



Mobile Source Strategy



DISCUSSION DRAFT

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Executive Summary

Over the next 15 years, California will need to build upon its successful efforts to meet critical air quality and climate goals. These include:

- Attaining federal health-based air quality standards for ozone in 2023 and 2031 in the South Coast and San Joaquin Valley, and fine particulate matter (PM 2.5) standards in the next decade,
- Achieving greenhouse gas (GHG) emission reduction targets of 40 percent below 1990 levels by 2030,
- Reducing our petroleum use by up to 50 percent by 2030,
- Minimizing health risk from exposure to toxic air contaminants, and
- Increasing energy efficiency and deriving 50 percent of our electricity from renewable sources by 2030.

Achieving these complementary goals will provide much needed public health protection for the millions of Californians that still breathe unhealthy air, and reduce exposure in disadvantaged communities, especially in light of new information regarding the sensitivity of children to toxic emissions early in life. Meeting California's GHG emission reduction targets is an essential part of the global action needed to slow global warming and achieve climate stabilization. Finally, actions to meet California's public health and climate goals will reduce our dependence on petroleum and establish a more secure energy future.

Mobile sources—cars, trucks, and a myriad of off-road equipment—and the fossil fuels that power them are the largest contributors to the formation of ozone, PM 2.5, diesel particulate matter, and GHG emissions in California. They are responsible for approximately 80 percent of smog-forming nitrogen oxide (NOx) emissions, 95 percent

of diesel particulate matter emissions, and 50 percent of GHG emissions. Given this contribution, significant cuts in pollution from these sources are needed.

In this report, the Air Resources Board (ARB or Board) staff is putting forward a proposed mobile source strategy for discussion that simultaneously meets air quality standards, achieves GHG emission reduction targets, reduces petroleum consumption, and decreases health risk from transportation emissions over the next 15 years. The integrated approach to planning described in this report allows consideration of the multi-pollutant benefits, identifies interactions between measures to guide policy, and maximizes program effectiveness.

ARB staff developed this strategy using a multi-pollutant scenario planning tool that quantifies changes in ozone and PM 2.5 precursor emissions, GHG emissions, petroleum usage, and diesel toxics emissions as various technologies become widespread in vehicle and equipment fleets. This tool, Vision 2.0, is the next generation of ARB's first Vision scenario planning tool used for ARB's *Draft Vision for Clean Air: A Framework for Air Quality and Climate Planning* published in 2012¹. Staff evaluated scenarios with varying assumptions about potential technology and fuel mixes, and explored different rates at which those technologies could become widely used.

The scenario analysis shows that the State's public health, climate, and petroleum reduction goals can be met with a strategy consisting of cleaner vehicle technologies, energy sources, and fuels. Technologies, energy sources, fuels, and the best policy tools will vary by sector based on the status of technology development in various applications, the multi-pollutant benefits, and the interactions between measure concepts.

For passenger vehicles, the strategy calls for increasing the penetration of plug-in hybrid electric vehicles (PHEV) and non-combustion zero-emission vehicles (ZEV) including battery-electric (BEV) and hydrogen fuel cell electric vehicles (FCEV) by over 50 percent compared to current programs. The electrical grid and hydrogen supply supporting these electric vehicles will need to represent 50 percent renewable energy generation. A large portion of the liquid fuels for combustion engine vehicles will also need to be sourced from renewable feedstock.

For heavy-duty vehicles, combustion technology will continue to dominate over the next 15 years. The strategy therefore calls for engine technology that is effectively 90 percent cleaner than today's current standards, with clean, renewable fuels comprising half the fuels burned. To position the heavy-duty sector for longer-term targets that extend beyond the timeframe of this strategy, actions to promote the use of clean-burning and near-zero emission vehicles must be complemented by targeted introduction of zero-emission technologies in heavy-duty applications that are suited to early adoption of ZEV technologies. Actions to promote ZEVs in these heavy-duty applications are important to further reduce regional and near-source toxics exposure

¹ Vision Scenario Planning <http://www.arb.ca.gov/planning/vision/vision.htm>

and foster the development of these technologies so they become suitable for broader use in the future. Off-road equipment will need to reflect this same type of transformation to a mix of zero and near-zero technologies operating on renewable fuels.

Along with the widespread use of cleaner technologies and fuels, the strategy calls for ongoing improvements in community design and efficiency improvements to the freight transport system. These efforts will make our communities and cities more sustainable and enhance the benefits of investments in cleaner technologies by reducing growth in vehicle miles travelled (VMT). In the longer-term, advanced transportation systems and technologies, such as autonomous vehicles, have the potential to be a transformative element of a cleaner, safer, and more efficient transportation system. The strategy also relies on the increased use of renewable fuels to ensure that GHG reductions are achieved while meeting the ongoing demand for liquid and gaseous fuels in applications where combustion technologies remain, including in heavy-duty trucks and equipment and light-duty hybrid vehicles.

The estimated benefits of the strategy in reducing emissions from mobile sources are shown in Figure ES-1. This includes an 80 percent reduction of smog-forming emissions, and a 45 percent reduction in diesel particulate matter emissions in the South Coast from today's levels. Statewide, the strategy would also result in a 45 percent reduction of GHG emissions and a 50 percent reduction in the consumption of petroleum-based fuels.

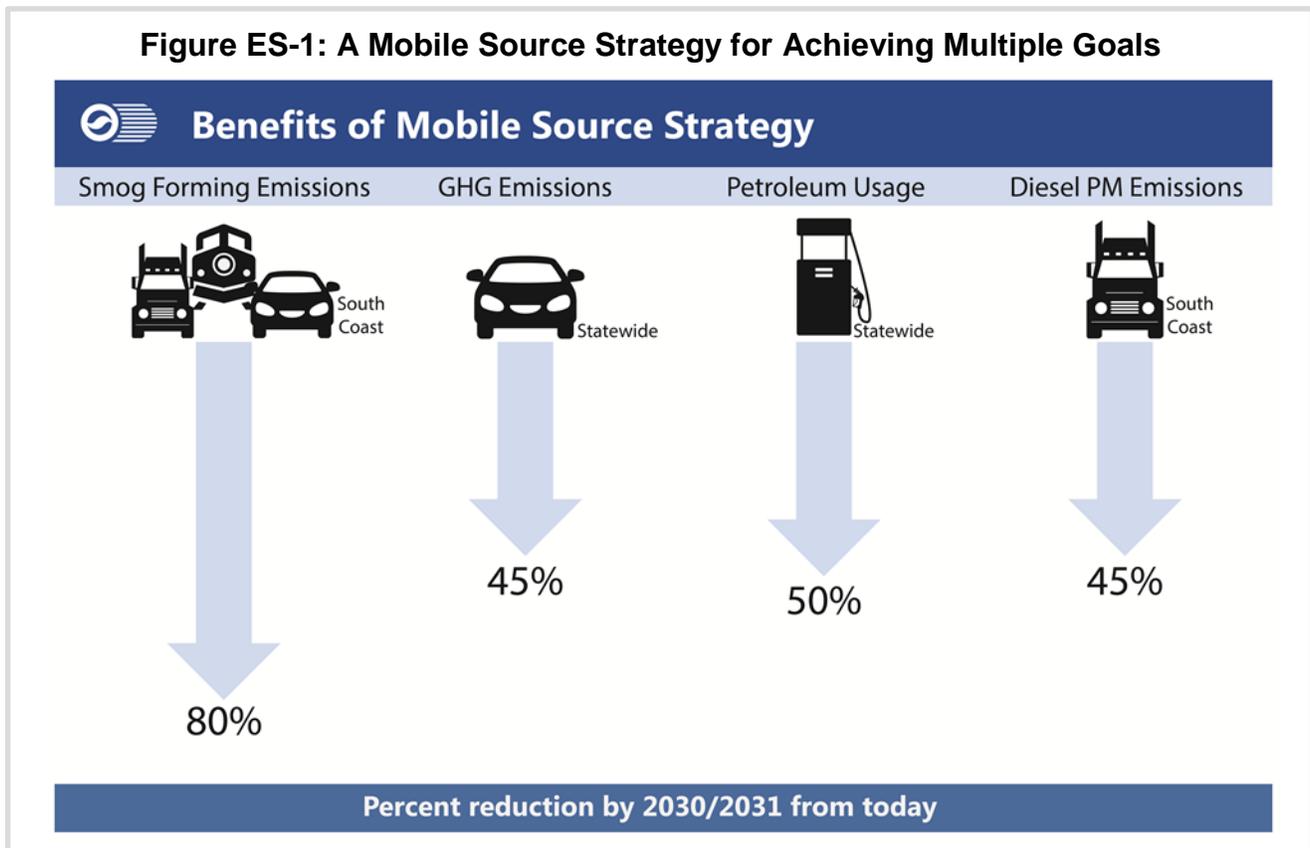


Table ES-1 highlights the scope of actions across all mobile sectors that are included as part of the proposed mobile source strategy. These actions would establish requirements for cleaner technologies (both zero and near-zero), deploy these technologies into the fleet, require cleaner fuels, and ensure in-use performance. Actions to accelerate the deployment of cleaner technologies through incentives, efficiency increases in moving people and freight, and support for the use of advanced transportation technologies, such as intelligent transportation systems and autonomous vehicles are also needed. Taken together, the actions in Table ES-1 would provide the reductions necessary from mobile sources to achieve federal health-based air quality standards for ozone in 2023 and 2031, reduce GHG emissions from on-road vehicles by over 40 percent below 1990 levels by 2030, reduce our transportation-related petroleum use by up to 50 percent by 2030, and decrease regional and near-source health-risk from exposure to toxic air contaminants.

California has a long and successful legacy of building a world-class economy in concert with innovative and effective environmental and public health policies. Significant investments will be needed to continue the transformation of California's transportation sector. The strategy in this report is an integrated approach to meeting multiple goals, and the investments necessary to implement the strategy will deliver broad environmental and public health benefits, as well as support much needed efforts to modernize and upgrade transportation infrastructure, enhance system-wide efficiency and mobility options, and promote clean economic growth in the mobile sector.

The overall mobile source strategy described in Chapters 1, 2, and 3 supports multiple planning efforts: State Implementation Plans (SIPs) required under the Clean Air Act to meet federal air quality standards, California's Scoping Plan Update to meet GHG reduction goals, the Short-Lived Climate Pollutant Plan to reduce potent short-lived climate forcers, and the California Sustainable Freight Action Plan to create a cleaner more efficient freight transport system. Under the Clean Air Act, SIPs to meet federal air quality standards must identify both the magnitude of emission reductions needed and the actions necessary to achieve those reductions by the required attainment deadline. Given the severity of ozone levels in the South Coast, meeting the ozone standards in this region will drive the scope and timing of regional emission reduction needs. Chapters 4 through 8 therefore specifically outline a coordinated suite of proposed measure concepts that provide the regulatory and programmatic mechanisms to implement SIP related requirements of the mobile source strategy and estimated NOx reductions in the South Coast. Subsequent planning work by ARB and other State agencies will further refine and expand on additional actions, such as those for renewable fuels, through the Scoping Plan Update process, and further efficiency activities through the California Sustainable Freight Action Plan.

ARB staff will provide the Board an informational briefing on the proposed mobile source strategy at its October 22, 2015 meeting in Diamond Bar. Prior to the Board meeting, staff will hold a public workshop on October 16, 2015. Both the workshop and the ARB meeting will provide the public the opportunity to comment on the strategy and the proposed measure concepts. After the October meeting, based on Board direction,

staff will work with stakeholders, the South Coast and other air districts, and other State agency partners to develop detailed measures.

This process will include incorporation of specific measures into the regional attainment demonstration in each air district's SIP for meeting federal air quality standards, including the specific legal structure of the SIP commitment. As part of this effort, ARB will continue to work closely with the South Coast on further development of detailed mobile source measures to meet the ozone standards in 2023 and 2031. This will include an evaluation of the costs and economic impacts of the mobile source measure concepts. As part of the public process, beginning with the October workshop, ARB will be specifically soliciting input and comment on the costs and economic impacts. After release of each region's draft SIP, additional workshops will be held to gather public comment on the SIP mobile source measure concepts along with measures for non-mobile source sectors. The South Coast Air Quality Management District (AQMD) anticipates releasing its draft SIP in October/November 2015. The anticipated release date for the San Joaquin Valley SIP has not yet been set, but will occur after the release of the South Coast plan. The ARB will consider approval of the regional SIPs and final mobile source measures prior to submitting the plans to U.S. EPA. Ozone SIPs are due to the U.S. Environmental Protection Agency (U.S. EPA) in July 2016 and PM 2.5 SIPs in October 2016.

The actions identified in the proposed mobile source strategy presented in this document will also provide the framework for development of the Scoping Plan Update and the California Sustainable Freight Action Plan. Initial planning efforts are underway for the Scoping Plan Update, with a public workshop scheduled for October 1, 2015. The first draft of the Scoping Plan Update is anticipated in spring 2016, with adoption of the final plan targeted for fall 2016. Building upon ARB's *Sustainable Freight: Pathways to Zero and Near-Zero Emissions Discussion Document* that was released earlier this year, ARB staff will update the Board on the Sustainable Freight Strategy in late 2015, with development of an integrated action plan by July 2016, as called for in Executive Order B-32-15².

² Executive Order B-32-15 <https://www.gov.ca.gov/news.php?id=19046>

Table ES-1: Mobile Source Strategy*

On-Road Light-Duty

- Increased ZEV sales coupled with expansion of necessary infrastructure
- More stringent engine performance standards and increased fuel efficiency
- Requirements to ensure durability of passenger vehicle technologies
- Incentive funding to achieve further ZEV deployment beyond vehicle regulations
- Electricity grid representing 50 percent renewable energy generation
- Increased use of renewable fuels
- Reductions from passenger vehicle miles traveled and intelligent transportation systems

On-Road Heavy-Duty

- More stringent engine performance standards reflecting technology 90 percent cleaner than today's standards and increased fuel efficiency
- Deployment of ZEV technologies into focused heavy-duty applications such as transit buses and last mile delivery
- Requirements to ensure durability of heavy-duty vehicle technologies
- Incentive funding to achieve further deployment of cleanest engine technologies
- Increased freight transport system efficiencies and use of intelligent transportation systems
- Increased use of renewable fuels

Off-Road Federal and International Sources

- Call for federal and international action to set more stringent standards for ocean going vessels, locomotives, and aircraft
- Cleaner technologies for older locomotives
- Decreased emissions from ocean going vessels at berth
- Increased freight transport system efficiencies
- Incentive funding to achieve further deployment of cleanest engine technologies
- Increased use of renewable fuels

Off-Road Equipment Sources

- Deployment of ZEV technologies into targeted equipment categories such as forklifts and airport ground support equipment
- Cleaner engine technology transfer from on-road to off-road applications
- Incentive funding to achieve further deployment of cleanest engine technologies
- Increased worksite efficiencies
- Increased use of renewable fuels

* Chapters 3 - 8 provide further details regarding the strategy concepts described in this table.

1. Blueprint for Mobile Source Transformation

ARB's current mobile source programs, coupled with efforts at the local and federal level, have achieved tremendous success in reducing emissions, resulting in significantly cleaner vehicles and equipment in operation today. Current control programs will reduce NOx emissions in 2030 by over 50 percent from today's levels, position California to meet our 2020 GHG target, and provide approximately half the petroleum reductions needed by 2030. These programs provide a significant down payment on the needed emission reductions. Nonetheless, meeting all of our air quality and climate goals will require large reductions beyond those occurring under existing programs.

The success of California's longstanding mobile program provides a blueprint for how to effectively implement a vision for the mobile source sector to meet mid-term goals by 2030 and 2031, as well as to position California for continued progress in addressing longer-term needs. The blueprint is a portfolio approach that combines technology-forcing fleet average standards for new vehicles, cleaner-burning fuels, durability requirements and inspection programs to ensure clean in-use performance, sales requirements for advanced technologies, pilot programs to demonstrate technologies, and incentive programs and other actions to accelerate technology deployment.

Using the light-duty sector as an example, this portfolio approach has resulted in significant progress in encouraging and deploying clean passenger vehicle technologies while setting the stage to transition to zero emission vehicles, which afford both air quality and climate benefits. ARB's Low Emission Vehicle (LEV) fleet emission standards have driven the ongoing clean-up of combustion technology. The Smog

Check program has ensured clean in-use performance, and the continued in-use performance assessment will do so even more effectively in the future. California's reformulated gasoline standard requires fuel producers to meet increasingly stringent standards, which has reduced emissions of NOx, reactive organic gasses, and toxic pollutants from gasoline. ARB's technology-forcing ZEV regulation continues to drive technology development needed for the long-term transformation of the passenger vehicle fleet. The success of these programs is evident: California is the world's largest market for ZEVs, with over 21 models available today, and a wide variety are now available at lower price points, attracting new consumers. As of January 2015, Californians drive 40 percent of all ZEVs on the road in the United States, while the U.S. makes up about half of the world market.

Looking forward, ARB, along with the Governor's Office, will continue California's leadership role to accelerate the market for ZEVs in order to meet the milestone of 1.5 million ZEVs in California by 2025, as laid out in Governor Brown's ZEV Action Plan.³ Since the 2013 ZEV Action Plan, which is currently being revised, additional priorities have emerged that focus on ensuring that ZEVs are accessible to a broad range of Californians, scaling-up ZEV technologies so they are suitable for use in medium and heavy-duty applications, and accelerating market growth beyond California. The multi-state ZEV Memorandum of Understanding and efforts to establish an International ZEV Alliance aim to foster continued national and international growth in the ZEV market.



Finally, partnerships with automotive manufacturers, energy providers and government and non-governmental organizations, like the California Plug-in Electric Vehicle Collaborative and the California Fuel Cell Partnership, have been key to addressing market barriers, infrastructure, and other gaps to further foster the commercialization of ZEVs and PHEVs.

California's portfolio of programs to reduce emissions from the heavy-duty on-road sector has also resulted in substantially cleaner fleets. These efforts include requirements for increasingly tighter new engine standards, vehicle idling, in-use performance systems, and in-use fleet standards. In addition, California's low sulfur diesel fuel program has established stringent standards for diesel fuel sold in the State. In planning for the expansion of ZEVs beyond light-duty vehicles, the portfolio of

³ Governor's Interagency Working Group on Zero-Emission Vehicles April 2015 ZEV Action Plan http://gov.ca.gov/docs/DRAFT_2015_ZEV_Action_Plan_042415.pdf

passenger vehicles policies can serve as a model for next steps in the heavy-duty sector. Just as the continued tightening of tailpipe emission standards for light-duty vehicles was integral to successfully reducing emissions while zero emission technology was developed and commercialized, policies to continue to increase the stringency of tailpipe emission standards for heavy-duty applications while ZEV technologies suitable for certain heavy-duty applications are developed will be essential. Developments in light-duty ZEV technology and California's ZEV mandate continue to foster technology improvements in FCEV and BEVs, which have led to technology advancements benefitting the heavy-duty sector. Specific off-road categories can also benefit from these technology advancements. Knowledge and technological innovation, economies of scale, and efficiency improvements gained by producing generations of lighter application technologies can reduce costs and accelerate commercialization of heavier technologies for both on- and off-road applications.

With the success of California's existing control programs for light- and heavy-duty vehicles, sources primarily regulated by the federal government, including locomotives, aircraft, and ocean going vessels, represent an increasing portion of emissions in California. Although ARB has established a number of requirements, including those for cleaner fuels to be used in ocean going vessels and auxiliary engines near ports, and accelerated the introduction of cleaner locomotives, further emission reductions from these sources are necessary to meet our goals. Measure concepts to reduce emissions from interstate sources depend on the federal government developing more stringent emission standards, and implementing those standards as soon as possible. For international sources such as ocean going vessels, the federal government must act on California's behalf to encourage cleaner requirements. While the need for federal and international action is critical, the strategy also identifies a suite of actions that ARB is prepared to undertake to reduce emissions from these sources, underscoring California's leadership role and ensuring continued momentum towards cleaner technologies in all mobile sectors.

In addition, a continued emphasis on development of cleaner renewable fuels and energy sources will be critical for decarbonizing the transportation system and reducing our reliance on fossil fuels. Renewable energy sources will be necessary to support the growing use of ZEVs and the associated growth in electricity demand. Parallel efforts will also be needed to develop the necessary charging and refueling infrastructure, and to integrate this infrastructure with the electricity grid. The Low Carbon Fuel Standard (LCFS) is an essential tool for reducing the carbon intensity of our fuel mix and reducing petroleum dependence. Transportation fuels are also covered under California's Cap-and-Trade program, and together with the LCFS, provide strong market incentives for fuel suppliers to develop cleaner fuels and sell them in California. Further strengthening of the LCFS standards post-2020 will continue this transition to greater use of renewable fuels. A cleaner diesel standard can also build on ARB's existing fuels framework by requiring that conventional diesel is blended with increasing amounts of qualifying renewable fuels that reduce carbon intensity and criteria pollutant emissions.

Applying this blueprint will take time, and will require a comprehensive suite of policy tools to be further refined, as well as new ones to be developed through a stakeholder process. These efforts will be predicated on early and sustained action. Regulatory approaches will help drive the introduction of cleaner technologies, fuels, and fueling infrastructure. Due to the magnitude of emission reductions needed for air quality and climate, the natural fleet turnover rate and the current pace of market development for zero and near-zero technologies will not be sufficient to meet California's needs. Therefore, funding mechanisms, partnerships, research and demonstration projects, and other innovative strategies will be needed to incentivize accelerated deployment.

Successful approaches and strategies must consider the economics of individual sectors and begin to build an environmental and business case that encourages and supports adoption of these technologies and mechanisms. It will also require partnerships with the private sector and across all levels of government to secure the needed funding and resources, put enabling policies in place, and continue to spur technology innovation as ARB continues to build on California's successful legacy of innovative environmental and public health policies.

Advanced Transportation Technologies and Efficiency Improvements

Beyond the approaches described above, other technology innovations and policies provide opportunities for further transformation. Additional gains in passenger transportation efficiencies can be achieved by developing sustainable communities that feature a range of mobility choices, including easy and equitable access to public transit, active transportation, and improved public transit and rail service utilizing zero and near-zero emission technologies. SB 375⁴, the Sustainable Communities and Climate Protection Act, is a key mechanism to move toward more efficient land use and to promote alternative modes of transportation.

Autonomous and connected vehicles and new approaches to personal mobility also represent an opportunity to fundamentally transform the transportation system and, if done correctly, substantially reduce emissions. Many new vehicles are now equipped with automated features for certain driving conditions, such as parking assist, adaptive cruise control, and automatic braking technology. The technology is maturing rapidly and several automakers are planning on the capability of a fully autonomous vehicle for sale by 2020. Part of this effort includes development of "vehicle-to-vehicle" or "connected vehicle" technology and software systems to communicate vehicle data and conditions of the surrounding driving environment. The potential for improvements in both speed and efficiency, from fewer stop-start cycles to more free-flowing traffic, could be significant, and the heavy-duty truck and freight facility applications for these technologies also show great promise.

⁴ Sustainable Communities <http://www.arb.ca.gov/cc/sb375/sb375.htm>

As part of the California Sustainable Freight Action Plan, ARB and other State agencies will identify strategies, developed in partnership with stakeholders, to promote greater efficiencies in the freight transport system and provide opportunities for more comprehensive approaches to reducing emissions from freight hubs such as seaports, railyards, airports, and distribution centers. Improvements in the efficiency of the freight transport system can be achieved through new technology, operational efficiencies, and smart logistics. Operational efficiencies include changes to business models that have the potential to increase freight flow and capacity in the transportation system. Logistics planning technologies can provide coordination and access to advanced scheduling systems that can improve routing, container tracking, productivity and congestion throughout the transportation system.

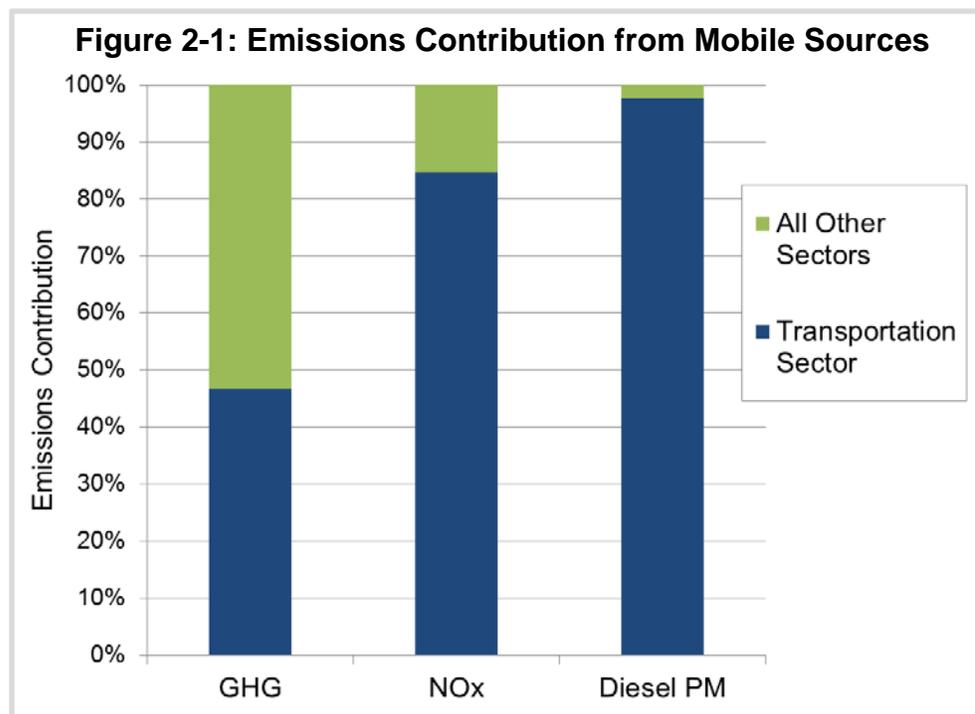
As these advanced technologies emerge and sustainable community strategies are implemented, the transportation sector will require a broader systems-based planning approach. This will require greater coordination among policymakers and stakeholders, and it will naturally lead to synergies between all elements of the transportation system to maximize potential benefits. These actions will work in concert to set California on the path for 2050 climate change goals, while achieving the necessary level of transformation to meet interim air quality and climate goals.

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2. Defining Needs to Meet California's Goals

Scope of the Challenge

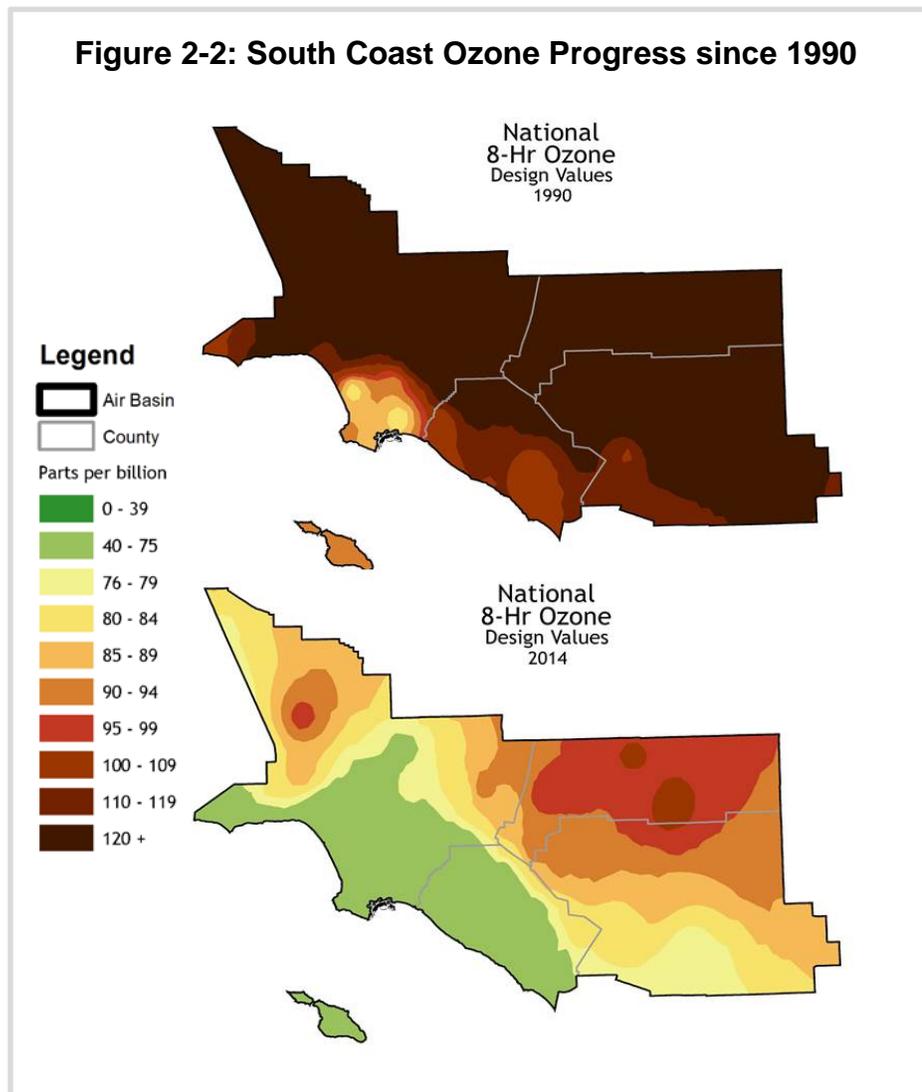
Over the next 15 years California will need to meet a number of critical air quality and climate goals. In response to new science demonstrating health impacts at lower and lower levels of pollution, U.S. EPA has progressively strengthened federal air quality standards. Most recently, U.S. EPA revised the 8-hour ozone standard to 75 parts per



billion (ppb) in 2008, and the annual PM 2.5 standard to 12 micrograms per cubic meter (ug/m3) in 2012. Exposure to PM 2.5 and ozone are associated with premature death, increased hospitalizations and emergency room visits due to exacerbation of chronic heart and lung diseases, and other serious health impacts. Governor Brown has also set ambitious climate change goals that include GHG emission reduction targets of 40 percent below 1990 levels by 2030 and reducing petroleum use up to 50 percent by 2030. At the same time, we must continue efforts to minimize near-source risk and exposure to toxic air contaminants. As illustrated in Figure 2-1, mobile sources and the fuels that power them contribute over 80 percent of smog forming NOx emissions, 95 percent of the diesel PM emissions, and nearly 50 percent of Statewide GHG emissions. Efforts to reduce pollution and fossil fuel use in mobile sources will therefore be essential in creating a future transportation system that provides the foundation for meeting California's goals.

Air Quality Standards

California has made significant progress in improving air quality through existing State and local air district control programs. Figure 2-2 illustrates the progress that has occurred since 1990 in the South Coast, the region with the highest ozone levels in the State. Twenty-five years ago the entire South Coast region violated the current 8-hour ozone standard of 75 ppb. Today, concentrations have declined 45 percent, and 40 percent of the population lives in communities that meet the standard. Nonetheless, the South Coast still has



the highest ozone levels in the nation while the San Joaquin Valley has the greatest PM 2.5 challenge. Statewide, about 12 million Californians live in communities that exceed the federal ozone and PM 2.5 standards.

Sixteen areas in California are designated as nonattainment for the 75 ppb 8-hour ozone standard. Ozone nonattainment areas are classified according to the severity of their air pollution problem, and areas with higher pollution levels are given more time to meet the standard (attainment date). The South Coast and San Joaquin Valley are the only two Extreme areas in the nation, with an attainment deadline of 2031. SIPs for meeting the 75 ppb ozone standard are due to U.S. EPA in July 2016. U.S. EPA is also expected to finalize a more stringent ozone standard in October of this year at a level between 65 and 70 ppb.

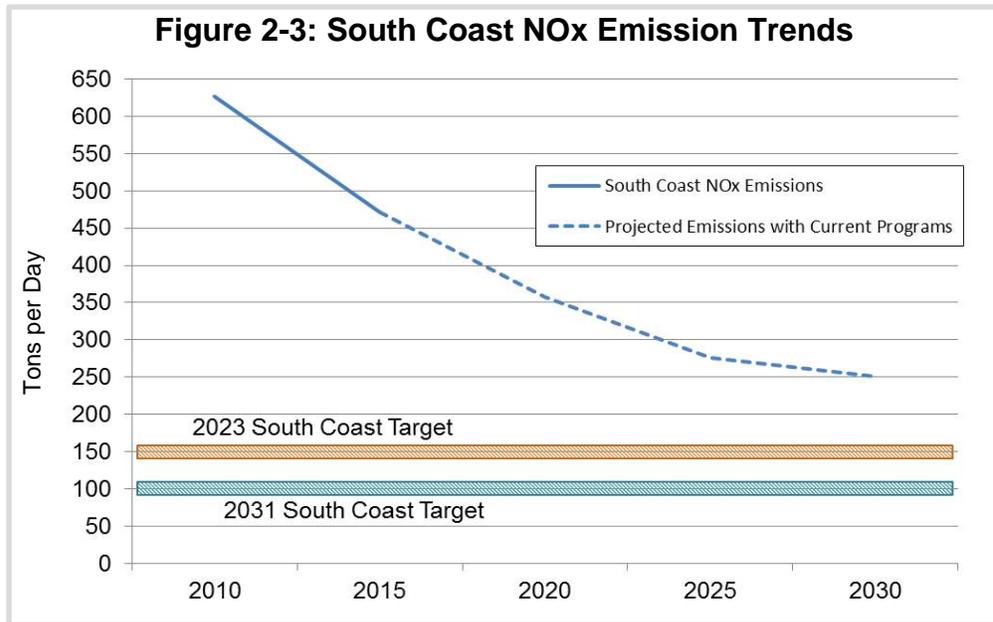
Four areas are designated as nonattainment for the 12 ug/m³ annual PM 2.5 standard. These areas include the South Coast and the San Joaquin Valley, as well as the border region of Imperial County and Portola Valley in Plumas County. While the PM 2.5 challenges in the South Coast and the San Joaquin Valley are regional in nature, the Imperial County and Portola Valley nonattainment areas reflect unique local conditions related to cross-border transport and wood smoke impacts, respectively. Separate, tailored control programs will be necessary for these two areas. SIPs for the annual PM 2.5 standard are due in October of 2016, and attainment dates range from 2021 to 2025.

In addition to the most recent air quality standards, the South Coast and San Joaquin Valley must also continue to address progress towards attainment of earlier standards that they have not yet achieved, including the 8-hour ozone standard of 80 ppb, and the 24-hour PM 2.5 standard of 35 ug/m³.

South Coast Attainment Needs

Air quality modeling is used to define the extent of emission reductions required to meet a standard by the attainment deadline. Given the severity of ozone levels in the South Coast, the scope and timing of emission reductions required to meet the 8-hour ozone standard in this region is a key driver for the development of the overall mobile source strategy which will provide the necessary reductions for ozone attainment throughout the State.

Figure 2-3 illustrates the NOx emission levels in the South Coast over time, and shows that existing ARB and district control programs are projected to reduce NOx emissions by over 50 percent from 2015 to 2030. These programs will also result in significant reductions in PM 2.5, as well as diesel particulate matter.



ARB and the South Coast have been collaborating on preliminary ozone modeling to provide initial estimates of the needed reductions. This modeling suggests that substantial reductions beyond those being achieved with the current control program will be needed to meet ozone standards in 2023 and 2031. The initial assessment indicates that NOx emissions will need to decline to approximately 150 tons per day (tpd) in 2023, and 100 tpd in 2031⁵ to provide for attainment in the remaining portions of the South Coast Air Basin that do not yet meet the standards. Reaching these levels will require an approximate 70 percent reduction from today's levels by 2023, and an overall 80 percent reduction by 2031. NOx reductions will also provide benefits for PM 2.5 by reducing ammonium nitrate formed from interactions between NOx and ammonia. Current health studies indicate that the largest share of air pollution-related health impacts occur from exposure to PM 2.5. Thus ongoing reductions in NOx will provide significant regional health benefits, coupled with reductions in diesel PM to reduce near-source exposure.

These preliminary modeling results will continue to be refined over the next few months, and will incorporate updated forecasts of regional growth being developed by the Southern California Association of Governments. In addition, growth forecasts for the region's ports are also under review.

⁵ South Coast 2016 AQMP Fact Sheet
<http://www4.aqmd.gov/enewsletterpro/uploadedimages/000001/Celia/FactSheet-2016%20AQMP-v9>

San Joaquin Valley Attainment Needs

As noted above, the San Joaquin Valley is also classified as Extreme for the 8-hour ozone standard. The mobile source measure concepts identified in this document will provide significant NO_x reductions in the Valley by 2031. The scope of these reductions is expected to be sufficient to meet the Valley's ozone attainment needs. However, meeting the PM 2.5 standards remains a challenge. The PM 2.5 attainment strategy for the Valley will need to consider the diversity of sources that contribute to PM 2.5, as well as the specific timeframes of meeting both the annual and 24-hour standards. Modeling efforts are underway for the San Joaquin Valley and any further region specific mobile source NO_x and PM 2.5 strategies will be defined through this process.

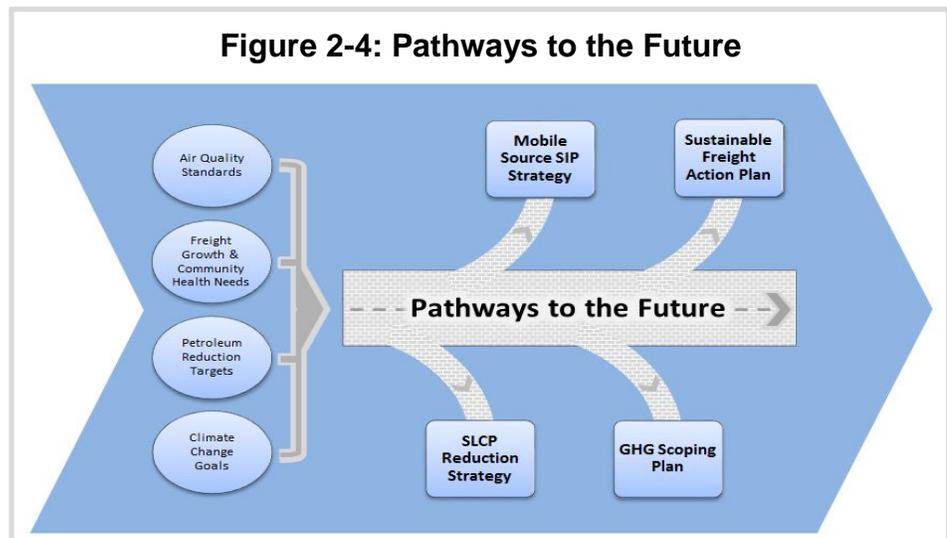
Climate and Other Goals

As Figure 2-4 illustrates, in conjunction with SIP needs, the State's climate, petroleum use, and risk reduction goals will drive the need for transformation of the mobile sector and necessitate a coordinated mobile source strategy.

The Global Warming Solutions Act of 2006 (AB 32) established a 2020 reduction target to achieve 1990 levels of GHG emissions, with a further reduction target of 80 percent below these levels by 2050 specified through Executive Order⁶.

In April 2015, Governor Brown

signed an Executive Order⁷ that established a 2030 target of a 40 percent GHG reduction below 1990 levels. Reducing GHG emissions this amount by 2030 ensures that California will continue its efforts to reduce carbon and stay on the trajectory to help stabilize global temperatures. Governor Brown further identified five key climate change strategy pillars for California in his January 2015 inaugural address to help achieve the 2030 target and establish a model for other states and nations to follow.



⁶ Executive Order S-3-05, <http://gov.ca.gov/news.php?id=1861>

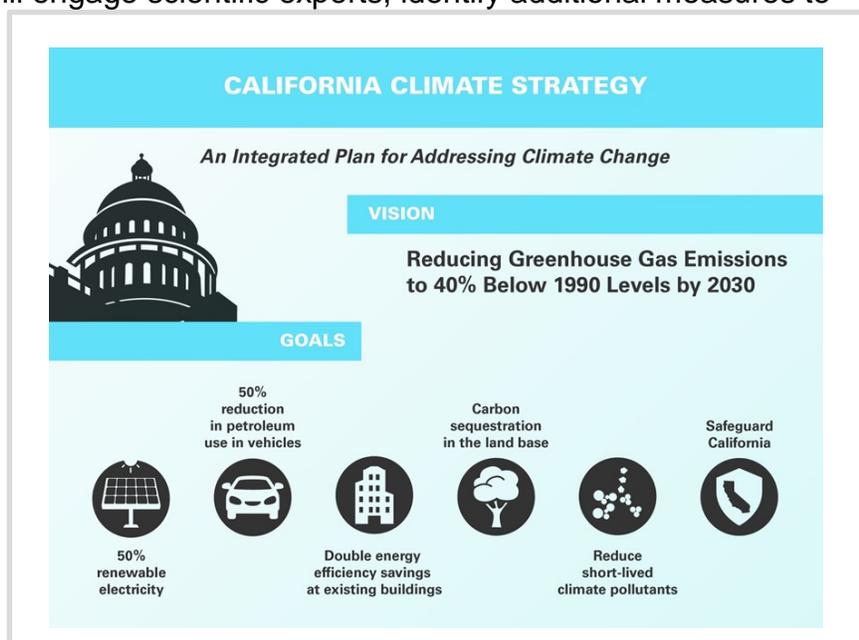
⁷ Executive Order B-30-15, <http://gov.ca.gov/news.php?id=18938>

These strategy pillars include:

- up to a 50 percent reduction in petroleum use;
- increasing the amount of electricity derived from renewable sources to 50 percent;
- doubling the efficiency savings achieved at existing buildings;
- reducing emissions of short lived climate pollutants; and
- managing natural and working lands so they can store carbon.

ARB is initiating a public process in October 2015 and will work closely with other State agencies to update the State's Climate Change Scoping Plan to address the actions that will be necessary to meet these new targets.

Additionally, in 2014 Governor Brown signed Senate Bill 605 (SB 605) (Lara, Chapter 523, Statutes of 2014), directing ARB to develop a comprehensive short-lived climate pollutant (SLCP) strategy by January 1, 2016. Short-lived climate pollutants are powerful climate forcers that remain in the atmosphere for a much shorter period of time than longer-lived climate pollutants like carbon dioxide. Development of the short-lived climate pollutant strategy will engage scientific experts, identify additional measures to reduce short-lived climate pollutants, and will build upon California's leading commitments to reduce GHG emissions and air pollution. ARB has released an initial concept paper describing many of California's efforts to reduce emissions of short-lived climate pollutants and is leading a collaborative process to develop a California Short-Lived Climate Pollutant Strategy⁸. A draft strategy document was released on September 30, 2015.



Finally, in July of 2015, Governor Brown released an Executive Order⁹ that directs State agencies to develop an integrated action plan by July 2016 to create a more sustainable

⁸ Reducing Short Lived Climate Pollutants in California <http://www.arb.ca.gov/cc/shortlived/shortlived.htm>

⁹ Executive Order B-32-15 <https://www.gov.ca.gov/news.php?id=19046>

freight system. ARB staff is working with the State's transportation and energy agencies, as well as its economic development office, local partners, and stakeholders to develop the California Sustainable Freight Action Plan. To inform that effort, the *Sustainable Freight: Pathways to Zero and Near-Zero Emissions Discussion Document*¹⁰ sets out ARB's vision of a clean freight transport system, together with the immediate and near-term steps that ARB will take to support use of zero and near-zero emission technology. The efforts outlined in this document are designed to reduce the unacceptably high risk from freight sources and transition to a less-polluting, more efficient, modern freight system. ARB staff will provide an update to the Board on the integrated planning effort and implementation of the actions in the *Pathways* document in late 2015.

¹⁰ Sustainable Freight Pathways to Zero and Near-Zero Emissions Discussion Document
<http://www.arb.ca.gov/gmp/sfti/sustainable-freight-pathways-to-zero-and-near-zero-emissions-discussion-document.pdf>

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3. Assessing Coordinated Planning Needs

Defining the scope of actions necessary to implement the blueprint for an integrated, long-term mobile source strategy relies upon a coordinated planning process. Given the interconnected nature of California's goals, and the timeframes under which they must be achieved, this type of planning effort is essential to address the interplay between pollutants and sources, and to consider the benefits of different technologies and energy sources. The strategic vision for continued transformation of the mobile source sector builds upon the success of existing programs. Technology assessments and scenario planning tools provide a means to identify the further advances in the types of technologies, fuels, and energy sources that will ultimately need to make up our vehicle and equipment fleets by 2031. In turn, these efforts define the scope, types, and timing of further improvements that will be needed along this pathway, and inform the policy and regulatory framework necessary to accomplish this.

Technology Assessments

ARB has developed a series of technology assessments for heavy-duty applications and the fuels necessary to power them¹¹, along with ongoing review of advanced vehicle technologies for the light-duty sector in collaboration with U.S. EPA and the National Highway Traffic Safety Administration. The South Coast Air Quality Management District has also prepared white papers describing available technologies

¹¹ Technology and Fuel Assessments <http://www.arb.ca.gov/msprog/tech/tech.htm>

and recommendations for approaches to achieve reductions in key source sectors¹². These assessments have identified the types of technologies that will be needed as part of a cleaner, more efficient transportation system. While the status of technology availability varies by sector, meeting the combined goals of South Coast ozone attainment by 2023 and 2031, and the State's GHG and petroleum reduction targets by 2030, will require a portfolio of both substantially cleaner combustion and zero-emission technologies. Key findings from these technology assessments are highlighted below:

- In the light-duty sector, conventional hybrid electric vehicles have gained significant market share, and ZEV commercialization is well underway, with increasing numbers of BEV and PHEV vehicles available for sale.
- In the heavy-duty sector, near-zero combustion technologies that provide ultra-low NOx emissions and operate on renewable fuels are beginning to enter the market. Low-NOx natural gas engines in some sizes, certified to an optional 0.02 g/bhp-hr standard are now becoming available, with low-NOx diesel engines certified to the optional standard of either 0.05 or 0.1 g/bhp-hr available shortly thereafter.
- The development of heavy-duty zero emission technologies is also underway. Zero-emission vehicles are already available in a number of applications such as forklifts and airport ground support equipment. Battery electric and fuel cell buses are in the early commercialization phase and demonstration projects are underway in additional applications such as zero-emission drayage and delivery trucks, certain types of off-road equipment, and at distribution centers, warehouses and intermodal facilities.
- Further emission reductions beyond current engine standards for locomotives and ocean going vessels are feasible with the use of aftertreatment technologies such as oxidation or three-way catalysts, diesel particulate filters, or selective catalytic reduction.
- Renewable fuels can provide significant GHG and petroleum reductions, as well as NOx and PM reductions in applications where combustion technologies will continue to operate. Vehicle grid integration and power to gas technologies can also help support a high renewable portfolio electrical grid.

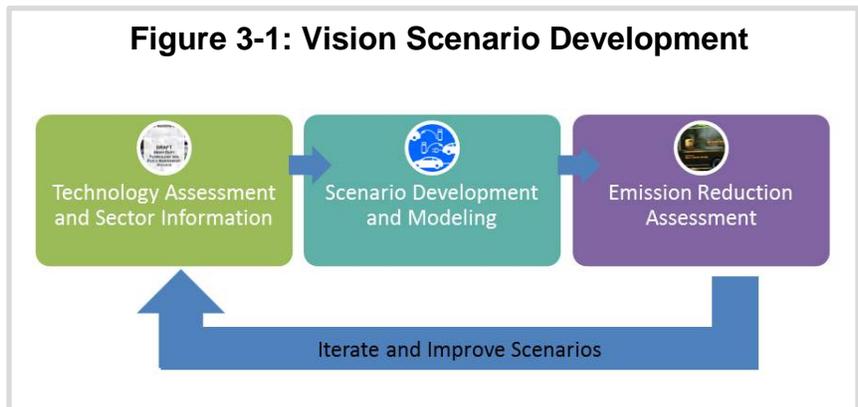
Scenario Planning

Recognizing that the mobile source strategy must include actions to deploy all of these technologies into California's fleets, scenario planning tools enable an examination of the magnitude of technology penetration necessary, as well as how quickly technologies

¹² 2016 AQMP White Papers <http://www.aqmd.gov/home/about/groups-committees/aqmp-advisory-group/2016-aqmp-white-papers>

need to be introduced. ARB’s Vision planning model¹³ provides a framework for this type of coordinated assessment that includes not only technology deployment, but also interactions with needed energy sources and efficiency improvements. The Vision modeling system was used to identify emission reductions associated with the existing mobile source control program, as well as to explore different mixes of a combination of further advancements in technologies and fuels, and the multi-pollutant impacts of policy choices, including technology synergies and tradeoffs, availability of renewable fuel stocks, and distribution of reductions across sectors. The Vision tool is described in detail, along with the specific assumptions made in the scenario modeling, in Chapter 9. The Vision 2.0 model is also available on ARB’s website.¹⁴

As shown in Figure 3-1, Vision scenario modeling is an iterative process to reflect different combinations of technology, energy, and efficiency assumptions that change over time, building from the benefits of existing programs.



These assumptions are informed by foundational technical work and the technology assessments. Results from initial scenarios provide feedback to understand the interplay between these types of strategies and their impact on criteria pollutant and GHG emission reductions. Through this process, the Vision model provides a unique opportunity to understand the intertwined nature of different policies. For example, strategies such as greater deployment of light-duty BEV technologies provide co-benefits across all pollutants and decrease petroleum use. At the same time, the associated increase in electricity demand must be coupled with greater use of renewable energy generation to meet climate goals. Similarly, deployment of cleaner combustion technologies for heavy-duty trucks provides significant NOx reductions, but requires use of renewable fuels to also achieve GHG and petroleum reductions. Understanding these interactions informs further scenario analysis to determine how strategies to meet both air quality and climate goals can best complement each other.

The scenario planning process highlights key insights that provide the foundation for the proposed mobile source strategy presented in this document. While the penetration of different technologies and the appropriate regulatory and policy mechanisms will vary by sector, the scenarios demonstrate significant additional progress is needed on all technology fronts, and multiple potential combinations of technology mixes that can allow us to realize needed reductions.

¹³ Vision Scenario Planning <http://www.arb.ca.gov/planning/vision/workshops.htm#vision2>

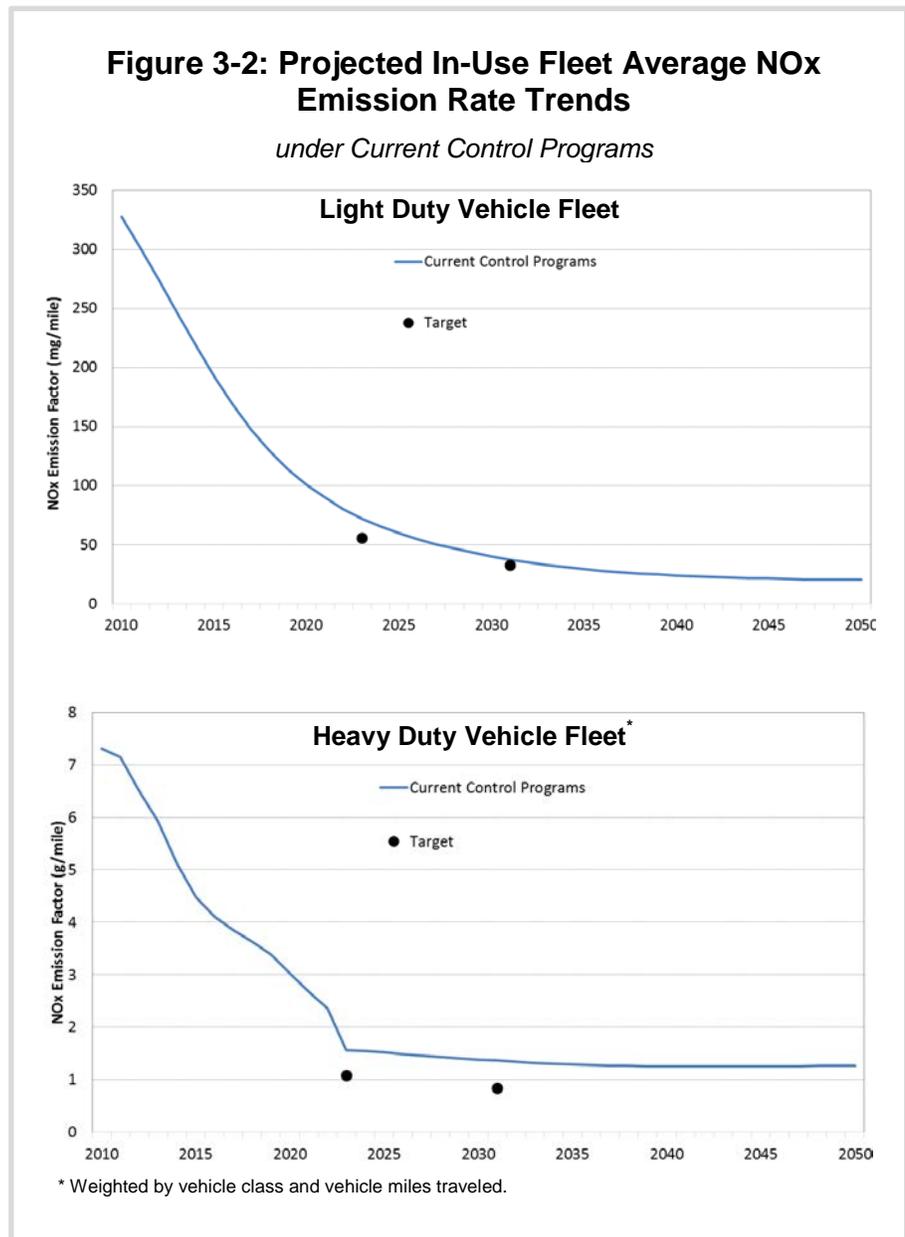
¹⁴ Vision Scenario Planning <http://www.arb.ca.gov/planning/vision/vision.htm>

Progress Due to Existing Policies

As described in Chapter 1, ARB’s success in reducing emissions from mobile sources has relied on a multi-pronged suite of policy and regulatory mechanisms that includes establishing emissions and performance standards for new vehicles and fuels, setting mandates and sales requirements for advanced technologies, developing pilot programs, and implementing incentive and other programs to accelerate technology deployment. Together, these approaches are designed to achieve progressively cleaner in-use fleet emission levels.

Figure 3-2 highlights the progress in reducing NOx emissions through currently adopted control programs for both the light- and heavy-duty on-road sectors in the South Coast. Significant efforts associated with implementation and enforcement will be required to ensure the benefits of these current programs are achieved. The figures also depict in-use emission rate performance targets that reflect a 70 percent reduction by 2023, and an overall 80 percent reduction by 2031, relative to today’s emissions.

In the light duty sector, currently adopted programs are projected to reduce the in-use fleet average NOx

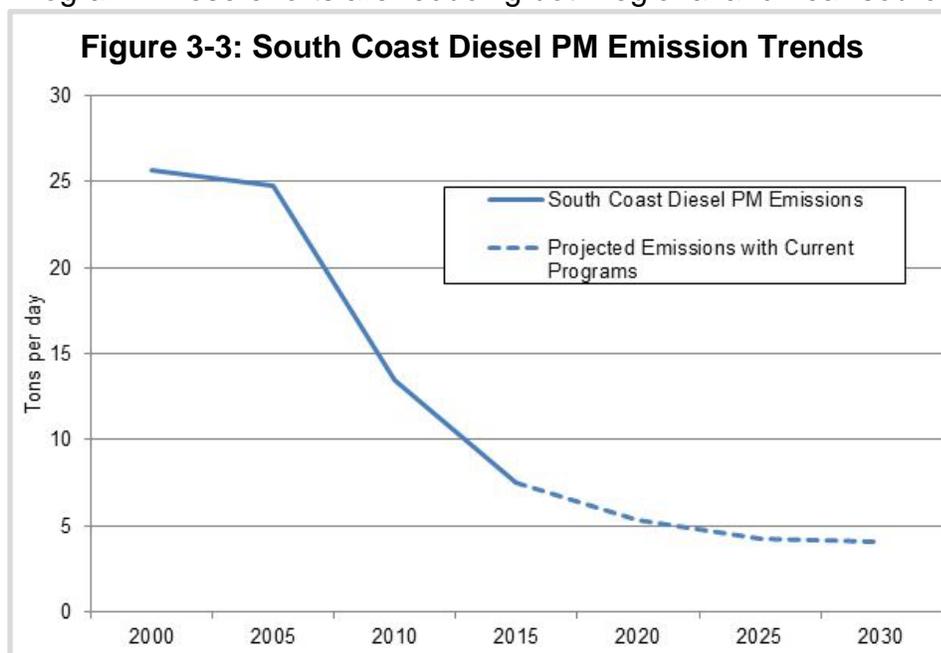


emission rates by almost 80 percent between 2015 and 2031. This progress is the result of new engine standards that have significantly reduced emissions from conventionally fueled vehicles. Alongside these programs, ZEV technologies have achieved commercial status, and sales mandates that increase ZEV penetration provide a trajectory that would meet the in-use targets over time.

For heavy-duty trucks, current programs reduce in-use NOx emission rates by nearly 70 percent by 2031. The significant drop in emission rates through 2023 reflects new engine standards, implementation of the Truck and Bus Regulation, and incentive funding to further accelerate turnover. The pace of emission reductions from existing control programs in the heavy-duty sector flattens after 2023, and is never projected to reach the targets. This demonstrates that while current programs achieve substantial reductions, in-use fleet emissions must continue to decrease and at a more rapid pace in order to meet ozone attainment needs. This is particularly important for the heavy-duty sector, where a significant gap remains.

While not pictured, NOx emissions from off-road sources such as construction and industrial equipment are projected to decrease approximately 40 percent by 2031 as a result of ARB programs to establish more stringent engine standards, in-use fleet rules, idling limits, and increasing electrification of smaller equipment. However, NOx emission reductions from sources that are primarily regulated by the federal government, such as ocean going vessels, aircraft, and locomotives, have not kept pace with other sectors and are only projected to decrease by approximately 20 percent. Thus significant further progress is needed to reach similar emission reduction targets as those for on-road sources.

As Figure 3-3 illustrates, diesel PM emissions also continue to decrease significantly as a result of regulations associated with implementation of ARB's Diesel Risk Reduction Program. These efforts are reducing both regional and near-source risk.



Finally, the existing suite of clean vehicle and fuel policies that comprise current control programs are anticipated to achieve approximately half of the reductions needed to meet the 2030 petroleum reduction goal, and place California on track

to meet the 2020 GHG target. These policies include the Advanced Clean Cars program for light-duty cars and trucks, designed to cut GHG emissions from new passenger vehicles in half by 2025, the ZEV mandate, and Phase 1 GHG emission standards for heavy-duty trucks. Additional efforts include the LCFS, which requires a reduction in the carbon content of transportation fuels by 2020, along with sustainable community strategies developed pursuant to SB 375 to reduce per capita GHG emissions from passenger vehicles by 2020 and 2035. Together, current programs are projected to further reduce on-road GHG emissions approximately 15 percent between 2020 and 2035.

Introduction of Cleaner Technologies and Fuels

Building on the baseline analysis of existing programs, ARB developed a scenario through the iterative Vision modeling process to evaluate the emission and petroleum reduction benefits resulting from deploying the types of cleaner vehicle technologies and fuels identified through the technology assessments. This assessment, called the *Cleaner Technologies and Fuels* scenario, focused on the benefits of new technologies that would replace older vehicles in the fleet under what is predominately a natural turnover rate, coupled with increasing percentages of renewable fuels and energy sources, and reductions in the growth of vehicle miles travelled (VMT).

In the light-duty sector, the scenario examined post-2025 technology approaches that would extend beyond current requirements in the Advanced Clean Cars regulation and the ZEV mandate. These actions included increasing the sales for ZEVs and PHEVs to 40 percent by 2030 to enhance market penetration, as well as setting more stringent vehicle NOx emission standards and new fleet standards for GHG emissions. Further reductions in the growth of VMT beyond those contained in current sustainable communities strategies developed through implementation of SB 375 were also included.

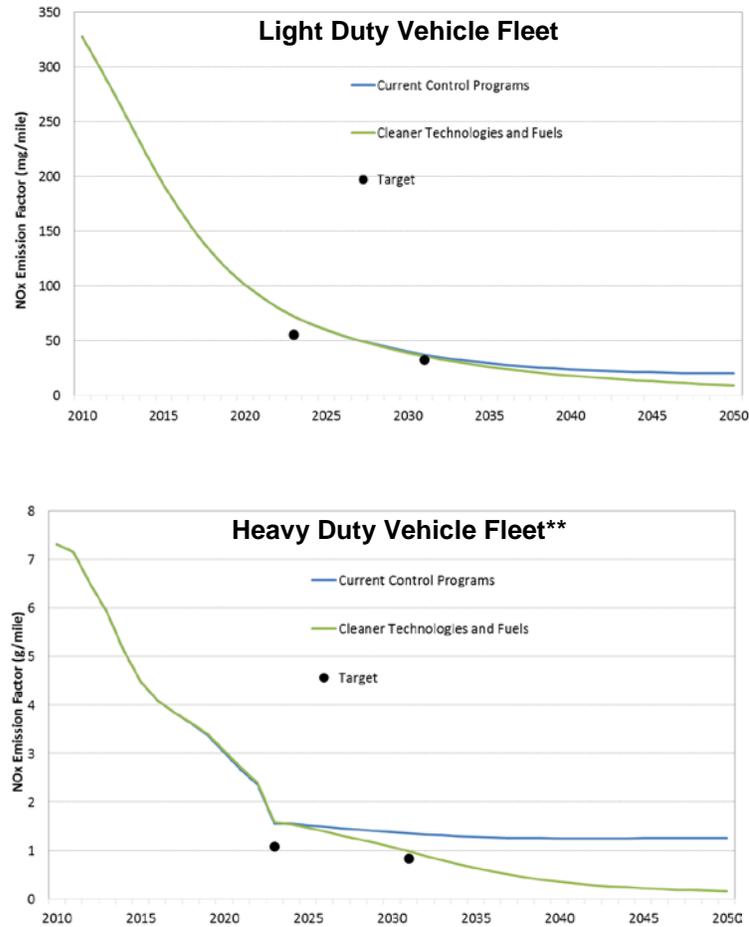
For heavy-duty trucks, the scenario evaluated assumptions about the availability of cleaner traditional combustion technologies through development of lower-NOx performance standards by California and U.S. EPA implemented in 2024 (representing a 90 percent reduction in overall emissions), efficiency improvements from a national Phase 2 GHG standard with implementation starting in 2018, and an approximate blend level of 50 percent biofuels by 2030 to provide petroleum and GHG emission reductions. Other assumptions included the introduction of zero-emission technologies in last-mile delivery applications as an initial deployment that will provide a foundation for subsequent migration of ZEV technology to other heavier platforms.

The *Cleaner Technologies and Fuels* scenario highlights actions that would provide for significant progress towards reaching California's air quality and climate goals. Building from existing programs, these efforts would result in substantial NOx reductions, and when coupled with even further penetration of cleaner technologies, would provide the

reductions needed to meet air quality standards in the South Coast. The actions modeled in the scenario would put California on a trajectory to meet the 2030 GHG emission target of 40 percent reduction from 1990 levels from on-road vehicles, and would reduce on-road petroleum demand by over 50 percent by 2030. The scenario would also result in further decreases in regional diesel PM emissions and other mobile source toxic air contaminants. Targeted actions will be needed to continue to reduce local exposure, especially in communities living near freight hubs such as seaports, railyards, and distribution centers. These targeted actions will be part of the Sustainable Freight Action Plan.

Both NOx and GHG emissions would decrease substantially between 2015 and 2031 under the *Cleaner Technologies and Fuels* Scenario. Figure 3-4 illustrates the South Coast in-use fleet average NOx emission rate trajectories for the on-road fleet that would result under this scenario.

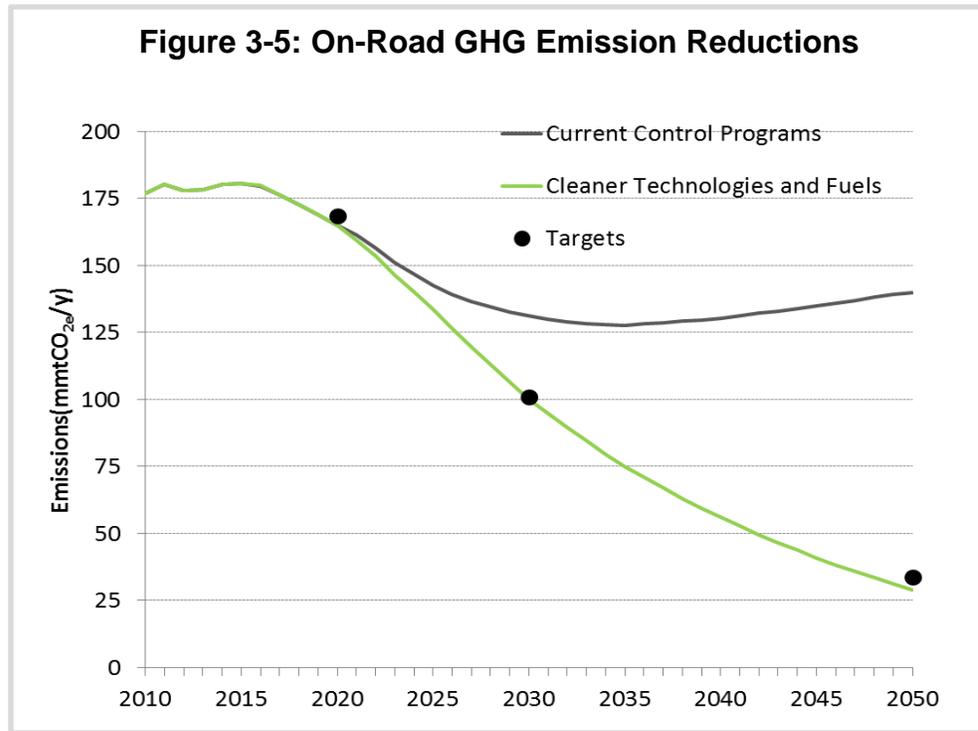
Figure 3-4: Projected In-Use Fleet Average NOx Emission Rate* Trends under *Cleaner Technologies and Fuels* Scenario



*In-use fleet average NOx emissions reflect natural turnover rates for light and heavy duty vehicles.

** Heavy duty vehicle fleet weighted by vehicle class and vehicle miles travelled.

Figure 3-5 illustrates the Statewide GHG emissions (using a well-to-wheel¹⁵ emissions analysis) for the on-road fleet. The greatest NOx reductions result from actions associated with the turnover of heavy-duty vehicles to cleaner technologies, while the greatest GHG reductions are in the light-duty sector.



For light-duty vehicles, this transition occurs as the penetration of PHEVs and pure ZEVs increases by over 50 percent, and the oldest, conventionally fueled vehicles are retired from the fleet. By 2031, there would be about 1 million pure ZEVs operating in the South Coast, with over 2 million Statewide. This technology transition is also coupled with reductions in the growth of VMT from light-duty vehicles that would result from continued advances in the development of more sustainable communities.

The trajectory for heavy-duty vehicles reflects substantial penetration of trucks meeting the Phase 2 GHG standards, as well as those meeting a new low-NOx standard. While the number of ZEV heavy-duty vehicles would be small, deployment in initial applications would provide a starting point for longer-term penetration as the capabilities of this technology expand. Altogether, by 2031 nearly two-thirds of the heavy-duty truck fleet operating in the State would consist of vehicles meeting the Phase 2 or low-NOx standards, with similar proportions in the South Coast.

¹⁵ Well to wheel (WTW) emissions analysis is a form of life cycle analysis that considers the energy or emissions intensity of all stages of fuel production and final use of a fuel in a vehicle (i.e. the production, transport, and consumption of fuels in a vehicle). A WTW analysis slightly differs from a broader life cycle analysis in that it is not a cradle-to-grave approach, i.e., it does not capture the energy or emissions associated with vehicle production and/or vehicle recycling phases.

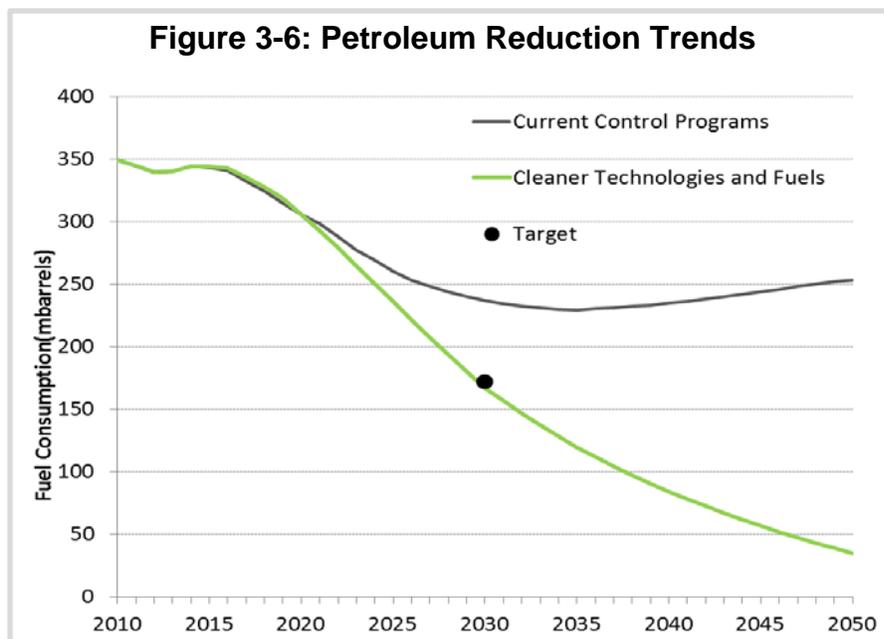


Figure 3-6 shows the corresponding reductions in petroleum consumption throughout the State under the *Cleaner Technologies and Fuels* Scenario and under current control programs.

Table 3-1 summarizes the projected changes in the composition of California’s transportation fuel mix between now and 2030 that would accompany the technology mix contained in this scenario.

Table 3-1: Projected Composition of California's On-Road Fuel* Mix

(Fuel Demand in Millions of Gasoline Gallons Equivalent)

	2015	2020	2025	2030
Petroleum Demand	16,700	14,800	11,500	8,100
Used in Light-Duty Vehicles	82%	80%	81%	85%
Used in Heavy-Duty Vehicles	18%	20%	19%	15%
Biofuel Demand	1,300	2,100	3,000	3,300
Biofuels as share of Light-Duty Fuel Supply	7%	10%	15%	20%
Biofuels as share of Heavy-Duty Fuel Supply	8%	21%	35%	44%
Electricity and Hydrogen Demand	10	40	130	380
Renewable Energy as share of Grid Mix	27%	33%	42%	50%
Total On-Road Fuel* Demand	18,010	16,940	14,630	11,780
Average Fuel Carbon Intensity**	96.6	93.9	87.1	79.6

* On-Road fuel is used in on-road light and heavy-duty vehicles. Excludes fuels use in off-road applications.

** Average carbon intensity (CI) of all regulated fuels under the California Low Carbon Fuel Standard (LCFS). Excludes air, rail and OGV fuels. Carbon Intensity is expressed in gCO₂e/MJ.

The projected fuel mix shown in Table 3-1 reflects two important trends in California’s fuel portfolio over time: decreasing consumption of petroleum-based gasoline and diesel, and increasing use of cleaner energy sources, including biofuels, electricity, and hydrogen. While many passenger vehicles transition to battery electric or other

zero-emission options in future years, many heavier applications are anticipated to continue operating on near-zero internal combustion technologies powered by liquid fuels blended with increasing levels of clean, renewable fuels. As such, heavy-duty diesel vehicles drive the majority of biofuel demand in future years.

This mix also represents an increasing share of renewable and more sustainable feedstock sources over time. This is true for both liquid transportation fuels and electricity, as biofuels displace increasing volumes of petroleum, and as the Renewable Portfolio Standard drives the California grid mix toward an increasing share of energy procured from renewable sources.

Further Deployment of Cleaner Technologies and Pathways to Attain Air Quality Standards

While the *Cleaner Technologies and Fuels* scenario is projected to achieve significant reductions, enhanced deployment of both cleaner on-road and off-road technologies will be needed to ensure that the mobile source strategy comprehensively meets all goals, especially the critical public health needs associated with attaining the federal 80 ppb and 75 ppb ozone standards by 2023 and 2031 in the South Coast.

ARB staff therefore examined further deployment of the same core technologies included in the *Cleaner Technologies and Fuels* scenario as part of a pathway to meet attainment needs in the South Coast. The additional deployment of these cleaner vehicles and equipment will also provide further benefits in reducing GHG emissions and petroleum demand, and continue to support trajectories for meeting these goals. As part of this effort, ARB worked with South Coast staff to assess the penetration of these cleaner technologies that would be required by 2023 to meet the 80 ppb ozone standard.

While many factors will influence the ultimate combination of technologies that will be necessary, including further engineering advances, the results of pilot demonstrations, and consumer acceptance and commercialization, this analysis represents staff's assessment of a likely mix of technologies based on the current status of technology readiness and market penetration. Based on this assessment, on-road sectors offer the greatest opportunities for further reductions. Thus staff's analysis included a focus on enhanced penetration of cleaner light- and heavy-duty vehicle technologies.

The mix of technologies and the emissions performance levels for meeting the 80 ppb and the 75 ppb ozone standards are similar, as evidenced by the results of the *Cleaner Technologies and Fuels* scenario. Thus appropriate actions to deploy cleaner technologies to meet the 80 ppb standard will carry forward towards meeting the 75 ppb standard. As a result, these investments in early deployment of cleaner technologies will not require that vehicles and equipment be replaced twice. Nevertheless, the 2023 deadline to meet the 80 ppb standard will require significantly earlier penetration of the

cleanest technologies. Given the timing and the overlay of current regulatory programs, technology deployment by 2023 must come primarily through incentive mechanisms. At the same time, it will be necessary to establish more stringent emissions standards, ramp up the use of renewable fuels, and require further ZEV penetration to meet all goals by 2030 and 2031.

For light-duty vehicles, the assessment focused on continued expansion of the pure ZEV fleet (both BEVs and FCEVs) to achieve greater NO_x reductions. Equally important, policies to increase ZEV penetration through 2030 and beyond are also a critical driver for addressing the State's climate change targets. By 2031, the population of pure ZEVs in the South Coast would increase to approximately 1.5 million vehicles, while maintaining a PHEV population of approximately 1.2 million vehicles. While PHEVs could also achieve needed NO_x reductions, the scenario relies on assumptions that PHEV electric mile range remains high throughout the lifespan of the vehicle and may not achieve equivalent reductions in petroleum use over the longer-term. Near-zero technologies such as PHEVs can play an important role in reducing NO_x and GHG emissions. However, with the majority of renewable fuels going to on-road and off-road heavy-duty applications in order to meet GHG reductions from those sectors, PHEVs operating on conventional gasoline with a more limited proportion of renewable gasoline are not sufficient for meeting longer-term goals beyond 2030.

In the case of heavy-duty vehicles, combustion is likely to remain a dominant technology through 2031 based on the maturity of current technologies, with gradual demonstration and introduction of technologies capable of zero emissions or zero emissions miles. Thus, the assessment focused on expanded deployment of low-NO_x trucks in larger weight classes. Under this approach, the population of trucks meeting a low-NO_x standard in the South Coast would increase by approximately 30,000, totaling over 400,000 trucks meeting a low-NO_x standard by 2031. Although broader deployment of battery-electric trucks to lower weight classes may be possible, achieving a much greater population of ZEV trucks will require faster advances in technology and infrastructure. However, enhanced deployment of ZEV technologies over time will be important in ongoing near-source risk reduction efforts, particularly in communities near freight hubs.

At the same time, further reductions will also be needed from off-road sources to achieve the aggregate reductions needed for attainment. ARB and South Coast staff therefore also examined mechanisms and opportunities to further advance technologies in off-road sectors. This included increased electrification of small equipment such as forklifts, transportation refrigeration units, and airport ground support equipment, as well as bringing the construction fleet up to current Tier 4 standards. As noted earlier, sources such as ocean going vessels, locomotives, and aircraft represent an increasing share of emissions in the South Coast, and emission reductions have not kept pace with those from on-road and other off-road equipment sources. Thus, strong action by the federal government and international agencies will be essential in developing effective solutions for these sources. Continued partnerships with the federal government to

conduct research and demonstration projects of new zero and near-zero technologies will also be needed.

Additional details regarding the scope of needed technology penetration within the 2023 and 2031 timeframes is provided in Chapters 5 through 7 for the individual sectors, along with recommended mechanisms and actions for achieving these reductions.

Strategy Conclusions

California's existing control policy framework, the technology assessments, and the scenario evaluations demonstrate combinations of technologies and fuels that together can transform the transportation sector over the next 15 years. These pathways will require a mix of both zero and near-zero emission technologies and increased use of renewable fuels. However, the appropriate balance between different technologies and fuels will vary by sector depending upon current fleet characteristics and the pace of future technology development. Appropriate regulatory and programmatic mechanisms to achieve further penetration of cleaner technologies also reflect the nature of each sector. Key elements of the mobile source strategy include:

- Policy levers to significantly increase the penetration of pure ZEVs into the light-duty fleet are necessary, particularly for achieving GHG reductions in 2030 and beyond. This must be coupled with increased all electric vehicle range for PHEVs and continued development of FCEVs to expand the attractiveness of ZEVs to a broader market, along with deployment of fueling infrastructure, and increase use of renewable electricity generation.
- Given the role that combustion technologies will continue to play in the heavy-duty sector, more stringent emission and efficiency standards will need to be developed, as well as measure concepts to ensure that technologies remain durable over the long lifetimes of these vehicles.
- The need for timely action by U.S. EPA to establish more stringent engine performance standards in collaboration with California efforts is essential. Interstate trucks registered out-of-state account for 34 percent of the heavy-duty vehicle miles travelled in the South Coast on any given day, and are exempt from California standards. U.S. EPA action to establish a federal low-NOx standard for trucks is critical. Delays in federal action on heavy-duty truck standards would result in a significant loss of emission benefits that cannot be made up by California acting alone.
- Federal action is also necessary for many off-road sources such as locomotives, aircraft, and ocean going vessels where U.S. EPA has primary regulatory authority. As sources covered by the State and Districts become increasingly cleaner, sources that fall under Federal and international authority will comprise an increasing portion of emissions in the South Coast unless the federal government takes parallel actions. Regulatory mechanisms and policies to

introduce zero-emission technologies into select on and off-road heavy-duty applications provide a foundation for accelerating commercialization into additional platforms. At the same time, continued investments in research and development, especially in off-road applications, will be needed to facilitate demonstration projects and the commercialization of new technologies.

- Substantial expansion in the use of renewable fuels and energy sources are needed to reduce petroleum demand and GHG emissions. Renewable fuels can also provide NO_x reductions and will represent an important alternative fuel source for heavy-duty trucks that will continue to rely on combustion technologies. A clean diesel fuel program that requires increasing use of fuels such as renewable diesel, NO_x-mitigated biodiesel, and/or renewable natural gas from biomethane also provides an effective control approach by reducing emissions from all the vehicles and equipment using those fuels, especially from off-road vehicles and equipment, marine vessels, locomotives, and interstate trucks operating on California fuels. Concurrent investments by other agencies will also be essential to help fund charging infrastructures, as well as low carbon and renewable fuels.
- Although establishing cleaner engine and fuel standards will provide ongoing reductions, actions to further accelerate penetration of the cleanest technologies by 2023 will be needed. This will require strategic investments and development of a comprehensive funding plan to identify funding needs and financing and incentive options will be a necessary first step. Acquiring the requisite level of funding will be an incremental process, but will provide ongoing progress in achieving the fleet transition needed.
- Greater system efficiencies, particularly in the freight sector, provide opportunities for emission reductions, especially as a means to mitigate potential growth in freight activity in the State and to supplement needed federal and international actions on new performance standards.
- Innovations in autonomous and connected vehicles also show promise. The potential for emission reductions from these broad system changes should be closely followed, with ongoing coordination among local, State and federal agencies to position California to take advantage of these emerging technologies.
- Coordinated regional planning can improve California's land use patterns and transportation policy in a way that reduces transportation-related emissions by reducing growth in VMT. The SB 375 process provides a mechanism to pursue these reductions through the development of sustainable community strategies meeting per capita GHG reduction targets for passenger vehicles.

Meeting integrated air quality and climate goals will require action on all of the policy findings above to transform the transportation sector to progressively cleaner technologies and fuels. The chapters that follow describe the proposed measure concepts and associated regulatory and policy mechanisms to implement this overall

strategy as part of SIP requirements. Other elements of the mobile source strategy, such as requirements for increasing usage of renewable fuels and strategies for both passenger vehicle and freight transport system efficiencies, will be developed as part of parallel planning efforts through the Scoping Plan Update, the California Sustainable Freight Action Plan, and the SB 375 program.

4. Mobile Source Strategy and Measure Concepts

ARB's existing policies, and the new reductions that will continue to accrue from these programs, establish a substantial down payment on the actions necessary to meet California's air quality and climate goals. Based on the conclusions outlined in Chapter 3 summarizing strategic approaches to further strengthen and expand these policies, ARB staff developed proposed new measure concepts designed to implement these actions. The measure concepts presented in this document represent elements of the strategy necessary to meet federal Clean Air Act requirements. Specific actions associated with additional aspects of the strategy, such as continued strengthening of renewable fuel standards, will be further developed in subsequent planning documents such as the Scoping Plan Update. Taken together, these measure concepts will provide a comprehensive mobile source strategy to simultaneously meet air quality standards, achieve GHG emission reduction targets, reduce petroleum consumption, and decrease near-source risk.

The proposed SIP measure concepts reflect a combination of regulatory and programmatic actions to:

- Establish more stringent engine performance standards for cleaner combustion technologies;
- Ensure that emissions control systems remain durable over the lifetime of the vehicle;
- Increase the penetration of the zero-emission technology across a broad range of applications;

- Expand the requirements for cleaner low carbon diesel fuels;
- Conduct pilot studies to demonstrate new technologies;
- Incentivize the turnover of equipment and fleets to the cleanest technologies; and,
- Increase system efficiencies.

Measure concepts in each sector reflect the maturity of current control programs as well as the nature of further technology deployment needed. For light-duty vehicles, the need to significantly increase the penetration of current ZEV technology and encourage advancements in battery range, hydrogen technology and fueling infrastructure will be implemented through the Advanced Clean Cars 2 measure concept, along with an ongoing in-use performance assessment and incentive funding to expand the deployment of cleaner vehicles.

In the heavy-duty sector, while ARB's current Truck and Bus Regulation is ensuring that the fleet consists of the cleanest engines currently available, the scenario analysis demonstrated that combined ARB and federal action to develop a more stringent low-NOx engine standard will be necessary to move towards even cleaner combustion technologies. Parallel measure concepts will require deployment of ZEV technologies in initial applications such as last mile delivery and urban transit buses. Finally, given the long lifetime of heavy-duty trucks, further incentive funding will be critical to achieve greater fleet turnover, especially within the 2023 time frame.

Similar actions will be necessary in the off-road sector, with a focus on the need for further federal and international actions to reduce emissions from these sources that become an increasing portion of the emission inventory. Measure concepts include petitions for new national Tier 5 emissions standards and regulation of non-new locomotives, as well as advocacy for international Tier 4 vessel standards. The remaining off-road equipment categories provide an opportunity to introduce zero and near-zero advanced emission technologies, with measure concepts to initially deploy zero emission technologies for transport refrigeration units and airport ground support equipment, with continued evaluation of technology transfer of cleaner on-road technologies to heavier off-road categories.

Coupled with these efforts is a measure concept to adopt a low NOx, PM, and carbon intensity diesel requirement to ensure even further reductions from vehicles and equipment still using combustion technologies.

Each source sector also includes a measure concept that reflects the further deployment of cleaner technologies described in Chapter 3 to target the remaining emission reductions needed for attainment in the South Coast. The types of approaches included in these measure concepts include:

- Incentive programs to further accelerate technology penetration. Existing incentive programs, ranging from the original Carl Moyer Program through the Low-Carbon Transportation investments with Cap-and-Trade proceeds, provide a programmatic structure. However, resources beyond those currently available will be required to achieve needed reductions.
- Increased efficiency in moving people and freight. SB 375 is helping to transform land use and promote sustainability, while focusing on reducing vehicle miles traveled. State agencies are also looking for strategies to incentivize greater freight transport system efficiencies through the California Sustainable Freight Action Plan.
- Transportation technologies, such as intelligent transportation systems and autonomous and connected vehicles, have the potential to fundamentally transform the transportation system making it more efficient, safer, and cleaner.
- Several of the near-term measure concepts in the off-road sector are designed to identify the appropriate next steps in further deploying zero emission technologies. While emission reductions are not yet associated with these measure concepts, the outcome of the assessments will provide a mechanism to identify specific regulatory approaches and the associated emission reductions.
- Further federal actions, including support for demonstration programs, and supporting policies to achieve reductions from sources under federal and international regulatory authority.

The specific combination of approaches to achieve reductions under the further deployment measure concepts will vary by source sector and the timing of needed reductions. ARB and South Coast staff have collaborated to develop an illustrative pathway for each sector outlining the scope of cleaner technology required as well as a suite of implementation tools and recommended actions to be implemented by both agencies, as well as U.S. EPA. These pathways are described as part of the measure concept write-ups contained in subsequent chapters.

The 2023 timeframe is short, which will require a primary focus on incentive funding to achieve the majority of the emission reductions. Over the next few months, ARB will be working with South Coast to identify the needed resources and potential funding strategies. These efforts will also need to ensure that investments for 2023 are supportive of technology pathways for 2031. The pathways reflect an initial starting point, recognizing that as funding is realized and specific projects implemented, and as advanced technologies further develop, the actual emission reductions achieved through some of these pathway actions may change. The Clean Air Act includes a provision for approval under Section 182(e)(5) to allow this future flexibility.

In conjunction with these measure concepts, the South Coast will also be identifying mechanisms under its local authority to achieve additional emission reductions from mobile sources within the region. These efforts will complement ARB's Statewide actions, and will be included in the District's AQMP.

Table 4-1 shows the ARB measure concepts that provide specific reductions needed as part of the SIP for the South Coast. The table includes the implementing agency, the date by which actions will be proposed (i.e. propose a regulation to the Board, disperse funding, or petition U.S. EPA for action), and the expected first year of implementation.

Table 4-1: Potential SIP Measure Concepts and Schedule

Measure Concepts	Agency	Action	Implementation Begins
On-Road Light-Duty			
Advanced Clean Cars 2	ARB	2020	2026
In-Use Performance Assessment	ARB / BAR	n/a	ongoing
Further Deployment of Cleaner Technologies	ARB / SCAQMD	ongoing	2016
On-Road Heavy-Duty			
Lower In-Use Emission Performance Level	ARB	2018	2021
Low-NOx Engine Standard – California Action	ARB	2017 - 2019	2023
Low-NOx Engine Standard – Federal Action	U.S. EPA	2017 - 2019	2024 <i>(no later than)</i>
Heavy-Duty GHG Phase II	U.S. EPA	2016 - 2017	2021
Advanced Clean Transit	ARB	2016	2018
Last Mile Delivery	ARB	2017	2020
Innovative Technology Certification Flexibility	ARB	2016	2016
Zero Emission Airport Shuttle Buses	ARB	2017 - 2018	2020
Incentive Funding to Achieve Further Emission Reductions from On-Road Heavy-Duty Vehicles	ARB / SCAQMD	ongoing	2016
Further Deployment of Cleaner Technologies	ARB / SCAQMD	ongoing	2016
Off-Road Federal and International Sources			
Tier 5 National Locomotive Emissions Standards	U.S. EPA	2018	2025
Amend Definition of New Locomotive Engine	ARB / U.S. EPA	2017	--
Regulation of Non-New Locomotives	ARB / U.S. EPA	2018	2022
Tier 4 Vessel Standards	ARB / IMO	2015 - 2025	2025
Incentivize Super Low Emission Efficient Ship Visits	ARB	2016	2018
At-Berth Regulation Amendments	ARB	2016	2022
Further Deployment of Cleaner Technologies	ARB / SCAQMD / U.S. EPA	ongoing	2016
Off-Road Equipment Sources			
Zero Emission Off-Road Forklift Regulation Phase 1	ARB	2020	2023
Zero Emission Off-Road Emission Reduction Assessment	ARB	2025	--
Zero Emission Off-Road Worksite Emission Reduction Assessment	ARB	tbd	--
Zero Emission Airport Ground Support Equipment	ARB	tbd	2020 +
Small Off-Road Engines	ARB	2018	2022
Transport Refrigeration Units Used for Cold Storage	ARB	2017	2020
Low-NOx, Low-PM, Low Carbon Intensity Diesel Requirement	ARB	by 2020	2023
Further Deployment of Cleaner Technologies	ARB / SCAQMD	ongoing	2016

Emission Reductions from the Measure Concepts

As discussed in Chapter 2, preliminary modeling indicates that total NOx emissions from all sources in the South Coast will need to decrease to approximately 150 tpd by 2023 and approximately 100 tpd by 2031 to meet ozone attainment dates.¹⁶ The strategy described in this document is designed to achieve the mobile source sector's equal share of the overall reductions needed from today's levels.

Most of the necessary reductions will come from the existing control program, which is projected to provide approximately 60 to 70 percent of the overall reductions. Achieving the benefits projected from the current control program will continue to require significant efforts for implementation and enforcement and thus represents a key element of the overall strategy. The proposed measure concepts provide the remaining reductions needed beyond those occurring from existing programs. Together, as shown in Table 4-2, these efforts are designed to achieve 284 tons per day of NOx reductions by 2023, increasing to 326 tons per day by 2031. The total amount of emission reductions needed to demonstrate attainment will be revised as necessary once final air quality modeling is completed.

Table 4-2: South Coast Mobile Source Emission Reductions

(NOx emission reductions in tons per day, from current levels)

	2023		2031	
	Emission Reductions	Percent of Needed Reductions	Emission Reductions	Percent of Needed Reductions
Current Control Programs	176	62%	221	68%
New Measure Concepts	108	38%	105	32%
Total Reductions Needed	284	100%	326	100%

At the end of this Chapter, Table 4-3 outlines preliminary estimates of the NOx emission reductions that will result in the South Coast from a combination of the current control programs along with the new measure concepts summarized by source. These measure concepts represent a 70 percent decrease in total mobile source NOx emissions from today's levels to meet the 80 ppb standard, reaching an 80 percent decrease to meet the 75 ppb standard. As described in Chapter 3, the combination of measure concepts is designed to provide a pathway to attainment of the ozone

¹⁶ These estimates are based on preliminary modeling results, which will continue to be refined over the next few months.

standards, with early deployment of cleaner technologies, primarily through incentive funding, coupled with regulatory efforts to set new engine standards, ensure durability, increase ZEV penetration, and establish cleaner fuel requirements.

Using the light-duty sector as an example, the strategies listed in the table would achieve 65 tpd of NO_x reductions by 2031. Ongoing implementation of existing policies would provide most of the needed reductions, with 47 tpd occurring by 2023. Accelerated deployment of cleaner passenger vehicles would provide an additional 7 tpd of NO_x reductions towards meeting the 80 ppb standard. At the same time, adoption and implementation of an enhanced Advanced Clean Cars regulation would continue to push even greater deployment of ZEV technologies post-2023.

In addition to NO_x reductions, the SIP measure concepts would also provide for reductions in reactive organic gases (ROG), and PM 2.5 emissions in the South Coast. The combination of the current control program and the new measure concepts would provide ROG reductions on the order of 87 tpd in 2023 and 132 tpd in 2031. The current control program contributes the majority of these reductions, representing 80 and 100 tpd reductions in ROG in 2023 and 2031, respectively. These reductions come predominately from light-duty vehicles and off-road equipment. New measure concepts such as the small off-road equipment (SORE) regulation would significantly reduce ROG emissions from lawn and garden equipment.

The current control program is projected to reduce PM 2.5 emissions by 4 tpd in both 2023 and 2031. The strategies listed in the table will also contribute to further PM 2.5 reductions, particularly those measure concepts that reduce diesel PM 2.5 emissions such as the displacement of petroleum-based diesel with renewable clean diesel fuels, as the low-NO_x, low-PM, low carbon intensity diesel measure concept listed in the table will require.

Table 4-3: South Coast NOx Reductions from Measure Concepts

NOx emission reductions in tons per day (tpd) from current levels

Measure Concepts	Agency	80% Reduction 75 ppb Standard (2031)	70% Reduction 80 ppb Standard (2023)
On-Road Light-Duty			
Reductions from Current Control Programs		59	47
Advanced Clean Cars 2	ARB	0.6	-
In-Use Performance Assessment	ARB / BAR	NYQ	NYQ
Further Deployment of Cleaner Technologies	ARB / SCAQMD	5	7
Total Category Reductions		65	54
On-Road Heavy-Duty			
Reductions from Current Control Programs		115	97
Lower In-Use Emission Performance Level	ARB	NYQ	NYQ
Low-NOx Engine Standard – California Action	ARB	7	-
Low-NOx Engine Standard – Federal Action	U.S. EPA	13	-
Heavy-Duty GHG Phase II	U.S. EPA	NYQ	NYQ
Advanced Clean Transit	ARB	0.1	<0.1
Last Mile Delivery	ARB	0.3	<0.1
Innovative Technology Certification Flexibility	ARB	NYQ	NYQ
Zero Emission Airport Shuttle Buses	ARB / SCAQMD	<0.1	<0.1
Incentive Funding to Achieve Further Emission Reductions from Heavy-Duty Vehicles	ARB / SCAQMD	3	3
Further Deployment of Cleaner Technologies	ARB / SCAQMD	11	34
Total Category Reductions		149	134
Off-Road Federal and International Sources*			
Reductions from Current Control Programs		15	9
Tier 5 National Locomotive Emissions Standards	U.S. EPA	0.5	NYQ
Amend Definition of New Locomotive Engine	U.S. EPA	-	-
Regulation of Non-New Locomotives	ARB / U.S. EPA	7	-
Tier 4 Vessel Standards	ARB / IMO	3	-
Incentivize Super Low Emission Efficient Ship Visits	ARB	NYQ	NYQ
At-Berth Regulation Amendments	ARB	1	.5
Further Deployment of Cleaner Technologies	ARB / SCAQMD/ U.S. EPA	38	48
Total Category Reductions		65	58
Off-Road Equipment Sources			
Reductions from Current Control Programs		32	23
Zero Emission Off-Road Forklift Regulation Phase 1	ARB	<0.1	-
Zero Emission Off-Road Emission Reduction Assessment	ARB	NYQ	NYQ
Zero Emission Off-Road Worksite Emission Reduction Assessment	ARB	NYQ	NYQ
Zero Emission Airport Ground Support Equipment	ARB	<0.1	<0.1
Small Off-Road Engines	ARB	3	0.7
Transport Refrigeration Units Used for Cold Storage	ARB	NYQ	NYQ
Low-NOx, Low-PM, Low Carbon Intensity Diesel Requirement	ARB	2	0.6
Further Deployment of Cleaner Technologies	ARB / SCAQMD	10	14
Total Category Reductions		47	38
Total Expected NOx Emission Reductions		326	284

* Quantification of emission reductions are based on current growth forecasts, which are undergoing review.

5. On-Road Light-Duty Sector

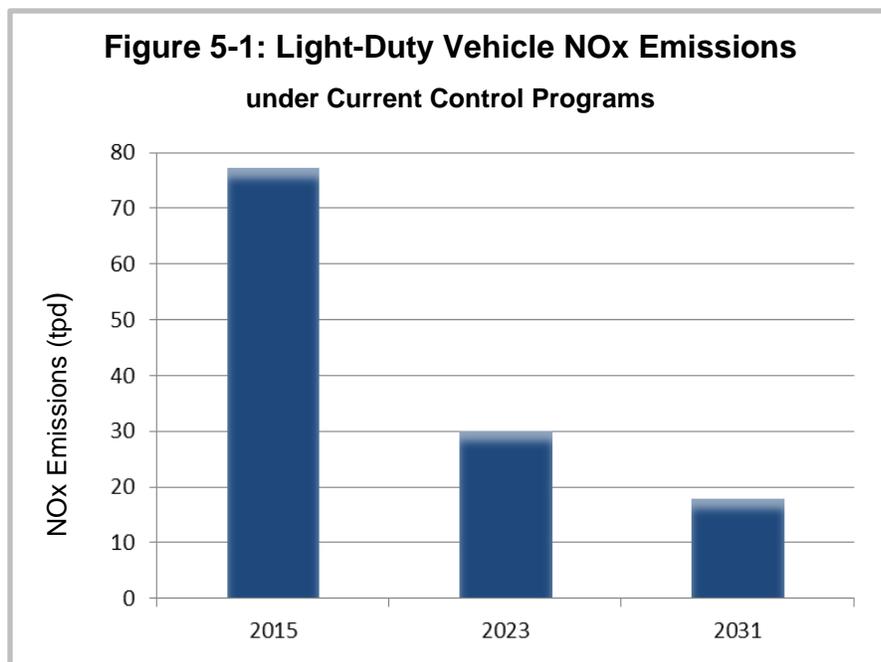
The light-duty transportation sector includes light-duty vehicles (LDVs) such as passenger cars, minivans, most sport utility vehicles and pickup trucks, and motorcycles. Since the 1960's, the Board has been successfully reducing emissions from the light-duty transportation sector through technology forcing emission standards. As a result, LDVs are now 99 percent cleaner than their uncontrolled counterparts. Board action has also successfully brought to market ZEVs and PHEVs. Figure 5-1 highlights the success of these regulations with light-duty vehicle NOx emissions forecasted to decrease by nearly 80 percent from 2015 to 2031 in the South Coast Air Basin.

Current Suite of Programs

In 2012, the Board adopted the Advanced Clean Cars (ACC) rulemaking, which is a suite of regulations that ensure emission reductions from the State's LDV fleet. The ACC brought together three major regulations that were previously separate. Two of these regulations, the LEV III GHG and LEV III criteria emission rules, are fleet average performance standards for new vehicles that provide for continued annual emission reductions as the stringency increases through 2025. These programs apply to the entire light-duty fleet by setting an average emissions requirement across all new vehicles that creates inherent market flexibility for compliance. The third program, the ZEV Regulation, focuses on advanced technology development and fleet penetration of ZEVs and PHEVs. The ZEV regulation ensures that advanced electric drive technology is commercialized and brought to production scale for cost reductions by 2025.

Also in 2012, the Board found federal GHG vehicle standards to be equivalent with California standards, and therefore allowed manufacturers the option to comply with federal standards or with California standards. The Board also agreed to participate in a joint-agency review of the 2022 through 2025 model year standards, commonly referred to as the midterm review, with the National Highway and Traffic Safety Administration and U.S. EPA. In addition to participation in the joint-agency review of the GHG standards, the Board directed staff to review the feasibility of accelerating the LEV III regulation's 1 milligram per mile particulate matter standards. Staff will present the findings of the midterm review to the Board in 2016, and will conduct a subsequent rulemaking to modify the standards if necessary. The midterm review provides the Board an opportunity to reaffirm the importance of the ZEV program with sufficient lead time that any necessary adjustments, including the possibility of increasing the standards, will be possible by the 2022 model year. The findings of the midterm review

will also play a role in informing future light-duty vehicle standards beyond 2025.



It can take decades for a new propulsion system to capture a large fraction of the LDV fleet because new technologies require time for vehicle manufacturers to incorporate them into numerous vehicle models with consumer acceptance. Once new technologies are widely available, it can take

over 15 years for these new vehicle models to fully replace existing vehicles in the fleet with natural turnover. Further, ZEV technology consumer acceptance is also a function of vehicle range, access to widespread infrastructure throughout the operating life of the vehicle, and driver behavior to charge the vehicle.

Therefore, incentive programs have been essential in facilitating the light-duty fleet transition to zero and near-zero emissions technologies. ARB's Air Quality Improvement Program (AQIP), is a voluntary incentive program to fund clean vehicle and equipment projects. Started in 2009, the Clean Vehicle Rebate Project is one of the current projects under AQIP, and is designed to accelerate widespread commercialization of ZEVs and plug-in hybrid electric vehicles by providing consumer rebates to partially offset the higher cost of these advanced technologies. Similarly, the Enhanced Fleet Modernization Program (EFMP) and EFMP Plus-Up programs provide funding to low-income consumers to remove older light-duty vehicles from the fleet and

replace them with cleaner alternatives. Federal incentives also exist to provide additional financial assistance.

In addition to vehicle policies and programs that expand ZEV sales, emission reductions from ZEVs are influenced by fuel-related government actions, including fuel supply policies that require a reduction in carbon intensity and/or use of renewable feedstock. Complementary policies such as ARB's Low Carbon Fuel Standard and the Public Utilities Commission's (PUC) Renewable Portfolio Standard play a critical role in ensuring that total emissions from ZEVs remain substantially cleaner than conventional vehicles. Public incentives and planning support have also been instrumental in developing and expanding advanced renewable fuel distribution networks throughout the State, including electric charging equipment and hydrogen stations.

To further foster the commercialization of ZEVs and PHEVs, automotive manufacturers have partnered with energy providers, government, and non-governmental organizations to jointly address market barriers and gaps through public-private partnerships such as the California Plug-in Electric Vehicle Collaborative and the California Fuel Cell Partnership. Collaboration between members has resulted in the development of infrastructure best practices, local government guidance and support, public messaging and outreach, and collective engagement with standards setting organizations.

The Importance of ZEVs

The updated Vision 2 analysis shows the vast majority of the on-road fleet must be ZEVs and PHEVs by 2050 in order to meet GHG targets, requiring sales to achieve nearly 100 percent ZEVs (BEVs, FCVs, and PHEVs combined) by that point. All scenario iterations explored by ARB show this consistent trend, though the mix of electric vehicle technology types may vary. Pure ZEV technology will be necessary well beyond the ZEV regulation levels in 2025. Plug-in hybrid electric vehicles could also comprise a large fraction of the fleet so long as the fraction of their mileage that is electric remains high throughout their lifespan.

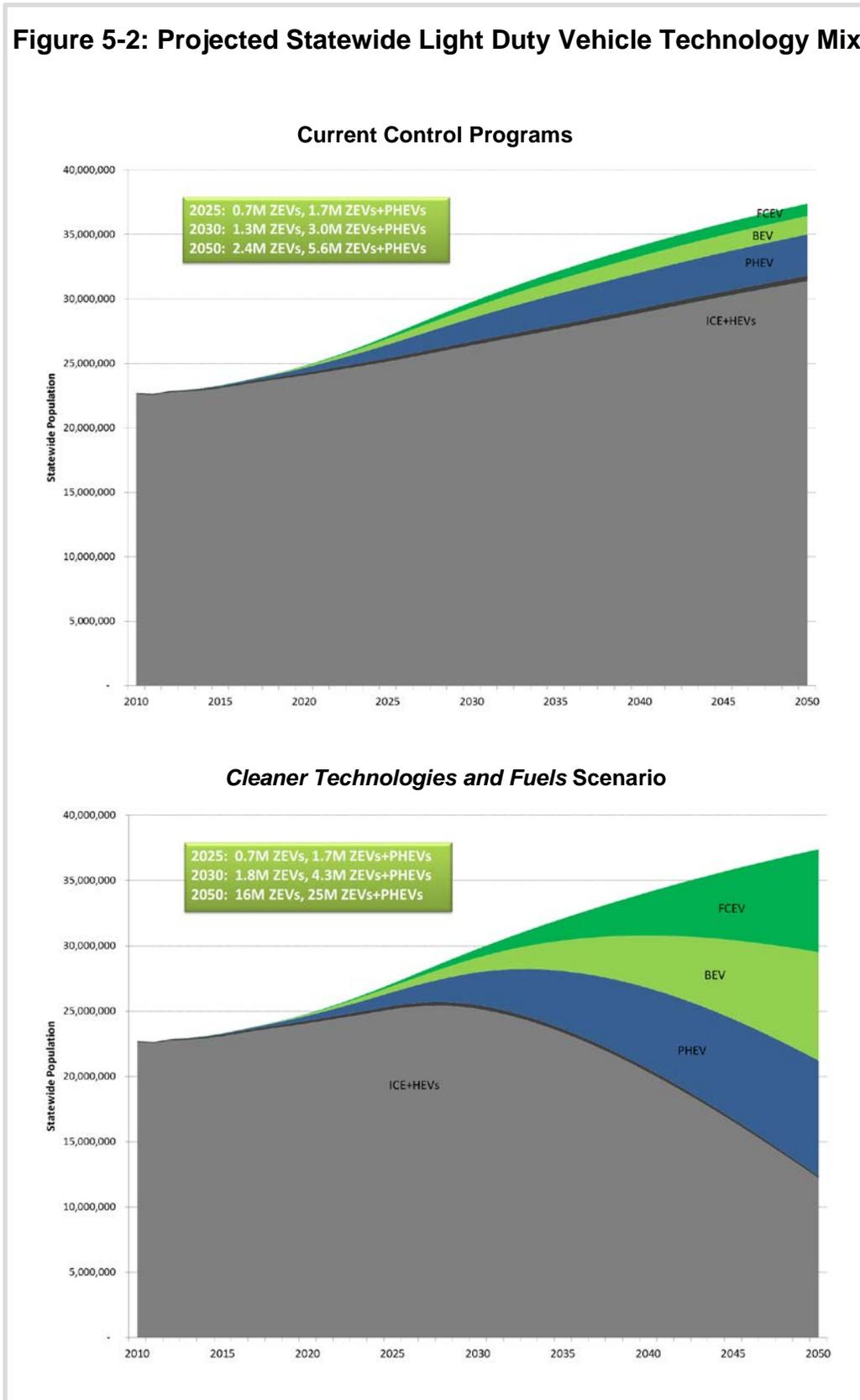
The *Cleaner Technology and Fuels* scenario described in Chapter 3 was developed with a few key themes in mind: the need for zero-emission technology development, the limit on renewable fuels available to meet GHG targets, and the current state of technology development in the light duty sector. Given these themes, staff's *Cleaner Technology and Fuels* scenario focused on the deployment of ZEV technologies over near-zero emission technologies. As shown in Figure 5-2, the Advanced Clean Car Regulation will result in 3.0 million combined ZEVs and PHEVs Statewide in 2030, and increasing to 5.6 million in 2050.

As a sensitivity case, staff also ran a scenario which relied predominantly on PHEVs instead of ZEVs. In this case ZEV sales were flat-lined from the Advanced Clean Car Regulation post-2025 and PHEV sales were increased until the fuel consumption

matched that achieved in the *Cleaner Technology and Fuels* case, which, as discussed in Chapter 3, met the interim 2030 GHG, 2050 GHG, and the petroleum reduction targets for on-road vehicles. To achieve this same level of fuel consumption, PHEV sales ramped up to 70 percent by 2030. However, even ramping up sales to 100 percent by 2035 did not achieve the necessary petroleum reductions by 2050 seen in the *Cleaner Technology and Fuels* scenario. Near-zero technologies such as PHEVs can play a role in achieving our air quality and climate goals, but alone are not sufficient to meeting them especially in 2050.

As ZEV and PHEV sales increase, emission benefits associated with those vehicles are included as part of the fleet-wide performance standards. For this reason, it is important to continue to maintain a strong ZEV regulation in order to commercialize the technology, and couple that with fleet performance standards to ensure sufficient levels of penetration of vehicles operating on the new technology.

Figure 5-2: Projected Statewide Light Duty Vehicle Technology Mix



Light Duty Proposed Measure Concepts

These measure concepts reflect the current status of the light-duty fleet, and recognize that much of the necessary zero emission technology has been developed and is currently commercially available for light-duty vehicles. Multiple car manufacturers offer passenger BEVs, FCEVs, and PHEVs with a large portion operating in an “all-electric range” that provide NOx and GHG emission reductions compared with conventional internal combustion vehicles.

Measure concepts include requirements for further emission reductions from advanced gasoline vehicles and requirements to accelerate the deployment of ZEVs and PHEVs to encourage more widespread penetration. Measure concepts also focus on supporting penetration of these vehicle technologies through incentive programs, which help to ensure that ZEVs and PHEVs are priced competitively relative to conventional vehicles. Other aspects address non-financial considerations, such as consumer preference for greater range and expanded refueling infrastructure to increase the convenience of refueling ZEVs and PHEVs. Finally, the on-board diagnostics assessment measure concepts will help to ensure that vehicles are operating at intended emission levels throughout their useful life.

Measure Title: Advanced Clean Cars 2

Measure Overview:

The goal of this measure concept is to make sure that zero- and near-zero emission technology options continue to be commercially available, with range improvements to address consumer preferences for greater ease of use. ARB would consider expanded California-specific standards for new light-duty vehicles to increase the number of new ZEVs and PHEVs sold in California and increase the stringency of fleet-wide emission standards.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: By 2020

Implementation schedule: 2026 – 2030 or 2035

Description of Measure and Commitment:

To further reduce new vehicle emissions in the LDV sector, ARB would consider expanded California-specific standards for new light-duty vehicles, building upon the technology and market assessments for advanced technology vehicles. The regulation may include lowering fleet emissions further beyond the super-ultra-low-emission vehicle standard for the entire light-duty fleet through at least the 2030 model year, and look at ways to improve real world emissions through implementation programs. Additionally, new standards would be considered to further increase the sales of ZEVs and PHEVs beyond the levels required in 2025 to ensure future emission reduction, climate, and petroleum targets are met.

Measure Title: Lower In-Use Emission Performance Assessment

Measure Overview:

The goal of this measure concept is to ensure that in-use vehicles continue to operate at their cleanest possible level. This is an ongoing further study measure focused on in-use performance and diagnostic inspection procedures.

Type of Action:

ARB and Bureau of Automotive Repair (BAR) assessment

Timeframe:

ARB Board adoption date: N/A
Implementation schedule: Ongoing

Description of Measure and Commitment:

This measure concept would evaluate California's in-use performance-focused inspection procedures and, if necessary, make improvements to further the program's effectiveness. ARB will conduct a study to further evaluate California's in-use performance inspection procedures through analysis of the Smog Check database and vehicle sampling obtained through BAR's Random Roadside Inspection Program. Comparison of test results from the fleet at the time Smog Check inspections take place with roadside inspections conducted at random times in between Smog Check inspections will allow for analysis of Smog Check station performance, repair durability, the real-world performance of in-use performance systems in detecting emission-related problems, and other factors that impact the emission benefits provided by the program. Further investigation and analysis of in-use vehicles at the ARB Haagen-Smit Laboratory will be conducted as needed based on the preliminary findings of the roadside data. Results from the study can be used to improve inspection test procedures, address program fraud, improve the effectiveness and durability of emission-related repair work, and to improve the regulations governing the design of in-use performance systems on motor vehicles to the extent necessary.

Measure Title: Further Deployment of Cleaner Technology: On-Road Light-Duty Vehicles

Measure Overview:

The goals of this measure concept are to accelerate the penetration of zero and near-zero emission vehicles and to promote in-use efficiency gains related to vehicle miles travelled (VMT), and through use of autonomous vehicles and advanced transportation systems.

Type of Action:

ARB and South Coast funding programs, efficiency strategies, advanced transportation systems

Timeframe:

Implementation schedule: 2016 - 2031

Description of Measure and Proposed Pathway:

This measure concept is designed to achieve further emission reductions for South Coast attainment in 2023 and 2031 through a suite of additional actions, including early penetration of zero and near-zero technologies, and emission benefits associated with increased transportation efficiencies, as well as the potential for autonomous vehicles and advanced transportation systems. The emission reductions will be achieved through a combination of actions to be undertaken by both ARB and the SCAQMD. These actions reflect an initial assessment of a pathway, recognizing that as funding is allocated and advanced technologies further develop, the balance amongst approaches will necessarily adjust.

Scope of Technology Penetration and Mechanisms to Achieve Reductions:

The Advanced Clean Cars regulation brings together a suite of regulations, including the LEV III standards and the ZEV regulation. To achieve the further reductions associated with early penetration of the zero- and near- zero vehicle technologies established under this regulation, ARB and South Coast staff estimate that approximately 500,000 to 600,000 passenger cars and trucks would need to be turned over to a model year vehicle meeting the currently applicable LEV III emissions standard or advanced hybrid or zero emission technology by 2023. The following mechanisms provide a pathway for achieving this scale of technology deployment:

- Expand and enhance existing incentive and other innovative funding programs for light-duty vehicles in order to accelerate the

(Continued on next page)

Measure Title: Further Deployment of Cleaner Technology: On-Road Light-Duty Vehicles

(Continued from prior page)

turn-over of older vehicles with replacement to vehicles meeting a LEV III or better emissions level. Assuming incentive funding is the primary mechanism to achieve the scope of further technology deployment described above, funding would be required for approximately 70,000 to 85,000 vehicles per year over a seven year period. The incentive funding required for this effort would go beyond the amount currently authorized for existing programs through 2023. This effort could expand upon the current EFMP and EFMP Plus-Up, and include increasing the use of these vehicles in underserved communities and by lower-income consumers. Continued incentive funding post-2023 to further accelerate the deployment of zero emission vehicles would provide additional reductions for 2031.

Determination of the needed resources will be based on assessment of the incremental cost of technologies and the type of funding mechanism employed. Funding needs and mechanisms will be identified working in collaboration with the South Coast District and other State agencies over the next several months.

- Continue to support infrastructure investment programs with the California Energy Commission (CEC) to maximize the use of electric vehicles through expanding charging and hydrogen networks.

Additional mechanisms reflect reductions achieved through reducing growth in VMT as well as through intelligent transportation systems. While these approaches have the greatest potential to provide further reductions post-2023, early advances in these areas could offset some of the reductions required through incentive funding. These additional pathway mechanisms include:

- Reducing growth in passenger vehicle VMT. Local planning jurisdictions are implementing strategies to create more sustainable communities and integrate transportation and land use planning. These efforts to increase mobility choices and focus growth within existing urban boundaries provide a more efficient passenger transportation system that reduces VMT. The SB 375

(Continued on next page)

Measure Title: Further Deployment of Cleaner Technology: On-Road Light-Duty Vehicles

(Continued from prior page)

Sustainable Communities and Climate Protection Act serves as a mechanism for implementation of efforts to reduce growth in passenger vehicle VMT.

- Advances in the development of autonomous and connected vehicles. These changes in how the on-road light duty sector would operate offer the potential to achieve criteria and GHG emission reductions, but could also reduce VMT and congestion as well as petroleum usage. These concepts are based on emerging technologies and will require significant exploration and demonstration, but also offer synergies in a continued transition to zero emission vehicle technologies.

Implementation Milestones and Schedule		
Proposed Strategy	Implementation Steps	Date
Identify and secure funding for incentive based and other innovative funding programs for accelerated turn-over of zero and near-zero passenger cars and trucks	<i>Phase 1:</i> Identify funding needs and potential sources	} 2015+ (annually)
	<i>Phase 2:</i> Pursue actions to secure funding	
	<i>Phase 3:</i> Implement funding/incentive programs	
Evaluate potential emission benefits from VMT reductions and autonomous vehicles and quantify and develop mechanisms to provide SIP reductions as appropriate	<i>Phase 1:</i> Evaluation of approaches and potential for emission reductions	2016 - 2023
	<i>Phase 2:</i> Demonstration of systems	2017 – 2026
	<i>Phase 3:</i> Quantification of emission reductions and mechanisms for incorporating into SIP	2023 – 2027

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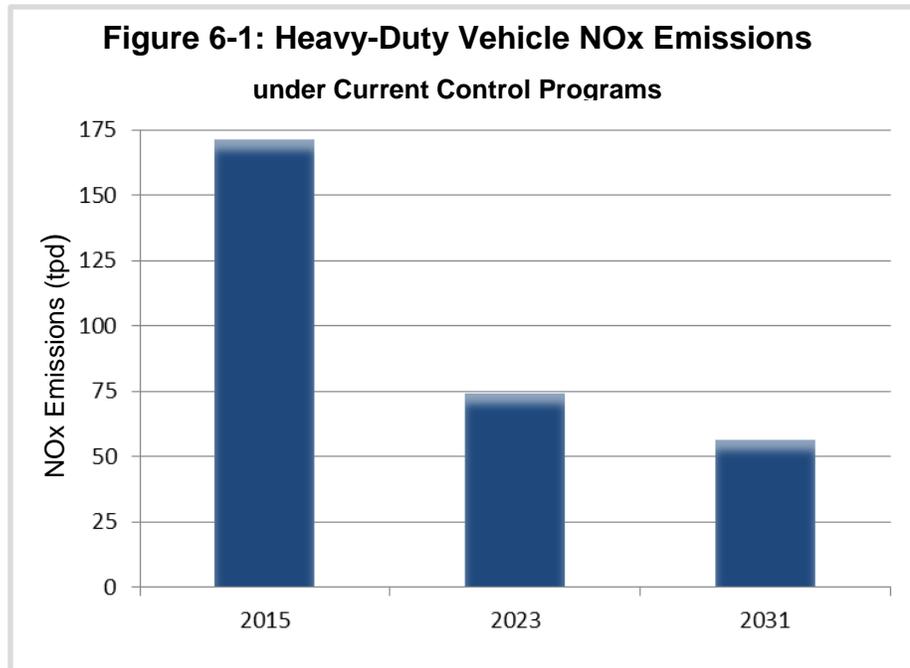
6. On-Road Heavy-Duty Sector

The on-road heavy-duty vehicles category includes heavy-duty gas and diesel trucks, urban and school buses, and motorhomes. The heavy-duty sector is diverse, with many different technologies and approaches that can achieve substantial emission reductions. Heavy-duty trucks that operate in California can travel long distances with about one-third of the trucks originating from out of state. Some trucks, however, are part of captive fleets that operate shorter distances.

Current Suite of Programs

Through ongoing efforts, California has developed the most stringent and successful heavy-duty vehicle emission control program in the world. These regulatory programs include not only requirements for increasingly tighter new engine standards, but also address vehicle idling, certification procedures, on-board diagnostics, and emission control device verification. Stringent fuel requirements further ensure that diesel engines are operating as cleanly as possible. ARB has also adopted in-use requirements that provide substantial further reductions. Most recently, ARB adopted optional low-NO_x emission standards that establish a certification pathway for a new generation of requirements for heavy-duty engines that are between 50 percent and 90 percent lower than current model year 2010 engine standards. As a result, California's heavy-duty fleets have made substantial investments over the past decade to adopt modern, lower-emitting vehicles and equipment. Figure 6-1 highlights the success of ARB regulations with heavy-duty vehicle NO_x emissions being reduced nearly 70 percent from 2015 to 2031.

Key regulations achieving these reductions include the Truck and Bus Regulation, the Heavy-Duty Tractor-Trailer Greenhouse Gas Regulation, and the Drayage Regulation. Adopted in 2008, the Truck and Bus Regulation impacts approximately 1 million inter- and intra-state vehicles, and requires privately and federally owned diesel fueled trucks



and buses and privately and publicly owned school buses to fully upgrade to newer, cleaner engines by 2023. The Heavy-Duty Tractor-Trailer Greenhouse Gas Regulation was adopted in 2008 to reduce greenhouse gas emissions by improving fuel efficiency of heavy-duty tractors that pull 53-foot or longer box-type trailers. An increase in fuel efficiency is achieved through improvements in tractor and trailer aerodynamics and the use of low rolling resistance tires. In addition to emission reductions, the Tractor-Trailer Greenhouse Gas Regulation has resulted in a reduction in fuel consumption and cost savings for truckers and trucking companies. Additionally, in 2007 ARB adopted the Drayage Truck Regulation in order to accelerate PM and NOx emission reductions and the associated community health risk from diesel fueled engines involved in moving goods into and out of California’s ports and railyards.

Incentive programs promote the purchase of cleaner vehicles and equipment, assist truck owners with the cost of upgrading their vehicles, and increase development and deployment of cleaner and advanced zero-emission technologies. These programs include the Carl Moyer Program, the Low Carbon Transportation and AQIP, the Loan Incentives Program, and the Proposition 1B Program. The Carl Moyer Program provides about \$60 million in grant funding annually through local air districts for cleaner-than-required engines and equipment. The Low Carbon Transportation and AQIP provide incentive funding to reduce greenhouse gas emissions, criteria pollutants, and air toxics from mobile sources through the development and use of advanced technology and clean transportation. The Governor’s proposed Fiscal Year 2015-16 State Budget includes \$350 million for Low Carbon Transportation investments. Considered separately from Low Carbon Transportation investments, the Legislature has already appropriated \$23 million for AQIP projects in the Fiscal Year 2015-16 State Budget. The Loan Incentives Program was given a one-time appropriation of approximately \$35 million in Fiscal Year 2008-09 to implement a heavy-duty loan

program that assists on-road fleets affected by the Truck and Bus Regulation and the Heavy-Duty Tractor-Trailer Greenhouse Gas Regulation. In addition to these programs, the Proposition 1B: Goods Movement Emission Reduction Program provides incentives to owners of equipment used in freight movement to upgrade to cleaner technologies sooner than required by law or regulation. Voters approved \$1 billion in total funding for the air quality element of the Proposition 1B program to complement \$2 billion in freight infrastructure funding under the same ballot initiative. ARB has awarded \$740 million to date, and has paid about \$719 million.

In order to meet our air quality goals and GHG emission and petroleum use reduction targets, the on-road heavy-duty sector must transition to near-zero emission technology coupled with advanced renewable fuels, and zero emission vehicles and equipment where available.

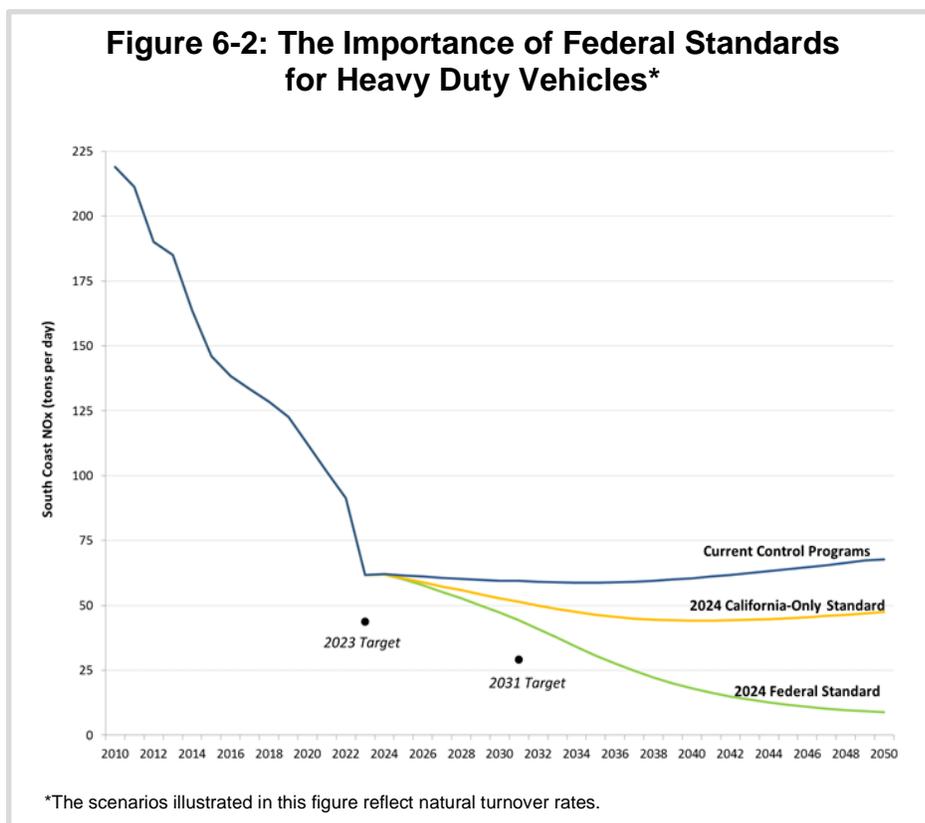
The Importance of the Federal Low-NOx Standard

Because out-of-state heavy-duty vehicles operating in South Coast are not covered by California standards, timely federal action to implement a national low-NOx performance standard is necessary to achieve an in-use fleet average that provides the emission reductions from heavy-duty trucks needed for ozone attainment. If U.S. EPA does not act at all, a California-only performance level would reduce NOx emissions, but not sufficiently enough to attain federal air quality standards.

ARB's Truck and Bus Regulation will ensure that nearly every heavy-duty vehicle operated in California by 2023 will meet 2010 heavy-duty engine emission standards, but even a highly aggressive full-fleet penetration of 2010-compliant engines would not provide sufficient NOx reductions to attain the federal ozone standard in the timeframe required. This drives the need for progressively more stringent heavy-duty engine NOx emission standards. The measure concepts outlined in this document call for U.S. EPA to develop a national low-NOx standard. Due to the preponderance of interstate trucking's contribution to in-state VMT, federal action would be far more effective at reducing in-state emissions than a California-only standard. However, California is prepared to develop a California-only standard, if needed, to meet federal attainment targets.

Timely action is also important. While the *Cleaner Technology and Fuels* scenario discussed in Chapter 3 assumed U.S. EPA action by 2024, delaying implementation until 2027 would result in a significant loss in overall emission benefits.

Figure 6-2 illustrates the need for federal action and shows the benefits associated with federal action in 2024, as assumed in the *Cleaner Technology and Fuels* case in green, versus the benefits of a California only measure concept, shown in yellow.



U.S. EPA is also expected to finalize a lower 8-hour ozone standard in October of 2015. New non-attainment areas will likely need strategies that reduce NOx emissions in order to meet attainment deadlines. California has the authority to set emission standards as long as the standards meet or exceed any federal emissions regulations and U.S. EPA grants a waiver for California to implement the standards. In addition, Section 177

of the Clean Air Act allows other states to adopt California’s standards in lieu of federal standards without U.S. EPA approval. This would allow other states to adopt a lower California NOx standard ahead of federal implementation if U.S. EPA does not act in a timely manner, or in lieu of the current standards if U.S. EPA fails to act, in order to meet attainment deadlines.

There have been past successes with other states adopting California emission standards in order to meet their specific air quality needs. During ARB’s California Phase 2 Symposium held on April 22, 2015, Paul Miller, from the Northeast States for Coordinated Air Use Management (NESCAUM), presented on other states’ positive experience adopting California’s mobile source programs¹⁷. According to NESCAUM, it is evident that there is a continued need for cleaner heavy-duty vehicles in other states in order for GHG and NOx standards to be met. NESCAUM believes that some states

¹⁷ Miller, Paul J. “States’ Experience and Perspectives with CA Mobile Source Programs”. Northeast States for Coordinated Air Use Management (NESCAUM). South Coast Air Quality Management District Headquarters, Diamond Bar, CA. 22 April 2015. Symposium Presentation.

may consider adopting California's optional low NOx engine standards if future federal action is insufficient to meet their air quality needs. Given past trends and successes, there is a great possibility of other states following California's lead and adopting lower heavy-duty engine emission standards. This could result in emission reductions from a portion of out-of-state vehicles operating in California if new lower national NOx standards are not in place.

Role of Low-NOx Truck Strategy

The truck technology attainment pathway described in Chapter 3 met the NOx emission reductions targets for 2031 ozone attainment in the South Coast and the 2030 GHG emissions and petroleum reductions targets statewide. Based on ARB staff's technology assessment, the most viable approach to meeting the 2031 and 2030 goals is low-NOx trucks. The pathway therefore assumed approximately 400,000 internal combustion trucks with NOx emissions 90 percent cleaner than today's standards and equipped with highly efficient particulate filters would be required. To meet the GHG emissions and the petroleum use reductions targets it was further assumed that approximately 55 percent of the truck fuel demand is met with renewable fuel. Staff also evaluated the population of zero-emission trucks that would be necessary to achieve an equivalent reduction, which would represent approximately 350,000 vehicles.

Low-NOx natural gas engines in some engine sizes, such as the Cummins 8.9 liter natural gas engine, are already certified to the optional 0.02 g/bhp-hr standard and are now becoming available, with other engine sizes meeting this same standard expected within the next several years, while low-NOx diesel engines certified to the optional standard of either 0.05 or 0.1 g/bhp-hr could also be available in the next several years. In contrast, deployment of 350,000 electric trucks over the next 15 years would require technology development and cost that are well beyond what will be needed to deploy low-NOx trucks. Still, zero-emissions trucks will be an important part of California's strategy to meet its long-term environmental goals. Therefore, the strategy also focuses on expanding the use of ZEV technologies in lighter heavy-duty trucks and in applications where commercial products are feasible and commercially available, such as last mile delivery and zero-emission transit buses.

A low-NOx pathway will also provide broad health benefits at both the regional and community level. Exposure to PM 2.5 and ozone are associated with premature death, increased hospitalizations and emergency room visits for exacerbation of chronic heart and lung diseases, and other serious health impacts. The available evidence indicates that PM 2.5 is responsible for the largest share of the air pollution-related health burden and that all PM 2.5 sources—both those that directly emit PM and those that lead to the formation of secondary constituents such as nitrates, sulfates, and organics—have similar potency on a mass basis. Nitrates formed from NOx emissions are the largest constituent of PM 2.5, representing about half of the total particle mass. Therefore, large-scale deployment over the next 15 years of low-NOx heavy-duty engines for

ozone and PM 2.5 attainment, combined with particulate filters to reduce direct particle emissions, will provide the largest health benefit of any single new strategy.

At the same time, near-term focused electrification and progress toward zero emission is critical to address the remaining localized risks of cancer and other adverse effects near major freight hubs. New health science tells us that infants and children are 1.5 to 3 times more sensitive to the harmful effects of exposure to air toxics, such as those emitted from freight equipment, than we previously understood, which heightens the need for further risk reduction. Governor Brown recently directed the California State Transportation Agency, the California Environmental Protection Agency, and the Resources Agency to develop a California Sustainable Freight Action Plan. That plan will include actions by all three agencies to reduce risk near freight hubs in the near term, drawing from existing State agency strategies including ARB's *Sustainable Freight Pathways to Zero and Near-Zero Emissions Discussion Document*.

On-Road Heavy Duty Proposed Measure Concepts

Measure concepts presented in this discussion draft will build on past successes to further reduce combustion emissions from engines and vehicles, and to quickly deploy currently available near-zero emission technologies, including low-NOx engines powered with renewable fuels. As vehicles purchased out-of-state account for a majority of the heavy-duty vehicle miles travelled in the South Coast on any given day, ARB will develop new heavy-duty diesel engine emission standards, while simultaneously petitioning U.S. EPA to establish a national standard, in order to achieve emission reductions from vehicles operating in California that were purchased in a different state. A lower NOx standard that reduces emissions from all trucks operating in California is critical to meeting 2031 air quality goals. Substantial future emission reductions can also be achieved through system and operational efficiency improvements to conventional technologies through measure concepts supporting advanced combustion, aerodynamics, hybridization, and connected vehicle technologies.

To keep pace with achieving long-term, zero emission goals, measure concepts will focus on expanding the use of ZEV technologies in lighter heavy-duty trucks and in applications where commercial products are feasible and commercially available, such as last mile delivery. Transit buses are one of the first heavy-duty applications where zero emission technologies have been demonstrated and are commercially available. Zero emission transit buses are primed to be one of the first heavy-duty vehicle types to achieve significant zero-emission vehicle sales volumes, leading and supporting technology development in the heavy-duty sector as a whole. While the development of heavy-duty zero emission technologies is well underway, it lags ZEV development in the light-duty sector; thus the heavy-duty sector has further to go to increase the penetration of zero-emission technologies. Nonetheless, ZEV technologies in heavier applications will benefit from technology migration and cost reductions achieved through

economies of scale, technological innovation, and learning gained along the path to commercialization.

Early investments and incentives that accelerate deployment of zero and near-zero technologies in the heavy-duty sector are essential. Incentive programs have played a vital role in transitioning on-road heavy-duty vehicles and equipment to cleaner technology and they will continue to play a critical role in the success of transitioning the heavy-duty sector to cleaner technology. Incentives will not only encourage increased development and deployment of zero and near-zero emission technologies in heavy-duty applications, they will also help encourage acceptance of new technology with consumers. The vehicles and equipment in heavy-duty sectors have long lifetimes, and many of the engines sold today may still be operating in 2030. Investments that bring the cleanest technologies to market as quickly as possible are essential for achieving near-term criteria pollutant reductions to our air quality and climate goals.

Measure Title: Lower In-Use Emission Performance Level

Measure Overview:

The goals of this measure concept are to ensure that in-use vehicles continue to operate at their cleanest possible level. ARB would develop and propose new, supplemental actions to address in-use compliance and to decrease engine deterioration.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2018
Implementation Schedule: 2021-2026

Description of Measure and Commitment:

ARB would develop new, supplemental actions to address in-use compliance and to decrease engine deterioration. This suite of actions includes: revising the warranty requirements to better reflect the operation of these vehicles; revising ARB's existing Periodic Smoke Inspection Program and Heavy-Duty Vehicle Inspection Program; revising the current opacity limit (i.e., currently 40 percent) to better reflect the capability of current technology (e.g., diesel particulate filters); and developing a "smog check" program for trucks. Other actions include revising the durability demonstration requirements as part of the certification process, redefining the "useful life" definition (consistent with the needed warranty revisions discussed above), and revising the existing not-to-exceed in-use compliance testing protocol, which would give ARB the means to conduct comprehensive in-use compliance testing in a timely, practical, and cost-effective manner. ARB would likely collaborate with several partner states to address the occurrence and frequency of vehicles traveling in California.

Measure Title: Low-NOx Engine Standard

Measure Overview:

The goal of this measure concept is to introduce near-zero emission engine technologies that will substantially lower NOx emissions from on-road heavy-duty vehicles. ARB will develop a heavy-duty low-NOx engine standard in California, and petition U.S. EPA to establish new federal emission standards for heavy-duty engines.

Type of Action:

ARB regulation / ARB petition / U.S. EPA regulation

Timeframe:

ARB Rulemaking:	2017-2019
U.S. EPA Rulemaking:	2017-2019
Implementation Schedule:	California regulation implementation would be from 2023 – 2027; If U.S. EPA establishes a similarly stringent national low-NOx standard, federal implementation should align with California. Under such a scenario, to ensure regulatory consistency, ARB would harmonize with U.S. EPA’s program.

Description of Measure and Commitment:

California Action

ARB will begin development of new heavy-duty low-NOx emission standards in California in 2017 with Board action expected in 2019. ARB will also petition U.S. EPA in 2015 to establish new federal heavy-duty engine emission standards. If U.S. EPA fails to initiate the rule development process by 2017, ARB would continue with its development and implementation efforts to establish a California-only lower NOx standard. If U.S. EPA begins the regulatory development process for new national heavy-duty emission standards by 2017, ARB will coordinate its regulatory development efforts with the federal regulation.

A California-only lower NOx standard would apply to all vehicles with new heavy-duty engines sold in California starting in 2023. As shown earlier in Figure 6-2: *The Importance of Federal Standards for Heavy Duty Vehicles*, because of the dynamics of the heavy-duty market, this approach would not achieve the full benefit of the emission reductions that could be realized through a national program.

(Continued on next page)

Measure Title: Low-NOx Engine Standard

(Continued from prior page)

Federal Action

National lower NOx standards could apply to all new heavy-duty trucks sold nationwide starting in 2023 or later. In order to achieve the maximum emission reductions from this measure concept, a national standard is necessary. This will ensure that all trucks traveling within California would eventually be equipped with an engine meeting the lower NOx standard. Without federal action to implement this emission standard, emission reductions would come mostly from Class 2b-6 vehicles (as most Class 7 and 8 vehicles operating in California were originally purchased outside the State) as a result of California-only ARB regulations.

Measure Title: Heavy-Duty GHG Phase II

Measure Overview:

GHG Phase II will include the next generation of GHG standards to build on Phase I of the GHG regulation. New GHG emissions standards will be adopted in California and nationwide and is expected to take effect with model year 2021 for all new heavy-duty trucks class 2b-8 sold in the nation and model year 2018 for new trailers.

Type of Action:

U.S. EPA regulation

Timeframe:

ARB Board adoption date: 2016 or 2017

Implementation schedule: Implementation will begin with model year 2021 for all new heavy-duty trucks class 2b-8 sold in the nation and model year 2018 for new trailers, and will be fully implemented by model year 2027.

Description of Measure and Commitment:

The federal Phase II program is expected to be adopted in spring of 2016 and to encourage the use of technologies such as aerodynamic features on trucks and tractors, waste heat recovery, and engine and transmission improvements. Phase II is expected to take effect with model year 2021 for all new heavy-duty trucks class 2b-8 sold in the nation and model year 2018 for new trailers, and to be fully phased in by model year 2027.

ARB plans to follow the federal adoption of Phase II with Board action to adopt California Phase II in late 2016 or early 2017. In addition to harmonizing with the federal Phase 2 standards, California may choose to adopt some stricter, California-only provisions that are necessary to meet California's unique air quality challenges. For example, California may layer additional requirements for trailer and vocational vehicle aerodynamics onto the federal Phase II program.

Measure Title: **Advanced Clean Transit**

Measure Overview:

The goal of this measure concept is to increase the penetration of the first wave of zero emission heavy-duty technology into applications that are well suited to its use, and will encourage the greater use of zero emission technologies in heavier applications by demonstrating its viability. ARB would develop and propose an Advanced Clean Transit (ACT) regulation that would require the purchase of zero emission buses for transit agencies with a goal of 100 percent purchase in 2030 and full zero emission transit fleets in 2040.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2016
Implementation schedule: 2018-2040

Description of Measure and Commitment:

ARB would develop and propose an ACT rule amendment with four elements. First, the ACT would require zero emission bus purchases by mandating a modest fraction of bus purchases to be zero emission technology starting in 2018, and set a goal of complete transit fleet transition to zero emission technologies by 2040. Next, the ACT would minimize emissions from the conventional fleet by requiring use of renewable fuels and the cleanest available engines as soon as feasible. Additionally, the ACT would provide regional flexibility for zero emission buses by allowing fleets within a region the option to pool requirements and work together to achieve a zero emission bus fleet. Lastly, the ACT will allow for transit agencies to work with Municipal Planning Organizations (MPOs) to develop and implement plans for increased efficiencies through the use of innovative transit technologies beyond conventional transit operations. This measure concept would advance ZEV commercialization by increasing the penetration of zero emission technologies.

Measure Title: Last Mile Delivery

Measure Overview:

The goal of this measure concept is to increase the penetration of the first wave of zero emission heavy-duty technology into applications that are well suited to using its use, given currently available technology. ARB would develop and propose a Last Mile Delivery regulation that would require the purchase of zero emission trucks for class 3-6 last mile delivery trucks in California.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2017
Implementation schedule: 2020-2050

Description of Measure and Commitment:

The structure of the Last Mile Delivery regulation would be very similar to the Advanced Clean Transit regulation. This regulation would require conventional purchases to be low-NOx engines with renewable fuels if feasible. It would also allow for credits for innovative delivery technologies and approaches. One option for this regulation would be to require that 10 percent of purchases of new last mile delivery trucks are zero emission trucks starting in 2020 and 75 percent of purchases of new last mile delivery trucks are zero emission trucks starting in 2030. Under a less aggressive option, 4 percent of purchases of new last mile delivery trucks must be zero emission trucks starting in 2020 and 40 percent of sale of new last mile delivery trucks must be zero emission trucks starting in 2030.

Measure Title: Innovative Technology Certification Flexibility

Measure Overview:

The goal of this measure concept is to facilitate the penetration of the first wave of zero emission heavy-duty technology by providing regulatory certification flexibility for innovative technologies, which will expand the application of zero emission technologies in heavier applications. ARB would develop and propose an Innovative Technology Certification Flexibility (ITR) regulation that would provide defined, near-term ARB engine and vehicle certification flexibility for medium- and heavy-duty vehicles and engines.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2016
Implementation schedule: 2016 - 2031

Description of Measure and Commitment:

ITR encourages early deployment of the next generation of truck and bus technologies through defined, near-term engine and vehicle certification flexibility for medium- and heavy-duty trucks. This regulation is intended to balance the need to provide key, promising technologies with a defined, predictable, and practical ARB-certification pathway, while preserving ARB's overarching objective to ensure expected emission benefits are achieved in-use. This regulation would also provide the greatest flexibility for potentially transformational engine and vehicle technologies, such as robust hybrids and heavy-duty engines meeting the optional low-NOx standard. The deployment of robust hybrids (including those with zero emission capability) is expected to both yield near-term GHG benefits and facilitate the battery innovation needed to expand the application of zero emission technology.

Accelerated development and deployment of low-NOx heavy-duty engines is critical for California to meet 2031 goals. By enabling early deployment of electric drivelines, low-NOx engines, and other key truck and bus technologies, this regulation would also help lay the foundation for the future technology-advancing regulation(s) needed to meet air quality and climate goals.

Measure Title: Zero Emission Airport Shuttle Buses

Measure Overview:

The goal of this measure concept is to further support market development of zero emission technologies in the heavy-duty sector by utilizing incentive support, memorandums of understanding (MOU), regulations, or a combination of these actions to initiate deployment of zero emission airport shuttle busses.

Type of Action:

ARB regulation, incentives, MOU

Timeframe:

ARB Board adoption date: 2017 - 2018

Implementation schedule: 2020+

Description of Measure and Commitment:

ARB would develop and propose a regulation to deploy zero emission airport shuttles in order to further support market development of zero emission technologies in the heavy-duty sector. Airport passenger shuttles that frequent the airport such as rental car and parking lot shuttles typically operate fixed short routes coupled with stop-and-go operation and low average speeds. As seen in past zero emission bus demonstrations, vehicles that operate on fixed routes, have stop-and-go operation, and maintain low average speeds are ideal candidates for zero emission electric technologies. The current successes of zero emission transit buses can reasonably be translated to airport shuttle buses due to the similarities between these two vehicle types. A near-term strategy to encourage airports to begin purchasing zero emission shuttle buses would introduce these buses into the marketplace, which may result in entire zero emission shuttle bus fleets in the future. Like transit buses, the inclusion of zero emission airport shuttles would serve as a stepping stone to encourage broader deployment of zero emission technologies in the on-road sector. Initially, incentive funding could be used to help defer the higher incremental cost of zero emission airport shuttles as compared to traditionally fueled shuttles. As the capital costs for zero emission technologies decrease due to higher sales volume, implementation of the near-term strategy could occur either by regulation or a memorandum of understanding, or a combination thereof.

Measure Title: Incentive Funding to Achieve Further Emission Reductions from On-Road Heavy-Duty Vehicles

Measure Overview:

The goal of this measure concept is to provide incentive funding to accelerate the penetration of zero and near-zero equipment beyond the rate of natural turnover achieved through implementation of the other measure concepts identified for on-road heavy-duty vehicles.

Type of Action:

Funding programs

Timeframe:

ARB Board adoption date: 2016 and annually thereafter

Implementation schedule: 2016 - 2023

Description of Measure and Commitment:

This measure concept would expand and enhance existing incentive and other innovative funding programs for on-road, heavy-duty vehicles to increase the penetration of and support for deployment of zero and near-zero equipment. Funding mechanisms would target technologies that meet an optional low-NOx standard through 2023, when implementation of a new low-NOx standard will begin and the current round of Moyer funding ends.

Pending annual appropriation by the Legislature and approval by the Board, ARB's Low Carbon Transportation and AQIP funds can be apportioned from 2015 through 2020 with approximately \$7 million per year allocated for low-NOx trucks using renewable fuels in South Coast. Additionally, up to \$28 million per year of District funds from AB 923 and Carl Moyer funds could be allocated for cleaner trucks in the 2015-2020 timeframe. The combination of available State and local funds in this measure concept could potentially achieve between 2.4 to 5.9 tons per day of NOx emission reductions in the short term.

It is important to note that funds under the control of the District may also be used for other applications, including off-road vehicles. Identifying the most effective use of funds in order to maximize emission reductions will depend on the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Accordingly, the use of these funds to maximize emission reductions for 2023 may be further refined.

Measure Title: Further Deployment of Cleaner Technology: On-Road Heavy-Duty Vehicles

Measure Overview:

The goals of this measure concept are to accelerate the penetration of zero and near-zero equipment and to promote in-use efficiency gains through use of connected and autonomous vehicles, telematics, and intelligent transportation systems.

Type of Action:

Funding programs, regulatory approaches, efficiency strategies, intelligent transportation systems

Timeframe:

Implementation schedule: 2016 - 2031

Description of Measure and Proposed Pathway:

This measure concept is designed to achieve further emission reductions for South Coast attainment in 2023 and 2031 through a suite of additional actions, including early penetration of zero and near-zero technologies, emission benefits associated with increased operational efficiency strategies, and the potential for new driver assist and intelligent transportation systems. The emission reductions will be achieved through a combination of actions to be undertaken by both ARB and the South Coast. These actions reflect an initial assessment of a pathway, recognizing that as funding is allocated and advanced technologies further develop, the balance amongst approaches will necessarily adjust.

Scope of Technology Penetration and Mechanisms to Achieve Reductions:

Under current regulations, nearly all heavy-duty trucks must meet 2010 engine standards by 2023, with the exception of very low mileage fleets and public fleets regulated under earlier fleet rule requirements. A key component of the mobile source strategy for heavy-duty vehicles is the adoption of a more stringent engine performance standard reflecting technology that is effectively 90 percent cleaner than today's standards. To achieve the further reductions associated with early penetration of these cleaner heavy-duty technologies, ARB and South Coast staff estimate that by 2023, approximately 100,000 to 150,000 trucks would need to have engine technologies equivalent to emissions represented by a 0.02 g/bhp-hr low-NOx standard. The following mechanisms provide a pathway for achieving this scale of technology deployment:

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Measure Title: Further Deployment of Cleaner Technology: On-Road Heavy-Duty Vehicles

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- Identify and develop regulatory mechanisms that incentivize development of near-zero and zero emission heavy-duty truck deployment. Such actions have been done in the South Coast, including local regulations and the San Pedro Bay Ports Clean Truck Program. These programs have allowed affected fleets to meet requirements through public funding assistance, such as the South Coast SOON program, and fee neutral policies such as the ports Clean Truck Program. The South Coast will include local measures in their AQMP to address heavy-duty vehicles.
- Expand and enhance existing incentive and other innovative funding programs for heavy-duty vehicles to increase the emphasis on and support for purchase of zero and near-zero equipment. Funding mechanisms would target technologies that meet either lower NOx standards, or are hybrid/zero-emission technologies. Assuming incentive funding is the primary mechanism to achieve the scope of further technology deployment described above, funding would be required for approximately 15,000 to 20,000 trucks per year over a seven year period, depending upon the availability of engines certified to ARB's optional low-NOx standards of 0.05 g/bhp-hr and 0.02 g/bhp-hr. The incentive funding required for this effort would go beyond the amount currently authorized for existing programs through 2023. Continued incentive funding post-2023 to further accelerate the deployment of trucks meeting a 0.02 g/bhp-hr standard would provide additional reductions for 2031.

Determination of the needed resources will be based on assessment of the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Funding needs and mechanisms will be identified working in collaboration with the South Coast District and other State agencies over the next several months.

Additional mechanisms reflect continued penetration of zero emission technologies, as well as reductions achieved through intelligent transportation systems and operational efficiencies. While these approaches have the greatest potential to provide further reductions post 2023, early advances in these areas could offset some of the reductions

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Measure Title: Further Deployment of Cleaner Technology: On-Road Heavy-Duty Vehicles

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required through incentive funding. These additional pathway mechanisms include:

- Several individual measure concepts focus on deploying zero emission vehicles in heavier applications that are currently well-suited for broad market development, such as transit buses, airport shuttles, and last mile delivery. Depending upon the success of these applications, and ongoing technology assessment, regulatory mechanisms to require zero emission vehicles in additional applications may be feasible. The greatest opportunities exist for fleets that are captive to the South Coast, and drive shorter distances. This technology assessment is already underway, including a solicitation for a \$25 million demonstration project for zero-emission drayage trucks.
- Advances in the development of autonomous and connected vehicle systems, particularly if based on zero-emission technologies, as well as greater operational efficiencies, and improvements in transportation logistics. These changes in how the heavy-duty truck sector would operate offer the potential to achieve criteria, toxic, and GHG emission reductions, but also reduce VMT and congestion as well as petroleum usage. These concepts are based on emerging technologies, and will require significant exploration and demonstration prior to becoming concepts with quantified emission reductions. Use of existing on-board diagnostic capabilities required on heavy-duty vehicles may enable the assessment of these new opportunities. To promote initial demonstration of these concepts, the FY 15/16 Greenhouse Gas Reduction Fund Funding Plan contains funding eligibility for demonstration projects related to intelligent truck systems and connected vehicles.

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Measure Title: Further Deployment of Cleaner Technology: On-Road Heavy-Duty Vehicles
 (Continued from prior page)

Implementation Milestones and Schedule		
Proposed Strategy	Implementation Steps	Date
Identify and secure funding for incentive based and other innovative funding programs for accelerated deployment of zero and near-zero heavy-duty vehicles	<i>Phase 1:</i> Identify funding needs and potential sources	} 2015 + (annually)
	<i>Phase 2:</i> Pursue actions to secure funding	
	<i>Phase 3:</i> Implement funding/incentive programs	
Develop regulatory strategies for deployment of zero-emission technologies in additional heavy-duty vehicle applications as appropriate	<i>Phase 1:</i> Evaluation of technology and prototype demonstrations	2015 – 2023
	<i>Phase 2:</i> Development of regulatory strategies	2020 - 2023
	<i>Phase 3:</i> Measure implementation	2025 – 2031
Evaluate potential for emission benefits from operational efficiencies and intelligent transportation systems and quantify and develop mechanisms to provide SIP reductions as appropriate	<i>Phase 1:</i> Evaluation of approaches and potential for emission reductions	2016 – 2023
	<i>Phase 2:</i> Demonstration of systems	2020 – 2024
	<i>Phase 3:</i> Quantification of emission reductions and mechanisms for incorporating into SIP	2024 – 2027

7. Off-Road Sector

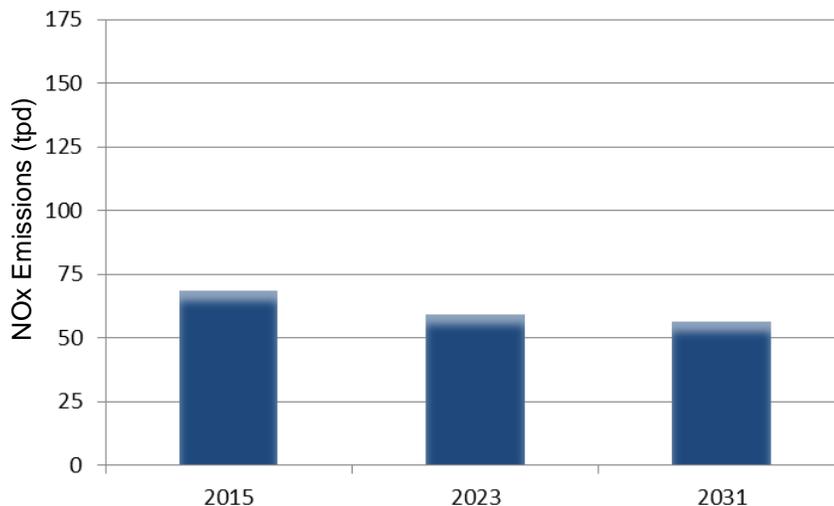
For the purposes of this document, sources in the off-road sector have been grouped into two categories. The federal and international sources category includes emissions associated with ships, locomotives, and aircraft. The other off-road equipment category encompasses lawn and garden equipment, transport refrigeration units, vehicles and equipment used in construction and mining, forklifts, cargo handling equipment, commercial harbor craft, and other industrial equipment.

Off-Road Federal and International Sources Category

Ocean going vessels, locomotives, and aircraft are sources that are primarily regulated by the federal government and international organizations (Figure 7-1). In contrast to the significant NO_x emission reductions in the on-road mobile sector, emission sources in this category are only forecasted to decrease by about 20 percent by 2031. ARB programs contributing to these reductions include efforts focusing on cleaner fuel requirements and use of cleaner locomotives and vessel shore power. For example, in 2007, ARB adopted a regulation to reduce emissions from diesel auxiliary engines while ships were berthing at a California port. ARB also adopted regulations requiring cleaner fuels for ocean going vessels within 24 nautical miles and cleaner diesel fuel requirements for intrastate locomotives. Finally, ARB and the Class I railroads have been implementing a memorandum of understanding to accelerate the introduction of cleaner locomotives in the South Coast since 1998.

ARB has identified a number of actions to achieve further emission reductions from these sources. These include ARB petitions to U.S. EPA to adopt more stringent criteria pollutant and GHG performance standards for locomotives, and to require most non-new locomotives to meet Tier 4 or better emission levels. ARB would also advocate with international partners for new

Figure 7-1: Federal and International Sources NOx Emissions under Current Control Programs



International Maritime Organization Tier 4 standards and efficiency targets. Other measure concepts for oceangoing vessels include development of criteria for and mechanisms to incentivize introduction of Super-Efficient Low Emission Ships, as well as amendments to ARB’s At-Berth regulation to further reduce emissions from vessels at berth. In addition to the measure concept descriptions provided in this Chapter, further detail can be found in the *Sustainable Freight: Pathways to Zero and Near-Zero Discussion Document*.¹⁸

Off-Road Equipment Category

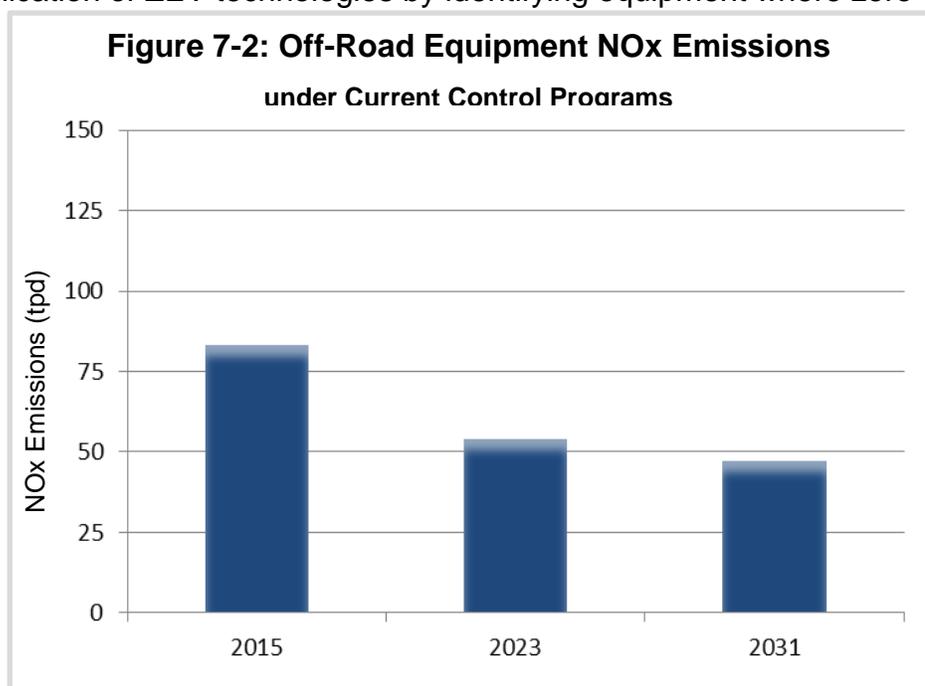
The off-road equipment category includes lawn and garden equipment, transport refrigeration units, vehicles and equipment used in construction and mining, forklifts, cargo handling equipment, commercial harbor craft, and other industrial equipment. Figure 7-2 highlights that NOx emissions from these sources are forecasted to decrease about 40 percent by 2031. These types of sources require a long-term, comprehensive approach to transition to the cleanest possible technologies. ARB has developed a number of regulatory and incentive-based approaches to ensure an ongoing transition to cleaner technologies.

In 2004, ARB adopted a fourth tier of increasingly stringent advanced aftertreatment based PM and NOx standards for new off-road compression-ignition engines. These

¹⁸ *Sustainable Freight: Pathways to Zero and Near-Zero Discussion Document*
<http://www.arb.ca.gov/gmp/sfti/sustainable-freight-pathways-to-zero-and-near-zero-emissions-discussion-document.pdf>

“Tier 4” standards were phased-in across product lines from 2008 through 2015 and reduced exhaust emission levels by up to 95 percent compared to previous control strategies. In 2007, ARB first approved the Off-Road Regulation that requires off-road fleets to reduce their emission by retiring, replacing or repowering older engines. This regulation expanded the penetration of existing clean technology to ensure that the engines and vehicles used today are as clean as possible.

Measure concepts for these sources will focus on deploying zero emission technologies in applications such as battery and fuel cell electric forklifts, where the technology is commercially available. ARB will also continue to review and analyze the status of technologies in order to better understand technology and pathways options, and to integrate emerging worksite efficiencies, vehicle automation, and fleet management technologies. These emission reduction assessments will inform future actions focused on expanding the application of ZEV technologies by identifying equipment where zero emission options are commercially feasible, such as forklifts. These measure concepts include purchase requirements as well as incentives for technology demonstration and deployment to further support market development of zero emission technologies in other off-road applications.



ARB is currently investigating the need for even cleaner new off-road compression ignition engine standards and related requirements. For instance, certain smaller engines do not meet stringent advanced aftertreatment NOx and PM standards. These smaller diesel engines comprise a significant portion of both the new off-road CI engine population and emissions inventory, and more stringent standards may be appropriate if effective emission controls can be demonstrated to be both feasible and cost-effective. ARB is also considering the need to further lower NOx standards for the larger new off-road CI engines similar to the voluntary low-NOx standards recently adopted for on-road CI engines. Another area that warrants consideration is mandatory requirements for the use of diesel particulate filters (DPFs) in off-road engines. Currently, a growing number of off-road engines that were expected to be certified with DPFs are meeting the current standard without them. These engines may have higher in-use PM emissions and elevated emissions of ultrafine particles relative to CI engines that incorporate a DPF.

ARB will continue to review and analyze the status of technologies in order to better understand technology, emission reduction, and pathway options, and use that information to strategically invest and support advanced technology demonstration opportunities to expand and advance the marketplace. In addition, ARB will support the development and deployment of emerging worksite integration and efficiencies, vehicle automation, and fleet management technologies. These measure concepts include incentives for pilot programs and expanding purchase requirements as appropriate to further support market development of zero emission technologies.

Off-Road Federal and International Sources Proposed Measure Concepts

Measure Title: **Tier 5 National Locomotive Emissions Standards**

Measure Overview:

The goal of this measure concept is to reduce NO_x, PM, and GHG emissions from locomotives in order to meet our air quality and climate change goals. ARB would petition U.S. EPA to begin the process of developing new Tier 5 national locomotive emissions standards for criteria and toxic pollutants, and GHG emissions by 2018.

Type of Action:

ARB petition for a federal regulation

Timeframe:

U.S. EPA rulemaking date: 2018
Implementation schedule: 2025 +

Description of Measure and Commitment:

ARB would petition U.S. EPA for new Tier 5 national locomotive emission standards for significant additional reductions in criteria and toxic pollutants and GHG emissions (based on aftertreatment, liquefied natural gas, and/or zero emission track miles). ARB staff estimates that the U.S. EPA could require manufacturers to implement the new locomotive emission regulations by as early as 2025. The proposed U.S. EPA locomotive emission regulations could further reduce emissions from the existing Tier 4 locomotive baseline by over 50 percent with the use of proven locomotive aftertreatment systems, renewable natural gas, hydrogen, or electricity. U.S. EPA could also include provisions with incentives for locomotive manufacturers and railroads to develop and operate locomotives with zero emission track miles for specific nonattainment areas in the country (e.g., South Coast Air Basin) that could provide additional criteria, toxic, and GHG reductions.

Measure Title: Amend Definition of New Locomotive Engine

Measure Overview:

The goal of the measure concept is to narrow the definition of a new locomotive engine under U.S. EPA regulations, which would create an opportunity for California to regulate a greater number of in-use locomotives, consistent with federal law, so that they operate at their cleanest level possible in California. ARB would petition U.S. EPA to amend in 2017 its locomotive emission regulations that define a “new” locomotive engine.

Type of Action:

ARB petition for a federal regulation

Timeframe:

U.S. EPA Rulemaking date: 2017

Implementation schedule: ---

Description of Measure and Commitment:

ARB staff would petition U.S. EPA to amend its locomotive emission regulations. The petition would request that U.S. EPA amend federal emission regulations to define a new locomotive engine as one that is “freshly” manufactured, through the end of a locomotive’s first useful life (typically seven to ten years). It is important that U.S. EPA maintain its existing requirements for remanufactured engines to provide national benefits. Redefining a “new” engine would allow California to regulate the universe of non-new interstate, regional, and switch (yard) locomotives operating within the State, consistent with federal law. This would provide NOx and PM reductions to meet federal air quality standards and cut the health risk in communities near railyards and rail lines.

Measure Title: Regulation of Non-New Locomotives

Measure Overview:

The goal of this measure concept is to provide for upgrades to in-use locomotives to achieve lower NOx, PM, and GHG emissions. ARB would work with U.S. EPA to develop and propose a statewide regulation to require non-new locomotives to maximize the use of Tier 4 or better engines, liquefied natural gas, or zero-emission track miles in line-haul, medium horsepower, and switch locomotives in California.

Type of Action:

U.S. EPA and ARB regulations and incentives
California action contingent upon changes to U.S. EPA definition

Timeframe:

U.S. EPA rulemaking date: 2018
ARB Board adoption date: 2018
Implementation schedule: 2022 - 2030

Description of Measure and Commitment:

ARB staff would work with U.S. EPA to develop and propose a regulation for most non-new locomotives in California to meet Tier 4 or better emission levels between 2022 and 2030. This regulation would provide further NOx and diesel PM emission reductions statewide. This approach would advance both aftertreatment and zero emission locomotive technologies nationally and in California.

Measure Title: Tier 4 Vessel Standards

Measure Overview:

The goal of this measure concept is to reduce emissions from ocean going vessels. ARB would advocate with international partners for the International Maritime Organization to establish new Tier 4 NOx and PM standards, plus efficiency targets for existing vessels in Ship Energy Efficiency Management Plans for International Maritime Organization Action.

Type of Action:

ARB advocacy and international standards

Timeframe:

ARB action:	2015 - 2018
IMO action, ratification, and implementation:	2020 - 2025

Description of Measure and Commitment:

Under this Action, ARB would work with the U.S. EPA, U.S. Coast Guard, and international partners to urge the International Maritime Organization to adopt more stringent emission standards for new ocean-going vessels and efficiency requirements for existing vessels. Specifically, ARB would advocate for a Tier 4 NOx standard for new marine engines on ocean-going vessels and vessel efficiency requirements for the existing in-use fleet.

Additional regulations are necessary because the existing International Maritime Organization marine engine regulations do not include a PM standard, and the Tier III 2016 NOx standard is higher than the NOx standards for other diesel equipment categories. In addition, the International Maritime Organization efficiency standards for existing vessels only require that vessels have a "Ship Energy Efficiency Management Plan." These regulations do not require approval of the plan, tracking of the vessel's progress, or actual improvement in energy efficiency.

Measure Title: Incentivize Super Low Emission Efficient Ship Visits

Measure Overview:

The goal of this measure concept is to achieve early implementation of clean vessel technologies (e.g., liquefied natural gas, Tier 3 standards or better) and incentivize vessels with those technologies in California service. ARB staff would work with California seaports, ocean carriers, and other stakeholders to develop the criteria and to identify the best way to incentivize introduction of Super-Efficient Low Emission Ships into the existing fleet of vessels that visit California seaports.

Type of Action:

Incentive program in partnership with California ports

Timeframe:

ARB Action date:	2016
Implementation schedule:	2018

Description of Measures and Commitment:

Numerous technologies are available that can reduce emissions from ships and improve the efficiency of a vessel. Incentive programs can be leveraged to encourage vessel owners and operators to implement technologies that exceed current regulatory requirements. Under this measure concept, ARB staff would work with California seaports and other stakeholders to develop criteria for a Super-Low Emission Efficient Ship, targeting NO_x, diesel PM, GHG, and sulfur oxide emissions. Incentives to encourage visits from ships meeting the criteria would involve identification of funding sources and implementation mechanisms such as development of new programs, enhancement of existing programs such as the Port of Long Beach Green Flag program and the Port of Los Angeles Environmental Ship Index Incentive Program, or incorporation into existing statewide incentive programs.

Measure Title: At-Berth Regulation Amendments

Measure Overview:

The goal of this measure concept is to further reduce emissions from ships at berth and to advance the commercialization of near-zero and zero emission technologies. ARB staff would develop and propose amendments to the current At-Berth Regulation to include other vessel fleets and types.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2016

Implementation schedule: 2022 - 2032

Description of Measure and Commitment.

In December 2007, ARB approved the Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port Regulation (Regulation). The Regulation was designed to reduce emissions from diesel auxiliary engines on container ships, passenger ships, and refrigerated cargo ships while at berth at California's major seaports. The Regulation is also limited to fleets of 25 or more vessels (five or more for passenger ships).

ARB would investigate whether the Regulation can be amended to include smaller fleets and/or additional vessel types (including roll-on/roll-off vehicle carriers, bulk cargo carriers, and tankers). In addition, there are two companies working on portable systems. One company has successfully demonstrated that its system can provide durable performance and may now be used for compliance with the Regulation on specified vessel types. If one or both systems become commercially available and are cost-effective, the technology could help support an ARB staff proposal to expand the scope of the Regulation to include additional vessel types and/or smaller fleets. ARB staff needs to investigate the feasibility and cost-effectiveness of expanding shore-power or alternative At-Berth technologies to additional vessel fleets and types not currently covered by the existing Regulation.

Measure Title: Further Deployment of Cleaner Technology: Off-Road Federal and International Sources

Measure Overview:

The goals of this measure concept are to increase the penetration of cleaner ocean going vessel, locomotive, and aircraft technologies, and to promote efficiency improvements at the equipment, sector, and systems levels.

Type of Action:

Incentive programs, regulatory approaches, efficiency practices

Timeframe:

Implementation schedule: 2016 - 2031

Description of Measure and Proposed Actions:

This measure concept is designed to achieve further emission reductions for South Coast attainment in 2023 and 2031 through a suite of additional actions, including early penetration of cleaner technologies and emission benefits associated with increased efficiencies.

This category includes a variety of sources that travel both nationally and internationally, including ocean going vessels, locomotives, and aircraft. Under current requirements, new locomotive engines must meet a Tier 4 engine emission standard. Beginning in 2016, new ocean going vessels must meet a Tier 3 standard if the vessel will be calling at marine ports located in an Emissions Control Area such as the North American Emission Control Area. Finally, new certificated aircraft engines must meet Tier 8 (CAEP/8) standards.

While more stringent engine standards have been established for new equipment, existing equipment tends to remain in operation for a long period of time. In addition, these sources are primarily regulated by the federal government and international organizations. As a result, emissions from these categories have not decreased at the same pace as those for other mobile sources. By 2023, ocean going vessel NOx emissions in the South Coast are projected to grow to 23 tons per day. Locomotive emissions will also grow to 23 tons per day, and aircraft emissions will grow to almost 17 tpd. Achieving the magnitude of emission reductions necessary from this category is therefore more difficult, and will require strong action at the federal and international level, coupled with State and local advocacy and action to facilitate these efforts.

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Federal and International Sources

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ARB and South Coast staff have estimated a scope of technology development and penetration as one example pathway of what would be necessary by 2023 and 2031 to achieve equal share reductions from this sector. Achieving equal share reductions would represent a significant expansion of cleaner technology deployment. The time frame to accomplish this is short, the development of cleaner technologies lags behind those for other sectors, and the scope of State and local authority is limited. These issues will need to be considered as the measure concepts are further developed for this SIP. For 2023, this would require: 1) all locomotives operating in the South Coast meeting the Tier 4 standard, 2) all aircraft meeting today's Tier 8 emission levels, and 3) ocean going vessels achieving emission levels significantly cleaner than today's requirements. An equal share pathway for this sector post-2023 would require deployment of locomotives meeting a more stringent Tier 5 standard. More stringent Tier 4 ocean going vessel standards would also be necessary. Finally, operational efficiency strategies would be needed to provide an additional mechanism for further reductions as a complement to deployment of cleaner technologies.

A series of actions that would be taken at the State and local level to achieve further reductions are outlined below:

- Expand and enhance existing incentive and innovative funding programs to increase the emphasis on and support for deployment of cleaner technologies in these sectors. Air quality incentives and transit funding programs, for example, will be effective in transforming the passenger rail system in the South Coast, with nearly all Metrolink trains expected to reach a Tier 4 level by 2023.

The incentive funding required will go well beyond the amount currently authorized under existing programs through 2023. Funding needs and mechanisms will be identified working in collaboration with the South Coast air district over the next several months.

- Advocate for opportunities to attract cleaner, more efficient ships to visit the San Pedro Bay ports by leveraging port and air agency incentives. This could include development of criteria for a Super Low Emission Efficient Ship as identified in the strategy concepts to

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Federal and International Sources

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achieve early implementation of clean technologies for newer vessels via existing and enhanced seaport incentive programs such as Green Ship and Environmental Ship Index.

- Partner with airports to incentivize cleaner aircraft to come to California airports, along with partnerships with international engine manufacturers to encourage production of cleaner, more efficient engines.
- Seek continued funding for and partnerships with federal agencies such as the U.S. Department of Energy, U.S. EPA, Federal Aviation Administration (FAA), U.S. Maritime Administration, and Federal Railroad Administration for new technology and fuel demonstration projects. This would include efforts on development of hybrid, battery and fuel cell technologies for locomotives, the FAA's CLEEN program, and retrofit technologies for in-use vessels and boilers.
- Encourage efficiency improvements, including industry based initiatives (like the San Pedro Bay Ports' Supply Chain Optimization effort to increase port competitiveness), as well as concepts being developed as part of the California Sustainable Freight Action Plan. These improvements may include approaches such as reducing unproductive moves, use of marine vessel sharing agreements that result in maximum use of cargo space, and increased reliance on logistics planning and operations software.

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Federal and International Sources

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Implementation Milestones and Schedule		
Proposed Strategy	Implementation Steps	Date
Identify and secure incentives, including funding, for accelerated deployment of cleaner ocean going vessels, locomotives, and aircraft in California service	<i>Phase 1:</i> Identify incentives, including funding needs and potential sources	} 2015 + (annually)
	<i>Phase 2:</i> Pursue actions to secure funding	
	<i>Phase 3:</i> Implement funding/incentive programs	
Work with federal and international agencies to advocate for increased stringency of emission standards and efficiency requirements, demonstration of new technologies, and incentives to attract the cleanest technologies to California	<i>Ongoing</i>	2015 - 2031
Evaluate, quantify and encourage efficiency improvements with the potential to result in lower emissions per unit of cargo transported, including changes in cargo and equipment activity that are typically reflected in SIP emission inventories	<i>Phase 1:</i> Retrospective and prospective evaluation of approaches with potential for lower systemwide emissions per unit of cargo transported	2016 – 2023
	<i>Phase 2:</i> Demonstration of system efficiency improvements and support for expanded private and public efforts	2018 – 2027
	<i>Phase 3:</i> Ongoing quantification of the effect of efficiency improvements on freight activity and emissions for incorporation into SIP	2020 – 2031

Off-Road Equipment Category Proposed Measure Concepts

Measure Title: Zero Emission Off-Road Forklift Regulation Phase 1

Measure Overview:

The goal of this measure concept is to accelerate the deployment of zero emission technologies in off-road equipment types that are already primed for the technologies that exist today and facilitate further technology development and infrastructure expansion. ARB would develop a regulation that focuses on forklifts with lift capacities equal to or less than 8,000 pounds.

Type of Action:

ARB regulation

Timeframe:

ARB Board adoption date: 2020
Implementation schedule: 2023 - 2035

Description of Measure and Commitment:

ARB would develop and propose a regulation to increase penetration of ZEVs in off-road applications, with specific focus on forklifts with lift capacities equal to or less than 8,000 pounds for which zero emission technologies have already gained appreciable customer acceptance and market penetration. It would also send a signal to technology manufacturers and investors that zero emission technologies will be strongly supported moving forward. This measure concept would advance ZEV commercialization by increasing the penetration of zero emission technologies. It is necessary to transfer such technologies to larger, higher power-demand off-road equipment types, such as high lift-capacity forklifts and other equipment types in the construction, industrial, and mining sectors. The regulation could also include requirements that result in the deployment of zero emission technologies in heavier equipment fleets that remain at a particular location for extended periods of time or other similar provisions that would spur further technology innovation.

Measure Title: Zero Emission Off-Road Emission Reduction Assessment

Measure Overview:

The goal of this measure concept is to expand the use of zero emission technology in non-freight, off-road applications. This further-study measure concept would be a follow-up to off-road measures implemented in the 2023+ timeframe, such as the Zero Emission Off-Road Phase 1 Regulation, and through it ARB would identify opportunities to further expand the use of zero and near-zero emission technologies in off-road applications.

Type of Action:

ARB technology review

Timeframe:

ARB Board date: 2025+
Implementation schedule: --

Description of Measure and Commitment:

ARB would provide the Board with an informational update regarding the status of ZEVs in off-road applications, which would identify opportunities to further expand their use. The focus of this measure concept is on transferring zero and near-zero emission technologies to heavier pieces of off-road equipment, such as high lift-capacity forklifts or other equipment in the construction, industrial, and mining sectors, with the intent of expanding their application as technology matures and infrastructure grows. This evaluation would focus primarily on the scalability and transferability of zero emission technologies to larger, higher power-demand equipment types and would be used to inform the development of the Phase 2 regulation. The information obtained from this technology review would be used to inform the development of Phase 2 of the Zero Emission Off-Road Regulation. The Zero Emission Off-road Phase 2 Regulation would build upon the Phase 1 regulation and focus primarily on larger, higher power-demand equipment types, such as large forklifts, construction equipment, etc. The scope and timeframe of the regulation would depend upon advancements in technology and information obtained through the Advanced Off-Road Emission Reduction Assessment.

Measure Title: Zero Emission Off-Road Worksite Emission Reduction Assessment

Measure Overview:

The goal of this measure concept is to advance ZEV commercialization by increasing the penetration of zero emission technologies. Through this emission reduction assessment and technology review, ARB would analyze developing worksite integration and efficiency technologies, such as connected vehicle, automation, and fleet management technologies in off-road sectors. ARB would also encourage deployment via incentives or by providing credit in the off-road rule.

Type of Action:

Technology review

Timeframe:

ARB Board date: tbd

Implementation schedule: --

Description of Measure and Commitment:

ARB staff would provide the Board with an informational update regarding an analysis of the technologies and/or strategies that increase worksite efficiency, such as connected vehicles, automation, and fleet management technologies. While there is not yet a consensus on how to quantify the benefits of such technologies, advanced machine control and worksite integration technologies that are commercially available today reportedly hold the potential for fuel savings of up to 30 percent or more, depending on worksite conditions. Some of these products are already available today from new equipment manufacturers, as well as aftermarket suppliers, and can be adapted/retrofitted to much of the existing legacy fleet. The scalability of these systems is wide ranging and such systems can be applied to a single piece of off-road equipment on a small project or on many vehicles at the largest, most complex worksites. While there is significant promise in these types of technologies, more work has to be done to ensure the development of a robust worksite efficiency program that is cost-effective and achieves emission reductions that are real and quantifiable. This measure concept would evaluate business return on investment, sustainability of the system, and ancillary benefits such as improved safety and work consistency. There would also be potential A/B testing comparing fuel efficiency, work productivity, and emission reductions via portable emission measurement system (PEMS).

Measure Title: Zero Emission Airport Ground Support Equipment

Measure Overview:

The goal of this measure concept is to increase the penetration of the first wave of zero emission heavy duty technology in applications that are well suited to its use, and will encourage the greater use of zero emission technologies by demonstrating its viability. ARB would transition diesel and Large Spark Ignition (LSI) airport Ground Support Equipment (GSE) to zero emission technology through a combination of natural turnover, existing regulations, and incentive funding.

Type of Action:

ARB regulation and incentives

Timeframe:

ARB Board adoption date: tbd
Implementation schedule: 2020 +

Description of Measure and Commitment:

ARB would develop and propose a regulation to transition diesel and LSI GSE to zero emission technology. The current commercial availability of several GSE equipment types indicates the feasibility of this transition. Battery-electric GSE are the most common type of zero emission GSE, and are available for several high-population equipment types. Many large air carriers which operate diesel GSE have already begun moving towards electric equipment. The added introduction of zero emission GSE will act as a catalyst to further zero emission equipment penetration in the off-road equipment sector and other heavier duty-cycle and longer range applications.

A conservative strategy would rely on incentives and natural turnover, along with current in-use requirements, to replace equipment in which electric replacements are readily available, such as belt loaders, baggage tractors and cargo tractors. A more aggressive turnover and implementation strategy could utilize a memorandum of understanding, regulation, or a combination thereof, along with incentives for demonstration, to ensure 60 percent of existing diesel equipment in these categories would be replaced with zero emission equipment by 2032, along with 50 percent of narrow body aircraft tugs and 30 percent existing wide-body aircraft tugs. Incentive funds would be targeted to demonstrating the feasibility of zero emission technologies in the high-power equipment applications (e.g., wide-body aircraft tugs).

Measure Title: Small Off-Road Engines

Measure Overview:

The goal of this measure concept is to reduce emissions from Small Off-Road Engines (SORE) and to increase the penetration of zero emission technology. Small off-road engines that are subject to ARB regulations are used in residential and commercial lawn and garden equipment, and other utility applications. ARB would develop and propose tighter emission standards, encourage increased use of zero emission equipment, and enhance enforcement of current emission standards.

Type of Action:

ARB regulation with possible incentives and enhanced enforcement

Timeframe:

Enhanced enforcement:	2015
ARB Board adoption date:	2018
Implementation schedule:	2022 - 2030

Description of Measure and Commitment:

ARB would develop and propose a regulation to tighten exhaust and evaporative emission standards for small off-road engines, with the possible inclusion of incentives for manufacturers to produce zero emission equipment. High failure rates have been observed in evaporative emissions testing of small off-road engines, preventing previously-claimed emission reductions from being realized. Exhaust and evaporative emissions from small off-road engines would be reduced through enhanced enforcement of the current emission standards, adoption of tighter emission standards, and increased use of zero emission equipment. Strategies will be developed for transitioning to zero-emission technologies from small off-road equipment, including phased emission standards and incentives for zero-emission equipment. A conservative strategy would use incentives and natural turnover to replace 25 percent of all spark-ignited small off-road engines and equipment with zero-emission equipment by 2030. The greatest emission reductions from incentives would be realized by the early turnover of commercial lawn and garden equipment to zero-emission equipment, which accounts for a disproportionate amount of SORE emissions.

Measure Title: Transport Refrigeration Units Used for Cold Storage

Measure Overview:

The goal of this measure concept is to advance zero and near-zero emission technology commercialization by increasing the early penetration of Transport Refrigeration Units (TRUs) used for cold storage, and supporting the needed infrastructure developments. ARB would develop a regulation to reduce NOx, PM, and GHG emissions by prohibiting the use of internal combustion engine powered transport refrigeration units for cold storage in phases, with incentive support for infrastructure.

Type of Action:

ARB regulation and incentives

Timeframe:

ARB Board adoption date: 2017
Implementation schedule: 2020+

Description of Measure and Commitment:

Transport refrigeration units are refrigeration systems that are powered by integral internal combustion engines (the engines housed inside TRUs) designed to control the environment of temperature-sensitive products that are transported in trucks, trailers, railcars and shipping containers. This regulation would address several transport refrigeration unit uses that result in NOx and GHG emissions. The initial concepts of the proposed regulation would limit the amount of stationary operating time that a transport refrigeration system powered by an internal combustion engine can operate at certain facilities. The time limit would decrease on a phased compliance schedule. Compliance options include the use of commercially available hybrid electric TRUs, TRUs equipped with electric standby motors, and cryogenic transport refrigeration systems. Hybrid electric and electric standby-equipped TRUs would plug into electric power plugs while stationary and use diesel engine power while on the road. Cryogenic transport refrigerators use liquid nitrogen and liquid carbon dioxide to provide cooling. Development and use of zero emission technologies, such as all-electric plug-in / advanced battery transport refrigeration systems would be encouraged, as well as adequately-sized cold storage facilities, and more efficient inbound delivery appointment and outbound dispatch scheduling.

Measure Title: Further Deployment of Cleaner Technologies: Off-Road Equipment

Measure Overview:

The goals of this measure concept are to accelerate the penetration of zero and near-zero equipment and to promote in-use efficiency gains through use of connected and autonomous vehicles, and worksite efficiencies.

Type of Action:

Funding programs, regulatory approaches, efficiency measures

Timeframe:

Implementation schedule: 2016 - 2031

Description of Measure and Proposed Pathway:

This measure concept is designed to achieve further emission reductions for South Coast attainment in 2023 and 2031 through a suite of additional actions, including early penetration of zero and near-zero technologies, and emission benefits associated with the potential for worksite integration and efficiency, as well as connected and autonomous vehicle technologies. These emission reductions will be achieved through a combination of actions to be undertaken by both ARB and the South Coast Air Quality Management District.

Scope of Technology Penetration and Mechanisms to Achieve Reductions :

This category includes a wide variety of off-road equipment including those used for construction and mining and industrial uses such as forklifts, transport refrigeration units (TRUs), airport ground support equipment, lawn and garden equipment, and recreational boats. Under current requirements, most new equipment is required to meet Tier 4 emission standards, and many smaller engines are converting to use of zero emission technologies. To achieve the further reductions associated with early penetration of the cleanest technologies across each sector, ARB and South Coast staff estimated the scope of penetration that would be required by 2023. This would include: 1) electrification of small engine forklifts less than 65 horsepower, 2) cleaner zero and near-zero technologies for TRUs, 3) electrification of ground support equipment such as baggage tugs, belt loaders, cargo tractors, and aircraft tugs), 4) electrification of certain types of lawn and garden equipment such as mowers, leaf blowers, and edgers, 5) replacement of construction, mining, and industrial equipment with engines that are below Tier 4 with Tier 4 final equipment. The following mechanisms provide a pathway for achieving this scale of technology deployment:

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Equipment

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- Identify and develop mechanisms to incentivize deployment of construction and mining equipment meeting Tier 4 final standards such as the South Coast's SOON program for the clean-up of off-road diesel equipment. Such programs have allowed affected fleets to meet requirements through public funding assistance. This could achieve further reductions from the approximately 7,000 pieces of equipment that would still have engines that are Tier 2 and below in 2023. The South Coast will include local measures to address certain types of heavy-duty equipment in their AQMP.
- Develop requirements for cleaner zero and near-zero technologies for TRUs. Emission reductions associated with Transport Refrigeration Units Used for Cold Storage measure have not yet been quantified. This measure concept reflects concepts to limit the amount of stationary operating time that a TRU powered by an internal combustion engine could operate at certain facilities. Development and use of zero emission technologies would be encouraged. This near-term measure concept will need to motivate distribution and other facilities to install the infrastructure needed to support zero and near-zero emissions technologies, encourage the development and demonstration of zero and near-zero emission technologies, and cause refrigerated fleets to evaluate and invest in zero and near-zero technologies.

Expand and enhance existing incentive and other innovative funding programs for off-road equipment to increase the emphasis on and support for zero emission equipment. Assuming incentive funding is the primary mechanism to achieve early deployment of zero emission technologies for forklifts, airport ground support equipment, and TRUs by 2023, funding would be required for at least 4,000 pieces of equipment per year over a seven year period. This early deployment through enhanced incentive funding would provide a down payment towards meeting requirements that would be established through the subsequent regulatory mechanisms identified for these categories. The population of lawn and garden equipment in the South Coast is very large, thus funding programs would target the types of equipment with the greatest emissions, such as mowers, leaf blowers, and edgers. Use of zero emission technologies would also provide near-source risk reduction for operators of the equipment. The incentive funding required for these efforts would go beyond the amount currently authorized through 2023.

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Equipment

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Determination of the needed resources will be based on assessment of the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Funding needs and mechanisms will be identified working in collaboration with the South Coast District and other State agencies over the next several months.

Additional mechanisms reflect continued penetration of zero emission technologies, as well as reductions achieved through worksite efficiencies. While these approaches have the greatest potential to provide further reductions post 2023, early advances in these areas could offset some of the reductions required through incentive funding. These additional pathway mechanisms include:

- Further advanced technology deployment. Based on on-going technology assessment, regulatory mechanisms to expand zero emission technologies into heavier pieces of off-road equipment such as high lift-capacity forklifts and other equipment in the construction, mining, and industrial sectors may be feasible. The greatest opportunities exist for engines that have a duty cycle to accommodate battery electric or fuel cell electric technologies.
- Advances in the development of autonomous systems, particularly if based on zero-emission technologies, as well as greater worksite integration, efficiency and fleet management technologies. These changes in how the off-road equipment sector would operate offer the potential to achieve criteria, toxic, and GHG emission reductions as well as reduce petroleum usage. These concepts are based on emerging technologies, and will require exploration and demonstration prior to quantifying emission reductions.

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Measure Title: Further Deployment of Cleaner Technology: Off-Road Equipment
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Implementation Milestones and Schedule:		
Proposed Strategy	Implementation Steps	Date
Identify and secure funding for incentive based and other innovative funding programs for accelerated deployment of zero and near-zero off-road equipment	<i>Phase 1:</i> Identify funding needs and potential sources	} 2015 + (annually)
	<i>Phase 2:</i> Pursue actions to secure funding	
	<i>Phase 3:</i> Implement funding/incentive programs	
Develop regulatory strategies for deployment of zero-emission technologies in off-road equipment applications as appropriate	<i>Phase 1:</i> Evaluation of technology and prototype demonstrations	2015 – 2023
	<i>Phase 2:</i> Development of regulatory strategies	2022 – 2025
	<i>Phase 3:</i> Measure implementation	2027 – 2031
Evaluate potential for emission benefits from operational efficiencies, and intelligent transportation systems and quantify and develop mechanisms to provide SIP reductions as appropriate	<i>Phase 1:</i> Evaluation of approaches and potential for emission reductions	2016 – 2023
	<i>Phase 2:</i> Demonstration of systems	2020 – 2025
	<i>Phase 3:</i> Quantification of emission reductions and mechanisms for incorporating into SIP	2025 – 2031

8. Fuels

ARB has a long history of achieving emission reductions via setting fuel standards. Cleaner fuel has an immediate impact in reducing emissions from the mobile source sector and has had a significant impact in reducing reactive organic compounds and sulfur oxide emissions. More recently, ARB developed the Low Carbon Fuel Standard to reduce the carbon intensity of transportation fuels, which will reduce our dependence on petroleum, and incentivizes increased production and use of renewable, low-carbon fuels.

This year, Governor Brown set a goal to reduce petroleum use by up to 50 percent by 2030. One of the opportunities to help meet this goal is for fuel providers to sell diesel with incrementally higher blends of advanced renewable fuels, which will support the Low Carbon Fuel Standard and ensure sufficient volumes of advanced renewable fuels are available. Because the mobile sector will continue operating on internal combustion engines for some time, it is critical that the fuels consumed in these vehicles contribute to the emission reductions needed to meet our 2031 air quality and 2030 climate and petroleum reduction goals. The Vision scenarios illustrate that, since diesel vehicles will comprise a large portion of the fleet still operating with combustion engines, a low-NOx, low-PM, low carbon intensity (LNPC) diesel standard would reduce NOx, diesel PM, and GHG emissions. Furthermore, a LNPC diesel fuel standard would provide the flexibility to target the most cost-effective emission reductions, for example by requiring higher blend levels in South Coast than in the rest of the State.

This standard would complement existing ARB programs that incentivize increased use of renewable fuels as substitutes for conventional gasoline and diesel fuels, and will focus on more completely transitioning the fuel mix away from petroleum-based diesel

to a cleaner, renewable mix of diesel substitute fuels such as renewable diesel from biomass, NOx-mitigated biodiesel, renewable natural gas from biomethane, gas to liquid diesel from biomethane, renewable hydrocarbon diesel, and/or co-processed renewable hydrocarbon diesel. The measure concept is anticipated to diversify the fuel pool, as it will incentivize increased production of LNPC diesel fuels. This measure concept would require incremental progress toward a goal of LNPC diesel comprising 50 percent of the on-and off-road diesel sold in State by 2030.

Fuel Proposed Measure Concept

Measure Title: Low-NOx, Low-PM, Low Carbon Intensity Diesel Requirement

Measure Overview:

The goal of this measure concept is to reduce NOx, diesel PM, and GHG emissions from the portion of the heavy-duty fleet that will continue to operate on internal combustion engines in order to reduce emissions as quickly as possible. This measure concept would put into place standards for Low-NOx, Low-PM, Low Carbon Intensity (LNPC) Diesel, and would require that diesel fuel providers sell steadily increasing volumes of LNPC until it comprises 50 percent of total diesel sales by 2031.

Type of Action:

ARB regulation with possible incentives

Timeframe:

ARB Board adoption date: by 2020
Implementation schedule: 2023-2031

Description of Measure and Commitment:

ARB would bring to the Board a measure that would require LNPC diesel comprise a steadily increasing percent of the CARB diesel pool, and would be implemented in a two-pronged strategy at the State and local level. Due to the magnitude of needed NOx reductions in the South Coast and the large volumes of LNPC Diesel needed for full statewide implementation, the measure concept would be phased-in with an implementation strategy that starts in the South Coast Air Basin, and subsequently expands statewide.

This standard is flexible and enables multiple fuel types to meet this standard. The specifications of LNPC diesel would require less than one percent aromatics, virtually no sulfur, and a blendstock carbon intensity maximum of 30-60 gCO₂e/MJ. This standard is anticipated to increase consumption of LNPC fuels, including: renewable diesel from biomass, NOx-mitigated biodiesel, renewable natural gas from biomethane, gas to liquid diesel from biomethane, renewable hydrocarbon diesel, and/or co-processed renewable hydrocarbon diesel. This measure concept would provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and Diesel PM benefits in potentially all model year off-road engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-state but operating on CARB diesel blended with LNPC diesel, are also anticipated to provide emission reduction benefits.

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9.

Vision Tools

Background

The Vision model was first developed in 2012 to enhance ARB's ability to conduct transportation system-wide, multi-pollutant, analysis to inform policy development. It allows for the evaluation of technology, fuel, and efficiency interactions across many source sectors and multiple pollutants. Measuring and analyzing the system-wide emissions impacts that stem from strategies in individual sectors requires a comprehensive approach that reflects real-world linkages. Initially much of the ARB Vision methodology was based on the Argonne National Laboratory national Vision model that included only on-road vehicle GHG emissions, leveraging the Argonne GREET lifecycle emission factors. This first version of the model, Vision 1.0¹⁹, was released publically in 2012 on the ARB website with a coinciding public workshop²⁰.

Over time, ARB staff revised the national Vision model platform with additional California-specific data and methodologies, and expanded the ability to analyze both GHG and criteria pollutants. Based on this work, ARB staff developed Vision 2.0 in 2014 and gave a detailed overview of the model at a public workshop²¹ in 2015. Vision 2.0 models will be made available the week of October 9, 2015 on ARB's Vision web page²².

¹⁹ Vision 1.0 Model <http://www.arb.ca.gov/planning/vision/downloads.htm>

²⁰ Vision 1.0 Workshop <http://www.arb.ca.gov/planning/vision/workshops.htm>

²¹ Vision 2.0 Workshop <http://www.arb.ca.gov/planning/vision/workshops.htm>

²² Vision 2.0 available at <http://www.arb.ca.gov/planning/vision/downloads.htm>

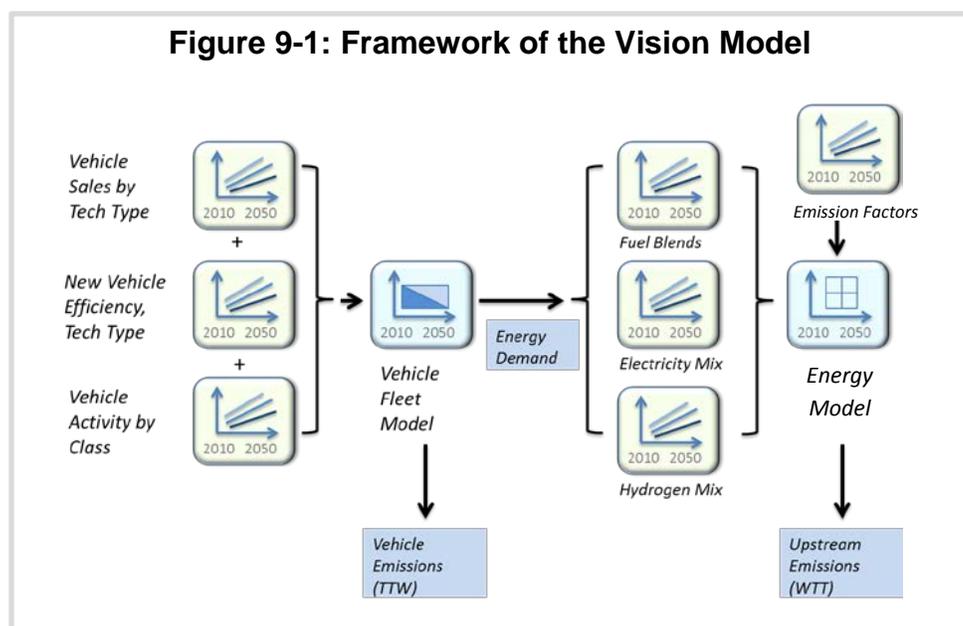
Vision 2.0 is a comprehensive modeling tool that provides the ability to analyze both upstream and downstream emissions by incorporating mobile sectors and fuel production activity. Vision 2.0 is unique in that it was designed to focus on California specific policy questions and metrics by incorporating ARB's most recent inventory work such as EMFAC2014 and reflects all adopted policies. In addition, it is one of the few scenario tools that integrates greenhouse gas and criteria emissions to inform how air quality, climate, and petroleum reduction goals can be met. The modules also have the most detailed breakdowns of each sector by vocation, technology type, and emissions process, and go further by providing that detail at an enhanced spatial resolution that can be merged with roadway network models. The output from the models can also be merged with information about the cost of technologies and infrastructure for an economic assessment of a policy.

Vision scenario modeling is an iterative process. Information on the current and potential future state of technology is synthesized into a scenario that reflects a combination of technology, fuel, and efficiency assumptions. These assumptions are revised as new information becomes available. The base assumptions are informed by foundational technical work and ongoing technology assessments by ARB²³ and other organizations. Results from scenarios are used to evaluate progress towards climate and air quality goals and inform policy making decisions.

Vision Methodology

The Vision tools incorporate detailed data from ARB's standard inventories, which include EMFAC, locomotives, ships, and OFFROAD, into separate modules where comprehensive scenarios can be run. These results are then aggregated into a central module that allocates fuels and energy and outputs emissions, as shown in Figure 9-1 below. For example, information about changing technology sales, how clean those technologies are, and any changes in the transportation system efficiency are defined inputs to the vehicle fleet model. The model then evaluates the impact of this scenario on tank-to-wheel (TTW) emission and the associated energy demand. This energy demand, plus input assumptions about the mix of fuels is input to the energy model where upstream well-to-tank (WTT) emissions are calculated.

²³ Technology and Fuels Assessments <http://www.arb.ca.gov/msprog/tech/tech.htm>



The baseline data in Vision incorporates all of the following state and national adopted policies and regulations:

On-Road Mobile

- EMFAC2014 inventory updates (LDV & HDV)
- Light-duty vehicles (LDV): Advanced Clean Cars and SB 375
- Heavy-duty vehicles (HDV): Phase 1 GHG, Truck & Bus Regulation

Fuels

- LCFS: Assumes 2020 compliance
- Grid: RPS 33 percent renewables by 2020
- Hydrogen: SB 1505 33 percent renewables, expected by 2020
- Biomethane: Landfill methane and waste diversion for biogas

Baseline Vehicle Fleet Model Inputs

The Vision 2.0 passenger and heavy duty vehicle models forecast population, vehicle sales, fuel efficiency, turnover, and vehicle-miles traveled (VMT), energy demand and emissions (NO_x, PM 2.5, and reactive organic gases) for various vehicle types in California under given scenarios. All scenario analyses are provided out to calendar year 2050 for the vehicle categories found in the EMFAC2014²⁴ model. The Vision models further breakdown EMFAC2014 into technology categories and emissions processes. For light-duty and heavy-duty vehicles, the categorizations are as follows:

²⁴ Mobile Source Emissions Inventory <http://www.arb.ca.gov/msei/categories.htm>

Table 9-1: Vision Vehicle Categories

EMFAC Vehicle ID	Description
LDA	Light-Duty Automobiles (i.e. Passenger Cars)
LDT1	Light-Duty Trucks (0-3,750 lbs GVWR)
LDT2	Light-Duty Trucks (3,751-5,750 lbs GVWR)
MDV	Medium-Duty Trucks (5,751-8,500 lbs GVWR)
UBUS	Urban Buses
SBUS	School Buses
OBUS	Other Buses
LHD1	Light-Heavy-Duty Trucks (GVWR 8501-10000 lbs)
LHD2	Light-Heavy-Duty Trucks (GVWR 10001-14000 lbs)
T6 Ag	Medium-Heavy Duty Diesel Agriculture Truck
T6 CAIRP heavy	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR>26000 lbs
T6 CAIRP small	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR<=26000 lbs
T6 instate	Medium-Heavy Duty Diesel instate construction Truck with GVWR>26000 lbs
T6 instate	Medium-Heavy Duty Diesel instate construction Truck with GVWR<=26000 lbs
T6 instate heavy	Medium-Heavy Duty Diesel instate Truck with GVWR>26000 lbs
T6 instate small	Medium-Heavy Duty Diesel instate Truck with GVWR<=26000 lbs
T6 OOS heavy	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR>26000 lbs
T6 OOS small	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR<=26000 lbs
T6 Public	Medium-Heavy Duty Diesel Public Fleet Truck
T6 utility	Medium-Heavy Duty Diesel Utility Fleet Truck
T6TS	Medium-Heavy Duty Gasoline Truck
T7 Ag	Heavy-Heavy Duty Diesel Agriculture Truck
T7 CAIRP	Heavy-Heavy Duty Diesel CA International Registration Plan Truck
T7 CAIRP	Heavy-Heavy Duty Diesel CA International Registration Plan Construction Truck
T7 NNOOS	Heavy-Heavy Duty Diesel Non-Neighboring Out-of-state Truck
T7 NOOS	Heavy-Heavy Duty Diesel Neighboring Out-of-state Truck
T7 other port	Heavy-Heavy Duty Diesel Drayage Truck at Other Facilities
T7 POAK	Heavy-Heavy Duty Diesel Drayage Truck in Bay Area
T7 POLA	Heavy-Heavy Duty Diesel Drayage Truck near South Coast
T7 Public	Heavy-Heavy Duty Diesel Public Fleet Truck
T7 Single	Heavy-Heavy Duty Diesel Single Unit Truck
T7 single	Heavy-Heavy Duty Diesel Single Unit Construction Truck
T7 SWCV	Heavy-Heavy Duty Diesel Solid Waste Collection Truck
T7 tractor	Heavy-Heavy Duty Diesel Tractor Truck
T7 tractor	Heavy-Heavy Duty Diesel Tractor Construction Truck
T7 utility	Heavy-Heavy Duty Diesel Utility Fleet Truck
T7IS	Heavy-Heavy Duty Gasoline Truck
PTO	Power Take Off

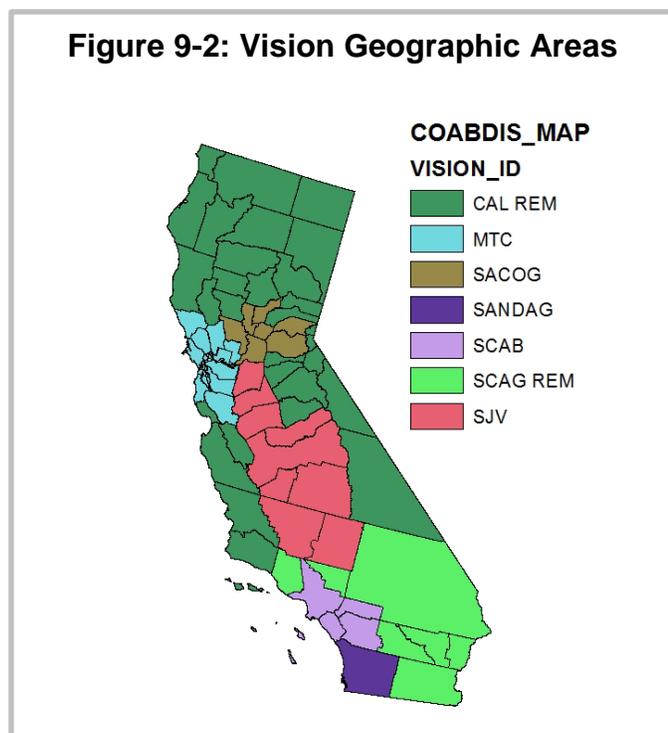
The vehicle types are further split into the following technology categories:

Table 9-2: Vision Vehicle Technology Categories

Technology ID	Description
GAS	Gasoline Fueled Vehicles
DSL	Diesel Fueled Vehicles
ELE	Electric Power Vehicles
E85	Ethanol Fueled Vehicles
CNG	Compressed Natural Gas Fueled Vehicles
LNG	Liquefied Natural Gas Fueled Vehicles
HYD	Hydrogen Power Vehicles (i.e. Fuel Cells)
PHEV	Plug-in Hybrid Vehicles

The model output is also output to seven geographic areas. These areas are aggregations of geographic areas found in the EMFAC 2014 model. Each of the 69 geographic areas in the EMFAC 2014 model is identified by county, air basin, and air district (COABDIS). The seven aggregated areas in the model represent areas where it would be relevant for specific SIP or climate related policies. The seven geographic areas are described below and displayed in Figure 9-2.

- South Coast Air Basin (SCAB):** those counties and geographic areas defined by California law as the South Coast Air Basin. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards as well as the 1997 and 2006 PM 2.5 air quality standards.
- Southern California Association of Governments (SCAG REM):** those remaining counties and geographic areas under the jurisdiction of the Southern California Association of Governments not included in the SCAB. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards as well as the 1997 and 2006 PM 2.5 air quality standards.
- San Diego Association of Governments (SANDAG):** the



geographic area confined by San Diego County. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards.

- **San Joaquin Valley (SJV):** those counties and geographic areas defined by California law as the San Joaquin Valley Air Basin plus the eastern portion of Kern County not included in the San Joaquin Valley Air Basin. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards as well as the 1997 and 2006 PM 2.5 air quality standards.
- **Sacramento Area Council of Governments (SACOG):** those counties and geographic areas under the jurisdiction of the Sacramento Council of Governments. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards as well as the 2006 PM 2.5 air quality standards.
- **Metropolitan Transportation Commission (MTC):** those counties and geographic areas under the jurisdiction of the Metropolitan Transportation Commission. Includes non-attainment areas for the 1997 and 2008 ozone air quality standards as well as the 2006 PM 2.5 air quality standards.
- **California Remaining Areas (CAL REM):** All remaining counties in California not in one the regions defined above. Some of the counties within this area are non-attainment for the ozone and/or PM 2.5 air quality standards.

Baseline Energy Model Inputs

The Vision 2.0 energy model is used to evaluate the liquid fuels, electric power, hydrogen and natural gas required to supply the demands of the vehicle fleet models. Additionally, the energy module calculates the upstream WTT emissions associated with transportation fuel consumption and total WTW greenhouse gases based on the composition of the fuels used in the scenario. The model processes data inputs from the vehicle fleet model in the form of demands, blending assumptions, supply capacities, emissions and emission factors. The model then outputs consumed quantities of finished fuels, feedstocks, electricity, and other supplies required to meet vehicle fleet model demands and their associated emissions. Data for the module was acquired from a number of different sources. Facility emission rates and well-to-wheel GHG emission rate inputs are obtained from facility reports²⁵, statewide emissions inventories²⁶, and CA GREET v2²⁷. The California Energy Commission (CEC), the US Energy Information Administration, and the Low Carbon Fuel Standard (LCFS) Program

²⁵ Facility Emissions Data available at <http://www.arb.ca.gov/ei/disclaim.htm>

²⁶ Emissions Inventories available at <http://www.arb.ca.gov/aqmis2/aqdselect.php>

²⁷ California Greet Model available at <http://www.arb.ca.gov/fuels/lcfs/ca-greet/ca-greet.htm>

provide data on blending input assumptions. Finally, supply capacities are derived from the CEC, the Department of Energy’s Billion Ton Study²⁸, and the LCFS Program.

The energy module contains a number of different fuels and blendstocks, including:

Table 9-3: Vision Fuels and Blendstocks

Demand	Blendstocks
Gasoline	CARBOB, Ethanol, Renewable Gasoline
Diesel	ULSD, Bio-diesel, Renewable diesel
Electricity	Coal, Natural Gas, Nuclear, Hydro, Wind, Solar,
Natural gas	Fossil, Landfill, AD Gas
Hydrogen	Reformed Natural Gas, Biomass, Wind, Solar
Jet Fuel	Petroleum, Bio-Jet, Renewable Jet

The module can vary blendstocks for the various demands so that it is able to optimize blends to utilize low-CI supplies. Supply mix choices can be varied for electricity and hydrogen (i.e. by varying the percent of electricity supplied by coal, nuclear, or solar power). Finally, the module allows for global, statewide, and regional boundaries to account for where emissions occur.

Scenario Assumptions

The scenarios outlined earlier in this document include a *Current Control Program* scenario, and a *Cleaner Technology and Fuels* scenario. The baseline *Current Control Programs* scenario reflects all adopted policies as discussed above. The *Cleaner Technology and Fuels* scenario explored a pathway to getting deeper NOx reductions and meeting climate and petroleum reduction goals. Lastly, *SIP Measure Concepts* represents the assumptions used in estimating the South Coast NOx reductions associated with the proposed measure concepts identified in Chapter 4.

The scenario concepts are translated into assumptions which can be used in the Vision 2.0 model. These assumptions, when run through the Vision modules, provide the emission reductions associated with each scenario or concept. The tables below display the concept on the left, and the translated assumptions on the right. These assumptions reflect the reductions that could be achieved from the concept, but do not necessarily represent what would ultimately be developed through the more rigorous regulatory or policy development process.

The *Cleaner Technologies and Fuels* scenario includes the following assumptions:

²⁸ US Department of Energy (DOE) Billion Tons Study <https://bioenergykdf.net/content/billiontonupdate>

Table 9-4: Vision Assumptions for *Cleaner Technologies and Fuels Scenario*

Measure Concept	Assumptions
On-Road Heavy-Duty	
Federal Low-NOx Engine Standards	Assume National Standard starting in 2024 (100% sales for Class 2B-8) that is 90% lower NOx than 2010 Std trucks
California Low-NOx Engine Standards	Assume California Standard starting in 2024 (100% sales for Class 2B-8) that is 90% lower NOx than 2010 Std trucks
Heavy-Duty GHG Phase II	Benefits phase in from 2018 to 2027. Efficiency improvements from 5 to 37 percent depending on vocation
Advanced Clean Transit	Urban Bus BEV sales begin in 2018 and increase to 100% of all sales in 2030.
Last Mile Delivery	Phase in sales requirements for BEV from 2020-2030. Sales begin in 2021 at approximately 200 units per year in 2021 up to 900 per year in 2032. ~3,100 BEV trucks by 2030
On-Road Light-Duty	
Advanced Clean Cars 2	<p>Combined LDA/LDT2 ZEV/PHEV sales increase from 18% to 40% between 2025 and 2030, and reach 100% by 2050.</p> <p>MDV ZEV/PHEV sales beginning in 2025, ramping up to 10% by 2030, and reach 50% by 2050.</p>
	<p>Increased fuel efficiency (~2.9% per year) 2025 to 2035 for gasoline vehicles.</p> <p>New SULEV NOx standard phased in between 2025 and 2030 for gasoline LDAs. 100% SULEV20 sales by 2030.</p> <p>VMT reductions ramping up to 15% below 2050 baseline VMT in 2050.</p>

Finally, Table 9-5 provides the *SIP Measure Concepts* assumptions:

Table 9-5: Vision Assumptions for SIP Measure Concepts

Measure Concept	Assumptions
On-Road Heavy-Duty	
Same as Cleaner Technologies and Fuels	
On-Road Light-Duty	
Advanced Clean Cars 2	<p>Combined LDA/LDT2 ZEV/PHEV sales increase from 18% to 40% between 2025 and 2030.</p> <p>MDV ZEV/PHEV sales beginning in 2025, ramping up to 10% by 2030.</p> <p>Increased fuel efficiency (~2.9% per year) 2025 to 2035 for gasoline vehicles.</p> <p>New SULEV NOx standard phased in between 2025 and 2030 for gasoline LDAs. 100% SULEV20 sales by 2030</p>
Off-Road Equipment	
Zero Emission Off-Road Forklift Regulation Phase 1	Assumes that approximately ~5k diesel and LSI forklifts (w/lift capacity ≤8,000lbs, approx. 65 HP) statewide (~2.5k in South Coast) will be electrified by 2031 through natural and accelerated turnover.
Zero Emission Airport Ground Support Equipment	Assumes that approximately 400 diesel GSE statewide (200 in South Coast) will be electrified by 2031.
Fuel	
Low-NOx, Low-PM, Low Carbon Intensity Diesel Requirements	Assumes 50% of the diesel pool is renewable by 2030. Assume NOx and PM benefits for non-SCR equipped vehicles -13% NOx reduction and 25% PM reduction. Also assumes an overall ~14% reduction in diesel carbon intensity.
Off-Road Federal and International Category	
Tier 5 National Locomotive Emissions Standards	Assumes Tier 4+ standard starting in 2025, 50% lower NOX emissions than Tier 4.
Regulation of Non-New Locomotives	Assumes ramp up of Tier 4 representation to 95% in South Coast by 2031.
Tier 4 Vessel Standards	Assumes new main and auxiliary engines will achieve a 70% reduction in NOx starting with calendar year 2025. No reductions to PM were assumed.
At-Berth Regulation Amendments	Assumes At-Berth Regulation expanded to include some of the following vessel types: auto, bulk cargo, general cargo, ro-ro and tankers. Assumed to start in 2022 at 10% compliance for these vessel types. Then every two years the compliance rate increases by 10% until 2032 when the rate becomes 50%.

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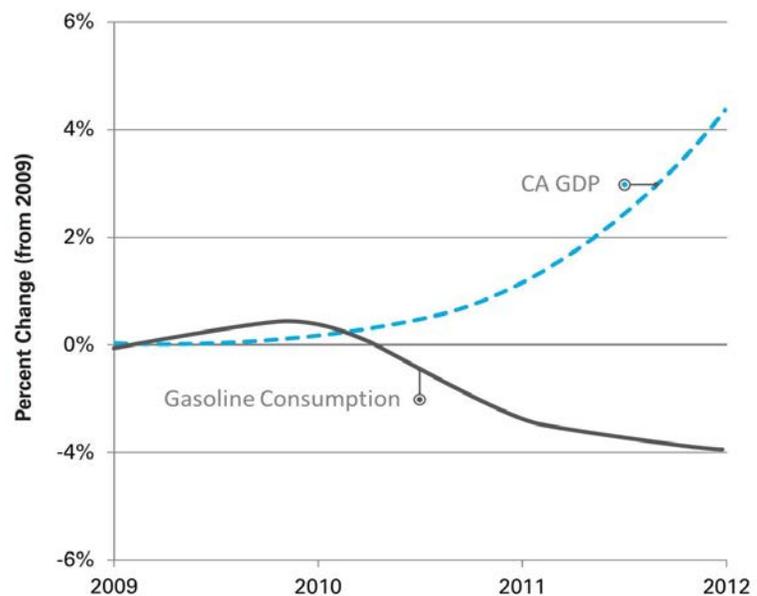
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Economic Impacts and Funding Mechanisms

ARB's strategic vision for the mobile source sector is based on the principle that economic prosperity and environmental sustainability can be achieved together. Undertaking transformative action in the transportation sector will continue California's long and successful legacy of building a world-class economy in concert with innovative and effective environmental and public health policies. Innovations in clean vehicles and fuels provide an opportunity for California to continue to leverage its position as a leader in the high-tech, green economy.

Figure 10-1 is one demonstration of the principle that economic prosperity and environmental sustainability

Figure 10-1: Economic Growth and Gasoline Use Trends



can be achieved together. The amount of gasoline used in California steadily declined since 2009 while the State's economy grew by five percent over the same time period, highlighting that our existing mobile source program has reduced the amount of gasoline consumed per dollar of economic output. It also shows what can occur by decoupling the often-assumed link between economic growth and increased resource consumption.

Achieving growth while reducing the amount and sources of energy we use will only become more important as California builds on the foundation of current programs. The transformative shift that the transportation sector will undergo in the next fifteen years will change the way people and goods interact with the transportation system, and that system will be characterized by cleaner, new technologies fueled by increasingly clean and renewable electricity and biomass-based fuels.

There will be substantial costs and funding needs associated with implementing the mobile sources strategy. This includes the costs of deploying cleaner technology vehicles, equipment, and fuels, as well as other associated funding needs such as research and development and demonstration projects, and infrastructure investments to produce and deliver new forms of fuels and energy. But while the costs and funding needs will be substantial, the investments will provide broad environmental benefits. The mobile source strategy is designed to simultaneously meet air quality standards, achieve GHG emission reduction targets, reduce petroleum consumption, and decrease health risk from transportation emissions over the next 15 years. As such, the total cost of reducing emissions through the transformation of transportation sector technology and fuels are attributable to addressing multiple environmental needs.

In addition to providing a framework to simultaneously assess what is needed to meet multiple environmental goals, the Vision tool also provides insight into identifying the right combination of regulatory pushes and incentive pulls to accelerate commercial markets for clean vehicles, equipment, and fuels. To implement the strategy, we have to coordinate and align public investments in ways that most effectively leverage private resources and harness the market power of the private sector. From the scenarios and the measure concepts that follow from them, the funding needs, timing, and potential trade-offs of incentive investments among source sectors can be evaluated.

For the SIP, ARB will evaluate, in conjunction with the South Coast AQMD, the economic impact of the proposed mobile source strategy on individuals, the transportation sector, and the California economy. A macroeconomic model of the California economy will be used to identify the cumulative impact of the mobile source strategy, including the estimated costs and benefits of both near-term and advanced technology provisions on the California economy through 2031.

Clearly, funding mechanisms and other innovative strategies will be needed to accelerate penetration of cleaner technologies, especially to meet the ozone attainment deadline in 2023. ARB will coordinate with the South Coast AQMD to outline the financing and investment needs for the measure concepts. Traditional State financing options include grants, rebates, low-cost loans, and tax exempt bonds. Additional

options for long term transformative funding include revolving loan funds, equity financing, and leveraging private funds that can be coordinated with existing clean energy financing programs through the State Treasurer's Office and the California Infrastructure and Development Bank (iBank).

The State currently has a number of complementary incentive programs aimed at developing and deploying advanced technologies, fuels, and infrastructure for the transportation sector. These include ARB's AQIP, which has focused investments in technology advancing projects. AQIP funds have been used for initial deployment of hybrid and zero emission trucks, zero emission and plug-in hybrid passenger cars, and other advanced technology demonstrations. Other ARB incentive programs, such as the Carl Moyer Program and the Proposition 1B: Goods Movement Emission Reduction Program, have generally focused funds on turning over the State's legacy fleet to cleaner, commercially available technologies ahead of compliance deadlines. The Proposition 1B: Goods Movement Reduction Program is a partnership between ARB and agencies to use incentives to reduce air pollution emissions and health risk from freight movement along California's trade corridors. The Carl Moyer Program is a voluntary grant program for vehicles and equipment developed to reduce air pollution by providing incentive funds to private companies and public agencies to purchase cleaner-than-required engines, equipment, and emission reduction technologies. Recent changes to the Carl Moyer Program focus on increased deployment of zero emission and near-zero technologies and to realize co-benefit GHG project reductions, as well as continue to provide criteria emission reductions. Additionally, the Enhanced Fleet Modernization Program provides monetary incentives to vehicle owners to retire older, more polluting vehicles.

Cap-and-Trade auction proceeds currently provide an additional funding source for ARB's clean transportation incentive programs through the Greenhouse Gas Reduction Fund (GGRF) for Low Carbon Transportation investments. This funding source has greatly expanded the technology advancing projects ARB has funded through AQIP, and funds several programs with an emphasis on investments that benefit disadvantaged communities. These investments are being used to expand AQIP projects such as the Clean Vehicle Rebate Project to promote the purchase of new battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles. Additionally, the GGRF is funding vouchers for hybrid and zero-emission trucks and buses through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project. The GGRF further funds a number of other low NOx and zero emission heavy-duty vehicle incentives and loan programs, in addition to programs that will accelerate the deployment of advanced technologies onto the road.

These incentive programs provide examples of the broader efforts that will be required as part of comprehensive funding mechanisms that will be identified in coordination with the South Coast AQMD.

California Environmental Protection Agency

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