A counterargument of the SPBP, however, revolved around economy of scale: “If zero or near-emission yard tractors, top handlers, rubber-tired gantry cranes and drayage trucks are manufactured in commercial quantities, the cost of port-related equipment is expected to drop considerably” (Mongelluzzo 2018). A further concern of terminal operators who had previously made investments in clean equipment is that they would be at a disadvantage by 2030 (the CHE zero-emissions deadline). These operators have already invested in producing less emissions, and the new regulations could possibly require them to repurchase new equipment making their previous investment obsolete. These investments can be referred to as “stranded assets,” investments that no longer have the value previously held because of improved technology. Stranded assets have become a barrier to new technology purchases because of not only the higher costs incurred as a terminal operator as an early adopter, but for the uncertainty regarding the life of the technology. The SPBP responded accordingly:

> “The revised terminal equipment strategy identifies requirements to bring in the cleanest available equipment at the time of purchase, consistent with the terminal operators procurement plans, minimizing stranded assets. If zero-emissions equipment or the supportive infrastructure is not available at the time of a new purchase, operators may buy near-zero if feasible or cleanest available equipment. The Ports will continue to work with terminal operators through leases and pursuit of grant funding to accelerate the timeline for replacement of equipment in support of our 2030 zero emission goal” (San Pedro Bay Ports, 2017).

Another barrier to implementation concerns the lack of infrastructure (e.g., charging infrastructure) prior to the procurement of technology. The cost of infrastructure is comparable to the cost of technology. It often requires permits, coordination with utilities, and the modifications of the power grid. Much of the current demand exceeds the original design of the grid. Increasing electrification requires more power supply. To meet the demand, California needs to triple its current grid capacity, according to the joint report developed by CEC, CPUC, and CARB (California Energy Commission, 2021).

The COVID-19 pandemic delayed many technology projects. COVID-19 caused severe labor shortages and supply chain disruptions resulting in significant slowdowns for technology manufacturers. It also prevented access to terminals and facilities by port staff for equipment and emissions testing (“Stakeholder-Advisory-Meeting-Presentation-Jan-27-2021.Pdf.Pdf” n.d.). The 2020 CAAP TAP update states:

> COVID-related shutdowns had a significant impact on the economy, leading to a drop in State revenue and financial hardship for many port operators. As yet, demonstration projects that were already underway with secured funding have not been affected by the downturn, but the future funding landscape is bleak. CARB has slashed its Clean Transportation Incentives Program, which was a major source of clean-technology funding, from $449 million in 2020 to $28.6 million in 2021 due to the Legislature’s delay in approving cap-and-trade expenditures amid COVID-induced budget uncertainty. The current Clean Transportation Incentives Program budget preserves incentives for zero-emission commercialized equipment but could impact future years of technology advancement (“2020-Tap-Annual-Report.Pdf.Pdf” n.d.).

Public and Private Sector Collaborations for Technology Development

Future TAP investments may include nascent technologies associated with CARB's expanding requirements for at-berth emission reductions from new vessels and the further demonstrations and assessments of clean fuel infrastructure requirements, sponsored by the CEC. These TAP projects exemplify how regulatory agencies and CAAP air quality control programs collaborate to reach lower GHG emissions (Figure 1). Further, testing in the port environment provides a harsh working environment for equipment with long work cycles combined with the corrosive element of proximity to the ocean. These conditions demonstrate the viability of these emerging technologies to OEMs in other industries nationwide, providing further opportunities to scale these innovations ("2020-Tap-Annual-Report.Pdf.Pdf" n.d.). In this way, industry and ports collaborate to strategize for technology manufacturing. In the 11th CAAP Update in January of 2021, the SPBP called out for more public subsidies to support equipment conversions, stating that the lack of sufficient public subsidies is a worldwide issue ("Ports to Give Clean Air Action Plan Update Jan. 27" 2021).

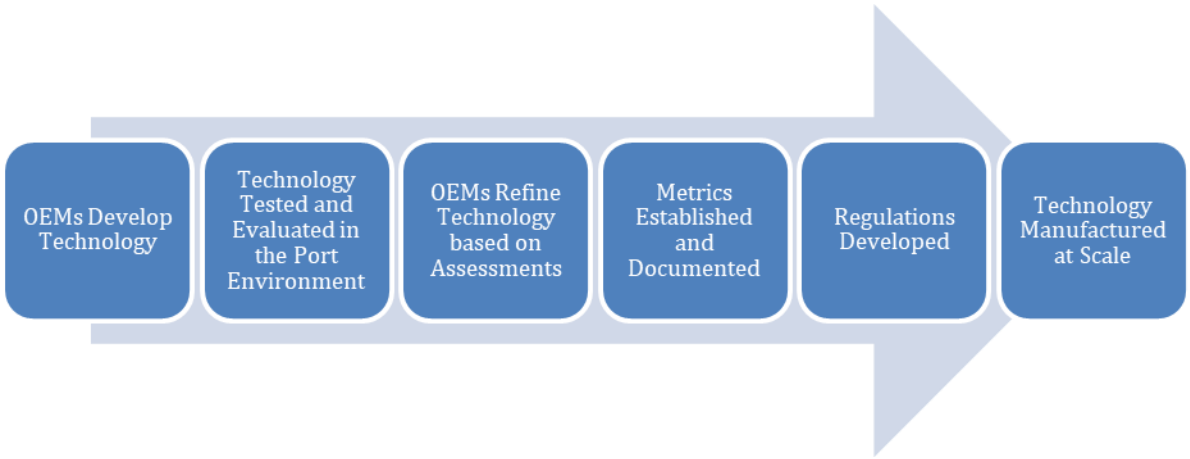

Figure 1. Steps in TAP Technology Assessment

Apart from CAAP's development, the ports are working together to tackle infrastructure developments to improve economic efficiency. An MOU between the ports in February 2020 focuses on the programs and strategies jointly developed to improve cargo transfer, connectivity in the supply chain, workforce development, metrics, and cybersecurity ("MOU POLA and POLB" 2020). This MOU serves to take cooperation between the ports beyond CAAP, as well as beyond previous cooperation on supply chain efficiency and security issues, to enhance the competitiveness of the SPBP, rather than of either port alone (Link-Wills 2020).

Case Study 2: Vessel Speed Reduction (VSR) Programs

A major component in the efforts of the SPBP to reduce harmful emissions from maritime vessels is the implementation of their voluntary Vessel Speed Reduction (VSR) programs. The goals of both ports' vessel speed reduction programs are similar. They aim to reduce the emissions surrounding in the SCAQMD region by providing incentives to vessel operators in exchange for participation in the programs. By introducing and documenting metrics for speed

and fuel usage, the SPBP can analyze change over time. The VSR programs elucidate the importance of industry and government collaboration and the development and usage of emission metrics, inventories, and innovations reported as critical by the EPA ("EPA Case Study CAAP Best Practices Lesson Learned" n.d.). Further, they show the complicated underpinnings required of a voluntary program under international, federal, state, regional and local jurisdictions.

The large diesel-run engines of OGVs close to ports-of-call is a substantial source of pollution, especially if these vessels are idling at port to maintain electricity onboard. According to the CAAP 1.0 overview and technical report, OGVs contribute the largest share of emissions for both ports at 90% of SOx, 59% of DPM, and 36% of NOx for the 2005 baseline year although CO2 emissions from heavy-duty vehicles exceed those from OGVs. Giuliano & Linder suggest that OGVs are the highest contributing source category because "OGVs are not subject to US national fuel standards" (Giuliano and Linder 2013, 25).[9] An unanticipated outcome of the COVID-19 pandemic has been increased GHG and criteria pollutant emissions from OGV anchorages near the SPBP since early 2020, which has contributed to increased PM and ozone emissions ("Stakeholder-Advisory-Meeting-Presentation-Jan-27-2021.Pdf.Pdf" n.d.). One of the solutions was proposed by the PMA, PMSA, and Marine Exchange, a working group of maritime industry leaders. Effective November 16, 2021, ships are assigned a place in the arrival queue based on their departure time from their last port of call and wait about 150 miles off the California coast. This new queuing process for container vessels bound for the LA-LB ports will allow vessels to slow their speed and spread out while improving safety and air quality. These anchorages are the result of severe disruptions in the supply chain brought with the COVID-19, including labor shortages.

Background to the VSR Programs

Headway was made in the 1990s and early 2000s to lessen OGV emissions. In 1994, the State of California Office of Spill Prevention and Response along with the U.S. Coast Guard created a "precautionary area" around the entrances of the ports to reduce OGV traffic while also helping air quality. In September 2000, it was estimated that the benefits of this initiative had been 3.4 tons/day of reduced NOx emissions (Kenny 2001). In early 2001, the PMSA held its first air emissions conference. In May 2001, industry representatives met with the SPB ports and regulators and signed a MOU to voluntarily slow the ships to 12 knots or less within 20 nautical miles of Point Fermin. In 2002, the POLA announced a program that would provide electrical connections to docked vessels from the shore to decrease diesel pollution, and in 2004, the first shoreline plug-in was installed at the POLA's China Shipping Terminal. In 2005, CARB required vessels within 24 miles of the coast to switch to diesel fuel that is lighter and cleaner. Not only did this latter regulation risk having little compliance by international vessels so far offshore

[9] However, much has changed since 2015, including new IMO engine standards for ships built in 2016, the IMO 2020 rule that changes the cap on sulfur content in fuels from 3.5% to 0.5%, etc. Also, it should be noted that since 2012, OGVs must use fuels with 0.1% sulfur content in the North American Emission Control Area (ECA) which extends 200 nautical miles of the territorial sea baselines of the United States and Canada.

(Carle 2006)m but it was also subject to a litigation. CARB lost, and in 2008 issued a revised version (effective 2009 with 0.5% sulfur cap, and 2014 with a higher 0.1% limit). In 2008, CARB adopted low-sulfur fuel rules for ships ahead of a 2010 U.S. mandate and 2020 international requirements. ECAs followed in 2012.

POLB Green Ship Program and POLA Environmental Ship Index (ESI) Program

The VSR programs are developed with International Maritime Organization (IMO) standards. The IMO established Tier I emissions standards in 1997 for preventing air pollution from ships. The Tier II and Tier III amendments followed in 2008, introducing requirements for fuel quality and for NOx emissions for new and pre-2000 engines. CAAP aims to reduce vessel NOx emissions at the POLB by having 50% of ship calls meet Tier II standards and 40% meet Tier III standards by 2023 ("Incentives - Port of Long Beach" n.d.).

The VSR programs within the POLB ("Green Flag Program") and the POLA ("Vessel Speed Reduction Program") were officially initiated in an MOU in 2001 by eight parties with a stake in these environmental issues within the SPBP. These parties included EPA, CARB, SCAQMD, the Long Beach Board of Harbor Commissioners, the Los Angeles Board of Harbor Commissioners, the Steamship Association of Southern California (SASC), the Pacific Merchant Shipping Association (PMSA), and the Marine Exchange LA/LB Harbor. Overall, the goals of this agreement were to 1) recognize the intentions to reduce harmful emissions in the SCAB with the voluntary vessel speed reduction programs by the ports; and 2) set guidelines for how the cities were to implement such measures (Kenny 2001). The MOU established the voluntary nature of the VSR as the parties could not legally uphold a mandatory speed reduction regulation.

Development of a Statewide VSR Program: Concerns and Considerations

Though considered successful in reducing emissions near the port complex and CARB currently evaluating a statewide VSR program based on data gathered ("Vessel Speed Reduction for Ocean-Going Vessels | California Air Resources Board" n.d.), there remain hurdles to address. The Pacific Merchant Shipping Association's (PMSA) had voiced concerns about balancing economic and environmental considerations and that the VSR initiatives may motivate a diversion of cargo away from the ports (Staff 2017), as previously described in the CAAP Overview section. In addition, with the increase of the radius guidelines from 20 nautical miles (nm) to 40 nm within the ports, the SPBP must upgrade the range of the existing radar systems to be able uphold these standards. The cost of this type of technology enhancement falls on the SPBP themselves.

The VSR Program is an example of a successful sustainability measure, but requires more resources, funding, and incentives for compliance to reach its full potential. The overall consensus about the program by the SPBP, however, is that it has been successful in lowering emissions. The 2020 report cites a 97% compliance rate within 20nm, and 93% compliance within 40nm (SPBP 2020b). But the program goals are ever-expanding: there are still issues related to longer travel times for vessel operators and outdated radar systems. According to a

public workshop report convened by CARB, the costs of this program to a vessel owner and/or operator can be between $250 to $600 daily due to the amount of time added to the transportation of the goods by slowing their speeds within the 20–40 nm—estimated to be a delay of an hour or more (CARB 2009). These concerns also have an impact on scheduling in-coming/out-going vessels for the Ports themselves.

The SPBP strategy to maintain participation is to evaluate shipping lines' unique operational hurdles. However, the final 2017 CAAP update suggests remedying the policy to better accommodate shipping lines that are unable to qualify. For example, rather than providing a discount for the year for 90% compliance, the policy could change to a per-call discount based on whether the vessel complied on a specific visit. The update also suggests that the 12 knots speed limit may be outdated and that some newer ships operate optimally at higher speeds. The 2019 1st Quarter Report cites a greater focus on preparing an alternative compliance plan for eligible shipping lines (SPBP 2019) and outreach to shipping lines continued through the fourth quarter (SPBP 2020a).

A further consideration is that different types of vessels may be better suited for this program than others. Ahl, Frey, & Steimetz (2017) write:

> A corresponding finding is that if financial incentives are warranted, it may be more effective to differentiate them by operator type. […] for example, a 5 per cent increase in the dockage-fee discount for containership operators would yield the same improvement in Green Flag compliance as increasing the discount by 28 per cent for general-cargo carriers. This suggests that the Port of Long Beach, and other ports looking to establish or improve VSR programs, should look beyond a 'one size fits all' policy for financially motivating compliance (Ahl, Frey, and Steimetz 2016, 615).

Research from Adland, Cariou, & Wolff (2020) developed a framework for measuring fuel efficiency in vessels that brings doubt to the efficacy of speed reduction measures as an environmental initiative. Their argument is that fuel consumption in relation to vessel speed depends on the vessel in question. Optimal speeds for efficient fuel use will vary from ship to ship. It is not clear that large scale CO2 emissions reductions can be attained through broad speed reduction measures without accounting for the many variables effecting speed elasticity, such as wind and sea current, for example. Their framework shows that the elasticity of consumption regarding speed cannot be generalized to all vessels (Adland, Cariou, and Wolff 2020).

CAAP Measure to Reduce At-Berth OGV Emissions: Shore Power and Unintended Consequences

A CAAP measure developed in tandem with the VSR programs is the Reduction of At-Berth OGV Emissions. Shore power, or cold ironing, refers to providing electrical power to a vessel that is

docked, and has been widely implemented across the nation.[10] In 2017, the EPA found that shutting down auxiliary engines that use diesel fuel while docked and utilizing regional electricity reduces overall pollutant emissions by as much as 98% (US EPA, et al. 2017). An unintended consequence of using shore power technology, however, is the instability of energy availability during heat waves. In August 2020, Governor Newsom issued an Executive Order to halt shore power usage (Newsom 2020). Heat waves made preventing vessel use of this shore power imperative to reduce the burden on the electrical grid system. With the COVID-19 pandemic, vessel congestion has increased emissions with OGVs anchoring waiting to dock. A further unintended consequence of the pandemic was the low cost of fuel and the consequent lessening of incentives to use the more expensive shore power while at berth. Perhaps this low cost of fuel affected both the VSR and the Reduction of At-Berth OGV Emissions programs ("2020-Tap-Annual-Report.Pdf.Pdf" n.d.).

Case Study 3: Clean Trucks Program (CTP)

Background to the CTP

Emissions standards for heavy-duty on-road engines are regulated by the EPA and CARB. The first standards were established in 1974 and have been amended and updated since. The Carl Moyer Program, developed in 1999, aimed to incentivize trucking companies to operate newer vehicles with lower emissions by offering subsidies for truck replacements, engine repowering, and engine retrofits. In 2007, the SPBP created the Clean Trucks Program (CTP), requiring truck owners entering the port complexes to have updated vehicles that follow certain emission standards. The original version of the plan in 2006 proposed that only trucks making 3.5 or more trips per week would be required to follow the guidelines. In the final version this distinction was eliminated, and the project was implemented as a tariff due to its non-voluntary nature. The Board of Harbor Commissioners for both ports approved the CTP tariff in November 2007. The CAAP 2017 Update included the goal of reaching 100% zero emission (ZE) drayage trucks by 2035. The SPBP are currently working to align these ZE goals with Governor Gavin Newsom's Executive Order N-79- 20, issued in September of 2020.

A major leap in the development and deployment of the Clean Trucks Program (CTP) took place in 2017. The Ports of Long Beach and Los Angeles adopted the Clean Air Action Plan (CAAP) Update. This update focused on reducing pollution from sources that are associated with the port. This includes on-road drayage trucks. Phase 1 of the CTP update requires any truck registered under the Port Drayage Trucks Registry (PDTR) after October 1, 2018, to update to engine model year 2014 or newer. Trucks already registered in the PDTR and current on their annual registration fees as of September 30, 2018, can continue to operate but must be compliant with standards established by CARB.

[10] As stated earlier, some auxiliary engines cannot be turned off when a ship is plugged in at berth. Boilers that heat water and fuel must operate the entire time. If the boilers shut down, fuel congeals and clogs everything. Also, emissions at berth are generated during connecting and disconnecting vessels, which can take anywhere from forty-five minutes to three hours.

Those standards include the Advanced Clean Trucks (ACT) Regulation adopted by CARB in June 2020. ACT requires manufactures to sell zero-emission or near-zero emission (NZEV) heavy duty vehicles starting with 2024 models. The SBP ports define near-zero emission trucks as emitting 90% less NOx than the EPA 2010 heavy-duty emission standards—not more than 0.02 g/bhp-hr of NOx and 0.01 g/bhp-hr of PM (particulate matter). The ports also include trucks emitting 75% less NOx than the EPA 2010 standard allows and hybrid and plug-in hybrid trucks using alternative and conventional fuels with renewable content (for the demonstrations). The definition of near-zero emissions from CARB is still pending. Manufacturers meet requirements by offsetting conventional engine sales with an increasing number of ZEV or NZEV trucks. In the absence of offsets or purchasing credits from other manufacturers, OEMs face fines for non-compliance.

Subsequent to the adoption of the ACT rule, 15 states plus the District of Columbia signed a Memorandum of Understanding agreeing to more aggressively develop the market for cleaner fuel vehicles. The target is to have 100% sales of all new medium and heavy-duty trucks be zero emission by 2050. The Federal Clean Air Act allows other states to adopt California's more restrictive clean air standards instead of federal standards (CARB 2021).

Drayage Truck Registry Program

As of 2008, every truck that enters the SPBP must participate in the Drayage Truck Registry (DTR). A Truck Environmental Fee was initiated for all trucks that did not meet the requirements of the CTP. In the CAAP 2010 update, the fees were based on size and how "dirty" the vehicle was, independent of the fuel-type used ("SPBP CAAP 2010 Update" 2010, 57). These funds were used to help finance the program. However, the trucking industry objected to this fee on two fronts: 1) a fee would diminish the value of trucks that can maintain low emissions for many years, and 2) the strategy had questionable legality. Later, this fee program would be modified ("CAAP Final Update 2017" 2017).

In 2012, the CTP permanently banned the oldest remaining trucks from the Port terminals that did not meet the 2007 federal standards for on-road vehicles (SPBP 2010). With the full implementation of the project in 2012, the amount of port truck emissions was reduced by more than 90% ("Clean Trucks" n.d.). As of Oct 2018, any new trucks in the Ports need to be 2014 or newer. According to EPA standards, all trucks must meet their 2010+ emission standards by Jan 2021. As of 2021, over 50% of the trucks are 2010 or newer with compliant emission engines.

Table 3. CTP Milestones and Updates ("EPA Case Study Fact Sheet CTP" n.d.)

Deadline Year	Updates
2018	New trucks entering the Ports Drayage Truck Registry (PDTR) must have a 2014 engine model year or newer. Existing trucks already registered in the PDTR can continue to operate.
2020	All heavy-duty trucks are charged a rate to enter the Ports' terminals, with exemptions for trucks that are certified to meet a near-zero standard or better.
2023	New trucks entering the PDTR must have engines that meet the near-zero-emission standard or better. Existing trucks already registered in the PDTR can continue to operate.

Clean Truck Fund (CTF)

CAAP 3.0 set a 2020 goal for implementing a Clean Truck Fund (CTF) fee for all loaded heavy-duty container trucks using the ports' terminals. Trucks that meet low emissions standards—those with at least CARB-certified low-NOx engines—would receive a rebate. Not only would this incentivize clean truck use, but the collected funds would be allocated toward the purchase of zero or near-zero emissions vehicles for fleets.

The SPBP ultimately concluded that a low CTF rate should be implemented to avoid cargo diversion. The CTF rate—$10-per-twenty-foot-equivalent-unit (TEU)—was approved by the Ports at a jointly held meeting in March 2020. Implementation in 2020 would incentivize near-zero emissions vehicles so that, in 2023, non-near-zero emissions vehicles would be prohibited from registering with the Ports (SCAQMD 2020). Through an MOU between the SPBP to initiate further cooperation, implementation for the fee was set for both ports to begin in fall 2020. However, in March 2020, the SPBP experienced a 30.9% drop in container volume due to the COVID-19 pandemic (Link-Wills 2020). This pressing challenge ultimately led to a divergence between the Ports. The Port of Long Beach (POLB), who had a relatively successful July in comparison to the Port of Los Angeles (POLA), announced that it would postpone the fee until 2021. However, POLA claimed that this was to be a unilateral decision. At the October 2020 stakeholder advisory meeting, the Ports stated that it is unclear when rate implementation would begin due to the dynamic nature of current events ("Stakeholder Advisory Meeting Minutes" 2020).

Multiple MOU drafts between SCAQMD and the SPBP were developed, ultimately with no agreement on language regarding CTF fees (SCAQMD 2020). SCAQMD and environmental organizations cited concerns about the proposed CTF rate of $10-per-TEU as too low.

Infrastructure and Technology Requirements

The Harbor Trucking Association (HTA), a Long Beach-based industry association, is a major stakeholder for the CTP initiative. HTA has expressed concerns with the feasibility of some

strategies for implementation. Of primary concern is the reliance on technological upgrades for cleaner trucks—technological advances that have been unreliable thus far (Staff 2017). This has led to a hesitancy among trucking fleets to update trucks, even with viable technology, due to previous attempts to work with inoperable technology. In addition, technology such as electric or hydrogen fuel cell batteries may not be available widely enough for all relevant fleets by the deadlines established in the CAAP. In November 2021, more than 19,000 trucks were registered with access to the LA-LB ports, and more than 14,000 were in active service. But only 22 trucks are battery electric and 3 are hydrogen fuel cell. The HTA cites concerns that cargo volume may consequently move elsewhere, hindering competition for freight at the ports (Link-Wills 2020).

Broader Supply Chain Issues

The implementation of the CTP intersects with a number of other broader supply chain challenges, some of which existed prior to the pandemic but which COVID exacerbated, that confront the trucking industry. These include driver status, additional costs borne by the drayage sector, and workforce-related issues.

First, short haul port drayage—as opposed to long-haul over the road trucking—has historically depended upon independent contractors. The cost of transitioning fleets to ZEV and NZEV technologies therefore impacts those drivers who struggle to bear the cost of new trucks which could total upwards of $100,000. Understanding this, and as part of the CTP rollout, the SPBP initially required that drivers dispatched for cargo pick-ups and drop-offs at the ports be employee drivers. This assumed that the cost of fleet transition would therefore be borne by more highly capitalized trucking companies. The American Trucking Associations sued over the employee driver provision and won in a 2011 U.S. 9th Circuit Court of Appeals decision (United States Court of Appeals for the Ninth Circuit, 2011). The implementation of the Clean Truck Program has therefore occurred without an employee driver mandate.

The result is that for the trucking industry as a whole, but particularly for independent contractors, the cost of compliance with both port and CARB regulations is an added capital and operational cost not fully supported by subsidies. This heightens concerns not only about potential cargo diversion but also the ability to sustain the trucking workforce.

As the pandemic has created unprecedented demands on the freight system, drayage trucking has been forced to prepare for the port and state's ZEV mandates along with other more short-term challenges. Contract drivers who are paid on a per-transaction basis depend upon a system of gate appointments, evening and weekend hours, and equipment management programs that ensure as many revenue trips as possible during allowable work hours. Congestion on the docks has resulted in a lack of chassis to effectuate moves as well as terminal-imposed operational standards that often require a truck driver to complete dual transactions (a pick-up and drop-off during the same port visit) in order to have gate access. These added restrictions often add time to the transaction, limiting the number of revenue-generating trips a driver may make when they're on the clock. Federally mandated hours of service regulations preclude extending the workday as a response. As a result, there have been

calls in some circles to postpone implementation of clean truck mandates until the impact of the pandemic on the trucking sector is better understood.

Case Study 4: The Southern California International Gateway (SCIG)

Background to Railroad Locomotives Control Measures at the SPBP

The SPBP is served by Burlington Northern and Santa Fe (BNSF), Union Pacific (UP), and Pacific Harbor Line (PHL) railway companies. The primary operation of the BNSF and UP is to transport intermodal containerized freight throughout the U.S., while PHL is a local class 3 railroad and operates only within the SPB ports. Line-haul locomotives are large and powerful engines that tow carriages and effectively ship cargo to locations across the US. BNSF and UP provide line haul service to and from the SPBP. These are classified as 'Class 1' railroad operations. Switchers are smaller engines with respect to the line-haul locomotives and are also used for short distance hauling throughout the ports. The PHL performs most of the switching operations throughout the ports, while BNSF and UP also provide switching services at their off-port locations.

Under the Clean Air Act, the Federal government has the authority to regulate on-road and off-road vehicles. According to these guidelines, the state government also has the authority to set their own standards. Railroad locomotives, however, cannot be regulated at the state level. As a result, MOUs have been developed with BNSF and UP rail yards as a part of the CAAP to advance emissions standards and technology that is stricter than the federal standards already in place.

In the 2017 CAAP update, initiatives regarding rail have refocused on expanding the use of rail for moving cargo to and from the ports. The rationale is that using rail can be more environmentally and economically beneficial than moving cargo by truck. Investments have been and continue to be made in developing the infrastructure to support increased rail usage. The SPBP continue to be serviced by Pacific Harbor Line, which has introduced Tier 4[11] locomotive engines and is "the cleanest rail company in the country" (SPBP 2017, 74). Many of the CAAP rail initiatives have been moved to the TAP.

With the shift in focus to moving more cargo by rail, the Southern California International Gateway (SCIG) becomes critical for this analysis. The following section shows how the SCIG project, a proposal to build an intermodal railyard allowing more cargo to move by rail, had been on hold for several years due to stakeholder concerns about environmental impacts. Though not a CAAP initiative, the private sector SCIG project is important as it further exemplifies an infrastructure project that requires collaboration between multiple stakeholders, particularly near-port communities and organizations that focus on EJ goals.

[11] Tier 4 locomotives are the cleanest diesel locomotives in the nation, are compliant with the latest EPA emissions standards, and will reduce particulate matter and nitrogen oxide emissions by up to 85 percent compared to older locomotives.

The Southern California International Gateway (SCIG)

First proposed in 2005 by BNSF and the Port and City of Los Angeles, BNSF planned to establish a 153-acre, near-dock railyard at the Port of Los Angeles with the goal of more efficiently handling the growing container volumes of the SPBP (Angell 2018). Although BNSF reported increased employment opportunities, reduced local truck miles (particularly on the I-710 freeway to intermodal rail yards near downtown Los Angeles), more effective use of the Alameda Corridor[12] and improved air quality, the environmental impact report (EIR) proved to be a major stumbling block for its development.

The proposed site raised concerns regarding atmospheric pollution of adjacent disadvantaged communities. The proposed location is adjacent to a housing project and schools. Anticipating airborne and noise pollution associated with port-related operations and off-port developments such as the SCIG, the Board of Harbor Commissioners approved an MOU in 2008 which established a Port Community Mitigation Trust Fund (PCMTF). This funding would be provided to cover soundproofing of schools and residences affected by near-port and off-port projects and installation of air filtration, ventilation, and conditioning purifiers in schools. Furthermore, funding was allocated for provision of inhalers, assistance to health clinics and service providers for treating respiratory problems, a job training/hiring program, and an environmental impact analysis on native ecology. The trust fund was estimated at $50 million (Los Angeles Harbor Department 2013).

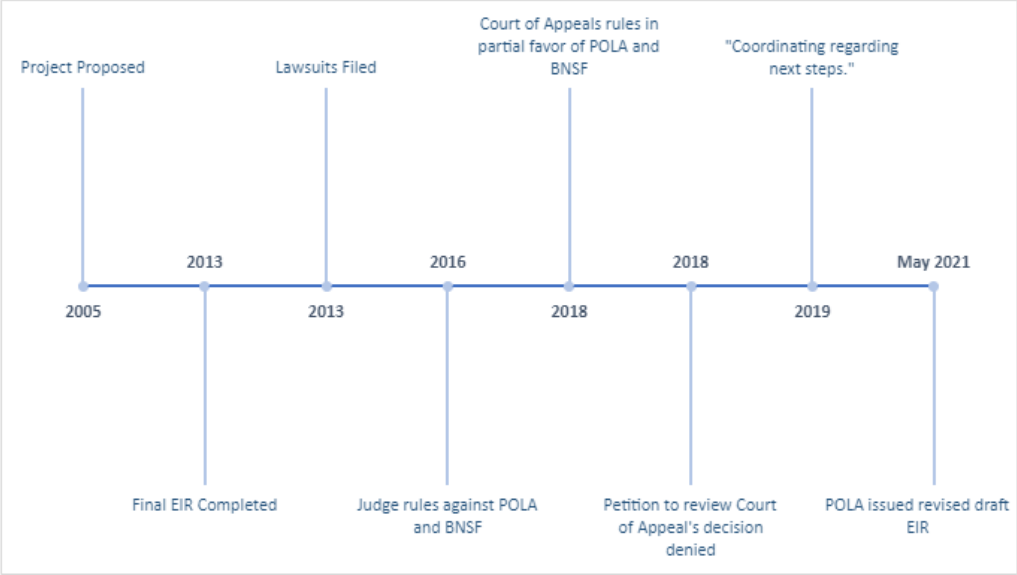

Figure 2. SCIG Development Timeline

Multiple lawsuits were filed against the $500 million project in 2013 by the Natural Resources Defense Council (NRDC) representing multiple community-based organizations, the City of Long

[12] The Alameda Corridor is a 20-mile freight rail expressway owned by the Alameda Corridor Transportation Authority that connects the national rail system near downtown Los Angeles to the SPBP.

Beach, and the Long Beach Unified School District (Weikel 2013), as well as SCAQMD. The NRDC represented multiple stakeholders in their suit, including local NRDC members, East Yard Communities for Environmental Justice, the Coalition for Clean Air, and the Century Villages at Cabrillo (Air 2016). Further, some goods movement companies were petitioners to block the project's approval as the development would encroach upon their land (Angell 2018). In 2016, it was ruled in Superior Court that the City of Los Angeles and POLA failed to provide an adequate environmental impact analysis (Parkin 2016). The following shortcomings in the EIR were key factors in the project's failure to gain approval:

- The EIR contained flawed methods for measuring the SCIG facility's impacts on air quality, GHG, noise, and traffic. These methods focused on average impacts of the facility's 24/7 operations without considering the unique impact of pollution during the night, such as with noise pollution.
- Periodic review of new technology at the railyard was deemed unenforceable because it would be implemented at BNSF's discretion.
- The EIR inaccurately assessed climate change impacts by failing to include the SCIG project's impacts on the Hobart facility in the City of Commerce and failing to analyze the cumulative impacts of SCIG in culmination with the nearby ICTF intermodal railyard.

The Port and City of Los Angeles were required to complete a more accurate environmental impact report before commencing any project activities (Parkin 2016). As SCAQMD stated in the final EIR, "The port failed to provide sufficient information to support its emissions calculations and modeling thus depriving the public of the ability to provide informed comment," and, among other concerns, "the port's responses to comments were frequently inadequate" (Nakamura 2013). BNSF failed to provide a robust, all-inclusive environmental impact analysis and comply with the regulated methods for gaining project approval. In January 2018, the California Court of Appeals ruled that the POLA and BNSF were in compliance with California Environmental Quality Act (CEQA) requirements on nearly all issues, overturning—though not completely reversing—the trial court's ruling in 2016. The appeal granted the SCIG project limited approval (City of LB v. City of LA 2018).

In May of 2021, the POLA issued a Revised Draft Environmental Impact Report (EIR) for SCIG for a 45-day period of public review and comment thereby revisiting the possibility of development ("Port of Los Angeles Releases Revised Draft Environmental Impact Report for Southern California International Gateway (SCIG) Project | References | Port of Los Angeles" n.d.).

Meaningful Community Involvement and Democratizing Planning In Infrastructure Development

Completing a rigorous, inclusive, and comprehensive environmental impact study with consistent and meaningful community engagement from project concept, should have been at the forefront when preparing a petition for approval. Allies in opposing the SCIG project were varied, including a city, school district, community-based organizations, health organizations, regulatory organizations, and industry. Furthermore, the technical capacity of community-

based organizations was strengthened by alliances with national environmental and civil rights organizations, such as the NRDC and the Moving Forward Network (MFN):

> The Moving Forward Network is a national network of over 50 member organizations that centers grassroots, frontline-community knowledge, expertise and engagement from communities across the US that bear the negative impacts of the global freight transportation system. MFN builds partnerships between these community leaders, academia, labor, big green organizations and others to protect communities from the impacts of freight. Its diverse membership facilitates an integrated and geographically dispersed advocacy strategy that incorporates organizing, communications, research, legal and technical assistance, leadership development and movement building. This strategy respects multiple forms of expertise and builds collective power ("Moving Forward Network | Transforming Global Trade for Healthy Communities" n.d.).

A primer for including equity concerns, such as air quality and public health, traffic congestion, and the creation of good jobs with a major infrastructure project supporting the goods movement industry is The California Endowment's *Building Healthy Communities: Democratizing Planning – How Communities are Raising Their Voices to Transform the I-710 Corridor Project* (Matsuoka, n.d.). Similarly, in the CAAP 2017 Update, a formalized process to include meaningful community involvement is included to ensure overburdened communities' perspectives are included in the planning process.

Findings and Analysis

The Clean Air Action Plan case studies as well as the SCIG case study reveal the complexities surrounding the implementation of environmental policies and programs in both the private sector and in the (quasi) public sector, as is the case with public port authorities. Even in the best of times, the long-term horizon of public efforts to improve environmental quality is likely to be at odds with the shorter-term economic imperatives of supply chain operations. The rollout of environmental measures during a pandemic with unprecedented cargo volumes sheds an even greater light on the relationship between a global supply chain and the more localized efforts to mitigate its impacts.

The CAAP is evidence of the fact that significant changes in environmental (in particular air) quality can be achieved using a combination of incentives, subsidies, and mandates with private operators playing a substantial role in their development. Replicability however depends upon a number of factors:

1. Ports are embedded in broader supply chains

Ports make for a likely focus of environmental measures not only because they are a source of significant emissions but also because the port authorities, as stewards of coastal lands seeking a social license to operate, have an incentive to prioritize environmental mitigation as part of their operations. As such, they are expected to use their position and leverage to influence behavioral change on the part of their terminal operator tenants and the industry stakeholders, including truckers and ocean carriers, that connect the port to the broader supply chain.

The success of a port-focused effort will then depend upon circumstances that are beyond the port's immediate control. This includes the availability of external funding to support the industry's transition to a more sustainable future and competing regulations, policies and operational standards that conflict with more localized efforts. Certainly, broader based adoption of alternative fuel standards (whether for vessels, trucks or rail) is made easier if implemented across the entire supply chain. This is true for the equipment manufacturer concerned about a broader market for its product and for the operator seeking to avoid investments in different systems with different standards in different places.

The decisions made by key stakeholders, including terminal operators, ocean carriers, rail companies and trucking companies also reflect a wider supply chain focus. Terminal operators with operations in different parts of the world are likely to respond to local port programs with an eye toward their impact on global standards. Even the local port authority must keep an eye on how the timing and cost of environmental measures effects the competitiveness of its facilities as a trade gateway. The Ports of Los Angeles and Long Beach, even with a geographic competitive advantage because of its proximity to Asian manufacturing centers, are still vulnerable to global supply chain trends that could ultimately favor other ports and trade lane

2. Not all stakeholders are created equal

The structure of trade and transportation is such that a small number of policies and programs are more easily set by the relatively small number of ports, terminal operators, ocean carriers and rail companies with both local influence and global reach. The more distributed nature of the drayage trucking sector and the number of actors involved make coordination more problematic. As a result, trucking is forced to react to rules established elsewhere even it largely bears the burden of cost.

These real and perceived imbalances in the process of making environmental improvements may translate into legal action. The courts have played a role in both the CAAP and SCIG, adding additional delay and cost to the process. Seeking to avoid further legislative action is one reason behind the development of the CAAP in the first place; but agreements among some stakeholders does not preclude court challenges from others.

3. Technology is not enough and Performance Metrics Matter

What is feasible technologically may not always be viable commercially. Environmental programs that aim toward zero emissions depend upon available products in the marketplace that allow the freight system to cover the cost of the new technology through regular operations. So, ZEV vehicles that do not allow for a similar range or cannot carry the same or similar payload as a conventional vehicle will meet resistance with the target audience. The TAP program provided an important mechanism to test technology with input from both the public and private sector, in the process hopefully minimizing unintended consequences.

Even so, assumptions regarding technology should be regularly questioned and adjusted based upon changing realities. Shoreside power for OGVs, for example, needs to be assessed in light of energy instability and demand. Changes in vessel size, speed and efficiency may make vessel

speed reduction programs both less necessary and effective. The availability and capability of ZEVs may dictate the need for near ZEV options in the near term.

Because of this, clearly defined measurements of success need to be established from the outset and agreed upon by the parties involved. AB 617 communities will emphasize environmental justice, system operators will seek efficiency as part of the implementation of new technologies, and the ports seek a balance between both. Articulating the purpose of programs and establishing benchmarks for success help to eliminate conflicts at the time of assessment. These benchmarks must take into account the pace of policy development, technology development and the economics of the transport sector as a whole.

Finally, it is important to consider the unique nature of Southern California when considering the value of the lessons from these case studies. California in general and Southern California in particular show evidence of a political will to take a leadership position in establishing environmental measures. The ability to do so is driven in part by the scale of the problem (both emissions as well as cargo volumes) and success of both regulatory efforts and legal remedies in forcing solutions. In addition, the large local market and port capacity have made the SPBPs less vulnerable to cargo diversions resulting in part from the costs of both congestion and environmental mandates.

The impact of the Southern California experience on other places may therefore depend more on how the supply chain drives changes elsewhere. Growing congestion, air pollution and a demand from local communities to address these issues may mean that the more aggressive Southern California approach to environmental mitigation will find an outlet in other large port communities around the US if not the world. The Section 177 agreements to adopt clean truck standards suggests this is the case. The new found visibility of the supply chain in the wake of the pandemic may also demand solutions that are implemented across the board regardless of local biases for or against individual measures.

At the same time, the supply chain continues to be made up of a diverse set of stakeholders with diverse interests and varying capacities to drive change. In the short term, that may mean the lessons of the Southern California case studies may be viewed as cautionary tales instead of Best Practices.

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Data Summary

The data used for this project is bibliographic in nature (and thus in the References) and/or from already publicly-available third-party sources. There are no additional products or data.