COORDINATED GOVERNANCE OF AIR & CLIMATE POLLUTANTS:

LESSONS FROM THE CALIFORNIA EXPERIENCE

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UCLA School of Law
Emmett Institute on Climate Change & the Environment

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TABLE OF CONTENTS

FIGURES & TABLES

CHAPTER ONE — INTRODUCTION

This is a report about the coordinated governance of air and climate change pollutants.

The concept is straightforward. By coordinated governance, we simply mean regulation that attempts to coordinate and optimize the regulation of multiple pollutants along multiple metrics of evaluation. This has been called "*multi-pollutant planning*," "*co-control*," and other terms.[1]

In part, coordinated governance is the logic of "killing two birds with one stone." All things being equal, in a world of finite resources, it is better to identify measures that produce "co-benefits" along multiple dimensions. Coordinated governance is also substantially about the selection of the optimal combination of policies (again as measured against a range of metrics) for achieving multiple regulatory goals.

Coordinated governance offers the promise of more effective pollution reduction at lower cost. A study on air pollutant and GHG co-control in China by Wang, et al. (2019), for example, found that a co-control scenario produced lower marginal and total abatement costs than single-pollutant approaches.[2] A coordinated approach also helps to ensure that governance is consistent with other important values (such as impacts on economic development, justice, fairness, legality, public acceptance, etc.). We emphasize the concept of "governance" here to highlight the importance of robust planning processes and procedures to achieve such coordination of regulatory goals and values in practice.

In short, coordinated governance requires both *conceptual* and *procedural* adjustments to regulatory business-as-usual. This means (i) thinking beyond single-pollutant planning (*conceptual*) and (ii) developing a robust planning process that is science-based, transparent, participatory, and accountable to the relevant stakeholders (*procedural*).

While the concept is simple, implementation is more complicated. It requires an express commitment to a coordinated approach, as well as dedicated, sustained planning and effort with the help of technically sophisticated scientific and legal staff. Those we spoke to in the course of research all expressed that multi-pollutant coordination was difficult and remained a work in progress. Moreover, despite the potential benefits, many jurisdictions have yet to embrace coordinated governance even at the conceptual level, and still carry out air pollution and climate change regulation without adequate multi-pollutant coordination or consideration of disparate goals and values.[3]

The aim of this report is to offer a study of the coordinated governance of pollutants that harm air quality and contribute to climate change—with a particular attention given to the California experience. The focus here is on multi-pollutant planning for traditional air pollutants (such as ground-level ozone, $PM_{2.5}$, NO_x,

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[1] Other reports have used the terms "climate-friendly air quality management" and "integrated co-governance." *See generally,* Christopher James, *Best Practices for Achieving Cleaner Air and Lower Carbon*, Reg. Assistance Project (Mar. 2019); Jiankun He, et al., *Synergizing Action on the Environment and Climate: Good Practice in China and Around the Globe*, U.N. Env't Programme (2019).

[2] Total abatement costs in the air and climate co-control scenario were USD $33 billion and $66 billion in 2020 and 2030, respectively, as compared to USD $43.6 billion and $88 billion in 2020 and 2030 for the combined cost of uncoordinated approaches to air quality and climate change regulation. *See* Lining Wang, Han Chen, & Wenying Chen, *Co-Control of Carbon Dioxide and Air Pollutant Emissions in China from a Cost-Effective Perspective*, Mitigation and Adaptation Strategies for Global Change (June 21, 2019).

[3] *See, e.g.,* U.S. Envtl. Prot. Agency Clean Air Act Advisory Comm. Air Quality Management Subcommittee, Recommendations to the Clean Air Act Advisory Committee: Air Quality Management Subcommittee Phase II Recommendations 6 (June 2007).

and VOCs) and greenhouse gases (GHGs).[4] In recent years, a number of jurisdictions in the U.S. and elsewhere have begun to engage in multi-pollutant planning in various forms. These include the U.S. states of California, Massachusetts, New Hampshire, North Carolina, and New York, as well as the European Union.

California has long been a leader in multi-pollutant approaches to traditional air pollutant regulation, and more recently has begun to build experience in the coordination of climate change regulation with traditional air pollutant regulation. South Coast Air Quality Management District (SCAQMD) is world-renowned for its work to address ozone, $PM_{2.5}$, NO_x, and VOC pollution in the Greater Los Angeles region. California's environmental and energy agencies (CalEPA, the California Air Resources Board (CARB), the California Energy Commission (CEC), and California Public Utility Commission (CPUC) and others) are recognized world leaders in climate change regulation and traditional air pollution control and in recent years have been engaged in various planning processes that have expressly taken a coordinated approach. At the regional level, the Bay Area Air Quality Management District (Bay Area AQMD) has since 2010 developed perhaps *the* leading example of a comprehensive multi-pollutant planning approach that considers traditional air pollutants, GHGs, and toxic chemicals.

This report is, to our knowledge, the first to focus on air pollution and climate change co-control experience in California.

Chinese policymakers and regulators are the primary intended audience of this report.[5] In China, the concept of coordinated control (协同控制) or coordinated governance (协同治理) has entered the highest levels of China's air quality and climate change planning in recent years.[6] Key Chinese environmental initiatives already reflect the idea of coordinated governance. In the Beijing-Tianjin-Hebei (京津冀) region, China has implemented a cap on coal usage and put in place measures to reduce the number of facilities and overall production of energy intensive industries (such as steel and cement).[7] The southern city of Shenzhen has put in place measures to shift away from coal-fired power and electrify public transportation. Measures in the Chinese power sector have reduced SO_2, NO_x, *and* carbon dioxide emissions.

At the same time, China's "war on pollution" since 2013 has focused largely on $PM_{2.5}$.[8] In recent years there has been great interest in China on increasing coordinated governance of $PM_{2.5}$ with other pollutants, such as ozone, NO_x, and VOCs. And, with climate change responsibilities only recently transferred to the Ministry of Ecology & Environment, China is still in the process of determining the best ways to coordinate air quality and climate change regulation. As in the U.S., coordinated governance of traditional air pollutants and GHGs in China remains a work in progress.

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[4] We use the term "traditional air pollutants" to include non-GHG air pollutants that affect air quality. This includes "criteria pollutants" for which the U.S. Clean Air Act requires there to be National Ambient Air Quality Standards (NAAQS); i.e., ground-level ozone, particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead. "Traditional air pollutants" also include other regulated pollutants that affect air quality, such as volatile organic compounds (VOCs). Although not the focus of this report, the best examples of coordinated, multi-pollutant governance consider toxic air pollutants as well.

[5] That said, we hope the lessons here will be of interest and value to stakeholders in other jurisdictions who are seeking to coordinate the regulation of air pollution and climate change policy as well.

[6] *See* PRC Min. of Ecology & Env't, China's Policies and Actions for Addressing Climate Change 11 (Nov. 2019).

[7] *See*, e.g., Jiankun He, et al., *Synergizing Action on the Environment and Climate: Good Practice in China and Around the Globe*, U.N. Env't Programme 14 (2019).

[8] Hard environmental targets promulgated since the eleventh five-year plan (for SO_2 and NO_x reduction, increased energy efficiency) have been managed through the more conventional single-pollutant approach common in much of the world.

In this report, we address coordinated governance challenges in two particular areas:

In traditional air pollutant regulation, a key challenge has been the coordinated regulation of ozone, NO_x, and particulate matter. In the U.S., California has grappled with this problem for several decades, particularly in the Greater Los Angeles area.

A comprehensive multiple pollutant approach must, however, look beyond traditional air pollutants to include GHGs in a coordinated fashion, given the importance of both issues to the U.S., China, and the world. The sources of traditional air pollutants (that harm local air quality) and greenhouse gas emissions (that cause climate change) overlap significantly.

- A 2019 study (Zhao, et al.), for example, found that electrification and renewable energy policies in California could reduce GHG emissions by 80% (by 2050 from 1990 levels), while also reducing $PM_{2.5}$ by 33%, NO_x by 34%, SO_2 by 37%, NH_3 by 34%, and reactive organic gas (ROG) by 18%.[9]
- A 2018 study (Ou, et al.) of air and climate co-benefit potential in the U.S. nationwide estimated, among other things, that a 50% CO_2 reduction scenario could also generate 23% reduction in NO_x, 44% reduction in SO_2, and 27% reduction in $PM_{2.5}$.[10]
- As mentioned above, a 2019 study by Wang, et al. expressly focused on the potential benefits of air and climate co-control in China found that a coordinated approach had lower total abatement costs than the combination of separate, but uncoordinated air and climate change regulatory scenarios.[11]

Coordinated policies in China, where coal represents a much larger percentage of the energy mix, offer the promise of even greater traditional air pollutant and GHG co-benefits than would be gained in California, which relies to a much greater extent on natural gas and renewable energy already.

Better planning and more intentional consideration of the "co-benefits" of air pollution and climate change policy offer the promise of reduced cost and effort and a higher likelihood of goal attainment. California is one of the earliest jurisdictions to grapple with coordinated governance of air and climate change, and the state now has nearly a decade and a half of experience in the coordinated planning and regulation of air and climate goals.[12]

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[9] Bin Zhao, et al., *Air Quality and Health Cobenefits of Different Deep Decarbonization Pathways in California*, 53 Envtl. Sci. Tech. 7163 (2019).

[10] Yang Ou, et al., *Estimating Environmental Co-Benefits of US Low-Carbon Pathways Using an Integrated Assessment Model with State-level Resolution*, 216 Applied Energy 482 (Apr. 15, 2018).

[11] Lining Wang, Han Chen, & Wenying Chen, *Co-Control of Carbon Dioxide and Air Pollutant Emissions in China from a Cost-Effective Perspective*, Mitigation and Adaptation Strategies for Global Change 14 (June 21, 2019).

[12] The U.S. federal-level EPA did so as well in the Obama administration. Under the Trump administration, however, the U.S. federal government has largely retreated from greenhouse gas regulation.

TABLE 1
Coordinated Governance in California Regulatory Targets & Metrics of Evaluation

Regulatory Area	Regulatory Targets	Metrics of Evaluation
Traditional air pollution	Ozone, NO_x, $PM_{2.5}$, VOCs & other traditional air pollutants	• Emission reduction potential • Cost-effectiveness • Enforceability • Public acceptability • Economic consequences • Technological feasibility • Fairness & equity • Legality
Air pollution & climate change	Traditional air pollutants & greenhouse gases	• Emission reduction potential • Air & climate co-benefits • Preventing leakage • Public health co-benefits • Impact on low-income communities and communities near large stationary sources • Compliance flexibility • Potential for use in other jurisdictions • Support for other regulatory programs

Sources: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan 4-4 (2016); Cal. Air Res. Bd., California's 2017 Climate Change Scoping Plan 33–34 (Nov. 2017); A.B. 617, 2017-2018 Leg. (Cal. 2017). Metrics from the first row are drawn from the SCAQMD 2016 Air Quality Management Plan, and metrics from the second row are drawn from the CARB 2017 Climate Change Scoping Plan.

1.1 Report Roadmap

This report is organized as follows:

Chapter Two provides a detailed examination of California's experience in coordinated governance of traditional air quality pollutants, including ground-level ozone, $PM_{2.5}$, NO_x and VOCs. The focus here is on the work of the South Coast Air Quality Management District (SCAQMD), which governs much of the Greater Los Angeles region. SCAQMD is a global leader in the modeling, planning, policy development, enforcement, and compliance of air pollution regulation. This Chapter will also discuss the experience of the San Joaquin Valley AQMD in Central California, and the Bay Area AQMD, which has jurisdiction in the Greater San Francisco/Oakland region.

The key take-away here is that there is no one-size-fits-all answer to coordinated governance of traditional air pollutants. Regulators in Southern California have emphasized NO_x pollution control (relative to control of VOCs) because of the greater co-benefits for ozone and $PM_{2.5}$ control associated with NO_x control.[13] Regions of China with high levels of ozone and $PM_{2.5}$ may be particularly interested in the approach taken

[13] *See* S. Coast Air Quality Mgmt. Dist., VOC Controls 11 (Oct. 2015) (recommending a NO_x-heavy approach with modest VOC controls).

here. The San Joaquin Valley AQMD, which has serious violations of $PM_{2.5}$ standards, takes a NO_x-heavy approach as well. The Bay Area AQMD, which has relatively lower concentrations of ozone and $PM_{2.5}$, takes a different approach (emphasizing VOC control in the near term) based on the analysis of local pollution levels and sources, geography, climate, co-benefits, and other factors.[14] We explain the reasons for the different approaches in Chapter Two.

Chapter Three describes California's experience in coordinated governance of air and climate objectives. Given the more recent provenance of climate change policy, the task of coordinated governance of air and climate policy remains a work in progress. Nonetheless, California has already made strides in developing a coordinated governance approach that includes traditional air pollutants and GHGs. This chapter will highlight key policy and governance approaches in transportation, land use, the energy sector, and industry, and discuss the planning processes that enable coordination of a complex set of policy goals.

California's 2016 Mobile Source Strategy and the Bay Area AQMD 2017 Clean Air Plan stand out as the most comprehensive and intentional attempts at coordinated, multi-pollutant governance—considering traditional air pollutants, GHGs, and air toxics.

The report will conclude in **Chapter Four** with a summary of recommendations on coordinated governance for China's fourteenth five-year plan.

A few points about our focus in this report are worth emphasizing:

- **Air Regulation as a Driver of Climate Change Regulation.** This report recognizes that China and other developing countries face the particular challenge of grappling with early stage air pollution and climate change regulation at the same time. Developed jurisdictions, like the U.S. and the E.U., have had decades of experience in building the institutions, systems, laws, and policies to tackle traditional air pollution and are engaging with climate change regulation at a time when the most severe air pollution problems have largely been addressed.

  The strong political support for air pollution control in China creates an opportunity to further develop what some have termed "climate-friendly air quality management." Given the overlap in the sources of traditional air pollutants and GHG emissions (coal, oil, gas, etc.), air pollution regulation can also produce benefits for GHG control if regulators take a coordinated governance approach.[15] In California, this is perhaps most true in the area of mobile source strategy (e.g., cars, trucks, ships, trains, airplanes), which is the largest contributor to California air pollution and GHG emissions as well. Electrification (or other non-fossil fuel-based means) of transport reduces both traditional air pollutants and GHGs.

  A coordinated governance approach also asks air quality regulators to look beyond the end-of-pipe control solutions (catalytic converters, flue gas desulfurization, denitrification technology) that have been the traditional focus of air quality regulation, and to incorporate strategies for clean energy and fuels, land use, and energy efficiency into the air regulation toolkit. In China, this shift in approach is, in part, simply a necessity as the installation of end-of-pipe technologies reaches saturation due to aggressive implementation efforts over the last decade and a half.

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[14] *See generally* Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1 (Apr. 19, 2017).

[15] *See, e.g.*, Lydia McMullen-Laird, et al., *Air Pollution Governance as a Driver of Recent Climate Policies in China*, Carbon & Climate L. Rev. 243 (2015).

Furthermore, a coordinated approach reminds regulators to *do no harm.* Put another way, attention to co-benefits can constrain regulators in beneficial ways, preventing them from taking short-term actions in the name of air pollution regulation that will make it *more* difficult to meet long-term climate change goals (or vice versa). For example, regulators in California recognize that heavy investment in natural gas trucks and related infrastructure can provide short-term air pollution benefits, but may lock in a fossil fuel pathway that hinders climate change regulatory regulation. As another example, subsidies for end-of-pipe pollution control equipment can inhibit switching to clean energy as fossil fuel users do not fully internalize the costs of their fuel use. Air regulators should also take care to avoid "hot spots" (concentrated areas of local air pollution) that can be created by market mechanisms (such as carbon trading and offset schemes).

- **Context Matters.** Our aim with this report is to highlight examples of multi-pollutant coordinated governance in California. We consciously do not call these "best practices" in recognition of the ways in which local dynamics may call for different solutions. The mix of pollution sources, the level of nonattainment, geography, and climate lead to variation in the particulars of control strategy even within the state of California. As mentioned above, California's three largest air quality management districts (South Coast–Greater Los Angeles; Bay Area; and San Joaquin Valley–Central California) vary in their emphasis on NO_x or VOCs. China's greater reliance on coal in the energy mix and the greater contribution of industry to pollution relative to other sectors may call for a different blend of control strategies. The particular strategies appropriate for China will also vary according to the mix of policy priorities and governance values at play. That said, we believe that planning processes and procedures that are science-based, transparent, participatory, and accountable generate the most robust, effective, and implementable regulatory solutions.

- **Report Scope.** It is worth noting what this report hopes to accomplish, and just as importantly, what it does not intend to do. As stated above, our report seeks to highlight the conceptual and procedural commitments necessary to a coordinated and integrated approach to air and climate regulation (i.e., "coordinated governance"). This approach considers multiple pollutants and policy goals against a range of evaluation metrics. It also brings in and coordinates a broader range of stakeholders, who each have a role in some aspect of regulation. We also provide a detailed description of the key strategies and policies that emerged out of such an approach in California.

  An important, indeed essential, component of this approach is the science, modeling and technical analysis needed to understand local conditions and to connect those conditions (e.g., source mix, pollution levels, geography) to specific control strategies. The details of how to engage in such scientific inquiry, modeling, and technical analysis are largely beyond the scope of this report, but California has many public resources that describe this work in detail. We provide a brief summary of California's "Vision for Clean Air" climate modeling approach in **Appendix A.**

1.2 The Necessity of Coordinated Planning

At the heart of coordinated governance are robust integrated planning processes that evaluate ways to achieve air and climate change targets set forth in law or by executive order.

1.2.1 Traditional Air Pollutants

Coordinated governance of traditional air pollutants is driven by the legal requirements of the U.S. federal Clean Air Act and state law. The U.S. system operates on the idea of "cooperative federalism," with targets and standards set at the federal level and implementation generally handled at the state level (with federal

oversight). State-level air regulation planning is substantially organized around the development of State Implementation Plans (SIPs). In California, regional Air Quality Management Districts (AQMDs) develop Air Quality Management Plans (AQMPs) that detail local-level action to meet goals within the SIP. These processes are designed to meet the federal standards and California's own ambient air quality standards.[16]

- **State Implementation Plans.** SIPs are comprehensive plans that explain how states will meet national ambient air quality standards as required under the U.S. federal Clean Air Act. Such plans are required in "nonattainment" areas that violate standards. The Greater Los Angeles region (South Coast Air Basin) is the largest nonattainment area in the U.S., covering a population of 15,702,771 people (2010 census). This region is considered in "extreme" nonattainment of federal 1-hour and 8-hour ozone standards and "serious" nonattainment of federal 24-hour and annual $PM_{2.5}$ standards.[17]

  The SIP for the South Coast Air Basin sets attainment dates for the various standards (Table 2).

TABLE 2
South Coast AQMD Attainment Deadlines

Standard	Value	Status	Attainment Deadline
1-hr ozone (1979)	0.12 ppm	Nonattainment (extreme)	2/6/2023
8-hr ozone (1997)	0.08 ppm	Nonattainment (extreme)	6/15/2024
8-hr ozone (2008)	0.075 ppm	Nonattainment (extreme)	7/20/2032
8-hr ozone (2015)	0.070 ppm	Nonattainment (extreme)	8/3/2038
24-hr $PM_{2.5}$ (2006)	35 µg/m³	Nonattainment (serious)	12/31/2019
Annual $PM_{2.5}$ (2012)	12 µg/m³	Nonattainment (serious)	12/31/2025

Source: S. Coast Air Quality Mgmt. Dist., National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) Attainment Status for South Coast Air Basins (Feb. 2016).

- **Air Quality Management Plans.** In California, 35 regional-level air quality management districts engage in air quality management planning processes to meet these air quality standards. South Coast AQMD, which governs the Greater Los Angeles region, and the San Joaquin Valley AQMD in California's Central Valley face some of the most serious nonattainment of ozone and $PM_{2.5}$ in the United States. That said, these AQMDs have also made significant progress in reducing air pollution over the last few decades.

  The South Coast and San Joaquin Valley AQMD Air Quality Management Plans (AQMPs) are good examples of a multi-pollutant approach to traditional air pollutant regulation. The Bay Area AQMD 2017 Clean Air Plan is perhaps the best example of a regional planning document that attempts to coordinate traditional air pollutants, GHGs, and toxics.

[16] Cal. Air Res. Bd., Air Quality Standards, https://ww2.arb.ca.gov/resources/background-air-quality-standards.

[17] S. Coast Air Quality Mgmt. Dist., National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) Attainment Status for South Coast Air Basins (Feb. 2016).

In the U.S. at large, the rules pursuant to the federal Clean Air Act have recommended (but do not mandate) that states take a multi-pollutant, coordinated approach to air regulation.[18] But most parts of the country do not yet take a multi-pollutant approach to air regulation. The EPA has described the approach as such:

> Many pollution sources (e.g., industrial facilities) emit several different pollutants that directly cause health and environmental impacts or react in the environment to form other harmful pollutants. Some control technologies can reduce emissions of multiple pollutants. It can be more efficient to develop integrated control strategies that address multiple pollutants rather than separate strategies for each pollutant individually.[19]

Efforts to promote multi-pollutant planning began with a 2007 report of the Clean Air Act Advisory Committee (CAAAC) and its Air Quality Management Subcommittee, which offered detailed recommendations to transition the EPA from a "single pollutant focus" to an "integrated, multiple pollutant model."[20] EPA also led pilot efforts in North Carolina, New York, and the city of St. Louis, among other places.[21] The Obama administration promoted such an approach, but the Trump administration has not continued to do so.

The deepest U.S. experience in coordinated planning of multiple traditional air pollutants arguably still resides at the state and local levels in California.

1.2.2 Air Pollution and Climate Change

The most comprehensive multi-pollutant approaches now include traditional air pollutants, GHGs and air toxics. Coordinated governance that incorporates traditional air pollutants and GHGs is complicated by the inclusion of a broader range of sectors (energy, for example) and strategies (electrification, fuel switching, efficiency). California's current approach incorporates a broad range of sector-specific planning processes (transportation, energy, buildings) and cross-sector planning processes focused on particular types of pollutants (traditional air pollutants, GHGs, short-lived climate pollutants, air toxics).

Mobile Source Planning

The 2016 Mobile Source Strategy is California's first major attempt to take a statewide coordinated approach to the planning of air quality and climate change regulation.[22] Whereas other earlier planning efforts, such as the Climate Change Scoping Plan and the State Implementation Plan, made reference to co-benefits, the Mobile Source Strategy is more intentional in its effort to coordinate a wide range of objectives, including federal and state air quality standards, state climate change goals, state petroleum reduction targets, community health needs, and economic demands for freight growth.

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[18] *See* Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements, 80 Fed. Reg. 44, 12265,12295 (Mar.6, 2015) (to be codified at 40 C.F.R. Parts 50, 51, 52, 70, and 71) (implementing 2008 ozone NAAQS); *and* Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements, 81 Fed. Reg. 164 58010, 58135 (Aug. 24, 2016) (to be codified at 40 C.F.R. pt. 50, 51, & 93) (implementing PM2.5 NAAQS).

[19] *See* U.S. Envtl. Prot. Agency, Managing Air Quality—Multi-Pollutant Planning and Control (Aug. 23, 2019), https://www.epa.gov/air-quality-management-process/managing-air-quality-multi-pollutant-planning-and-control.

[20] U.S. Envtl. Prot. Agency Clean Air Act Advisory Comm. Air Quality Management Subcommittee, Recommendations to the Clean Air Act Advisory Committee: Air Quality Management Subcommittee Phase II Recommendations at 6.

[21] U.S. Envtl. Prot. Agency, Pilot Areas, https://archive.epa.gov/airquality/aqmp/web/html/pilot.html (Feb. 23, 2016) (last visited May 20, 2020). The U.S. EPA also has pilot projects in Detroit, South Carolina, and the California Bay Area.

[22] California law requires CARB to update this 2016 Mobile Source Strategy by January 1, 2021, and every five years thereafter. *See* Cal. Air Res. Bd., Mobile Source Strategy, at 24 (May 2016), https://ww2.arb.ca.gov/resources/documents/2020-mobile-source-strategy.

Specifically, the Mobile Source Strategy attempts to coordinate the following planning processes:

- State SIP Strategy (and local AQMPs);
- Climate Change Scoping Plan;
- Short-Lived Climate Pollutants Strategy;
- Diesel Risk Reduction Plan;
- SB 375 regional transportation and housing planning (to reduce vehicle miles traveled);
- Sustainable Freight Action Plan (*no longer active*); and
- AB 617 Community Air Protection Program.

California developed a multi-pollutant scenario planning tool called *Vision for Clean Air 2.1*, that models ozone and $PM_{2.5}$ precursor emissions, GHG emissions, diesel toxics emissions, and petroleum usage with different vehicle technologies, energy sources, and fuels.[23]

Air Quality Planning

The key air quality planning processes (which are cross sector in nature) have also integrated climate change considerations to varying extents. The best example of comprehensive multi-pollutant planning arising out of the air quality planning context is the Bay Area AQMD's Clean Air Plan process.[24] Bay Area AQMD developed a Final 2017 Clean Air Plan that expressly considers GHG and traditional air pollution control strategies in a coordinated fashion. It first took such a coordinated approach in its 2010 Clean Air Plan.[25]

South Coast AQMD's 2016 AQMP also offers detailed analysis of the climate and energy aspects of air quality regulation, although it is fair to say that the SCAQMD AQMP is organized primarily around the traditional air pollutant requirements of the Clean Air Act, and not focused in any significant way on GHG emissions. In 2011, SCAQMD's Governing Board passed an "Air Quality-Related Energy Policy" that sets forth ten policies and ten actions, including promotion of zero and near-zero emission technologies in stationary and mobile applications, zero or near-zero emission electricity supply, demand side management energy efficiency programs, among other things.[26] South Coast AQMD has also put out white papers analyzing regional residential and commercial energy and future energy needs in the region.[27]

These examples from the Bay Area and South Coast AQMD offer examples of coordinated air and climate governance in the two largest economic regions in California.

Climate Change Planning

The 2017 Scoping Plan Update pursuant to California Assembly Bill 32 (AB 32) includes consideration of air pollution co-benefits in various respects. For example, regulators are required by law to evaluate each measure proposed in the climate change scoping plan according to three criteria:

- GHG emissions changes;
- Traditional air pollutant changes; and
- Cost-effectiveness, including avoided social costs.

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[23] Cal. Air Res. Bd., Vision 2.1 Scenario Modeling System: General Model Documentation 30-34 (Feb. 2017). *See* Appendix A to this report for a summary of this modeling approach.

[24] *See, e.g.*, Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1.

[25] *Id.* at 1/18.

[26] *See* S. Coast Air Quality Mgmt. Dist., Attachment A: AQMD Air Quality-Related Energy Policy (Sept. 9, 2011).

[27] *See generally* S. Coast Air Quality Mgmt. Dist., 2016 AQMP White Papers, https://www.aqmd.gov/nav/about/groups-committees/aqmp-advisory-group/2016-aqmp-white-papers (last visited May 20, 2020).

These requirements are set forth in AB 197 (2016) and constitute a legal requirement to engage in coordinated governance of air pollution and climate change. Note that this law requires the quantification and disclosure of air pollution co-benefits when making climate change policy. California should consider a legal requirement that requires similar calculations in the air quality management planning process. While air regulators have researched and considered GHG emissions benefits, a clear legal requirement would lead to better consideration of the climate co-benefits of air pollution regulation.

TABLE 3
Ranges of Estimated Air Pollution Reductions by Policy or Measure in 2030

Measure	Range of NO_x reductions (tons/day)	Range of VOC reductions (tons/day)	Range of $PM_{2.5}$ reductions (tons/day)	Range of Diesel PM reductions (tons/day)
50 percent RPS	~0.5	< 0.1	~0.4	< 0.01
Mobile Sources CTF and Freight	51–60	4.6–5.5	~1.1	~0.2
18 percent Carbon Intensity Reduction Target for LCFS - Liquid Biofuels*	3.5–4.4	0.5–0.6	0.4–0.6	~0.5
Short-Lived Climate Pollutant Reduction Strategy	–	–	–	–
2x additional achievable energy efficiency in the 2015 Integrated Energy Policy Report (IEPR)	0.4–.05	0.5–0.7	< 0.1	<0.01
Cap-and-Trade Program	**	**	**	4–9

* LCFS estimates include estimates of the NO_x and $PM_{2.5}$ tailpipe benefits limited to renewable diesel consumed in the off-road sector.
– CARB is evaluating how to best estimate these values. Criteria and toxic values are shown in tons per day, as they are episodic emissions events with residence times of a few hours to days, unlike GHGs, which have atmospheric residence times of decades.
** Due to the inherent flexibility of the Cap-and-Trade Program, as well as the overlay of other complementary GHG reduction measures, the mix of compliance strategies that individual facilities may use is not known. However, based on current law and policies that control industrial and electricity generating sources of air pollution, and expected compliance responses, CARB believes that emissions increases at the statewide, regional, or local level due to the regulation are not likely. A more stringent post-2020 Cap-and-Trade Program will provide an incentive for covered facilities to decrease GHG emissions and any related emissions of criteria and toxic pollutants.

Source: Cal. Air Res. Bd., California's 2017 Climate Change Scoping Plan 38 (Nov. 2017).

These measures, as required by AB 197, also enable CARB to make a calculation of the health co-benefits of GHG reduction measures, which also reduce particulate matter, toxic air pollution, and other pollution.[28]

1.3 Coordinating Fragmented Institutions

Coordinated governance is made more challenging by the need to coordinate the work of multiple actors at different levels of government and in the private sector. Both areas addressed in this report (traditional air pollutant co-control; traditional air pollutant and GHG co-control) raise difficult institutional coordination issues.

[28] Cal. Air Res. Bd., California's 2017 Climate Change Scoping Plan 47 – 49 (Nov. 2017).

1.3.1 Traditional Air Pollutant Co-Control

The coordinated governance of multiple air pollutants is made more complicated in the California context by the distribution of regulatory authorities, both vertically (levels of government) and horizontally (across agencies, sectors, jurisdictions, etc.). South Coast and Bay Area AQMDs, for example, have direct regulatory authority over stationary sources, but not mobile source standards (emissions, fuel efficiency, etc.) for cars, trucks and off-road vehicles. The AQMDs also have no authority over ocean-going vessels, locomotives, and airplanes. In California, authority over mobile source emissions standards is situated at the state-level. The federal government, on the other hand, sets fuel economy standards. The federal government, under the Trump administration, is currently arguing that California's mobile source emissions standards authority for GHGs can and should be withdrawn. The division of authorities (and disputes over the allocation of authorities) creates problems for coordinated governance.

1.3.2 Traditional Air Pollutant and GHG Co-Control

A coordinated approach to air quality and climate change regulation involves even more complicated institutional coordination challenges, particularly in coordinating traditional environmental regulation and energy regulation. Such an approach necessarily invokes a broader range of sectors, including energy, buildings, and land-use planning, that have traditionally been less central to air quality regulation (with its focus on industrial and mobile sources). The following is an overview of the diverse institutions that play some role in air and climate coordinated governance.

- **Federal institutions.** U.S. EPA, U.S. Dept. of Transportation, U.S. Dept. of Energy, National Highway Transportation Safety Administration (NHTSA), Council of Economic Advisors, Office of Management and Budget (OMB);
- **State-level institutions.** California Air Resources Board (CARB), California EPA, California Energy Commission (CEC), California Public Utilities Commission (CPUC), California Independent System Operator (CAISO), California Natural Resources Agency, Governor's Office of Planning and Research (OPR), Caltrans, and others;
- **Regional and local-level institutions.** Air Quality Management Districts (South Coast, Bay Area, San Joaquin Valley), Southern California Association of Governments (SCAG), local transportation commissions, transit districts, rail operators, cities and counties, fire and building departments, local ports (Port of Los Angeles & Long Beach), Los Angeles Department of Water & Power (LADWP);
- **Private actors.** Investor-owned utilities (Pacific Gas & Electric (PG&E), Southern California Edison), railroads, vehicle companies (e.g., BYD), original equipment manufacturers (OEMs);
- **Civil society actors and citizens.** Environmental groups, universities, community groups, associations, law firms, media.

Foreign governments and international organizations can influence U.S. regulation as well via formal treaties and agreements or direct action. For example, United Nations conventions, treaties, and other coordination initiatives; transboundary air pollution agreements; and international organizations, such as the International Maritime Organization (IMO) and International Civil Aviation Organization (ICAO), all can affect U.S. regulation. Other examples include the effect of foreign port rules on shipping emissions, the California-Quebec agreement linking carbon markets in the two jurisdictions, and others.

TABLE 4
Institutional Actors for Air & Climate Governance

	Air	Energy	Transport	Planning	Other
Federal	U.S. EPA	U.S. DOE	U.S. DOT, NHTSA	White House Council on Environmental Quality (CEQ)	Council of Economic Advisors, OMB
State	CARB	CEC, CPUC, CAISO	CARB, Caltrans	OPR, CalEPA	
Regional / Local	AQMDs	LADWP	Transportation commissions, transit districts	SCAG, local government planning depts.	Local ports, city and county regulatory authorities, (e.g., land use, fire, building), municipal utilities
Non-state	Investor-owned utilities, environmental groups, universities, community groups, associations, law firms, media, rail operators & vehicle cos (BYD), OEMs				
International	UNFCCC, IMO, ICAO, transboundary air pollution agreements, foreign government partnerships				

This report focuses primarily on actors at the **state**, **regional**, and **local** levels.

Planning processes can help to coordinate these diverse actors, but strong leadership and long-term relationships among staff within these institutions is essential to coordinated governance; otherwise, fragmentation and competition among these institutions are likely to create challenges for coordinated governance.

1.4 Recommendations

We describe our recommendations in greater detail in **Chapter 4**. In short, we make three main recommendations with various specific measures in each category.

1. **Adopt a coordinated approach to air and climate governance that attempts to maximize co-benefits among traditional air pollutants, GHGs, and air toxics.**

2. **Establish the processes & procedures for multi-pollutant planning and coordinated governance.** These include monitoring, robust emissions inventories, and modeling of various sorts. Require evaluation and consideration of multi-pollutant co-benefits in planning. Incorporate important public values like environmental justice (distribution of harms) and just transition (employment impacts) into planning. Conduct planning in a transparent, participatory way.

3. **Incorporate rules and policies that maximize air and climate co-benefits in the transportation, land use planning, energy, buildings, and industrial sectors.** Institute effective enforcement and compliance mechanisms to ensure implementation.

The next two chapters provide further detail on coordinated governance in the areas of traditional air pollutant control and air quality and climate change co-control. These chapters will discuss the specific targets and plans, the control strategies, and the policies and regulatory tools used to achieve these complex objectives.

CHAPTER TWO — COORDINATED GOVERNANCE OF TRADITIONAL AIR POLLUTANTS

We begin our discussion of coordinated governance in California with a focus on the regulation of multiple *traditional air pollutants.* This is an area in which California is a world leader with long-standing experience over more than half a century.[29] It is also, as of this writing, the subject of ongoing regulatory development and a core objective of air quality regulation in China. We believe that a comprehensive approach should integrate consideration of traditional air pollutants, GHGs and air toxics. Nonetheless, we still believe that California experience in coordinated regulation of traditional air pollutants is instructive and worthy of attention.

Coordinated governance is operationalized in California through the process of developing an Air Quality Management Plan (AQMP), which is "a thorough analysis of existing and potential regulatory control options, includes available, proven, and cost-effective strategies, that seeks to achieve multiple goals in partnership with other entities promoting reductions in greenhouse gases and toxic risk, as well as efficiencies in energy use, transportation, and goods movement."[30]

Along these lines, the South Coast Air Quality Management District states:

> An integrated control strategy addressing multiple objectives provides for a more efficient path in meeting all clean air standards, including the federal $PM_{2.5}$ and ozone standards. For example, the NO_x emission reductions that are needed for ozone attainment also reduce $PM_{2.5}$ to attainment levels. Therefore, allocating resources towards NO_x reductions is a more cost-effective strategy than separately implementing controls that only benefit $PM_{2.5}$. Furthermore, in designing an integrated control strategy to achieve the ozone and $PM_{2.5}$ air quality standards, consideration must be given to the health of the public, the economic well-being of the region, and challenges for local business. History has shown that air quality levels can be greatly improved while maintaining a growing and vibrant economy.[31]

State and federal approaches emphasize the "health, environmental and economic" benefits of coordinating multiple policy goals, such as "reducing concentrations of ozone, particulate matter, and hazardous air pollutants (HAPs) such as mercury" in coordination with planning of transportation and energy needs or other priorities.[32] The California state approach expressly considers enforceability, public acceptability, environmental justice, legality, and other considerations as well.

While this report encourages a comprehensive multi-pollutant management approach that includes traditional air pollutants, GHGs, and toxics, even multi-pollutant approaches that only focus on traditional air pollutants have been shown to have substantial cost savings as compared to single traditional air pollutant approaches. Wesson, et al. (2010), for example, compared multi-pollutant and single-pollutant "status quo" approaches to traditional air pollutant air quality management in the Detroit area and found that

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[29] S. Coast Air Quality Mgmt. Dist., The Southland's War on Smog: Fifty Years of Progress Toward Clean Air (Through May 1997), https://www.aqmd.gov/home/research/publications/50-years-of-progress (last visited May 20, 2020); Bay Area Air Quality Mgmt. Dist., History of the Air District, https://www.baaqmd.gov/about-the-air-district/history-of-air-district (last visited May 20, 2020).

[30] S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan ES-1 (Mar. 2017).

[31] *Id.* at 4-1.

[32] *Id.*

the "multi-pollutant, risk-based" approach could: "achieve the same or greater reductions of $PM_{2.5}$ and O_3" while more cost-effectively producing "approximately two times greater monetized benefits for $PM_{2.5}$ and ozone."[33]

We note that the two jurisdictions in California that face the most serious air quality problems —South Coast AQMD in the Greater Los Angeles area and San Joaquin Valley AQMD in Central California—have determined that a NO_x-heavy strategy is the most effective way to address ozone and $PM_{2.5}$ problem. This is primarily because NO_x reductions help to reduce both ozone and secondary $PM_{2.5}$ formation. The discussion below explains in particular why SCAQMD chose to emphasize NO_x control over VOC strategies, and why the Bay Area AQMD did not. Moreover, NO_x and VOC measures to meet ozone standards are not sufficient on their own to meet $PM_{2.5}$ standards, and the SCAQMD AQMP proposes additional $PM_{2.5}$ measures to ensure attainment of $PM_{2.5}$ requirements.

2.1 Background

2.1.1 Federal Law

The federal Clean Air Act (CAA), enacted in 1970, is the basic framework for air quality regulation throughout the United States.[34] The CAA requires the United States Environmental Protection Agency (EPA) to set national standards for the traditional air pollutants, called "criteria pollutants": ozone, $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and lead. These are called National Ambient Air Quality Standards, or NAAQS. "Primary" standards must be protective of public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. "Secondary" standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. The NAAQS standards are reviewed periodically by the EPA through a process involving scientific analysis and public participation and updated where appropriate.

The obligation to meet the federal standards is borne, in the first instance, by the states or by areas of states known as air basins. If a state or air basin is not in compliance with a federal air quality standard using EPA-approved testing methodology, it is said to be in "nonattainment" for that standard and must create and submit to the EPA for approval a state implementation plan, commonly called a SIP, which provides an enforceable plan for reaching attainment for the pollutant in question. Time periods to come into attainment vary depending on how serious the problem is.

So as not to make bad air worse, new transportation and related projects in a nonattainment area must demonstrate—with a so-called *conformity analysis*—that they will not make attainment of federal standards more difficult.[35] Many other major new projects or major upgrades in nonattainment areas must offset their projected emissions by a ratio of 1.2/1 or sometimes more, by buying credits or buying and shutting down other sources of emissions.[36]

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[33] Karen Wesson, et al., *A Multi-Pollutant, Risk-Based Approach to Air Quality Management: Case Study for Detroit*, 1:4 Atmospheric Pollution Res. 296–304 (Oct. 2010).

[34] A useful overview of the CAA can be found on the U.S. EPA's website. *See* U.S. Envtl. Prot. Agency, Summary of the Clean Air Act, https://www.epa.gov/laws-regulations/summary-clean-air-act (last visited May 20, 2020).

[35] U.S. Dep't of Transp., Transportation Conformity: A Basic Guide for State & Local Officials 1 (Feb. 2017).

[36] *See* 40 C.F.R. Appendix S to pt. 51. Some of the offset ratios for ozone nonattainment areas are the following: at least 1.1:1 in marginal nonattainment areas, at least 1.15:1 in moderate nonattainment areas, and at least 1.2:1 in serious nonattainment areas.

For example, the South Coast Air Basin in Southern California is in nonattainment for ozone at the eighty parts per billion level, and must reach attainment by 2024.[37] It is also in nonattainment for twenty-four hour and annual standards regarding particulate matter 2.5 microns or less ($PM_{2.5}$).

Sanctions for failing to come into attainment in the time allotted can be very serious and can include a cutoff of federal transportation funds to the area as well as a federally enforceable increased offset requirement for new major projects. Moreover, if the EPA finds that a SIP will not produce attainment conditions, the EPA can impose a Federal Implementation Plan in lieu of an adequate state plan. These sanctions can have a powerful negative economic effect on a region. Thus, officials in regions such as the South Coast Air Basin are highly motivated to meet the NAAQS standards.

These legal requirements of the Clean Air Act are the drivers of a coordinated approach. The need to meet multiple regulatory goals under threat of penalty and the reality of limited (i.e., insufficient) regulatory resources create the incentives for local regulators to identify the most efficient and effective approaches to achieving their goals.[38]

2.1.2 California Law

California has a bifurcated system of air quality regulation. Stationary sources such as power plants or oil refineries are regulated by delegation of EPA authority to local air basin agencies such as the South Coast Air Quality Management District (SCAQMD) in the Los Angeles area and Bay Area Air Quality Management District (BAAQMD) in the San Francisco/Oakland area. Major new stationary sources and significantly upgraded facilities must obtain a permit from relevant AQMD that limits their emissions, and those sources are subject to extensive monitoring and reporting requirements. California also regulates GHG emissions from most stationary sources on a statewide basis by its cap-and-trade program, discussed below in Chapter 3.

Mobile sources are regulated by the state-level California Air Resources Board (CARB). For example, CARB has promulgated regulations about permissible truck engine ages for port and rail yard drayage, and for general on-road trucking. Under federal law, California is the only state that may set its own tailpipe emission standards if certain criteria are met.[39] CARB also regulates the at-berth emissions of cargo ships, requiring most large ships to use (electric) shore power or its equivalent when at dock in California ports.

One particularly important CARB function is regulating NO_x emissions from mobile sources. This is because smog (ground-level ozone) is a major problem, especially in Southern California, and ozone is formed when NO_x and volatile organic compounds (VOCs) interact in the atmosphere. Like South Coast AQMD, CARB has chosen to attack the ozone problem primarily through limiting NO_x emissions.[40] Led by California, there is at present a unified California and federal rule regulating NO_x emissions from heavy-

[37] *See* Table 2 for a list of all ozone and $PM_{2.5}$ standards for which SCAQMD is in nonattainment.

[38] China has arguably sought to achieve this dynamic through the establishment of environmental hard targets and potential punishments for party and government leaders who fail to meet these targets. But despite the calls for coordinated governance within China, the major emphasis of traditional air pollutant control has been $PM_{2.5}$. Hard targets for both ozone *and* $PM_{2.5}$ that are the obligation of Party-state leaders at each level of government will create the need to develop stronger coordinated governance approaches.

[39] Other states may opt into California's standards. As of this writing, California's right to set its own tailpipe GHG emission limits is under challenge by the federal government.

[40] *See* Cal. Air Res. Bd., Nitrogen Dioxide & Health, https://ww2.arb.ca.gov/resources/nitrogen-dioxide-and-health (last visited May 20, 2020).

duty truck engines manufactured in 2010 or later.[41] However, vehicle technology has advanced since this regulation was enacted and there are now truck engines on the market with one-tenth the NO_x emissions of the state and federal rule.[42] Accordingly, both CARB and the U.S. EPA have begun rulemaking processes to lower the NO_x emission limits for heavy-duty truck engines.[43] In addition, in June 2020, CARB voted to adopt new regulations requiring that, starting in 2024, a significant percentage of medium- and heavy-duty trucks sold in California be zero-emission by 2035 or earlier.[44]

CARB has also enacted a zero-emission light duty vehicle requirement to reduce both traditional air pollutant and GHG emissions.[45] As noted above, California's ability to enact a zero-emission requirement for GHG reduction purposes is now under challenge by the federal government.

Finally, when a SIP is required, the local air district creates it for submission to CARB, which reviews and approves it before submitting it to the U.S. EPA (the federal level) for final review and approval. Public hearings accompany each stage of this process. Ideally, CARB and the local air districts work cooperatively to meet federal air quality requirements but in practice, this is not always so. Cooperation can break down because of the divided regulatory authority between mobile and stationary sources and the difficulty of achieving attainment at the local or regional level. For example, NO_x attainment in the South Coast basin will rely on mobile source emissions reduction, but SCAQMD cannot guarantee those reductions given CARB's and the U.S. EPA's authority over mobile source NO_x emissions.[46] Policymakers in China will want to be attentive to the challenges created by fragmented regulatory authorities as well.

2.2 California's Regional Air Quality Management Districts

Thirty-five regional air quality management districts sit at the front lines of air quality regulation in California. The three largest of these are South Coast AQMD (Greater Los Angeles), Bay Area AQMD (San Francisco/Oakland), and San Joaquin Valley AQMD (Central Valley). This section describes the varied approaches taken in these AQMDs, which reflect differences in the nature and severity of their pollution problems, source mix, geographic and climatic differences and other factors.

2.2.1 South Coast AQMD

South Coast AQMD has taken a coordinated, multi-pollutant approach in particular in its emphasis on NO_x regulation as a way to combat ozone and $PM_{2.5}$ pollution. SCAQMD has also incorporated assessments of co-benefits from state and federal air and climate change regulation and regional transportation planning measures.

SCAQMD was formed in 1977 to create a regional air management district combining Los Angeles, Orange, Riverside, and San Bernardino Counties in Southern California (an area of approximately 10,743 square miles). This is a region with a population of more than 17 million people (roughly half of California's

[41] *See* U.S. Envt'l Prot. Agency, Heavy Duty Compression-Ignition Engines and Urban Buses: Exhaust Emission Standards 3 (Mar. 2016).

[42] *See, e.g.*, Cal. Nat. Gas Vehicle Partnership, https://cngvp.org/natural-gas-vehicles. We note, however, concerns about the negative impact of natural gas trucking investment and infrastructure on long-term climate change goals.

[43] *See* U.S. Envtl. Prot. Agency, Regulations for Emissions from Vehicles and Engines: Cleaner Trucks Initiative, https://www.epa.gov/regulations-emissions-vehicles-and-engines/cleaner-trucks-initiative (last visited May 20, 2020); Cal. Air Res. Bd., Heavy-Duty Low NO_x Program: Proposed Heavy-Duty Engine Standards at a Diamond Bar, CA Public Workshop (Sept. 26, 2019).

[44] *See* discussion of the Advanced Clean Trucks Rule below at pp. 50-51.

[45] See discussion of the Advanced Clean Cars Program below at pp. 44-50.

[46] Such challenges of vertical coordination are present in the Chinese system, although the dynamics differ from the U.S. context.

overall population). SCAQMD regulates about 28,400 permitted businesses. About 25% of traditional air pollutant emissions in the region come from stationary sources (commercial and residential). About 75% of emissions come from mobile sources - primarily cars, trucks, and buses but also off-road (construction) equipment, ships, trains, and airplanes. SCAQMD's annual budget is approximately USD $162 million, supporting a staff of 876.[47] SCAQMD is overseen by a thirteen-person governing board.

FIGURE 1
Map of South Coast Air Quality Management District

California Air Districts

Sources: Cal. Air Res. Bd., Map: California Map for Local Air District Websites, https://ww3.arb.ca.gov/capcoa/dismap.htm; S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 1-4.

The Air Quality Management Plan

Every four years, SCAQMD prepares an air quality management plan (AQMP) for submission first to CalEPA/CARB and then to the U.S. EPA, to show how it plans to meet NAAQS attainment goals. This is a public process with scores of workgroup meetings. The final product, after regulatory approvals, becomes part of the State Implementation Plan and is thus enforceable in court by citizens. The most recent 2016 AQMP was approved in March 2017. The SCAQMD Governing Board has approved past AQMPs in 1989, 1991, 1994, 1997, 1999, 2003, 2007 and 2012.

Adoption of Control Measures

The 2016 AQMP describes the theories behind the adoption of control measures. It recognizes that "the magnitude of the NO_x emission reductions needed for attainment of the ozone NAAQS poses the most

[47] S. Coast Air Quality Mgmt. Dist., Budget Fiscal Year 2018-2019, at 12.

significant challenge. This challenge requires an aggressive mobile source control strategy supplemented with focused and strategic stationary source control measures, and close collaboration with federal, state, and regional governments, businesses, and the public."

With respect to co-control, the AQMP recognizes that, "[t]he total required emission reductions, technology readiness, cost-effectiveness, economic impacts, and interaction with other attainment deadlines for all pollutants are critical considerations in developing an integrated multi-pollutant control strategy."[48]

SCAQMD uses the following tools to achieve its goals:

- Regulation;
- Promotion and deployment of cleaner technologies;
- Dissemination of "best practices;"
- Incentives; and
- Co-benefits from climate and energy efficiency programs.

This mix of regulatory approaches in part reflects the fact that AQMDs do not have direct regulatory authority over mobile sources, shipping, aviation, and trains. SCAQMD must therefore address emissions from these sources through education, financial and other incentives, and government procurement.

The specific factors and values considered by SCAQMD in adopting control measures include:

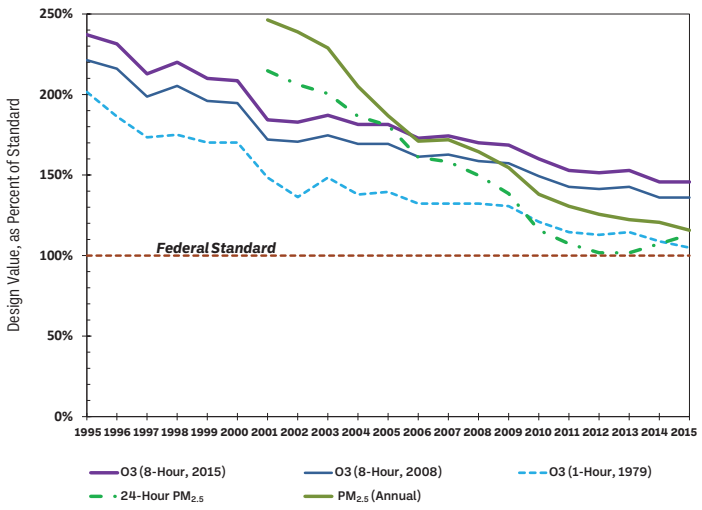
- **Cost-Effectiveness.** The cost of a control measure per reduction of emissions of a particular pollutant (cost includes purchasing, installing, operating, and maintaining the control technology).
- **Emission Reduction Potential.** The total amount of pollution that a control measure can reduce.
- **Enforceability.** The ability to ensure compliance with a control measure.
- **Legal Authority.** The ability of the SCAQMD or other adopting agency to legally implement the measure.
- **Public Acceptability.** The likelihood that the public will approve or cooperate in the implementation of a control measure. While not explicitly stated, this is understood to include consideration of economic impacts.
- **Rate of Emission Reduction.** The time it will take for a control measure to reduce a certain amount of air pollution.
- **Technological Feasibility.** The likelihood that the technology for a control measure is or will be available.[49]

These measures have helped to reduce the concentrations of ozone and $PM_{2.5}$ in SCAQMD, but the district still faces serious nonattainment problems, particularly with ozone.

[48] S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan 4-1 – 4-2 (2016).

[49] *Id.* at 4-4.

FIGURE 2
Ozone & $PM_{2.5}$ Levels (as a Percentage of Standard)



Source: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 1-10.

Ozone and NO_x Control Strategy

The South Coast Air Basin has never been in attainment of the NAAQS for ozone. The primary causes of local ozone pollution are mobile sources, especially NO_x emissions from heavy-duty diesel trucks associated with commerce at the Ports of Los Angeles and Long Beach. Like Beijing, Los Angeles often suffers from temperature inversions that trap local pollutants and lead to the formation of more ozone through the reaction of NO_x and VOCs in the atmosphere. Due to local geography and climate, and based on extensive data collection and modeling, SCAQMD has adopted NO_x limitation as its primary ozone decrease strategy as NO_x mitigation contributes both to the reduction of ground-level ozone and secondary $PM_{2.5}$. The discussion below will elaborate on how SCAQMD has allocated relative effort between NO_x and VOC control based on a multi-pollutant analysis.

Chinese regulators may be particularly interested in the SCAQMD approach because many Chinese cities and regions similarly face problems of high levels of ozone *and* $PM_{2.5}$.

SCAQMD's self-described approach to air quality management includes: (i) monitoring, (ii) emissions inventories, (iii) air quality modeling, (iv) planning, (v) rulemaking, (vi) enforcement and education, and (vii) technological innovation.[50] Our focus in this report is on planning and the implementation of control strategies and policies (through rulemaking, education, incentives, etc.), but we reference some of the other aspects of the approach below as well.

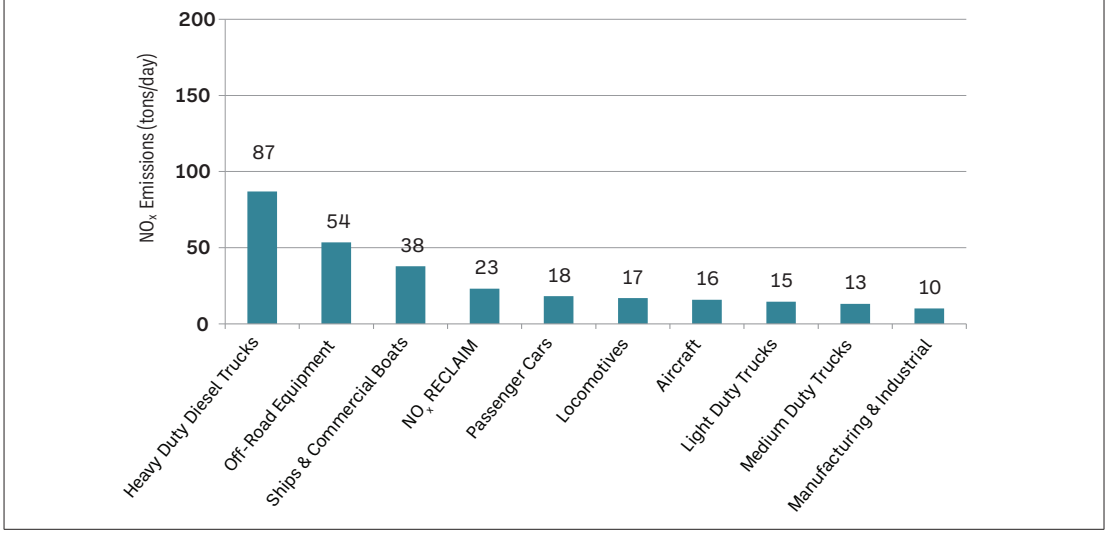
SCAQMD obtains information from, among other places, a network of 43 monitoring stations. SCAQMD works with CARB and the Southern California Association of Governments (SCAG)[51] to estimate the sources of the district's air pollution problems. These estimates show that the vast majority of NO_x emissions

[50] *Id.* at 7–9.

[51] SCAG is the metropolitan planning association representing six counties, 191 cities, and more than nineteen million residents in the greater Los Angeles region.

in the district arise out of mobile sources—heavy duty diesel trucks, off-road (construction) equipment, ships and commercial boats, passenger cars, locomotives, aircraft, light duty trucks, and medium duty trucks. Industrial facilities (stationary sources identified below under "NO_x RECLAIM") make up the next largest category of NO_x emissions.

FIGURE 3
SCAQMD Top Ten Emitter Categories for NO_x in 2019 (Summer Planning)



Source: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 3-33.

Stationary Sources. With respect to stationary sources of NO_x, SCAQMD is taking five regulatory measures.[52] These are achieved through a mix of mandates and incentives.

- **Zero and Near-Zero Emission Combustion Technologies.** Reduction of NO_x emissions from traditional combustion sources, such as diesel back-up generators, by replacing older, high-emitting equipment with new, lower or zero-emitting equipment. This includes low NO_x emitting equipment, electrification, battery storage, process changes, efficiency measures or fuel cells for combined heat and power to improve or replace engines, turbines, boilers and other equipment used for power (facility or distributed), heating or steam production.

- **Zero and Near-Zero Emission Commercial & Residential Appliances.** Emission reductions from unregulated commercial space heating furnaces and from regulations and incentives to replace existing older boilers, water heaters, and space heating furnaces and other natural gas or liquefied petroleum gas (LPG) equipment with zero emitting or lower NO_x technologies.

- **Non-Refinery Flares.** Utilization of excess gas from non-refinery flares.

- **Restaurant Burners & Residential Cooking.** Reductions from commercial restaurant burners and residential cooking appliances.

[52] S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 4-13 – 4-15.

- **Best Available Retrofit Control Technology (BARCT).** Transitioning the RECLAIM program (industrial source cap-and-trade program) into a command and control regulatory structure requiringindustrial sources to meet best technology requirements (meeting a BARCT standard).[53]

SCAQMD also recognizes traditional air pollutant co-benefits from GHG programs, policies and incentives, building energy efficiency measures and emissions reductions from cool roof technology.[54]

Mobile Sources. With respect to mobile sources of NO_x, which are the biggest problem in the South Coast area, the AQMD adopted for consideration fifteen control measures, not all of which are being implemented. These measures are described in Table 5.

[53] RECLAIM is a cap-and-trade system for stationary source NO_x emissions that SCAQMD has had in place for two decades. California state law required RECLAIM to be at least as effective in controlling NO_x emissions as the best available retrofit control technology. However, the RECLAIM program suffered from an over-allocation of credits and a failure to ensure timely control technology compliance and so, under community pressure, the South Coast Governing Board voted to abandon it in favor of a command and control system for stationary sources of NO_x. The implementing regulations are being drafted as of the time of this writing.

[54] S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 4-16.

TABLE 5
SCAQMD Mobile Source Eight-Hour Ozone Measures

Emission Growth Management Measure:
EGM-01 Emission Reductions from New Development and Redevelopment Projects
Facility-Based Mobile Source Measures:
MOB-01 Emission Reductions at Commercial Marine Ports
MOB-02 Emission Reductions at Rail Yards and Intermodal Facilities
MOB-03 Emission Reductions at Warehouse Distribution Centers
MOB-04 Emission Reductions at Commercial Airports
On-Road Mobile Source Measures:
MOB-05 Accelerated Penetration of Partial Zero-Emission and Zero-Emission Vehicles
MOB-06 Accelerated Retirement of Older Light-Duty and Medium-Duty Vehicles
MOB-07 Accelerated Penetration of Partial Zero-Emission and Zero-Emission Light-Heavy- and Medium-Heavy Duty Vehicles
MOB-08 Accelerated Retirement of Older On-Road Heavy-Duty Vehicles
MOB-09 On-Road Mobile Source Emission Reduction Credit Generation Program
Off-Road Mobile Source Measures:
MOB-10 Extension of the SOON Provision for Construction/Industrial Equipment
MOB-11 Extended Exchange Program
MOB-12 Further Emission Reductions from Passenger Locomotives
MOB-13 Off-Road Mobile Source Emission Reduction Credit Generation Program
Incentive Program Measure:
MOB-14 Emission Reductions from Incentive Programs

Source: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 4-25 – 4-26.

A few illustrative measures are described in greater detail below:

Diesel Truck Incentives. One control measure adopted by SCAQMD is the replacement of the regional diesel truck fleet through incentive payments. The estimated cost of this huge task was USD $1 billion per year for fifteen years. SCAQMD did not identify a funding source and has fallen far short of the funding that it claims to need. At present, there is no realistic prospect that the local truck fleet will be substantially cleaner by 2023 when SCAQMD faces its next NAAQS attainment date.

Indirect Source Rule. In theory, CARB and the U.S. EPA, not SCAQMD, regulate mobile sources of NO_x. However, a tool available to SCAQMD under federal law is an indirect source rule (see control measures MOB-01 through MOB-04 above), a regulation that treats as a stationary source an area where many mobile sources congregate. This is a hybrid of mobile source and stationary source regulation. Mobile source emissions associated with a port, railyard, or warehouse district are examples of what might be regulated with an indirect source rule; such regulation could lead to a modernization of the diesel truck fleet. This regulation can have economic impacts on industry and so can be controversial. The South Coast Governing Board is considering rulemaking under this theory, including an indirect source rule for the Southern California ports and for the associated inland warehouses, but is encountering substantial opposition from industry.

As it stands today, SCAQMD has little chance of meeting its 2024 ozone attainment requirement because local NO_x emissions are far too high. Although it has the ability to reduce NO_x emissions from stationary sources and by implementing indirect source rules, political concerns are making those changes difficult.

Ozone and VOC Control Strategy

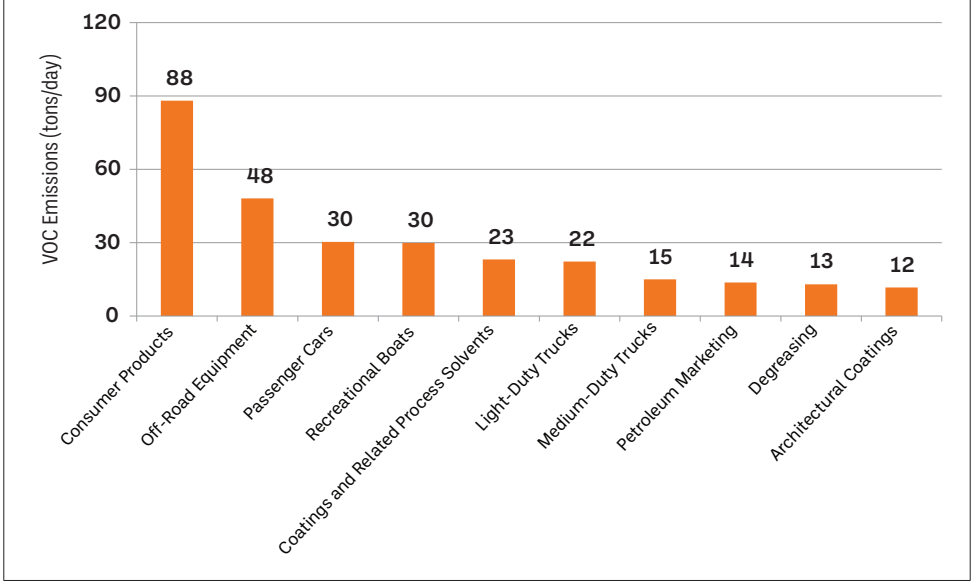
South Coast AQMD also looked into the efficacy of controlling ozone by reducing VOCs in a 2015 white paper in the course of deciding on a NO_x-heavy strategy.[55] The white paper evaluated the need for additional volatile organic compound (VOC) controls to achieve more stringent annual fine particulate matter ($PM_{2.5}$) and 8-hour ozone standards in the South Coast Air Basin. It also assessed the role of VOCs in forming ozone and $PM_{2.5}$ to inform policymakers of the most efficient and effective strategies to attain the federal standards that are the subject of the upcoming 2016 Air Quality Management Plan (AQMP). The following material is adapted from that white paper.

VOCs are carbon-containing chemicals found in fuels, solvents, coatings, cleaning supplies, building products, and other materials. VOCs readily evaporate (hence "volatile") or are emitted as a byproduct of combustion processes, such as wood burning, power generation, or internal combustion engines. Sources of VOCs include mobile sources (e.g., cars and trucks), and stationary sources (e.g., refineries, chemical plants, and homes). Once VOCs enter the atmosphere, they react with NO_x in the presence of sunlight to form surface level ozone pollution and particulate matter.

[55] *See, e.g.*, S. Coast Air Quality Mgmt. Dist., VOC Controls.

The chart below shows estimated sources of VOCs in SCAQMD in 2019.

FIGURE 4
SCAQMD Top Ten Emitter Categories for VOC in 2019 (Summer Planning)



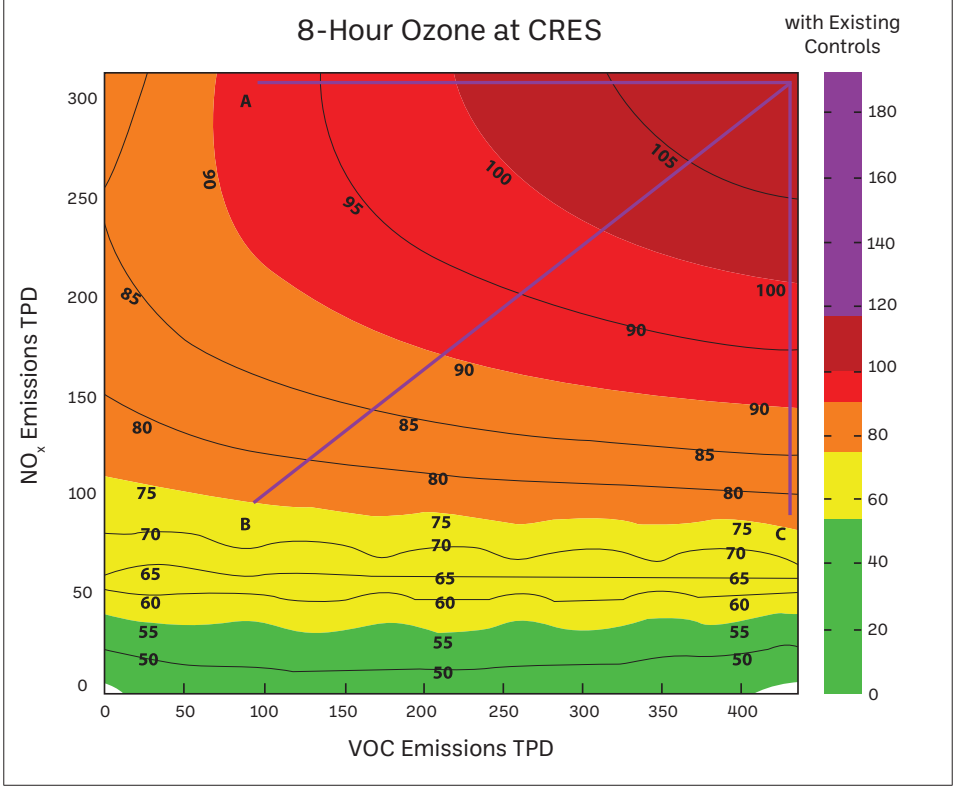
Source: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 3-30.

The chemistry of ozone is beyond the scope of this report, but suffice it to say that ozone formation depends on NO_x and VOC levels, as well as the ratio of NO_x and VOC concentrations. Increased NO_x emissions can actually reduce ozone concentrations in "NO_x rich" areas near the emission source, and NO_x reductions in such areas can cause ozone levels to increase (often referred to as "ozone disbenefits"). Below a certain threshold, reductions of NO_x will slow down reactions with VOCs that generate greater ozone.

To model these NO_x and VOC interactions in relation to different control strategies, SCAQMD uses the EPA's Community Multiscale Air Quality (CMAQ) model. The results of this modeling are visualized via Empirical Kinetics Modeling Approach "isopleths" that show ozone levels at different levels of NO_x and VOCs.

SCAQMD then considered three control strategies for ozone (NO_x only, VOC only, and an equal NO_x-VOC strategy). Although, South Coast once used a VOC-heavy approach, based on this analysis (and for the reasons described below), it ultimately adopted a NO_x-heavy strategy with modest VOC controls.

FIGURE 5
VOC Emissions TPD versus NO_x Emissions TPD



Source: S. Coast Air Quality Mgmt. Dist. Mobile Source Committee, Update on the 2016 AQMD Emissions Inventory and Modeling: Item #2 (May 15, 2015). TPD = Tons Per Day.

NO_x-Only Strategy. AQMD modeling determined that a NO_x-only approach (with approximately 50-65% reduction in total NO_x emissions) could lead to ozone attainment for the South Coast Air Basin. Such reductions could be achieved through significant investments in zero and near zero NO_x emission reduction technologies that are currently available and immediately deployable. Such reductions would also generate GHG and air toxics co-benefits. Reductions in NO_x would also mitigate some adverse health effects from inhalation. A NO_x-only approach has "ozone disbenefits" (i.e., raises ozone levels at first) in the densely populated "western basin," potentially exposing millions of people to more polluted air that exceeds federal standards.[56]

VOC-Only Strategy. In contrast, a VOC-only control strategy (without additional NO_x controls) would not lead to attainment of ambient ozone standards. Moreover, zero and near-zero VOC technologies are not as readily available and would take time to come to market.

A Combined Strategy. In the end, SCAMQD determined that a NO_x-heavy strategy with modest "strategic and tiered VOC reductions" was the best option. It would allow attainment of ozone standards, while also

[56] S. Coast Air Quality Mgmt. Dist., VOC Controls, at 11.

mitigating initial ozone increases in NO_x-rich areas and providing co-benefits for $PM_{2.5}$, toxics, and GHGs.[57]

$PM_{2.5}$ and Ozone

Sources of particulate matter in the South Coast Air Basin include fossil-fueled combustion sources such as cars, trucks, trains, ships, aircraft, certain types of industrial facilities, meat cooking, residential wood burning, wildfires, and dust storms. There is also secondary formation of particulate matter due to mixing of other pollutants in the atmosphere, including NO_x. In the South Coast Air Basin, the majority of $PM_{2.5}$ is estimated to derive from secondary sources.[58] Because NO_x is also a precursor to ozone, NO_x reductions can affect both ozone and secondary $PM_{2.5}$ formation. NO_x-heavy strategies in the SCAQMD and San Joaquin Valley AQMD reflect in significant part this determination that NO_x contributes both to ozone and $PM_{2.5}$ formation, and that PM co-benefits would be lower under a VOC-based system of ozone control.

PM emissions from stationary sources are easier to control than, for example, the millions of automobiles and trucks in the Southern California area. It is likely that SCAQMD will attain its PM NAAQS standards within a few years. From a coordinated governance perspective, SCAQMD has focused on co-benefits from NO_x and VOC reductions because such measures can help to reduce ozone *and* $PM_{2.5}$. At the same time, the SCAQMD 2016 Air Quality Management Plan acknowledges that these measures alone are insufficient to meet $PM_{2.5}$ standards. Thus, the 2016 AQMP lists additional measures for $PM_{2.5}$ reduction, including those listed in Table 6.[59]

TABLE 6
SCAQMD Stationary Source $PM_{2.5}$ Control Measures (Proposed)

BCM-01: Further Emission Reductions from Commercial Cooking
BCM-02: Emissions Reductions from Cooling Towers
BCM-03: Further Emission Reductions from Paved Road Dust Sources
BCM-04: Emission Reductions from Manure Management Strategies
BCM-05: Ammonia Emission Reductions from NO_x Controls
BCM-06: Emission Reductions from Abrasive Blasting Operations
BCM-07: Emission Reductions from Stone Grinding, Cutting and Polishing Operations
BCM-08: Further Emission Reductions from Agricultural, Prescribed and Training Burning
BCM-09: Further Emission Reductions from Wood-Burning Fireplaces and Wood Stoves
BCM-10: Emission Reductions from Greenwaste Composting

Source: S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 4-47.

[57] South Coast also used the BENMAP model to estimate health costs for various approaches to ozone control. That model is based on loss of work hours, emergency room visits, mortality, and other factors that may not correlate directly with Chinese conditions. *See* U.S. Envtl. Prot. Agency, Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE), https://www.epa.gov/benmap (last visited May 20, 2020).

[58] S. Coast Air Quality Mgmt. Dist., VOC Controls, at 3.

[59] S. Coast Air Quality Mgmt. Dist., Final 2016 Air Quality Management Plan, at 4-47.

State and Federal Control Measures; SCAG Regional Transportation Plan/ Sustainable Communities Strategy and Transportation Control Measures

In addition to measures directly under the control of SCAQMD, the 2016 SCAQMD AQMP considers the impact of state and federal measures with respect to on-road light-duty vehicles, on-road heavy-duty vehicles, off-road construction equipment, aircraft, locomotives, and ocean-going vessels. The 2016 AQMP also considers the impact of transportation planning carried out by SCAG and the Metropolitan Planning Organization (MPO) for Southern California. These are based on SCAG's 2016 Regional Transportation Plan/Sustainable Communities Strategy. This includes land use strategies (e.g., planning for higher density development) and transportation strategies (e.g., public transit). Further detail about these measures can be found in Chapter 4 of the 2016 AQMP.

2.2.2 San Joaquin Valley AQMD

The San Joaquin Valley is a largely agricultural area north of the South Coast Basin and southeast of the Bay Area Basin. There is some oil refinery capacity in the Bakersfield area in the southern San Joaquin Valley but not substantial stationary source emissions otherwise. Mobile source emissions are enormous due to agricultural equipment and heavily trafficked north-south truck routes, Interstate 5 and U.S. Highway 99. The area is far out of attainment both for $PM_{2.5}$ and for ozone.

FIGURE 6
Map of San Joaquin Valley Air Quality Management District

California Air Districts

Sources: Cal. Air Res. Bd., California Map for Local Air District Websites, https://ww3.arb.ca.gov/capcoa/dismap.htm; San Joaquin Valley Air Quality Mgmt. Dist., About the District, https://www.valleyair.org/general_info/aboutdist.htm.

For years, the San Joaquin Valley AQMD has asserted that it has tightened down on stationary source

emissions as far as possible and that mobile source emissions are out of its hands for jurisdictional reasons. Until recently, the AQMD's plan to deal with their mobile source problem was to go to Congress and try to weaken the Clean Air Act, but partly because of community opposition, that has not worked.

The San Joaquin Valley ozone analysis is similar to the SCAQMD South Coast analysis in that both focus on NO_x reductions. The San Joaquin Valley 2016 Plan for the 2008 8-Hour Ozone Standard explains:

> Both VOC and NO_x emissions contribute to the formation of ozone. Under high- NO_x and low-VOC conditions, the reaction is more sensitive to the amount of VOCs and is considered a NO_x-rich regime. Alternatively, when the atmosphere is under high-VOC and low-NO_x conditions, the formation of ozone is influenced by a NO_x-limited regime, which means ozone formation is sensitive to changes in NO_x concentration. Determination of an ozone formation regime requires an understanding of chemical kinetics and the ability to model the spatial and temporal intricacies of the interactions between reactants and products. To date, grid-based photochemical models remain the best available tool to determine relative precursor limitations.
>
> Modeling shows that the Valley is a NO_x-limited regime, especially in projections of future years. For this reason, the District focuses its emissions reductions efforts on NO_x reductions, as they are most effective in reducing Valley ozone concentrations. As proven through extensive modeling and successful reduced ambient ozone levels based on NO_x-centric strategies, developing VOC reduction strategies based on a NO_x rich regime would not be effective in the Valley. While understanding VOC reactivity is an important component of ozone plan analysis, the Valley's ozone formation has transitioned to a NO_x-limited regime; therefore, NO_x reductions are the most effective way to reduce Valley ozone concentrations. [60]

2.2.3 Bay Area AQMD

The Bay Area AQMD (BAAQMD) takes a VOC-heavy approach to ozone regulation. The discussion below explains why BAAQMD has taken a different approach to ozone.[61] BAAQMD, created in 1955, was the first regional air pollution agency in the U.S. It has 340 staff members and is governed by a twenty-four person board of directors.[62] BAAQMD's regional air quality management plan is known as a Clean Air Plan. Since 2010, the BAAQMD Clean Air Plans (also in 2017) have taken a comprehensive, multi-pollutant approach to regulation of traditional air pollutants, GHGs and toxics. We describe the 2017 BAAQMD Clean Air Plan in greater detail in **Chapter 3** and **Appendix B**. Here we describe BAAQMD's VOC- (or ROG-) heavy approach to traditional air pollutant regulation and explain why BAAQMD has taken a different approach to SCAQMD.

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[60] San Joaquin Valley Air Pollution Control Dist., 2016 Ozone Plan for the 2008 8-Hour Ozone Standard 4-4, C-172 (June 16, 2016).

[61] U.S. EPA issued a rule in January 2013 confirming Bay Area compliance with the 24-hour $PM_{2.5}$ Standard. BAAQMD is in attainment for the annual $PM_{2.5}$ standard.

[62] Bay Area Air Quality Mgmt. Dist., History of the Air District, https://www.baaqmd.gov/about-the-air-district/history-of-air-district (last visited May 20, 2020).

FIGURE 7
Map of Bay Area Air Quality Management District

California Air Districts

Sources: Cal. Air Res. Bd., California Map for Local Air District Websites, https://ww3.arb.ca.gov/capcoa/dismap.htm; Cal. Air Res. Bd., San Francisco Air Basin, https://ww3.arb.ca.gov/ei/maps/basins/absfmap.htm.

With respect to ozone control, as noted above, South Coast AQMD, covering the Greater Los Angeles area, has adopted a NO_x-heavy reduction strategy to reduce ozone levels, based on local sources, weather and climate, air monitoring results and modeling. In contrast, the Bay Area AQMD in California, covering the San Francisco Bay area, takes a different (VOC-heavy) approach to ozone control based on local conditions: local geography (no temperature inversions), the location of several large oil refineries, and the relatively lower level of ship, diesel truck and locomotive traffic to and from the Port of Oakland.

The BAAQMD 2017 Clean Air Plan targets VOC reductions rather than NO_x reductions given local conditions. The BAAQMD 2017 Clean Air Plan explains:[63]

> The ROG [reactive organic gases] to NO_x ratio strongly affects the ozone formation rate. The Air District's ozone modeling indicates that the Bay Area is "ROG-limited" for ozone formation. This suggests that reducing ROG emissions will be more productive in reducing ozone, at least in the near term. However, modeling also indicates that large reductions in NO_x emissions will be needed over the long term to achieve the reduction in ozone concentrations required to attain state and national ozone standards which have become progressively more stringent in recent decades.

[63] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at 2/12.

BAAQMD further explains:[64]

> A 20 percent reduction in anthropogenic VOC emissions reduces ozone 1–2 percent on most simulation days at all four stations. A 20 percent reduction in anthropogenic NO_x emissions, however, increases ozone 1–2 percent. This is because core urban areas of the Bay Area are still considered to be NO_x rich despite the fact that both anthropogenic NO_x and VOC emissions have been significantly reduced in the region over the last 20 years.

Note that SCAQMD also found such "ozone disbenefits" in its evaluation of control strategies, but selected a NO_x-heavy strategy because significant NO_x reductions were the only way to attain the ozone levels required by federal standards.[65] Modest VOC reductions were added to the SCAQMD strategy to mitigate these ozone disbenefits.

From a coordinated governance perspective, California AQMDs have considered, among other things, the ways in which NO_x contributes to both ozone and $PM_{2.5}$ reductions, the role of state air quality and climate change regulation in reducing local air pollution, the co-benefits from regional transportation planning, and the optimal balance between NO_x and VOC measures in achieving overall air quality and public health goals. The lesson for China from the differing approaches to ozone control in the three largest California AQMDs in particular is that one size does not fit all. Ozone control is a complex problem involving the relative contributions of stationary and mobile sources, atmospheric chemistry, emissions profiles, geography, meteorology, and related factors. The nature of the problems depends on all of those and so a solution set needs to be tailored to the local situation. Local jurisdictions must do their emissions inventory and modeling homework before coming up with a regulatory solution that works for them.

[64] *Id.* at Appendix D-8.

[65] Based on conversations with SCAQMD staff.

CHAPTER THREE — COORDINATED GOVERNANCE OF TRADITIONAL AIR POLLUTANTS & GREENHOUSE GASES

A comprehensive multiple pollutant approach should not only consider the nexus among multiple traditional air pollutants, but also include planning around mitigation of greenhouse gases.[66] This chapter will discuss the particular mix of priorities, strategies and regulatory tools for coordinated governance of traditional air pollutants and greenhouse gases in California. While we believe that much of California's approach is worth emulating, we also provide an assessment of areas in which California could do better. We also reiterate that the particular mix of priorities, strategies, and tools appropriate to other jurisdictions (such as China) will depend in part on local factors, such as the sources of pollution, geography, climate, administrative capacity, etc. Caveats aside, we nonetheless believe that the California experience holds lessons worth considering in China and other jurisdictions.

The key insight from the California experience is that a comprehensive planning process that considers multiple pollutants (traditional air pollutants, GHGs, toxics) against multiple clearly stated values (pollution reduction potential, cost effectiveness, economic impact, fairness, legality, administrability, transparency, public participation, etc.) can generate numerous co-benefits.

A coordinated multi-pollutant approach to air and climate regulation also brings to the fore the potential of decarbonization (such as through electrification, fuel switching, or efficiency measures) as a regulatory strategy that can reduce air pollution (while also limiting GHG emissions). The traditional air pollution regulation playbook has not focused much on clean energy, electrification or energy efficiency; but these strategies can help to eliminate persistent, long-term pollution problems even as they generate co-benefits for climate change.

A coordinated approach also highlights the interconnection between the sectors of the economy that contribute to air pollution and climate change. For example, vehicles (transportation sector) require gasoline and diesel fuel, which creates demand in oil refineries (a major source of pollution in California). But as vehicle electrification increases this will put a premium on decarbonization of the energy sector (i.e., moving away from coal and gas to wind, solar, hydropower in the power sector). A coordinated approach enables planners to anticipate these interactions and to use them in the service of air and climate regulation.

3.1 Key Targets

Coordinated governance aims to achieve multiple regulatory goals. In California, regulators must meet a series of ambitious climate change targets, as well as air quality targets mandated by federal and state law. Pollutants addressed include ozone, particulate matter, greenhouse gases and toxic air contaminants.

[66] Although this chapter focuses on coordinated governance of traditional air pollutants and GHGs, we reiterate that the most comprehensive planning processes consider the nexus between traditional air pollutants, greenhouse gases *and* toxic pollutants.

TABLE 7
Key Climate & Air Targets

California Climate Change Targets	
Reduce to 1990 levels[67]	2020 (*met in 2016*)
Reduce 40% below 1990 levels[68]	2030
Reduce 80% below 1990 levels[69]	2050 *(set in 2005)*
State-wide carbon neutrality[70]	2045 *(set in 2018)*
SCAQMD Air Pollution Targets[71]	
24-hour $PM_{2.5}$ (35 $\mu g/m^3$)	2019
Annual $PM_{2.5}$ (12 $\mu g/m^3$)	2021-25
1-hr ozone (120 ppb)	2023
8-hr ozone (80 ppb)	2024
8-hr ozone (75 ppb)	2032

California's landmark legislation in 2006, AB 32, also known as the Global Warming Solutions Act of 2006, established California as the leader within the United States on climate change and greenhouse gas emissions controls. AB 32 set an absolute statewide limit on greenhouse gas emissions, confirming California's commitment towards sustainability and green energy. Under the law, California issued a mandate to reduce its greenhouse gas emissions to 1990 levels by 2020 and to 40% below 1990 levels by 2030.

Ten years after AB 32, when it became clear that the state would meet its 2020 target, California extended and strengthened its limits on greenhouse gas emissions with a new law, SB 32 (2016), which established an ambitious target to reduce GHG emissions to 40% below 1990 levels by 2030. Under these targets, the annual 2030 statewide target emissions level for California is 260 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).[72]

A companion piece of legislation to SB 32, known as AB 197 (2016), included provisions that expressly linked traditional air pollution and GHG emissions regulation. To our point above about doing no harm, these provisions are designed to prevent climate change measures, such as carbon trading, from exacerbating local air pollution with disproportionate impacts on "the state's most impacted and disadvantaged communities." The law requires CARB to calculate the social cost of GHG emissions and prioritize "direct emission reductions at large stationary sources of [GHG] emissions and direct emissions from mobile

[67] Cal Health & Safety Code § 38550 (West) (AB 32, 2006); Cal. Exec. Order S-3-05 (2005).

[68] Cal Health & Safety Code § 38566 (West) (SB 32, 2016); Cal. Exec. Order B-30-15 (2015).

[69] Cal. Exec. Order S-3-05 (2005).

[70] Cal. Exec. Order B-55-18 (2018). This more stringent target was set in 2018.

[71] U.S. Envt'l Protection Agency, NAAQS Table, https://www.epa.gov/criteria-air-pollutants/naaqs-table (last visited Mar. 16, 2020).

[72] The state was able to achieve its 2020 target four years early. However, at California's GHG reduction rate of 1.15% published by CARB in 2017, the 2030 goal will not be attained until 2061. As of late 2019, California must reach emissions reductions of 4.51% per year to achieve its 2030 targets for greenhouse gas emissions. California faces unprecedented challenges if it wishes to attain its climate and air quality goals over the next decade. *See* Next 10, 2019 California Green Innovation Index (Oct. 2019).

sources."[73] It also formalizes inventory-keeping and reporting on GHG emissions, traditional air pollutants, and toxics.[74]

California's GHG Targets[75]

Measures to reduce GHG emissions are expected to generate substantial co-benefits for ozone and $PM_{2.5}$ reduction and public health improvements. These include reductions of 48-75 tons/day of NO_x, 5.1-7.3 tons/days of VOCs, 1.4-2.4 tons/day of $PM_{2.5}$, and 5-10 tons per day of diesel particulate matter. In California, regulators are required by law to assess and publicize the traditional air pollutant co-benefits of proposed climate change measures.

TABLE 8
Summary of Ranges of Estimated Air Pollution Reductions for Scoping Plan Scenario in 2030

Scenario	Range of NO_x reductions (tons/day)	Range of VOC reductions (tons/day)	Range of $PM_{2.5}$ reductions (tons/day)	Range of Diesel PM reductions (tons/day)
Scoping Plan Scenario	48–73	5.1–7.3	1.4–2.4	5–10

Source: Cal. Air Res. Bd., California's 2017 Climate Change Scoping Plan, at 39.

To meet greenhouse gas emissions and traditional air pollutant reduction targets, California has also established sectoral targets (e.g., transportation, electricity, industry) and targets for individual pollutants (such as short-lived climate pollutants). These targets are briefly summarized in the next section.

Transportation

Transportation sector targets aim to reduce emissions from light and heavy-duty vehicles, including through vehicle electrification, reducing the carbon intensity of vehicle fuels, and limiting vehicle miles traveled. These measures improve air quality and reduce GHGs through a reduction in consumption of fossil fuels and associated reductions in petroleum production and refining. Table 9, below, summarizes transportation targets and measures.

[73] Cal Health & Safety Code § 38562.5 (West) (AB 197, 2016).

[74] Cal Health & Safety Code § 39607 (West) (AB 197, 2016). More recently, the oil industry obtained protection from local air districts through a piece of legislation that prohibited local districts from regulating the GHG emissions of oil refineries that are under the California cap-and-trade system. As discussed below, we believe such local authority to impose GHG emissions standards on industrial facilities is an important tool for environmental regulation and should not be limited in this way.

[75] Mac Taylor, *Assessing California's Climate Policies—Transportation*, Legis. Analyst's Off. (Dec. 2018).

TABLE 9
Transportation Targets & Measures

GHG Emissions Targets	
80% decrease in GHG emissions from transportation sector from 1990 levels[76]	2050
SB 375 regional "sustainable communities" GHG targets: % reduction in per capita GHG emissions from passenger vehicles[77]	Various
So. Cal Assoc of Govts. (SCAG)	2020 (8%); 2035 (19%)
SF Bay Area Metro Transport Comm (MTC)	2020 (7%); 2035 (19%)
San Joaquin Valley	2020 (12%); 2035 (16%)
Light- and Heavy-Duty Vehicles	
Advanced Clean Cars LEV III rules (traditional air pollutants & GHGs)	Various rules
Advanced Clean Trucks rules	Various rules
ZEV Targets	
1.5 million ZEVs on CA roadways[78]	By 2025
5 million ZEVs on CA roadways[79]	By 2030
250,000 EV charging stations[80]	By 2025
Low Carbon Fuel Standard[81]	
10% reduction in fuel carbon intensity[82]	2020
20% reduction in fuel carbon intensity[83]	2030
Carbon Cap and Trade[84] *covers petroleum refining and fuel distribution*	
Indirect Source Rule[85]	

[76] Cal. Exec. Order B-16-12 (2012).

[77] Cal. Gov't Code § 65080 (West) (SB 375, 2008); Cal. Air. Res. Bd., SB 375 Regional Plan Climate Targets (stating that SB 375 targets went into effect on Oct. 1, 2018), https://ww2.arb.ca.gov/our-work/programs/sustainable-communities-program/regional-plan-targets.

[78] Cal. Exec. Order B-16-12 (2012).

[79] Cal. Exec. Order B-48-18 (2018).

[80] *Id.*

[81] *See* Cal. Exec. Order S-01-07 (2007); 17 Cal. Code Regs. § 95480.

[82] Cal. Exec. Order S-01-07 (2007).

[83] Cal. Air Res. Bd., Resolution 18-34 (Sept. 27, 2018); see also Cal. Air Res. Bd., Low Carbon Fuel Standard Basics 6, available at https://ww2.arb.ca.gov/resources/documents/lcfs-basics.

[84] We describe California's carbon trading program under the section entitled "Industry," but note that the trading program also includes emissions from the distribution of petroleum and natural gas and electricity generation and importation.

[85] *See* discussion at p. 24 above.

Electricity Generation and Consumption

California has established ambitious targets for the production of electricity from renewable sources and improvement of energy efficiency for buildings (residential and commercial) and industrial facilities. These supply- and demand-side measures seek to reduce fossil fuel production and consumption, producing benefits for air quality and climate change mitigation.

TABLE 10
Electricity Generation & Consumption Targets & Measures

Electricity Generation[86]	
50% of electricity from eligible renewable sources	2025
60% of electricity from eligible renewable sources	2030
100% of electricity from eligible renewable sources and zero-carbon resources[87]	2045
State-wide carbon neutrality[88]	2045
Energy Efficiency[89]	
All new residential construction will be zero net energy (ZNE)	2020
All new commercial construction will be ZNE	2030
50% of existing commercial buildings retrofit to ZNE	2030
50% of new major renovations of state buildings to ZNE	2025
Appliance standards	Various
Doubling energy efficiency in electricity and natural gas final end use of retail customers[90]	2030
Carbon Cap and Trade[91]	

Industry

Industrial facilities are a major contributor of GHGs and traditional air pollutants in California. The Climate Change Scoping Plan calls for industrial GHG reductions of 8-15% below 1990 levels by 2030. Depending on the type of facility or industry (e.g. cement and steel) it can be extraordinarily difficult to eliminate combustion from some industrial processes. Efficiency improvements, limits on production level, and end-of-pipe technologies (for traditional air pollutants) are generally the approaches to reducing traditional air pollutants and GHGs.[92] California's carbon cap-and-trade program covers large industrial

[86] Cal. Pub. Util. Code § 399.11 (West) (SB 100, 2018).

[87] Cal. Pub. Util. Code § 454.53 (West) (SB 100, 2018).

[88] Cal. Exec. Order B-55-18 (2018).

[89] Cal. Pub. Util. Comm'n, *Zero Net Energy*, https://www.cpuc.ca.gov/ZNE/ (last visited Mar. 18, 2020).

[90] Cal. Pub. Res. Code § 25310 (West) (SB 350,2015).

[91] As previously mentioned, California's carbon cap-and-trade program covers electricity generation (as well as industrial sources and fuel distribution).

[92] California has recently removed the authority of local AQMDs to regulate GHGs at industrial facilities beyond the requirements of California's carbon cap-and-trade program. BAAQMD previously had regulations limiting GHG emissions at Bay Area refineries that would also contribute to traditional air pollutant reductions. Such regulations were made invalid by SB 398 (2019).

facilities (that emit more than 25,000 metric tons of CO_2e per year), electricity generators and importers, oil refineries, and fuel distributors.

Short-Lived Climate Pollutants

Short-lived climate pollutants (SLCPs), such as ozone, black carbon and methane, are significant contributors to climate change *and* poor air quality. Ground-level (tropospheric) ozone is a traditional air pollutant with significant impacts on health and ecosystems, as well as a cause of atmospheric warming.[93] Methane, another SLCP, contributes to ozone formation and is a much more potent greenhouse gas (with an 84x greater impact on climate change than CO_2 over twenty years).[94] Black carbon is a key component of $PM_{2.5}$ and a greenhouse gas 460-1,500 times stronger than CO_2.[95]

Control of SLCPs is a central component of California climate strategy, and can contribute to air quality management as well. In September 2016, California Governor Jerry Brown signed into law SB 1383 to achieve statewide reductions of short-lived climate pollutants. SB 1383 codified into law California Air Resource Board's Short-Lived Climate Pollutant Reduction Strategy and targeted 50% anthropogenic black carbon emissions, and 40% methane emissions reduction by 2030, compared to 2013 levels.[96]

TABLE 11
California's Short-Lived Climate Pollutant Emissions & Targets ($MMTCO_2e$)

Pollutant	2013	2030 Business as Usual	2030 Emission Reduction Target (percent reduction from 2013)
Black Carbon (anthropogenic)	38	26	19 (50%)
Methane	118	117	71 (40%)
Hydrofluorocarbons	40	65	24 (40%)

Source: Cal. Air Res. Bd., Short-Lived Climate Pollutant Reduction Strategy 6 (2017).

Monitoring & Reporting Requirements

In addition to substantive emissions targets, California has recognized the importance of accurate monitoring for evaluation of existing air pollution control policies, especially given the intersection of different pollutant control measures, implemented across different agencies and air districts. Environmental justice advocates have also been concerned that market mechanisms for industrial facilities lead to slower reductions in traditional air pollutants that affect local communities. AB 197 (2016) included inventory and disclosure requirements for GHGs, traditional air pollutants, and toxic air contaminants "broken down to a local and subcounty level for stationary sources and to at least a county level for mobile sources."[97] AB 617 (2017) requires the state board to prepare "a monitoring plan regarding the availability and effectiveness of toxic air contaminant and traditional air pollutant advanced sensing monitoring technologies and existing community air monitoring systems" to create a "statewide strategy to reduce emissions of toxic

[93] Climate & Clean Air Coal., Tropospheric Ozone, https://ccacoalition.org/en/slcps/tropospheric-ozone (last visited May 20, 2020).

[94] Climate & Clean Air Coal., Methane, https://ccacoalition.org/en/slcps/methane (last visited May 20, 2020).

[95] Climate & Clean Air Coal., Black Carbon, https://ccacoalition.org/en/slcps/black-carbon (last visited May 20, 2020).

[96] Cal. Health & Safety Code § 39730.5 (West) (SB 1383, 2016).

[97] Cal Health & Safety Code § 39607 (West) (AB 197, 2016).

air contaminants and traditional air pollutants in communities affected by a high cumulative exposure burden" at least once every five years, and would also require a "district that is in nonattainment for one or more air pollutants to adopt an expedited schedule for the implementation of best available retrofit control technology."[98]

3.2 Planning Processes

Achievement of these multiple targets is coordinated through several interrelated state-led planning processes. The two most important processes in California are the State SIP Strategy, which is required under the Clean Air Act, and the Climate Change Scoping Plan required by California's AB 32 Global Warming Solutions Act.

Various sub-planning processes support these overarching plans. The State SIP Strategy incorporates the work of Air Quality Management Plans (AQMPs) developed by local air quality management districts. A number of sectoral- or pollutant-based planning processes support the Climate Change Scoping Plan and the achievement of other specific air, climate, and energy-related requirements established by legislation or executive order. These processes (with date of passage, and lead agencies in parentheses) include:

- Mobile Source Strategy (2016; CalEPA, CARB);[99]
- ZEV Action Plan 2016 & Priorities Update 2018 (state interagency);[100]
- Short-Lived Climate Pollutant Reduction Strategy (2017; CalEPA, CARB);[101]
- California Transportation Plan 2040 (2016; Caltrans);[102]
- California Energy Efficiency Action Plan (2019; CEC);[103]
- California Long-term Energy Efficiency Strategic Plan (2011; CPUC);[104]
- State Forest Carbon Plan (CNRA, CalEPA);
- Sustainable Freight Action Plan (state interagency — no longer active).[105]

These plans take an integrated approach to considering cross-pollutant co-benefits to one extent or another. At the state level, the most important formal example of coordinated planning of air quality and climate

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[98] Cal. Health & Safety Code §§ 40920.6, 42705.5, 44391.2 (West) (codifying A.B. 617 [2017]).

[99] *See* Cal. Air Res. Bd., Mobile Source Strategy (2016).

[100] *See* Governor's Interagency Working Grp. on Zero-Emission Vehicles, 2016 ZEV Action Plan (2016); Governor's Interagency Working Grp., 2018 ZEV Action Plan Priorities Update (2018). The ZEV Action Plan was developed pursuant to Governor Jerry Brown's January 26, 2018 Executive Order B-48-18. The ZEV Action Plan includes actions by more than 25 state agencies, including: CPUC, CEC, CARB, CAISO, GO-Biz, DMV, DGS, SGC, GovOps, OPR, CalSTA, Caltrans, HCD, BSC, DSA, and others (see p. 14 of 2016 ZEV Action Plan for agency abbreviation key).

[101] *See* Cal. Air Res. Bd., Short-Lived Climate Pollutant Reduction Strategy (2017).

[102] *See* Cal. St. Transp. Agency, California Transportation Plan 2040 (2016). This plan takes into account a range of legislation and executive orders, such as those listed on Caltrans' website. *See* Cal. Dep't of Transp., California Transportation Plan, https://dot.ca.gov/programs/transportation-planning/state-planning/california-transportation-plan (last visited June 15, 2020)

[103] *See* Cal. Energy Comm'n, 2019 California Energy Efficiency Action Plan (2019). This 2019 plan combines and updates the prior Existing Buildings Energy Efficiency Action Plan and the Doubling of Energy Efficiency Savings by 2030 Report.

[104] Each chapter of the Strategic Plan is implemented through an individual action plan. These include the: (i) Zero Net Energy Commercial Building Action Plan (2011); (ii) Lighting Action Plan (2013); (iii) Research and Technology Action Plan (2013); (iv) Codes and Standards Action Plan (2014); and (v) New Residential Zero Net Energy Action Plan (2015). For more information, *see* Cal. Pub. Util. Comm'n, Energy Efficiency Strategic Plan, https://www.cpuc.ca.gov/General.aspx?id=4125 (last visited May 20, 2020).

[105] *See* Cal. Exec. Order B-32-15 (2015). This plan was required pursuant to Governor Jerry Brown's July 2015 Executive Order B-32-15. The agencies involved include: CalSTA, CalEPA, California Natural Resources Agency, CARB, Caltrans, CEC, and the Governor's Office of Business and Economic Development.

change goals is the 2016 Mobile Source Strategy, which expressly sought to harmonize multiple air and climate-related goals. Among the local AQMPs, the Bay Area AQMD's 2017 Clean Air Plan is the clearest example of coordinated governance of multiple pollutants. Since its 2010 Clean Air Plan, BAAQMD has taken a coordinated multi-pollutant approach that considers ground-level ozone and ozone precursors (VOCs, NO_x), directly emitted and secondary particulate matter, GHGs and key air toxics.[106] Other state planning processes also consider impacts on multiple pollutants. The Climate Change Scoping Plan is required by law to consider traditional air pollutant co-benefits. Transportation and mobile source-related planning processes expressly consider multiple pollutants and a range of regulatory objectives.

Although beyond the scope of this report, we note that multi-pollutant coordinated governance in California depends on strong capacity in several technical areas, including:

- Air quality monitoring capacity;
- Robust emissions inventories;
- Effective air quality modeling; and
- Tools for multi-pollutant evaluation and modeling (e.g., the costs and benefits of different policy combinations in achieving multi-pollutant objectives).[107]

California regulators have developed different tools for multi-pollutant planning. CARB's *Vision for Clean Air 2.1* is a modeling tool and process for determining the right policy mix.[108] The Bay Area AQMD has developed a multi-pollutant evaluation method (MPEM), which is a tool that estimates benefits of "individual control measures and the control strategy as a whole in protecting public health, extending the average lifespan of Bay Area residents and protecting the climate."[109] These technical aspects of coordinated governance are discussed in greater detail in the planning documents listed above and elsewhere.

Overall, the trend for traditional air pollutants and GHGs has been downward.[110] The figure below shows that GHG emissions, GHG emissions per capita, and GHG emissions per unit of GDP have all been declining for a decade or more.

[106] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at 1/19.

[107] *Id.* at 2/7 – 2/10.

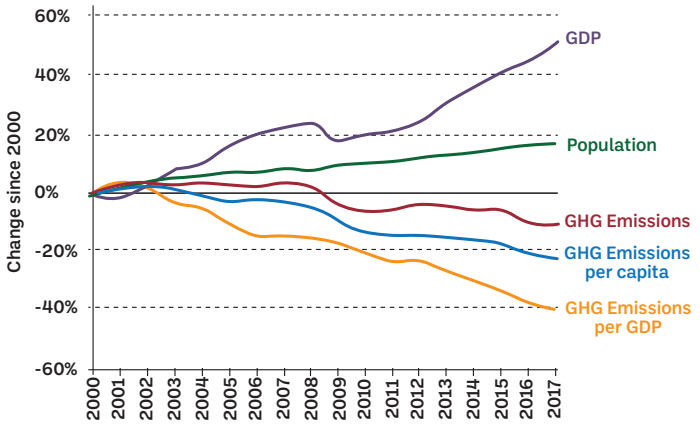
[108] *See* Cal. Air Res. Bd., Vision Scenario Planning, https://ww3.arb.ca.gov/planning/vision/vision.htm (last visited May 20, 2020).

[109] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at 2/10, C/1 – C/9.

[110] *See* Cal. Air Res. Bd., California Greenhouse Gas Emission Inventory: 2000-2017 3 (2019).

FIGURE 8

Change in California GDP, Population & GHG Emissions Since 2000



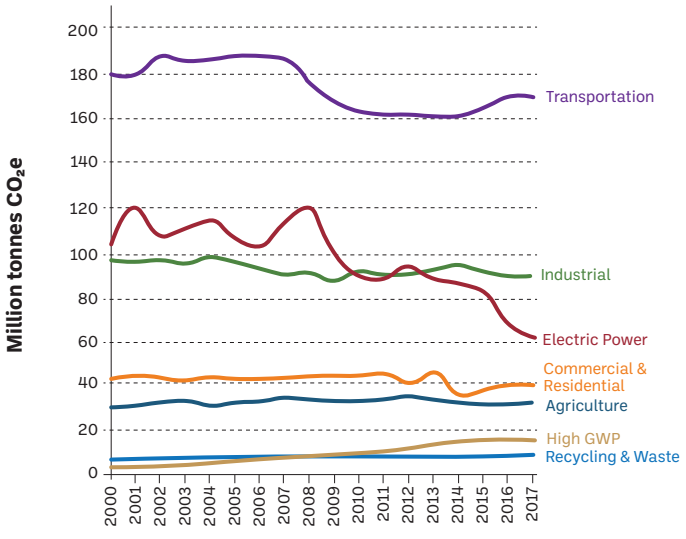
Metric	Associated 2017 Value
GDP	2.6 trillion (2012 $)
Population	39.6 million
GHG Emissions	424.1 MMTCO$_2$e
GHG Emissions per capita	10.7 metric tons CO$_2$e
GHG Emissions per GDP	164 metric tons CO$_2$e per million dollars

Source: Cal. Air Res. Bd., California Greenhouse Gas Emission Inventory: 2000-2017, at 4.

The two figures below show sectoral trends in GHG emissions and the relative contribution of each sector to California's overall GHG emissions.

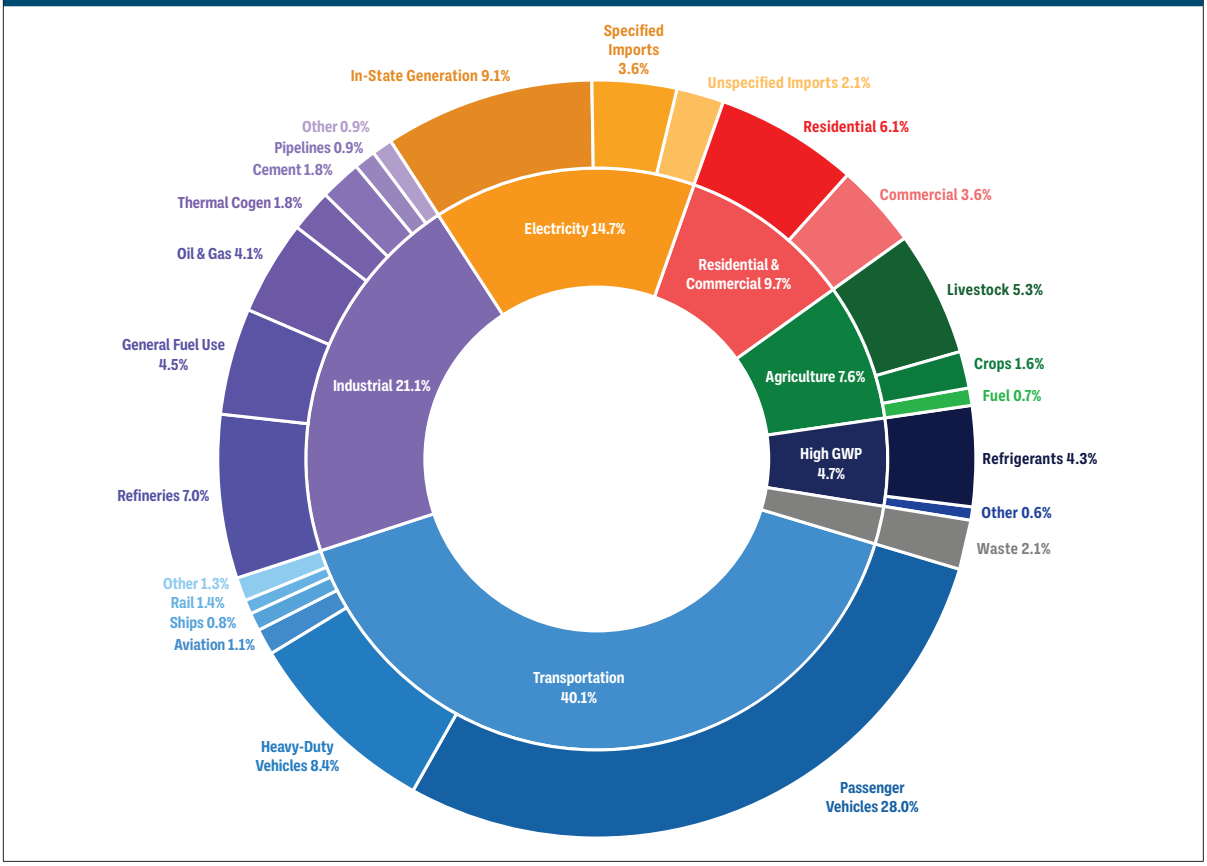
FIGURE 9

Trends in California GHG Emissions



Source: Cal. Air Res. Bd., California Greenhouse Gas Emission Inventory: 2000-2017, at 5.

FIGURE 10
California 2017 GHG Emission by Scoping Plan Sector & Sub-Sector Category



Source: Cal. Air Res. Bd., California Greenhouse Gas Emission Inventory: 2000-2017, at 7.

3.3 Control Strategies & Tools

Control Strategies

California's multi-pollutant coordinated control strategies are aimed at four key priorities:

- Reduction of traditional air pollutants, such as ozone, PM2.5 and their precursors;
- Decarbonization of the energy system (e.g., carbon-free electricity, electrification of vehicles and buildings)
- Decreasing demand for fossil fuels through efficiency or reduced consumption; and
- Reduction of SLCPs, such as black carbon and methane.

Regulatory goals can be achieved through rulemaking and funding, capacity-building and technical assistance, and persuasion and advocacy. California regulators appeal to each of these approaches to meet key priorities.

Policies & Tools

This section describes specific policies and regulatory tools that produce co-benefits for traditional air pollutants and greenhouse gas emissions. China's use of these or similar tools should be informed by China-

specific analysis that takes into consideration local energy mix, sectoral contributions, and other factors. Major differences between California and China include a heavier reliance on coal in China and the greater relative contribution of transportation to poor air quality compared to industry in California (as compared to China).

Specifically, we will discuss policies and tools in the areas of transportation (including mobile sources and land use), electricity generation and consumption (including energy mix and efficiency), and industry. While important to climate change policy, we do not discuss agriculture, waste, water-energy nexus, or carbon sinks here, given our focus in this report on opportunities for air and climate change co-benefits. We also discuss non-sectoral measures we group under incentives and environmental justice.

TABLE 12
Summary of Coordinated Governance Policies & Tools

Transportation
Advanced Clean Cars Program
Low-Emission Vehicle III Regulation for Criteria Pollutants
Low-Emission Vehicle III Regulation for GHGs
ZEV Program—Light and Medium-Duty Vehicles
Advanced Clean Trucks Program
Emissions standards for heavy-duty vehicles
ZEV trucks
Corporate Average Fuel Economy (CAFE) Standards
Fuels
Low Carbon Fuel Standard
Transportation Planning (to lower Vehicle Miles Traveled)
Environmental Impact Assessment (CEQA)
Carbon Cap and Trade for Fuel Distributors (discussed under "Industry")
Other—off-road equipment, shipping, aviation and locomotives
Electricity Generation and Consumption
Renewable portfolio standards
GHG performance standards—Clean Power Plan/ACE Rule
Energy efficiency standards for appliances, equipment
Building energy efficiency and fuel switching
Carbon cap and trade for electricity generators and importers (discussed under "Industry")
Industry
Carbon cap and trade
Industrial (technology and performance) standards
Incentives
Cap-and-Trade funding investments, subsidies, grants
Environmental Justice
AB 617 & AB 1550

3.4 Transportation

California's "vast transportation system connects 38 million residents."[111] Its economy generates USD $3.175 trillion in annual gross domestic product, making it the world's fifth largest economy if it were a stand-alone country. It is the "nation's largest gateway for international trade and domestic commerce."[112] Its complex freight transportation system is responsible for one-third of the State's economy and jobs, with freight-dependent industries accounting for over USD $740 billion in revenue and over 5 million jobs in 2014.[113] Heavy-duty (e.g., diesel trucks) and passenger vehicles contribute significantly to GHG emissions, ozone and $PM_{2.5}$. Other mobile sources, such as off-road construction equipment, airplanes, locomotives, and ships also contribute to climate change and air pollution.

Transportation emissions account for 40% of total state GHG emissions,[114] 83% of the state's nitrogen oxide emissions,[115] and 97% of diesel particulate matter emissions.[116]

Mobile source measures thus offer the potential for substantial air and climate co-benefits. CARB has estimated that the measures in its Mobile Source Strategy will reduce smog-forming emissions by 80% and diesel particulate matter 45% in the SCAQMD, and statewide will reduce GHG emissions 45% and petroleum consumption by 50% by 2030-31.[117]

California transportation policy for the reduction of traditional air pollutants and GHGs is built on a "three-legged stool":[118] vehicles (efficiency and electrification), fuels (reducing carbon intensity and incentivizing a shift away from fossil fuels), and mobility (lowering miles traveled and building transportation infrastructure).

Below we discuss:

- The Advanced Clean Cars Program (which combines emissions standards for traditional air pollutants and GHGs and zero-emissions vehicle targets);
- The Advanced Clean Trucks Program;
- Federal-level fuel efficiency standards;
- The Low-Carbon Fuel Standard;
- Planning procedures and incentives to lower vehicle miles traveled; and
- Incentives for vehicle turnover, vehicle electrification, and vehicle charging infrastructure.

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[111] Cal. Exec. Order B-32-15 (2015).

[112] Cal. Energy Comm'n, State Releases Final Plan to Transform Freight System, https://calenergycommission.blogspot.com/2016/07/state-releases-final-plan-to-transform.html (last visited May 20, 2020).

[113] *Id.*

[114] Cal. Air Res. Bd., California Greenhouse Gas Emission Inventory: 2000-2017, at 6. The 2017 emissions data includes passenger vehicles (28%), heavy-duty vehicles (8.4%), and aviation/ships/rail/other (3.6%). It does not include emissions from petroleum refineries and oil production.

[115] Cal. Air Res. Bd., ARB Almanac 2013 - Chapter 2: Current Emissions and Air Quality 2-3 (2013). (discussing 2012 emissions data).

[116] *Id.* at 2-6.

[117] Cal. Air Res. Bd., Mobile Source Strategy, at 6-7.

[118] Daniel Sperling & Anthony Eggert, *California's Energy and Climate Policy for Transportation*, 5 Energy Strategy R. 88, 89-92 (2014).

3.4.1 Advanced Clean Cars Program

In California, coordinated governance of traditional air pollutants and GHGs from passenger vehicles is handled primarily through a set of regulations adopted in 2012 known as the Advanced Clean Cars Program.[119] The program is composed of three components:

- Low-Emission Vehicle III (LEV III) Emissions Standards for Criteria Pollutants;
- Low-Emission Vehicle III Emissions Standards for Greenhouse Gases; and
- A technology-forcing mandate for zero-emission vehicles (ZEV).

As discussed in greater detail below, pursuant to Section 209 of the CAA, California may seek a waiver from the EPA to implement its own tailpipe emissions standards, provided they are, in the aggregate, equally or more stringent than federal tailpipe emissions standards. California was granted such a waiver for its Advanced Clean Cars Program in 2013, but in September 2019, the NHTSA and EPA jointly finalized regulations revoking the portions of that waiver that permitted California to set its own tailpipe GHG emissions for new motor vehicles and to implement its updated ZEV mandate.[120] As of the date of this report, California is challenging these regulations.

California's Low Emission Vehicle Program

The U.S. Clean Air Act (CAA) of 1970 sets forth comprehensive national emissions standards for new automobiles. Section 209 of the CAA barred the states from setting their own automobile emissions standards but provided California - alone among states - with the option to apply for a waiver to this bar (and to set its own auto emissions standards).[121] While no other states can apply for such a waiver, states may choose to adopt California's emissions standards instead of federal standards pursuant to CAA Section 177.

Pursuant to this authority, in 1990, California adopted traditional air pollutant emissions standards for passenger vehicles (model years 1994 to 2003) under its Low Emissions Vehicle (LEV) program.[122] This first generation of vehicle emissions standards, known as the LEV I regulations, included three elements:

- Tiers of exhaust emission standards for increasingly more stringent categories of low-emission vehicles;
- A mechanism requiring each auto manufacturer to phase-in a progressively cleaner mix of vehicles from year to year through compliance with "fleet" average emissions rates for passenger cars and light-duty trucks;
- A requirement that a certain percentage of passenger cars and light-duty trucks be zero-emission vehicles (ZEVs) – with no exhaust or evaporative emissions.[123]

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[119] *See* Cal. Air Res. Bd., Advanced Clean Cars Program, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program (last visited May 20, 2020).

[120] This revocation was related to the EPA's proposal of a new vehicle emissions rule known as the "Safer Affordable Fuel-Efficient (SAFE) Vehicles" rule.

[121] At the time of the 1970 Clean Air Act, California was the only state in the U.S. to have passed comprehensive state-level auto emissions standards.

[122] EPA approved California's waiver for LEV I regulations applicable to passenger cars and light-duty trucks in 1993, and granted a waiver for LEV I standards for medium-duty vehicles in 1998.

[123] Cal. Air Res. Bd., Low-Emission Vehicle Program, https://ww2.arb.ca.gov/our-work/programs/low-emission-vehicle-program/about (last visited May 20, 2020).

In 1998, California passed its LEV II emissions standards, which included more stringent fleet average emissions standards for light- and medium-duty vehicles in model years 2004 to 2010.[124] The light-duty truck category included vehicles up to 8,500 lbs. gross vehicle weight rating, such that it would subject most sport utility vehicles, pick-up trucks, and minivans to the low-emission vehicle standards. In 2002, the California Legislature passed the first GHG emissions standards for light-duty vehicles in the U.S. (AB 1493, the "Pavley standards").[125] California subsequently incorporated these GHG standards into the LEV II program. By 2012, thirteen states and the District Columbia (some 40% of the national light-duty vehicle market) had adopted the California standards.

In 2012, California (working with EPA and the NHTSA) developed the Advanced Clean Cars program, which included amended LEV III standards for criteria pollutant emissions, the LEV III GHG emissions standards, and ZEV standards that require automakers to sell a certain number of ZEVs (discussed in further detail below). These standards were a negotiated compromise that included input from automakers in an effort to consolidate California and federal standards. The LEV III criteria pollutant emissions standards are aimed at reducing smog-forming emissions in vehicles made between 2015 and 2025. LEV III criteria standards aim to have cars in 2025 emit 75% less smog-forming pollution than the average car in 2012. The LEV III GHG standards are expected to reduce GHG emissions from new vehicles in 2025 by approximately 40% from 2012 averages.[126] Technologies to achieve this goal include advancements in engine and emission control, wider application of hybrid technology, and increased use of stronger and lighter materials.[127] A midterm review of the Advanced Clean Cars program released in January 2017 determined that automakers had exceeded the standards in the early years of the program even while growing vehicle sales.[128]

Zero-Emission Vehicle Rules

The California Air Resources Board first adopted California Zero Emission Vehicle (ZEV) requirements in 1990 under its LEV regulation.[129] Because commercially available electrification technologies were scarce at the time, CARB was not able to meet its initial goal that 10% of new car sales in the state would be EVs by 2001.[130] The rule was meant to be "technology forcing," but viable ZEVs remained a very small fraction of the car market during this first phase of regulation. However, the second phase of ZEV regulation was helped along by technological innovation that would make electric vehicles feasible, such as the development of hybrid vehicles. The success of hybrid vehicles led to advancements in electric drive systems, battery technologies, and electric accessories.

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[124] EPA approved California's waiver for the LEV II program in 2003.

[125] EPA approved California's waiver for these standards in 2009, after the Bush-era EPA had first denied a waiver in 2008.

[126] Cal. Air Res. Bd., Advanced Clean Cars Program, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program (last visited May 20, 2020).

[127] *Id.*

[128] CARB conducted midterm review of its Advanced Clean Cars program. EPA carried out a midterm evaluation of federal light-duty vehicle GHG standards. The status of both California and federal standards is uncertain now as the Trump administration has proposed a new rule and attempted to revoke California's waiver to set its own standards.

[129] Cal. Air Res. Bd., Zero-Emission Vehicle Program: About, https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program/about (last visited Mar. 19, 2020).

[130] Virginia McConnell & Benjamin Leard, *California ZEV Program: A Long and Bumpy Road, but Finally Some Success*, Res. Mag. (Dec. 12, 2019), https://www.resourcesmag.org/common-resources/california-zev-program-long-and-bumpy-road-finally-some-success/.

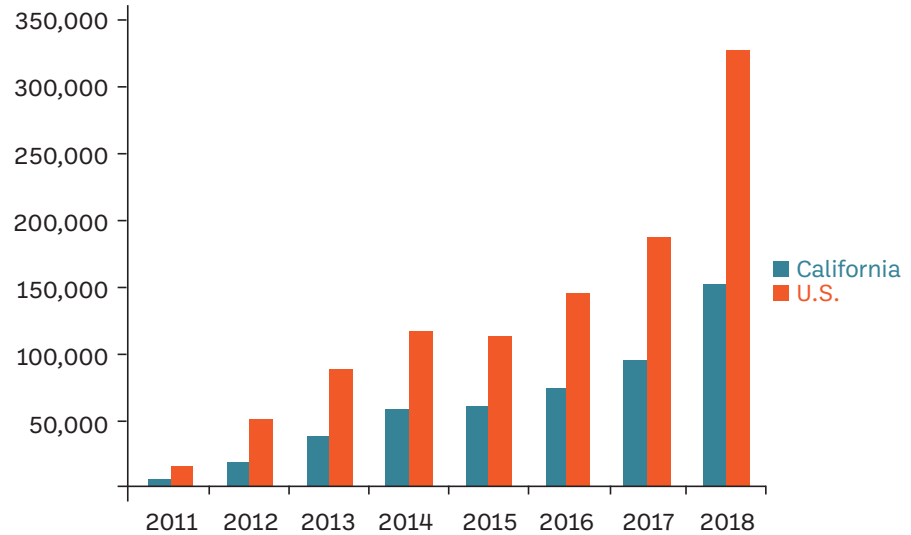
In 2012, CARB set out further ZEV mandates in its Advanced Cleans Cars program.[131] For the purposes of these mandates, ZEVs include hydrogen fuel cell electric vehicles (FCEVs) and plug-in electric vehicles (PEVs), which include both pure battery electric vehicles and hybrid electric vehicles.

Under California's ZEV mandate program, manufactures are required to produce a certain number of ZEVs and plug-in hybrids each year based on their total number of sales.[132] Each vehicle receives a certain number of credits based on its electric driving range, and these credits can be banked for future years, traded, or sold to other manufacturers.[133] Small-volume manufacturers (volume status less than 4,500 units) are exempt from the mandate, while intermediate-volume (4,500–20,000 units) and large-volume manufacturers (greater than 20,000 units) are subject to the mandate, with the latter having a minimum requirement of pure ZEVs (ranging from 2% in 2018 to 16% in 2025). [134] The ZEV mandate program is set to result in a ZEV market share of about 8% by 2025 according to CARB.

The third and current phase of the ZEV program began in 2018, with the number of manufacturers mandated to sell all electric vehicles doubling, hybrid vehicles no longer earning credits, and manufacturers not being able to use the "travel provision" which allowed vehicles to count toward compliance no matter where they were sold.

Almost half of all ZEV vehicles in the U.S. have been sold in California, in no small part due to the fact that the state has been promoting the ZEV mandates for over thirty years.[135]

FIGURE 11
Sales of Electric Vehicles (EVs) Including Battery EVs & Plug-in Hybrid EVs



Source: Virginia McConnell & Benjamin Leard, *The California ZEV Program: A Long and Bumpy Road, but Finally Some Success*, Resources Mag. (Dec. 12, 2019), https://www.resourcesmag.org/common-resources/california-zev-program-long-and-bumpy-road-finally-some-success/.

[131] *See* Cal. Air Res. Bd., *Advanced Clean Cars Program*, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program (last visited Mar. 19, 2020).

[132] Cal. Air Res. Bd., Zero Emission Vehicle Fact Sheet.

[133] *Id.*

[134] Int'l Council on Clean Transp., Overview of Global Zero-Emission Mandate Programs 4 – 5 (Apr. 2019).

[135] Jonathan Lesser, *Short Circuit: The High Cost of Electric Vehicle Subsidies*, Manhattan Inst. 5 (2018).

Governor Brown and the Governor's Office of Business and Economic Development (GO-Biz) first released California's ZEV Action Plan in 2013 as a roadmap to support a goal of 1.5 million ZEVs on the road by 2025.[136] Supporting more ZEVs on the road would involve building up city infrastructures to accommodate them, lowering costs for ZEVs to be competitive with conventional cars, accessibility to consumers, and widespread usage in public transportation and freight.[137] This action plan was updated in 2016, and again most recently in 2018 through Executive Order B-48-18, and sets new goals of 5 million ZEVs on the road by 2030 as well as infrastructure targets for electric and hydrogen fueling stations.[138]

The ZEV Action Plan has six stated goals in promoting ZEVs:

1. Achieving mainstream consumer awareness of ZEV options and benefits;
2. Making ZEVs an affordable and attractive option for drivers;
3. Ensuring convenient charging and fueling infrastructure for greatly expanded use of ZEVs;
4. Maximizing economic and job opportunities from ZEV technologies;
5. Bolstering ZEV market growth outside of California; and
6. Leading by example to integrate ZEVs into state government practice.

California has implemented a variety of programs to promote ZEV adoption and the achievement of ZEV targets. These include financial incentives for ZEV purchase and retirement of fossil fuel powered vehicles, benefits for ZEV owners (such as access to HOV lanes), and support for ZEV charging infrastructure.

ZEV rebate programs provide sizable monetary rebates for buying or leasing ZEVs, depending on the type of car. ZEV rebates are mostly funded by California Climate Investments, which is a statewide initiative utilizing cap-and-trade dollars to reduce GHG emissions, particularly in disadvantaged communities. The current major ZEV rebate programs are: Clean Vehicle Rebate Project, Clean Vehicle Assistance Program, and Clean Cars 4 All.

Clean Vehicle Rebate Project. The Clean Vehicle Rebate Project (CVRP) provides low-income consumers with vehicle rebates on a first-come, first-served basis for new passenger plug-in hybrid or battery electric vehicles. For the fiscal year of 2017-2018, the program had an approved budget of USD $140 million, and has provided over 200,000 rebates throughout the state as of 2018. [139] It is available to individuals, businesses, nonprofits, and government agencies in California.[140] Rebates vary among different types of vehicles purchased, and are awarded after a qualifying clean car purchase.

Clean Vehicle Assistance Program.[141] The Clean Vehicle Assistance Program (CVAP) provides funding to help qualified residents purchase hybrid or electric vehicles.[142] Unlike CVRP, CVAP provides grants

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[136] *See generally,* Governor's Interagency Working Group on Zero-Emission Vehicles, 2013 ZEV Action Plan: A Roadmap Towards 2.5 Million Zero-Emission Vehicles on California Roadways by 2025 (Feb. 2013).

[137] *Id.*

[138] Governor's Interagency Working Grp. on Zero-Emission Vehicles, 2018 ZEV Action Plan Priorities Update, at 2.

[139] See Jared Brey, *California Wants Everyone to Be Able to Afford Clean Energy Cars*, Next City (Sept. 13, 2018); Cal. Air Res. Bd., Implementation Manual Clean Vehicle Rebate Project Public Fleet Incentives FY 2018-19 1 (June 2018).

[140] *See* Center for Sustainable Energy, Rebates and Incentives, https://cleanvehiclerebate.org/eng/cvrprebate (last visited May 20, 2020).

[141] *See* Brey, *supra* note 139; Cal. Air Res. Bd., *supra* note 139.

[142] See Center for Sustainable Energy, Rebates and Incentives, https://cleanvehiclerebate.org/eng/cvrprebate (last visited Jun 15, 2020).; Beneficial State Found. & Cal. Air Res. Bd., Clean Vehicle Assistance Program, https://cleanvehiclegrants.org/ (last visited June 15, 2020).

and loans instead of rebates to consumers. The CVAP grants are awarded at the point of a qualifying clean vehicle purchase, not after the sale.[143] The grants are currently USD $2,500 for hybrid cars and USD $5,000 for electric cars. As long as the grantee complies with all program requirements, the grant will be given to the dealer to lower the cost of the vehicle. Grantees who purchase a battery electric vehicle or a plug-in hybrid are also able to get a free charging unit with installation support, which can cost up to USD $2,000.

Clean Cars 4 All. Various air quality management districts in California have also implemented vehicle retirement and replacement programs aimed at upgrading lower-income consumers to ZEVs. These are called, variously, Clean Cars 4 All in the Bay Area and Sacramento, Replace Your Ride in the South Coast area and Drive Clean in the San Joaquin area.[144] Eligible applicants can receive up to USD $9,500 towards the purchase of a new ZEV, or choose up to USD $7,500 in incentives to access public, private, and shared mobility options.

Another incentive program is the HOV Lane Access Program, also known as the Clean Air Vehicle (CAV) Decal Program, which allows ZEV drivers to use high-occupancy vehicle lanes.[145] The CAV Decal Program is subject to federal authorization.[146] Currently, decals are issued to qualifying pure plug-in or hydrogen fuel cell electric and compressed natural gas vehicles that meet state super ultra-low emission (SULEV) and federal inherently low-emission (ILEV) standards. Qualifying plug-in hybrid electric vehicles that meet California transitional zero emission vehicle standards qualify as well. Decals provide an access period of three full years plus the remainder of the year from when it was issued, and the state DMV will establish a new decal color every year. The CAV Decal Program will end on September 30, 2025.

[143] Beneficial State Found. & Cal. Air Res. Bd., Clean Vehicle Assistance Program FAQ, https://cleanvehiclegrants.org/ (last visited June 15, 2020).

[144] Cal. Air Res. Bd., Moving California: Clean Cars for All (2016), https://ww3.arb.ca.gov/msprog/lct/vehiclescrap.htm (last visited May 20, 2020).

[145] Cal. Dep't of Motor Vehicles, Clean Air Vehicle Decals for Using Carpool and HOV Lanes, https://www.dmv.ca.gov/portal/dmv/detail/vr/decal (last visited May 20, 2020).

[146] *Id*.

TABLE 13
Clean Air Vehicle (CAV) Decal Color & Expiration

Decal Type	Year First Issued	Decal Expires	Description
	2020	1/1/2024	These CAV decals are issued to vehicles that meet California's super ultra-low emission vehicle (SULEV), inherently low-emission vehicle (ILEV), and transitional zero emission vehicle (TZEV) evaporative emission standards for exhaust emissions. Compressed natural gas (CNG) and liquefied petroleum gas (LPG) fueled vehicles may also qualify for the CAV decal program.
	2019	1/1/2023	
	2018	1/1/2022	
	2012	1/1/2019	Green CAV decals were issued to vehicles that met Enhanced AT PZEV (TZEV standards for exhaust emissions.) Vehicles issued a green decal prior to January 1, 2017 are no longer eligible for this program after January 1, 2019.
	2000	1/1/2019	White CAV decals were issued to vehicles that meet ZEV, CNG, LPG, and ULEV standards for exhaust emissions and the federal ILEV standard. Ultra-low emission vehicles (ULEVs) are no longer eligible to participate in this program after January 1, 2019.
	2004	7/1/2011	These decals were issued to early models of qualifying hybrid vehicles.

Source: Cal. Dep't of Motor Vehicles, Clean Air Vehicle Decals - High Occupancy Vehicle Lane Usage, https://www.dmv.ca.gov/portal/dmv/detail/vr/decal.

Apart from ZEV rebates and CAV decals, California has also been working to develop and expand the infrastructure to support ZEVs. One example is the state's implementation of the California Electric Vehicle Infrastructure Project (CALeVIP). CALeVIP offers rebate incentives for the purchase and installation of

electric vehicle charging infrastructure at publicly accessible sites throughout the state.[147] While providing drivers of plug-in vehicles with convenient access to chargers, CALeVIP strives to encourage more citizens to consider purchasing ZEVs. CALeVIP aims to provide a streamlined application process for charger installation.[148] The program is funded by the California Energy Commission and implemented by the Center for Sustainable Energy. It is currently funded for USD $71 million, with the potential of up to USD $200 million in funding.

Moreover, California has explored using utility programs to expand plug-in electric vehicle (PEV) charging network. The California Public Utilities Commission authorizes these programs. For example, Southern California Edison (SCE) launched the Charge Ready Program in May 2016 to add EV charging stations to its service area.[149] San Diego Gas & Electric (SDG&E) created the Power Your Drive Program in 2016 to install charging stations at apartments, condominiums and workplaces.[150]

3.4.2 Advanced Clean Trucks Program

Heavy-duty vehicles like diesel trucks are also major contributors to traditional air pollutant and greenhouse gas emissions. NO_x engine emission standards are critical to attaining federal standards for ozone and $PM_{2.5}$. CARB works closely with the U.S. EPA, manufacturers, and other stakeholders to address the issue of heavy-duty emissions.

Section 1956.8 Title 13 of the California Code of Regulations contains California's emission standards for heavy-duty vehicles.[151] In 2013, CARB adopted an optional standard for NO_x emissions to encourage engine manufacturers to innovate new technologies that could reduce emissions to 90% below the current standard.[152] In April 2017, two natural gas engines were certified to the optional NO_x standards and two more in August of the same year.

Reduction of traditional air pollutants and GHGs from diesel trucks will require a shift away from fossil fuels toward zero-emission trucks. In June 2020, CARB voted to adopt the first wave of ZEV truck regulations, the Advanced Clean Trucks Regulation, as part of a holistic approach to accelerate large-scale transition of Class 2B (light/medium trucks heavier than 8,500 pounds) to Class 8 (heavy trucks over 33,001 pounds) vehicles to ZEVs.[153] The regulation has two requirements: a manufacturer sales requirement similar to the ZEV mandate for light-duty vehicles, and a reporting requirement that large entities that own, control, or dispatch medium- and heavy-duty trucks must report information about shipments and shuttle services. Fleet owners with 100 or more trucks would also be required to report about their existing fleet operations to inform future policies ensuring fleets purchase and use ZEV trucks.

Beginning in 2024, the Advanced Clean Trucks sales mandate requires trucks sold in California to be zero-emission in increasing percentages. By 2035, ZEVs must comprise 55% of sales of medium-duty

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[147] Center for Sustainable Energy & Cal. Energy Comm'n, About CALeVIP, https://calevip.org/about-calevip (last visited May 20, 2020).

[148] *Id.*

[149] Fadia R. Khoury & Andrea L. Tozer, *Southern California Edison Company's (U 338-E) Charge Ready Pilot Program Report*, s. Cal. Edison 7 (July 13, 2018).

[150] E. G. Barnes, *Electric Vehicle-Grid Integration Pilot Program ("Power Your Drive") Fourth Semi-Annual Report of San Diego Gas & Electric Company (U902-E)*, S. Cal. Edison (Nov. 14, 2013).

[151] Cal. Air Res. Bd., On-road Heavy Duty Vehicle Program (July 2, 2019), https://ww2.arb.ca.gov/our-work/topics/road-heavy-duty-vehicles.

[152] *See* Cal. Air Res. Bd., Optional Reduced NO_x Standards for Heavy-Duty Vehicles, https://ww2.arb.ca.gov/our-work/programs/optional-reduced-nox-standards.

[153] Cal. Air Res. Bd., Advanced Clean Trucks Fact Sheet, https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet.

trucks between 8,500 and 14,000 pounds; that number reaches 75% for medium- and heavy-duty trucks weighing more than 14,000 pounds.[154] This rule will reduce both criteria pollutant and GHG emissions in the transportation sector.

As CARB describes:

> Mobile sources and the fossil fuels that power them are the largest contributors to the formation of ozone, greenhouse gas emissions, fine particulate matter ($PM_{2.5}$), and toxic diesel particulate matter. In California, they are responsible for approximately 80% of smog-forming nitrogen oxide (NO_x) emissions. They also represent about 50% of greenhouse gas emissions when including emissions from fuel production, and more than 95% of toxic diesel particulate matter emissions. Zero-emission vehicles have no tailpipe emissions. When compared to diesel vehicles, they are two to five times more energy efficient, reduce dependence on petroleum, and reduce GHG emissions substantially.[155]

The rule will also create an estimated USD $3.2 billion to USD $8.9 billion in health benefits from 2020 to 2040. The potential climate benefits of reducing more greenhouse gas emissions are estimated at nearly $1 billion. The rule is also expected to create 8,000 new jobs by 2040.[156]

To go into effect, California will need to obtain a Clean Air Act waiver from the U.S. EPA. The Trump administration is currently asserting that California is not entitled to GHG waivers under the Act; that matter is being litigated. But the Trump administration has not challenged California's ability to obtain EPA waivers for regulation of tailpipe emissions of criteria pollutants such as $PM_{2.5}$ and NO_x.

California is also updating its own heavy-duty truck NO_x rules to reduce emissions from non-ZEV trucks. We expect this rulemaking to be finalized in 2020, but it may be subject to legal attack depending on the outcome of a federal regulatory process, which we discuss below.

While California has its own set of NO_x regulations, federal NO_x engine emission standards are necessary to regulate vehicles operating in California that are purchased outside the state.[157] On November 13, 2018, the U.S. EPA announced a federal Cleaner Trucks Initiative targeting NO_x emission reductions for heavy-duty engines. This proposed regulation is expected to be published in 2020 and could take effect by the 2024 model year, so while it has not been announced what the rules will be, the U.S. EPA has stated that it views updates to the NO_x standard as an opportunity to "harmonize" federal and California rules regulating NO_x emissions.[158] As noted above, if the California and federal NO_x standards differ, legal challenges may ensue.

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[154] Full descriptions of the CARB advanced clean trucks rule can be found at https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet and at https://www.nrdc.org/experts/patricio-portillo/ca-takes-step-forward-new-clean-truck-proposal.

[155] Cal. Air Res. Bd., Advanced Clean Trucks Fact Sheet, https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-trucks-fact-sheet.

[156] Patricio Portillo, *CA Takes a Step Forward with New Clean Truck Proposal*, Natural Resources Defense Council (Apr. 25, 2020), https://www.nrdc.org/experts/patricio-portillo/ca-takes-step-forward-new-clean-truck-proposal.

[157] *See* Cal. Air Res. Bd., *supra note* 155.

[158] U.S. Envtl. Prot. Agency, Memorandum in Response to Petition for Rulemaking to Adopt Ultra-low NO_x Standards for On-highway Heavy-Duity Trucks and Engines 11 (Dec. 2016).

3.4.3 Corporate Average Fuel Economy (CAFE) Standards

Vehicle fuel economy standards are an important means of reducing both traditional air pollutant and GHG emissions. Fuel combustion emits air pollutants (such as NO_x and VOCs) and GHGs, and more fuel-efficient vehicles use less fuel per distance traveled. First enacted by Congress in 1975, the Corporate Average Fuel Economy (CAFE) standards set federal, nation-wide fuel economy standards for automakers.[159] Fuel economy, also known as "fuel efficiency," is a measurement of the amount of fuel consumed by a vehicle over a set distance, expressed by "miles per gallon" in the U.S.[160]

The NHTSA sets and enforces CAFE standards, while the EPA sets tailpipe GHG emissions standards.[161] Automakers are required to achieve the CAFE standards, which are fleetwide average fuel economy standards, for each model year.[162] The Energy Policy and Conservation Act of 1975 preempts state fuel economy standards; accordingly, California has not enacted its own fuel economy standards.[163] There are different CAFE standards for passenger cars and light-duty trucks. Coverage of medium and heavy-duty trucks has been included in CAFE regulations since 2014.[164]

As discussed above, under the Obama administration, NHTSA and the EPA (working closely with California) set standards to improve fuel economy and tailpipe GHG emissions for passenger cars and light-duty trucks model years 2017-2025. The 2025 fuel economy standards were projected to hit a fleet wide average of 54.5 miles per gallon.[165] As CAFE standards are raised, automakers will need to develop a more fuel-efficient fleet to meet the standards.

The Trump administration has been working on rolling back Obama-era CAFE standards, which, among other things, includes a revocation of California's waiver to set tailpipe GHG emissions standards and a revised CAFE standard requiring annual average improvements to fuel efficiency of 1.5% (which relaxes the stringency of Obama-era standards).[166]

3.4.4 Low Carbon Fuel Standard

California's Low Carbon Fuel Standard (LCFS) is an innovative policy designed to help California meet its GHG emissions targets by reducing the carbon intensity of transportation fuels.[167] While typically associated

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[159] U.S. Dep't of Transp., Corporate Average Fuel Economy (CAFE) Standards (Aug. 11, 2014), https://www.transportation.gov/mission/sustainability/corporate-average-fuel-economy-cafe-standards.

[160] Union of Concerned Scientists, Transportation Technologies and Innovation, https://www.ucsusa.org/transportation/technologies (last visited May 20, 2020).

[161] U.S. Dep't of Transp., Corporate Average Fuel Economy (CAFE) Standards (Aug. 11, 2014), https://www.transportation.gov/mission/sustainability/corporate-average-fuel-economy-cafe-standards.

[162] *Id*.

[163] 49 U.S.C. § 32919 (West 2020) ("a State or a political subdivision of a State may not adopt or enforce a law or regulation related to fuel economy standards or average fuel economy standards").

[164] U.S. Dep't of Transp., Corporate Average Fuel Economy (CAFE) Standards (Aug. 11, 2014), https://www.transportation.gov/mission/sustainability/corporate-average-fuel-economy-cafe-standards.

[165] U.S. Envtl. Prot. Agency, EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks 1 (Aug. 2012).

[166] U.S. Envtl. Prot. Agency, The Safer Affordable Fuel Efficient (SAFE) Vehicles Final Rule for Model Years 2021-2026, https://www.epa.gov/regulations-emissions-vehicles-and-engines/safer-affordable-fuel-efficient-safe-vehicles-final-rule (last visited May 20, 2020).

[167] Cal. Air Res. Bd., Information for Entities that Take Delivery of Fuel for Fuels Phased into the Cap-and-Trade Program Beginning on January 1, 2015.

with California's efforts to combat climate change, the LCFS also reduces traditional air pollutant emissions through its promotion of lower carbon alternative fuels.

The LCFS is an intensity standard that requires fuel suppliers to limit the carbon intensity of the fuels they sell (expressed as CO_2 equivalent per megajoule (MJ) of energy produced) to designated levels. Fuel suppliers comply by either producing fuel at the required intensity levels or purchasing credits to compensate for any exceedances. Suppliers that produce fuel at a carbon intensity below current targets receive credits that may be sold on the market to non-complying firms or "banked" for use by the supplier in future years.

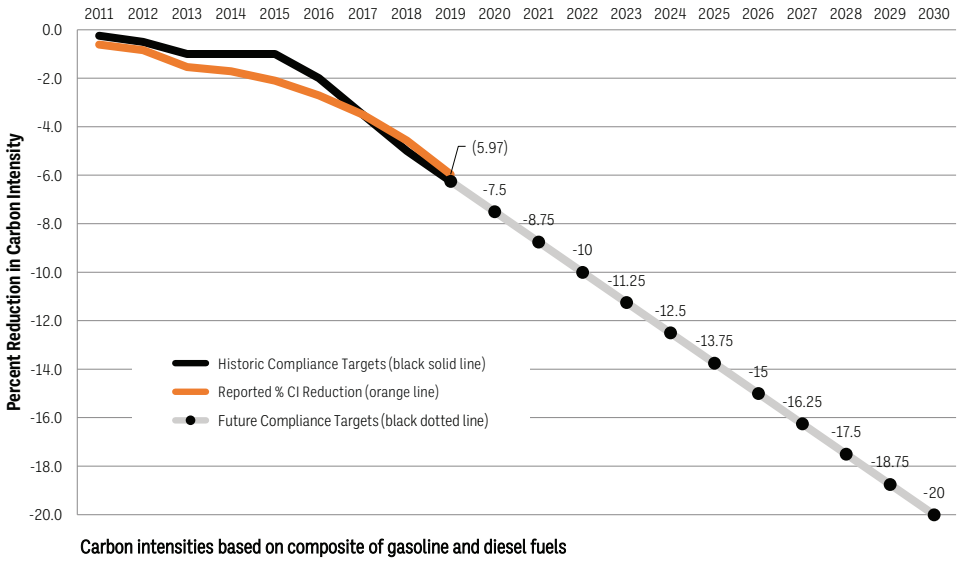
Under the LCFS, California's average fuel carbon intensity declines each year to 10% below the 2010 level in 2020 and then 20% below the 2010 level in 2030. One notable innovation of the LCFS is the use of life-cycle assessment to determine emissions generated throughout the "fuel pathway" – including extraction, production, processing, transportation and consumption.[168]

The LCFS regulations define separate carbon intensity baselines for gasoline and its replacements, and for diesel and its replacements.[169] Alternative fuels regulated under the LCFS include gas (natural gas and bio-gas), ethanol, bio-diesel, renewable diesel, electricity, hydrogen and others. Whether a fuel is considered a gasoline or diesel replacement is determined by intended use. Fuels for light- and medium-duty vehicles are generally considered gasoline replacements. Those for heavy-duty vehicles are mostly considered diesel replacements. The two groups (gasoline and diesel—as well as their respective replacements) must meet targets separately under the LCFS.

[168] Edward A. Parson, et. al., *Controlling Greenhouse Gas Emissions from Transport Fuels: The Performance and Prospect of California's Low Carbon Fuel Standard*, Emmett Inst. on Climate Change & the Environment 5 (June 2018) (Pritzker Brief No. 10).

[169] See *id.* at 9.

FIGURE 12
2011-2019 Performance of the Low Carbon Fuel Standard



This figure shows the percent reduction in the carbon intensity (CI) of California's transportation fuel pool. The LCFS target is to achieve a 20% reduction by 2030 by setting a declining annual target, or compliance standard. The compliance standard was frozen at 1% reduction from 2013-2015 due to legal challenges, contributing to a build-up of banked credits as regulated parties bringing new alternative fuels to market continued to over-comply with the standard. The program will continue post 2030 at a to be determined stringency.

Source: Cal. Air Res. Bd., 2011-2019 Performance of the Low Carbon Fuel Standard (May 2020), https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm.

Since its implementation, the LCFS has generated large expansions of alternative fuel supply and significant reductions in overall carbon intensity in California's fuel markets.[170] As of 2019, the LCFS had led to the displacement of almost 3.3 billion gallons of petroleum diesel fuel by clean, low-carbon alternatives.[171]

3.4.5 Land Use Planning — Reducing Vehicle Miles Traveled

Given that transportation-related GHG emissions are now the largest contributor to climate change, both in California and throughout the U.S., and that vehicular emissions are also responsible for a significant amount of smog-forming pollutants, California has recognized that reducing vehicle miles traveled (VMT) can reduce both GHG and traditional air pollutant emissions.

California is experiencing an acute housing crisis—many more units are needed than are being built. Many cities in California, particularly coastal cities like Los Angeles and San Francisco, are beset by a very

[170] Cal. Air. Res. Bd., Public Hearing to Consider Proposed Amendments to the Low Carbon Fuel Standard Regulation and to the Regulation on Commercialization of Alternative Diesel Fuels, Staff Report: Initial Statement of Reasons 7 (Mar. 6, 2018).

[171] Cal. Air. Res. Bd., Cleaner Fuels Have Now Replaced More Than 3 Billion Gallons of Diesel Under the Low Carbon Fuel Standard (May 16, 2019), https://ww2.arb.ca.gov/news/cleaner-fuels-have-now-replaced-more-3-billion-gallons-diesel-fuel-under-low-carbon-fuel.

serious jobs and housing imbalance, which means that there isn't enough affordable local housing for local employees to live in. This can result in long commutes of over an hour or more each way by workers driving alone. Building more housing close to jobs, rather than far away in the suburbs is a way to reduce these long commutes, but this can be expensive and controversial.

California's SB 375 (2008) is a law meant to align land use and transportation planning with the state's overall climate change goals.[172] The law requires local Metropolitan Planning Organizations (MPOs) to develop Sustainable Communities Strategies (SCS) as part of federally-mandated Regional Transportation Plans. MPOs work with CARB to develop regional GHG emissions targets. SCS documents spell out transportation planning consistent with these targets. The law provides streamlined procedures under California's environmental review law, the California Environmental Quality Act (CEQA), for projects consistent with the SCS. SB 375 has received mixed reviews more than a decade after its passage.[173] Critics note that the law imposes few hard requirements on local jurisdictions. Given this and local citizen resistance to higher density housing development, affordable housing, and transit-oriented housing, it is not surprising that the law has not had a significant impact on the siting of residential development.

CEQA can serve as an alternative tool for promoting greener land use planning. The California Attorney General, community groups, and environmental and housing NGOs have all turned to CEQA litigation[174] to promote dense urban infill housing and discourage suburban sprawl, all in the name of reducing VMT in California. CEQA requires a full analysis of the environmental effects of a project, public or private, when there is a fair argument that the project will have a substantial effect on the environment. California courts have interpreted CEQA to require analysis of GHG emissions from a proposed project.

CEQA also requires that the negative environmental effects of a project be mitigated to the extent feasible. It is this mitigation requirement that can help reduce VMT and so reduce GHG emissions. For example, given the need to reduce GHG emissions statewide in California, many advocates insist that new projects be, at worst, net zero new GHGs over baseline conditions. For a housing development that is built on vacant land, the GHG baseline will be zero and so, under this theory, GHG emissions from the project should be net zero, meaning net of any permitted GHG offsets.

For new suburban housing developments, what this often means in practice is that the developer must make an enforceable commitment to build and maintain a net zero project. The California Attorney General and others have been taking this position. Projects can achieve net zero status through using all electrical hookups for heating and cooking (assuming a fully renewable power source of electricity), wiring all homes for electric vehicle charging, providing for public transit where possible, increasing the energy efficiency of new homes over building code requirements, unbundling parking from multi-family home development pricing, and similar measures. These measures tend to increase project cost and are thus sometimes opposed by developers.

On the other hand, as mentioned above, to promote dense urban infill housing near public transit, state, and local laws now allow CEQA streamlining for qualifying projects. Typically, a project will need to be in an urban area, be located within a certain distance of a major public transit stop, and dedicate a certain percentage of units affordable to low-income families. CEQA streamlining for such projects is intended

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[172] S.B. 375, 2007-08 Leg. (Cal. 2008).

[173] Sarah Mawhorter, et al., *California's SB 375 and the Pursuit of Sustainable and Affordable Development* (Terner Ctr., Working Paper, July 2018).

[174] The text of CEQA can be found at Cal. Pub. Res. Code §§ 21000, *et seq*.

to make it easier to build developments sited near jobs and public transit, thus reducing residents' VMT. Academic studies on whether such projects do, in fact, reduce VMT are, so far, inconclusive.

3.5 Electricity Generation and Consumption

The generation of electricity is a significant contributor to traditional air pollutants and greenhouse gas emissions. In the United States, the electric power sector is responsible for 36% of the carbon dioxide (CO_2) emissions, 49% of sulfur dioxide (SO_2) emissions, and 11% of nitrogen oxides (NO_x) emissions.[175] In California, the electricity sector is relatively less carbon intensive, contributing to 14.7% of California GHG emissions.[176] Electric utilities contribute only 1.4% of NO_x and about 1% of $PM_{2.5}$, due to greater reliance on natural gas and renewable energy, as well as long-standing efforts to control emissions through "end-of-pipe" technologies.[177] In China, where about 64% of electricity is produced by coal, power generation contributes to approximately 44% of national CO_2 emissions and is a significant contributor to traditional air pollutant emissions.[178]

Traditional air pollutants, such as SO_2 and NO_x, have traditionally been reduced through regulation requiring the deployment of "end-of-pipe" or "smokestack" abatement technology at power plants.[179] But such approaches require additional energy, which can generate additional GHG emissions. Commercially viable end-of-pipe technologies for reducing CO_2 emissions from power generation are generally not available.[180] Therefore, strategies for reducing CO_2 emissions from the power sector generally focus on shifting to renewable energy or less carbon intensive fuels, and improving energy efficiency.[181] Such strategies can reduce emissions of greenhouse gases *and* traditional air pollutants.

The evidence of air and climate co-benefits from the types of energy policies discussed below is substantial. A 2019 study by Zhao et al. models the potential emissions reduction and public health co-benefits of various deep decarbonization pathways. The authors find "that achievement of [California's] 80% GHG reduction by 2050 target would bring substantial air quality and health co-benefits," but that the magnitude of the co-benefits varies depending on the technological pathway chosen. Specifically, they model one scenario that prioritizes electrification and clean renewable energy against a lower cost scenario that prioritizes combustible renewable fuels. The former scenario has higher levels of electrification in agriculture, industry, commercial, residential and oil production and refining sectors than the latter. The first scenario also has higher penetrations of EVs and wind and solar power. The study found that the first pathway reduced $PM_{2.5}$ by 33%, SO_2 by 37%, NH_3 by 34%, NO_x by 34%, and ROG by 18%. These reductions are generated through reduced energy consumption and greater resort to cleaner energy sources. The second scenario (focused on renewable fuels) produces more modest co-benefits (ranging from 6-24% depending on pollutant).

A study of the energy efficiency programs implemented by seven investor-owned utilities (electricity and natural gas providers) in California from 2013-2015 found substantial reductions in CO_2, NO_x, and other

[175] Christopher V. Atten, et al., *Benchmarking Air Emissions of the 100 Largest Power Producers in the United States*, MJ Bradley (June 2019).

[176] Cal. Air Res. Bd., California Greenhouse Gas Emissions for 2000 to 2017, at 6.

[177] Cal. Air Res. Bd., 2015 GHG Facility and Entity Emissions (Nov. 4, 2019), https://ww2.arb.ca.gov/mrr-data.

[178] *See* People's Republic of China, Second Biennial Update Report on Climate Change 19 (calculating that 9,123,940 kt total CO_2 emissions, or 3,995,344 kt "energy industry" CO^2 emissions equals 43.79% in 2014).

[179] Christopher James, *Best Practices for Achieving Cleaner Air and Lower Carbon*, Reg. Assistance Project (Mar. 2019).

[180] *Id.*

[181] *Id.*

traditional air pollutants from efficiency improvements in the electric and natural gas sectors.[182] These energy efficiency programs were estimated to have reduced CO_2 and NO_x emissions substantially over a three-year period (2013-15), avoiding more than 4.1 million tons of CO_2 and 1.6 million pounds of NO_x emissions.[183]

This section will discuss programs aimed at reducing emissions from both the *production of* and *demand for* electricity. These include:

- Renewable portfolio standards;
- GHG performance standards for power plants;
- Energy efficiency programs;
- Building codes and standards.

At the state level, policymakers have adopted renewable portfolio standards (RPS) that require a portion of the electricity consumed in the state to be generated by renewable sources.

At the federal level, policymakers have attempted to adopt state-level carbon emissions standards that encourage the power generation portfolio within a state to shift away from fossil-fuel generation sources.[184] These policies reduce CO_2, SO_2, and NO_x emissions from power generation largely because fossil-fuel generation is replaced with renewable generation (such as solar and wind power), which does not produce any greenhouse gases or traditional air pollutant emissions.[185]

Building codes and standards seek to reduce building use of fossil fuel for power and heating (electrification, solar panels, etc.) and lower energy use through efficiency measures (insulation, lighting, etc.).

Energy efficiency programs implemented by the federal and state governments achieve co-control of air pollutant and greenhouse gas emissions through a reduction in demand for power generation.

The benefits and costs of fuel switching and energy efficiency will vary by the particular mix of energy sources in a jurisdiction. China's electricity generation remains dominated by coal (64.09% in 2018), despite relative declines in recent years.[186] In the U.S., the rise of natural gas (35.4% in 2018) has reduced the carbon intensity of electricity generation, although coal still accounts for 27% of the mix.[187]

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[182] Cal. Pub. Util. Comm'n, Energy Efficiency Portfolio Report (May 2018); *see also* Cal. Pub. Util. Comm'n, 2010-2012 Energy Efficiency Annual Progress Evaluation Report (Mar. 2015).

[183] Cal. Pub. Util. Comm'n., Energy Efficiency Portfolio Report 10 (May 2018). These statistics reflect net savings (those attributed to the efficiency programs alone). Gross savings, which include program-related efficiencies and efficiencies that would have been adopted even without the utility efficiency programs, are even larger – 7 million tons of CO_2 and 2.6 million pounds of NO_x avoided during the three-year period. *See* p. 10.

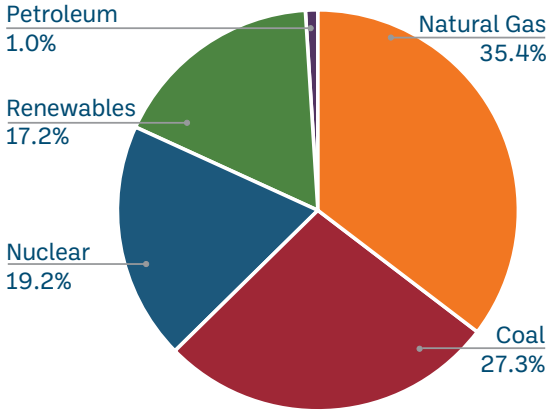
[184] We highlight the Obama-era Clean Power Plan as an example of good coordinated governance but note that the Trump administration has repealed this rule and proposed a new rule that will provide lower environmental benefits.

[185] Some of the reduction in CO_2, SO_2, and NO_x emissions can be attributed to coal generation being replaced with natural gas generation, which emits less greenhouse gas and air pollutant emissions than coal generation.

[186] According to the China Electricity Council, in 2018, 64.09% of electricity generation in China came from coal, 3.08% from natural gas, 4.22% from nuclear and 25.37% from renewables (17.61% from hydro, 2.53% from solar and 5.23% from wind). *See* China Elect. Council,中电联发布《中国电力行业年度发展报告2019》, [China Electricity Council publishes the Annual Development Report of Chinese Electricity Industry 2019](June 13, 2019), https://www.cec.org.cn/detail/index.html?0-7166.

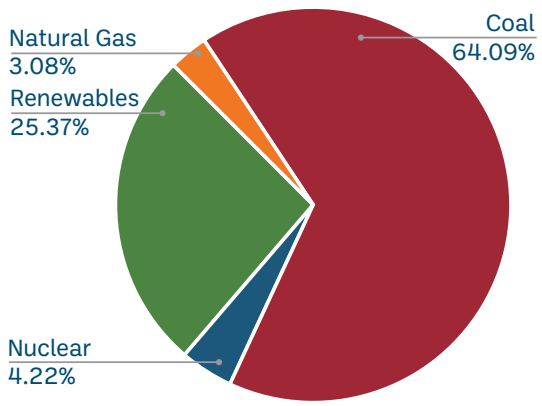
[187] According to the U.S. Energy Information Administration, in 2018, 35% of electricity generation in the U.S. came from natural gas, 27% from coal, 19% from nuclear, 17% from renewables and 1% from petroleum. U.S. Energy Info. Admin., Electricity Explained: Electricity in the United States (Apr. 19, 2019), https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php.

FIGURE 13
Sources of U.S. Electricity Generation, 2018



Source: U.S. Energy Information Admin., Electricity Explained: Electricity in the United States, https://web.archive.org/web/20200215091308/https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.

FIGURE 14
Sources of Chinese Electricity Generation, 2018

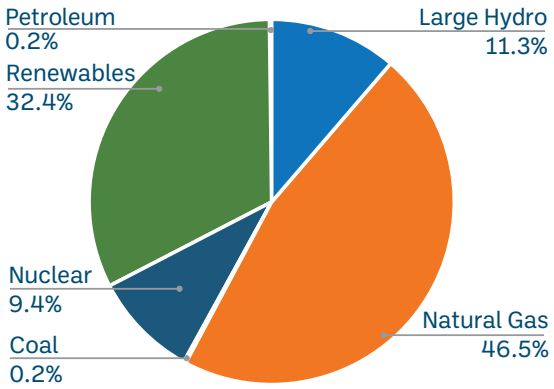


Source: China Elec. Council,中电联发布《中国电力行业年度发展报告2019》,[China Electricity Council publishes the Annual Development Report of Chinese Electricity Industry 2019](June 13, 2019), https://www.cec.org.cn/detail/index.html?0-7166.

Power generation in California is significantly less carbon intensive than in either China and the U.S. as a whole. In 2018, only 3.3% of California's overall power supply came from coal (almost entirely imported from out of state), 42.04% came from renewables (large hydropower plus other renewables), 34.91% from natural gas, 9.05% from nuclear and 10.54% from unspecified sources that are imported.[188] Efforts to decarbonize the power sector in California focus on the reduction of natural gas use and limiting imports of fossil-fuel-based energy.

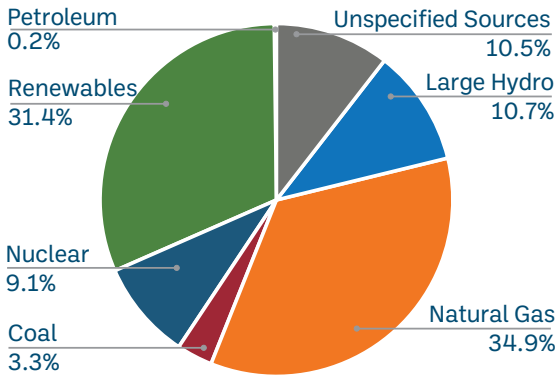
[188] Cal. Energy Comm'n, 2018 Total System Electric Generation (June 2019), https://web.archive.org/web/20200401230820/https://ww2.energy.ca.gov/almanac/electricity_data/total_system_power.html. California imports 35% of its electricity in 2018 thus its overall electricity structure is different from its in-state generation structure. *Id.* 10.5% of electricity generated for California was from unspecified sources (all imported) which could range from coal to renewables. *Id.* Natural gas makes up 46.54% of in-state power generation but only provides 34.91% of overall power supply. *Id.*

FIGURE 15
California In-State Generation, 2018



Source: Cal. Energy Comm'n, 2018 Total System Electric Generation (June 2019), https://web.archive.org/web/20200401230820/https://ww2.energy.ca.gov/almanac/electricity_data/total_system_power.html.

FIGURE 16
California Energy Mix Imports Included, 2018



Source: Cal. Energy Comm'n, 2018 Total System Electric Generation (June 2019), https://web.archive.org/web/20200401230820/https://ww2.energy.ca.gov/almanac/electricity_data/total_system_power.html.

Another major difference between U.S. and Chinese electricity systems is the growth rate. Total electricity generation and total electricity generation capacity of the U.S. have both remained stable since 2008 with an increase of less than 1%.[189] California has also had a very stable demand for electricity at around 290,000 GWH per year. In comparison, China's electricity demand continues to grow. As of first quarter 2019, China's year-on-year electricity consumption growth was 5.5% while the year-on-year production growth was 4.2%. From 2008 to 2018, China's total electricity generation capacity grew at an annual rate of 7.9% or higher, and China's total electricity generation has an average annual growth rate of 6%. The Chinese dynamic presents both opportunities (e.g., to focus on renewable energy for capacity generation expansion) and challenges (i.e., the challenges of shifting away from historical patterns of coal-based energy growth).

3.5.1 Renewable Portfolio Standards

Renewable Portfolio Standards (RPS) require that certain percentages of all electricity provided to retail customers be produced by specified eligible renewable sources. By displacing fossil-fuel generation, RPS therefore act to reduce the traditional air pollutant and GHG emissions associated with the combustion of fossil fuels.

Numerous studies have determined that significant reductions in traditional air pollutants and GHGs can be achieved from the adoption of renewable energy sources, such as solar and wind power. One study found that the new renewable energy used to meet state-level RPS obligations in just one year (2013), reduced national CO_2 emissions by 59 million metric tons, SO_2 emissions by 77,400 metric tons, NO_x emissions by 43,900 metric tons, and $PM_{2.5}$ emissions by 4,800 metric tons.[190] These reductions were estimated to produce USD $7.4 billion in health and environmental benefits. States on the East Coast experienced more

[189] U.S. Energy Information Admin., Summary Statistics for the United States, 2008 - 2018, https://www.eia.gov/electricity/annual/html/epa_01_02.html (last visited May 20, 2020).

[190] Ryan Wiser, et. al., *A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards,* Nat'l Renewable Energy Lab. vii – viii (Jan. 2016).

significant GHG and traditional air pollutant emissions reductions and associated benefits because more high-emitting fossil-fuel plants were displaced by renewable energy and population densities are higher.[191]

Moreover, the benefits of the RPS programs do not only fall on those states that have adopted them because of the regional nature of electricity markets and the ability to use renewable energy generated out-of-state to satisfy the RPS obligations.[192]

Nationwide Overview

In the United States, twenty-nine states and D.C. have adopted renewable portfolio/energy standards (RPS/RES) that incentivize and/or compel electric utilities to procure a certain percentage of the electricity that they sell to consumers from renewable or zero-carbon generation sources.[193] Nearly half of renewable energy deployment in the U.S. since 2000 can be attributed to state renewable energy policies.[194] This increase in renewable energy sources in the power generation mix displaces fossil fuel generators, reducing both greenhouse gas and air pollutant emissions.

California RPS

The story of the California RPS is one of increasing ambition and success. California established the RPS in 2002 and is now operating under a long-term target for retail sellers of electricity to obtain 100% of electricity from eligible renewable sources and zero-carbon resources by 2045. In September 2002, California enacted SB 1078, which established an RPS in California with an initial renewable energy target of 20% by 2017.[195] SB 107 (2006) accelerated the 20% target date to 2010.[196] SB 2 (2011) added a target of 33% by 2020.[197] In October 2015, California enacted SB 350, which added a 50% by 2030 target.[198] Under SB 100 (2018), California's RPS was again revised to include the following targets: 44% by 2024;

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[191] *Id.*

[192] *Id.* Wiser and Millstein, et al., estimated the potential impact of the U.S. Department of Energy's SunShot Vision goals, which aim for 14% of power to be generated from solar by 2030 and 27% by 2050. *Id.* The authors find that, from 2015-2050, SunShot would reduce CO_2 emissions by 8 billion metric tons or 10%, SO_2 emissions by 9%, NO_x emissions by 11%, and $PM_{2.5}$ emissions by 8%. Ryan Wiser, et al., *Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States*, 113 Energy 472, 479 (2016). The authors find that CO_2 emissions reductions are concentrated in California, Texas, and the Southeast because they have the greatest potential for solar deployment and/or have a larger share of coal plants that are displaced by new solar. *Id.* In another study, Wiser and Bolinger, et al. (2016) estimated the potential impact of the U.S. Department of Energy's Wind Vision goals, which aim for 10% of power to be generated from wind by 2020, 20% by 2030, and 35% by 2050. Ryan Wiser, et al., *Long-Term Implications of Sustained Wind Power Growth in the United States: Potential Benefits and Secondary Impacts*, 179 Applied Energy 146 – 158 (Oct. 1, 2016). The authors find that, from 2013-2050, Wind Vision would reduce CO_2 by 12.3 billion metric tonnes, SO_2 emissions by 2.6 million metric tonnes, NO_x emissions by 4.7 million metric tonnes, and $PM_{2.5}$ emissions by 0.5 million metric tonnes. *Id.*

[193] Ryan Wiser, et. al., *A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards* Nat'l Renewable Energy Lab, at vii.

[194] Galen L. Barbose, U.S. *Renewables Portfolio Standards: 2018 Annual Status Report*, Lawrence Berkeley Nat'l Lab. (Nov. 2018).

[195] S.B. 1078, 2001-02 Leg. (Cal. 2002) ("beginning on January 1, 2003, each electrical corporation shall, pursuant to subdivision (a), increase its total procurement of eligible renewable energy resources by at least an additional 1 percent of retail sales per year so that 20 percent of its retail sales are procured from eligible renewable energy resources no later than December 31, 2017"); Cal. Pub. Util. Comm'n, Renewable Portfolio Standard (RPS) Program, https://www.cpuc.ca.gov/rps/ (last visited May 20, 2020).

[196] S.B. 107, 2005-06 Leg. (Cal. 2006).

[197] S.B. 2, 2011-12 Leg. (Cal. 2011).

[198] S.B. 350, 2015-2016 Leg. (Cal. 2016); Cal. Energy Comm'n, What Does SB 350 Do?, https://www.energy.ca.gov/rules-and-regulations/energy-suppliers-reporting/clean-energy-and-pollution-reduction-act-sb-350 (last visited May 20, 2020).

52% by 2027 and 60% by 2030.[199] SB 100 also states that these RPS requirements for the electric utilities support overall program goals to achieve a 50% renewable resources target by 2026 and a 60% target by 2030. It also clarifies the state policy that 100% of retail electric sales come from eligible renewable energy resources and zero-carbon resources by 2045.[200]

TABLE 14
California Renewable Portfolio Standard Targets

Electric Utility RPS Targets	
20%	2010 *(was initially 2017)*
25%	2016
33%	2020 *(met in 2018)*
44%	2024
52%	2027
60%	2030 *(was initially 50%)*
State Goals for Electricity from Renewable Sources	
50%	2026
60%	2030
100%*	2045

* From eligible renewable energy resources *and* zero-carbon resources

Los Angeles RPS

Los Angeles is the only major city in the United States that owns a municipal electric utility, Los Angeles Department of Water and Power (LADWP). This effectively gives Los Angeles local control over power generation, which is traditionally regulated at the state level. In 2004, Los Angeles City Council created the first renewable generation target for LADWP, which required LADWP to generate 20% of its power from renewable sources by 2017.[201] In 2007, this target date was accelerated to 2010 (consistent with amendments to state targets), which LADWP met.[202] In 2017, LADWP generated 30% of its power from renewable sources.[203] This was achieved by shutting down three coal plants, retrofitting natural-gas plants with cleaner technology and expanding renewable generation. As a result, in 2016 LADWP CO_2 emissions were 41% below 1990 levels. By 2025-27, CO_2 emissions are anticipated to be 77% below 1990 levels and annual NO_x emissions are expected to decline from 10,000 metric tons to zero.

In 2016, the LA City Council motioned for LADWP to create a pathway to achieve a 100% renewable energy supply.[204] LADWP is currently completing the LA100 Study with the National Renewable Energy

[199] S.B. 100, 2017-18 Leg. (Cal. 2018).

[200] *Id.*

[201] L.A. Dep't of Water and Power, RPS Policy Enforcement Program 4 (Dec. 2013).

[202] *Id.*

[203] David H. Wright, *L.A.'s Clean Energy Transition: 100% Renewable Energy Study*, L.A. Dep't of Water and Power (Nov. 16, 2018).

[204] *Id.*

Laboratory (NREL).[205] In April 2019, Mayor Eric Garcetti formally announced Los Angeles' goal of 80% renewable energy by 2036 and 100% renewable energy by 2045.[206] This followed Mayor Garcetti's announcement that LADWP would not rebuild three natural gas power plants in the Los Angeles basin when they must comply with new regulations preventing their use of once through cooling with ocean water by 2024 (at the Scattergood plant) and 2029 (at the Harbor and Haynes plants).[207] In September 2019, LADWP announced a new solar contract that would provide 6-7% of LADWP's power.[208]

3.5.2 GHG Performance Targets — the Federal Clean Power Plan

CO_2 emissions performance targets that incentivize fuel switching and energy efficiency can reduce traditional air pollutants and GHG emissions. In August 2015, the EPA issued the Clean Power Plan (CPP), which aimed to reduce CO_2 emissions from power generation to 32% below 2005 levels in 2030.[209] Although the Trump administration has proposed a different rule (the ACE Rule) to replace the CPP, we focus our discussion on the CPP as studies have shown the CPP to be superior to the ACE Rule for reducing GHGs and traditional air pollutants.

Under the CPP, the EPA set a CO_2 emissions reduction goal for each state and the state would create an Integrated Resource Plan to detail how to meet the rate-based and/or mass-based emission reduction targets for new and existing power generation.[210] The CPP provided states with flexibility in how to achieve their emission reduction targets–by operating coal plants more efficiently; using gas plants more, coal plants less; and/or increasing the use of renewable energy.[211] The CPP also afforded the states the ability to work with other states to achieve the CO_2 reductions, such as through emissions trading.[212]

In the Regulatory Impact Analysis for the CPP, the EPA quantified the co-benefits that this CO_2 emission reduction rule had on the emissions of SO_2 and NO_x (to assess the economic benefits that this rule has on human health).[213] In 2030, 413-415 million tons of CO_2 (19% reduction), 280-318 thousand tons of SO_2 (21.3-24.2% reduction), and 278-282 thousand tons of NO_x (21.5-21.8% reduction) would be abated under the CPP compared to the no policy baseline.[214] As a result of the CPP and other EPA regulations on SO_2 and NO_x emissions (namely the Clean Air Interstate Rule and Cross-State Air Pollution Rule) in 2030, CO_2 emissions from the power sector would be 32% of 2005 levels, SO_2 emissions from the power sector

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[205] *Id.*

[206] Off. of Mayor Eric Garcetti, Mayor Garcetti Launches L.A.'s Green New Deal (Apr. 29, 2019).

[207] L.A. Dep't of Water and Power, Briefing Book 2018-19 (2019).

[208] Kevin Stark, *Mayor Garcetti: LA Won't Invest $5 Billion to Rebuild Coastal Gas Plants*, Greentech Media (Feb. 12, 2019); Sammy Roth, *Los Angeles OKs a Deal for Record-Cheap Solar Power and Battery Storage*, L.A. Times (Sept. 10, 2019)

[209] U.S. Envtl. Prot. Agency, Fact Sheet: Overview of the Clean Power Plan (May 9, 2017), https://archive.epa.gov/epa/cleanpowerplan/fact-sheet-overview-clean-power-plan.html. In Massachusetts v. EPA (2007), the U.S. Supreme Court ruled that the EPA can regulate greenhouse gas emissions under the Clean Air Act (CAA) because the definition of air pollutant includes CO_2 and five other greenhouse gases. See Mass. v. E.P.A., 549 U.S. 497, 534 (2007). In December 2009, the EPA found that the CO_2 emissions "endanger both the public health and the public welfare of current and future generations." Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act Final Rule, 74 Fed. Reg. 66496 (Dec. 15, 2009). After issuing this Endangerment Finding, the EPA began regulating CO_2 emissions in the U.S.

[210] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64662 (Oct. 23, 2015) (to be codified at 40 C.F.R. pt. 60).

[211] White House, Fact Sheet: President Obama to Announce Historic Carbon Pollution Standards for Power Plants (Aug. 3, 2015), https://obamawhitehouse.archives.gov/the-press-office/2015/08/03/fact-sheet-president-obama-announce-historic-carbon-pollution-standards.

[212] *Id.*

[213] U.S. Envtl. Prot. Agency, Regulatory Impact Analysis for the Clean Power Rule (Oct. 23, 2015).

[214] *Id.*

would be 90% of 2005 levels, and NO_x emissions from the power sector would be 72% of 2005 levels.[215]

The CPP was expected to shift power generation in the U.S. from coal, gas, and oil to renewables. Compared to statistics in 2015, by 2030, the CPP was estimated to increase the generation capacity of non-hydro renewables (primarily solar and wind) by 11-13% compared to the no policy baseline.[216] Power generation capacity from coal was estimated to decline by 11-16%, while generation capacity from oil would decline by 15-18%.[217] While the CPP would have no impact on existing power generation capacity from natural gas, it would reduce the demand for new natural gas generation capacity by 38-68%.[218]

In 2019, the Trump EPA issued the Affordable Clean Energy (ACE) Rule, which repealed the CPP. The ACE Rule adopts a "source-based" approach of improving heat rates in individual power plants, while the CPP was a "system-based" approach that aimed to reduce emissions across the entire electricity grid/generation portfolio within a state through fuel switching and demand side management. In a study comparing the proposed ACE Rule and CPP regulatory approaches, the authors found that CO_2 emissions under the proposed ACE Rule will be 63% higher than under the CPP, SO_2 emissions will be 88% higher, and NO_x emissions will be 56% higher.[219] In August 2019, a coalition of twenty-nine states and cities challenged the ACE Rule in the D.C. Circuit Court.[220]

3.5.3 Energy Efficiency; Building Codes & Standards

Energy efficiency programs are another means of reducing both traditional air pollutants and GHG emissions by reducing the demand for energy. Energy efficiency programs achieve the best co-control when they displace energy produced by coal power generation. Relative to other co-control policies in power generation, energy efficiency programs may not be as effective in reducing emissions because they do not displace existing fossil fuel plants as quickly.[221] Without complementary policies reducing emissions from power generation, the reduced demand for electricity disincentivizes buildout of new power generation, causing the existing generation portfolio to remain.

Federal, state, and local governments all have a role in creating energy efficiency programs and policies that reduce demand for power. The federal government is primarily involved in creating energy efficiency standards for appliances and vehicles that are sold in the national market.[222] State governments primarily implement energy efficiency programs through building codes and in their regulation of electricity service providers.[223] Local governments have a role in implementing energy efficiency through zoning, planning, and building codes and permits.[224]

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[215] U.S. Envtl. Prot. Agency, Fact Sheet: Overview of the Clean Power Plan (May 9, 2017), https://archive.epa.gov/epa/cleanpowerplan/fact-sheet-overview-clean-power-plan.html.

[216] U.S. Envtl. Prot. Agency, Regulatory Impact Analysis for the Clean Power Rule (Oct. 23, 2015).

[217] *Id.*

[218] *Id.*

[219] Amelia Keyes, et al., *Carbon Standards Examined: A Comparison of At-the-Source and Beyond-the-Source Power Plant Carbon Standards* (Res. for the Future, Working Paper, Aug. 2018).

[220] Lisa Friedman, *States Sue Trump Administration Over Rollback of Obama Era Climate Rule*, N.Y. Times (Aug. 13, 2019).

[221] Marilyn A. Brown, et al., *Exploring the Impact of Energy Efficiency as a Carbon Mitigation Strategy in the U.S.*, 109 Energy Pol. 249, 259 (Oct. 2017).

[222] Elizabeth Doris, et al., *Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government*, Nat'l Renewable Energy Lab. (Dec. 2009).

[223] *Id.*

[224] *Id.*

Federal Energy Efficiency Programs

The U.S. federal government administers a wide range of energy efficiency programs. This section will describe several, but by no means all, of these programs. For example, the 1978 National Energy Conservation and Policy Act granted the U.S. Department of Energy (DOE) the authority to create energy efficiency standards for thirteen household appliances.[225] Further laws expanded the scope of appliances subject to standards and stringency of energy efficiency goals. In 2013, compared to appliances sold in 1980, gas furnaces used 18% less energy, central air conditioning used 50% less energy, refrigerators used 65% less energy, and washing machines used 75% less energy.[226] In addition to setting energy efficiency standards, the DOE administers the Weatherization Assistance Program (WAP), which is a grantmaking program to provide low-income grantees funding to improve the energy efficiency of their homes.[227]

California Energy Efficiency Programs

California has been a leader among states in energy efficiency. In October 2015, California enacted SB 350 Clean Energy and Pollution Reduction Act of 2015.[228] The law requires the state to double statewide energy efficiency savings in electricity and natural gas end uses by 2030.[229]

The California Energy Commission published the 2019 California Energy Efficiency Action Plan in November 2019 to implement this and other legal requirements.[230]

California lays out three goals in its 2019 Energy Efficiency Action Plan:

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[225] *Id.*

[226] Steven Nadel, Neal Elliott, & Therese Langer, *Energy Efficiency in the United States: 35 Years and Counting*, American Council for an Energy-Efficient Econ. (June 2015).

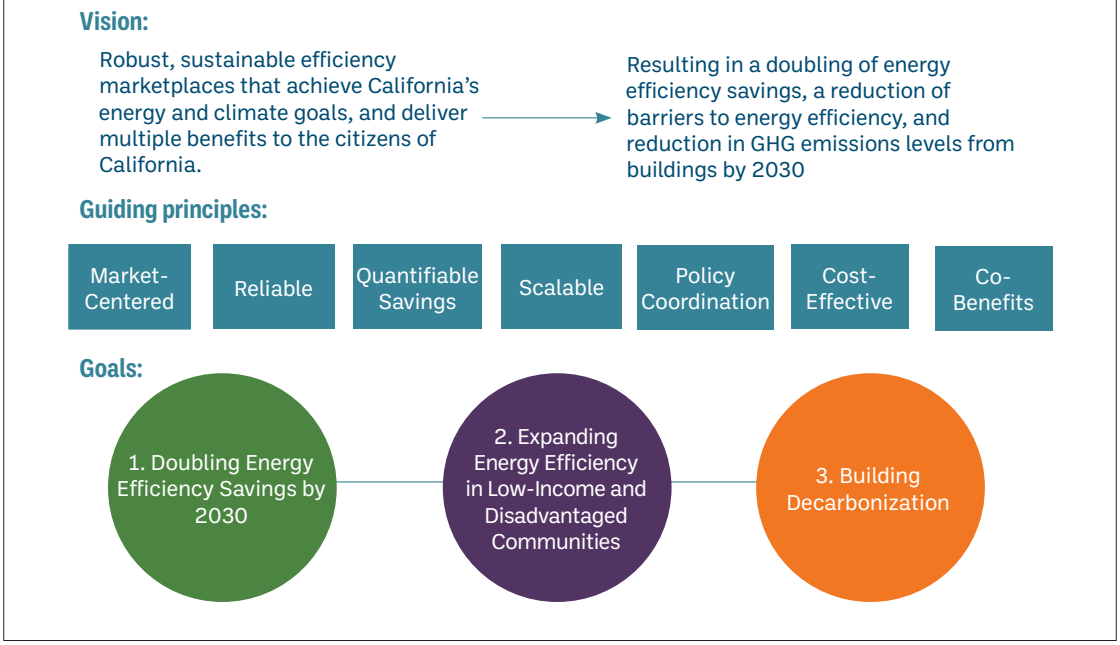
[227] The program's funding increased from USD $250 million to $5 billion under the American Recovery and Reinvestment Act of 2009. See Bruce Tonn, et al., *Weatherization Works II — Summary of Findings From the ARRA Period Evaluation of the U.S. Department of Energy's Weatherization Assistance Program*, Oak Ridge Nat'l Lab. (July 2015); Bruce Tonn, et al., *Evaluation of the U.S. Department of Energy's Weatherization Assistance Program: Impact Results*, 118 Energy Pol. 279, 290 (July 2018).

[228] S.B. 350, 2015-2018 Leg. (Cal. 2016).

[229] Cal. Energy Comm'n, Clean Energy and Pollution Reduction Act — SB 350, https://www.energy.ca.gov/rules-and-regulations/energy-suppliers-reporting/clean-energy-and-pollution-reduction-act-sb-350 (last visited May 20, 2020).

[230] The Energy Efficiency Action Plan is a combined update of the Existing Buildings Energy Efficiency Action Plan and Doubling of Energy Efficiency Savings by 2030 Report. Cal. Energy Comm'n, 2019 California Energy Efficiency Action Plan.

FIGURE 17
Vision & Goals of 2019 California Energy Efficiency Action Plan

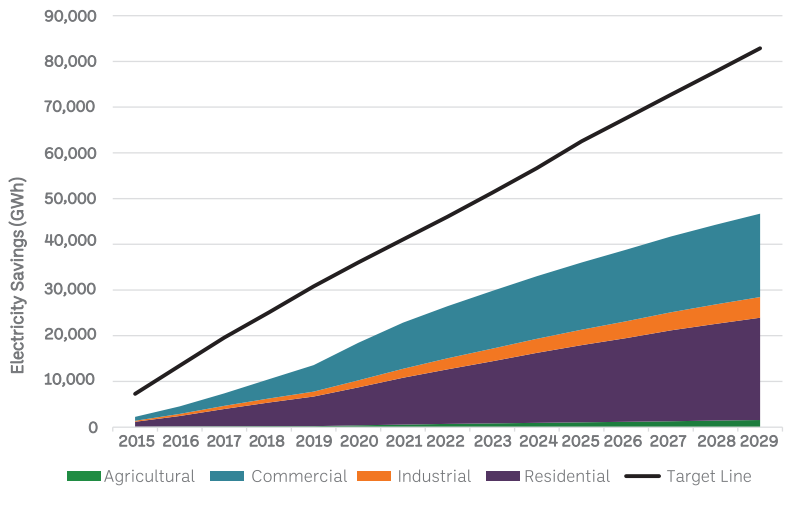


Source: 2019 Cal. Energy Comm'n, California Energy Efficiency Action Plan 11.

1) Doubling Energy Efficiency Savings by 2030

This first goal is in coordination with SB 350, which codifies a goal to achieve a doubling of energy efficiency savings and reduced demand in electricity and natural gas in 2030 as compared to 2015. SB 350 specifically directs the CEC to set annual targets in collaboration with agencies, utilities, and other stakeholders. Currently, the state is not on track to meet the 2030 goal, without additional action. Specifically, programs need to increase participation and stimulate new market activity, while the state needs to increase compliance.

FIGURE 18
SB 350 Combined Energy Savings



Source: 2019 Cal. Energy Comm'n, California Energy Efficiency Action Plan 4.

2) Expanding Energy Efficiency in Low-Income and Disadvantaged Communities

The second goal aims at ensuring that clean energy benefits are broadly distributed, especially to those in low-income, disadvantaged, or rural communities. The CEC and other agencies have convened the Disadvantaged Communities Advisory Group, adopted a Clean Energy in Low-Income Multifamily Buildings (CLIMB) Action Plan, and continue to track key metrics to understand energy barriers. There still needs to be a focus on removing financing barriers, and developing the local workforce needed to implement the clean energy solutions set forth by the other goals.

3) Reducing Greenhouse Gas Emissions from Buildings

The last goal involves decarbonizing buildings. There are three components that are necessary to the process of building decarbonization: a clean supply of energy, high levels of energy efficiency, and demand flexibility. SB 100 mandated 100% of all retail sales be provided by renewable energy and zero-carbon resources by 2045. Executive Order B-55-18 calls for economy wide carbon neutrality by then as well, and both these policies aim to culminate in a downward trend of GHG emissions from the electricity sector. In order to continually progress with decarbonization, the state needs more funds and financing mechanisms as it will require a large investment, and the state must also adapt its energy efficiency programs with decarbonization in mind.

Implementation

The California Public Utility Commission (CPUC), the California Energy Commission (CEC), local governments, and other entities develop and administer energy efficiency programs to meet these goals. CPUC and CEC provide direction and oversight for more than 400 utility-administered energy efficiency programs in California.[231] These programs are administered by the four major investor-owned utilities (IOUs) in California—Pacific Gas & Electric (PG&E), Southern California Edison (SCE), Southern California Gas Company (SCG), and San Diego Gas & Electric (SDG&E)—and others.[232]

These efficiency programs are aimed at a number of sectors: residential homes, commercial buildings, appliances, lighting, heating and cooling, industrial uses, manufacturing, and agriculture.[233] Efficiency is achieved through different tools, including financial incentives, research on efficient technologies, financing, building codes, appliance standards, and educational outreach. These programs were developed as part of the California Long Term Energy Efficiency Strategic Plan.

Fifty-four percent of electricity savings came from indoor and outdoor lighting. 13% from HVAC. Natural gas savings came from industrial sector process improvements (43%), whole building measures (17%), HVAC (13.2%) and water heating (12%) improvements. The mix of opportunities for efficiency in China will differ because of different practices and the progress already made in promoting energy efficiency.

As stated above, these energy efficiency programs were estimated to have reduced CO_2 and NO_x emissions substantially over a three-year period (2013-15), avoiding more than 4.1 million tons of CO_2 and 1.6 million pounds of NO_x emissions.[234]

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[231] Cal. Pub. Util. Comm'n, Energy Efficiency Portfolio Report (May 2018).

[232] Two regional energy networks, BayREN and SoCalREN, and a community choice aggregator, Marin Clean Energy (MCE).

[233] Residential homes account for 17%of California electricity use; commercial buildings account for 43%, while industry and agriculture account for 18% and 7%, respectively.

[234] Cal. Pub. Util. Comm'n, Energy Efficiency Portfolio Report 10 (May 2018).

Building Codes & Standards

Building codes can be effectively utilized to reduce GHG emissions and air pollution.[235] California in particular has strict building codes and appliance standards that have helped it maintain a consistent per capita energy consumption level for over forty years.[236] Recent legislation and regulation has targeted improving the energy efficiency in and reducing greenhouse gas emissions from new and existing buildings in the state. [237] Zero Net Energy (ZNE) building goals seek to have the value of the energy consumed annually by a building equal the energy produced by on-site renewable energy resources.[238] Key ZNE targets include the following:

- All new residential construction and all new commercial construction in California will be zero net energy by 2020 and 2030, respectively;
- 50% of existing commercial buildings will be retrofit to ZNE by 2030;
- All new state buildings and major renovations shall be ZNE beginning in 2025;
- 50% of existing state-owned building area by 2025 shall be ZNE.[239]

Buildings constitute 38% of total energy spending in the United States, with the average household spending about USD $2,150 annually on their energy bills.[240] However, building codes can cut these costs by 15% or more each year (which amounts into about USD $300 of savings per household).[241] Studies have found that investing 1% of the construction value in building code compliance can achieve 90% compliance with energy codes, and that each dollar spent on code compliance achieves six times the payoff in energy savings.[242]

In California, the CEC updates the state's Building Energy Efficiency Standards (codified under Title 24 of the California Code of Regulations) every three years, working with stakeholders in a public and transparent process.[243] Currently, proposed standards for the 2022 Building Energy Efficiency Standards are being adopted, with workshops being held to present revisions and obtain public comment.[244] These will improve upon the prior 2019 Building Energy Efficiency Standards, which were a major step towards meeting the state's Zero-Net Energy goal by 2020.[245] These standards are made up of three basic sets: 1) mandatory requirements that apply to all buildings, 2) performance standards that vary by climate zone and building type, and 3) alternatives to the performance standards, which are prescriptive packages that provide a checklist compliance approach.[246] The most significant revisions to the 2019 residential standards

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[235] Christopher James, *Best Practices for Achieving Cleaner Air and Lower Carbon*, Reg. Assistance Project (Mar. 2019).

[236] *Id.*

[237] Cal. Energy Comm'n, 2019 California Energy Efficiency Action Plan.

[238] Cal. Pub. Util. Comm'n, Energy Efficiency Portfolio Report 57 (May 2018).

[239] *Id.*

[240] Christopher James & Rebecca Schultz, *Climate-Friendly Air Quality Management*, Reg. Assistance Project (Nov. 2011).

[241] *Id.*

[242] *Id.*

[243] Cal. Energy Comm'n, Building Energy Efficiency Standards—Title 24, https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards (last visited May 20, 2020).

[244] Cal. Energy Comm'n, 2022 Building Energy Efficiency Standards, https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency (last visited May 20, 2020).

[245] Cal. Energy Comm'n, 2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Dec. 2018).

[246] *Id.*

included the introduction of photovoltaic into the prescriptive package, improvements for attics, walls, water, heating, and lighting.

Cities can have stricter building codes than the state itself prescribes under Title 24, which are termed as "reach codes." Berkeley, California for example, became the first city in the country to ban fossil gas hook-ups in new buildings while dozens of localities in the state are considering following suit.[247] Specifically, Berkeley did not go through the traditional reach code route, which requires CEC approval, but rather used its city authority to phase out new gas hookups citing public health and safety as the grounds for doing so.[248] Other cities in California have passed electrification reach codes, with requirements for heat pump or solar thermal water heating in new residential construction, or requiring additional energy efficiency measures for new buildings with gas.[249] More cities adopting these types of requirements may signal the CEC to align Title 24 to also require all-electric new construction.[250]

3.6 Industry

Industrial facilities (or stationary sources), such as oil refineries, cement plants, and natural gas production and distribution facilities, contribute significantly to traditional air pollutant and GHG emissions in California. As such, these facilities represent good targets for coordinated multi-pollutant regulation. Nonetheless, industrial emissions present a major challenge for coordinated air and climate governance. Stationary sources in relatively mature, high-energy consumption industries will face difficulties in identifying technological fixes for combustion related GHG emissions, even if smokestack solutions are available for traditional air pollutants. China still has some low-hanging fruit in terms of increasing the scale of facilities and upgrading to the most efficient technologies available. These options are less available in California, where industries have been the subject of stringent regulation for many years. This section will discuss the key measures in California that have an impact on multiple pollutants. These include California's carbon cap-and-trade program, facility-wide emissions limits and other regulatory rules and limits, and subsidy programs.

3.6.1 California Cap and Trade

Cap and trade is a market mechanism for the reduction of greenhouse gas emissions. California originally created its carbon cap-and-trade program as a "backstop" to ensure that the state met its goal of annual greenhouse gas emissions of 40% below 1990 by 2030 and 80% below 1990 levels by 2050.[251] But California now projects that emission reductions from cap and trade will be the largest piece in California's greenhouse gas emissions reduction plan—30% of the required cumulative emission reductions over the 2021-2030 period and 47% of annual reductions in 2030.[252] The program covers over 750 entities. We discuss California's carbon cap-and-trade system here under "Industry," but note that the system is cross-sectoral, covering large industrial facilities, power plants, and fuel distributors.[253] These entities account for 80-85% of all greenhouse gas emissions in California.[254]

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[247] Susie Cagle, *Berkeley Became First US City to Ban Natural Gas. Here's What That May Mean for the Future*, Guardian (July 23, 2019).

[248] Matt Gough, *Forward-Looking Cities Lead the Way to a Gas-Free Future*, Sierra Club (Feb. 18, 2020).

[249] *Id.*

[250] *Id.*

[251] Cal. Air. Res. Bd., 2017 Climate Change Scoping Plan Update (Jan. 20, 2017).

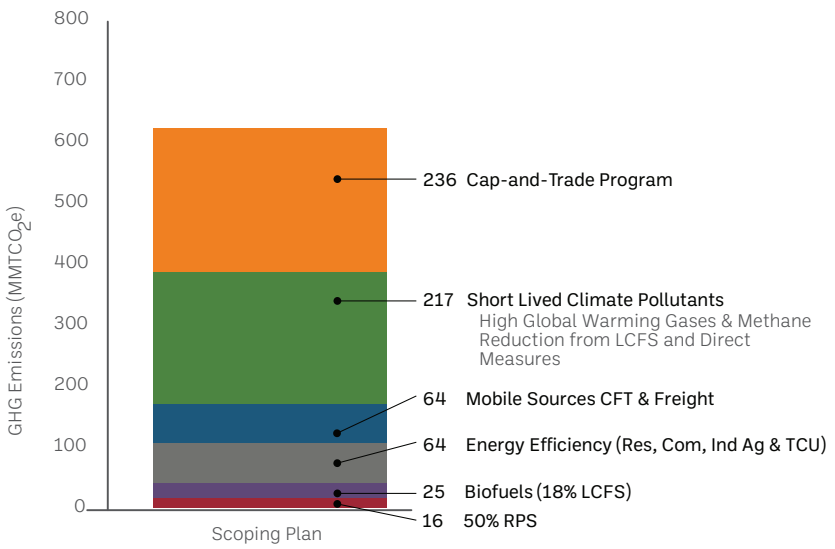
[252] *Id.*

[253] Cal. Air Res. Bd., Annual Summary of GHG Mandatory Reporting: Non-Confidential Data for Calendar Year 2018 (Nov. 4, 2019).

[254] Cal. Air. Res. Bd., 2017 Climate Change Scoping Plan Update ES6 (Jan. 20, 2017); *see* Envtl.. Def. Fund, California's Cap-and-Trade Program Step by Step: How California Built the Cornerstone of Its Climate Policy.

FIGURE 19

Scoping Plan Scenario Estimated Cumulative GHG Reductions by Measure (2021-2030)



Source: Cal. Air Res. Bd., 2017 Climate Change Scoping Plan Update, at 28.

California's cap-and-trade program reduces greenhouse gas emissions by placing an economy-wide cap (limit) on the amount of greenhouse gases that businesses covered under the program can emit. [255] Covered businesses must hold an allowance (a tradable permit) or an offset credit (a credit for a verifiable emission reduction from a source outside of the cap-and-trade program) for every metric ton of carbon dioxide equivalent of greenhouse gas that it emits. A certain number of allowances are given directly to businesses and another portion is deposited into the Allowance Price Containment Reserve, a government reserve that is used as a mechanism to smooth market prices of allowances. Generally speaking, the rest can be bought at quarterly state-run auctions or traded with other businesses in the private market. At the end of each two-to-three-year compliance period, businesses must turn in allowances and offset credits (also called compliance instruments) equivalent to the metric tons of greenhouse gases that they emitted throughout that period.

Most sources that emit more than 25,000 $MTCO_2e$ are required to participate in the cap and trade program. Other sources that emit 10,000 $MTCO_2e$ or more are required to report their emissions but are not required to turn in compliance instruments at the end of the compliance period.

How is California's Cap-and-Trade Program Operated?

The California Air Resources Board (CARB) regulates and facilitates California's cap-and-trade program. All covered entities must register with, report to, and can participate in auctions and markets established and overseen by CARB.

Registration and reporting are done through CARB online systems. All covered entities must first register with CARB through the Compliance Instrument Tracking System Service. This system tracks allowances

[255] The cap is measured in metric tons of carbon dioxide equivalent ($MTCO_2e$) to maintain consistency across the program.

and offsets and records cap-and-trade market compliance. As of 2009, all covered entities are required to report their annual greenhouse gas emissions through the Mandatory Reporting of Greenhouse Gas Emissions Regulation. Greenhouse gas emissions reporting requires independent verification. Covered entities also have the option of using a certain number of offsets if CARB has adopted a compliance-offset protocol for that type of project. Offset credits also require independent verification.[256] So far, CARB has adopted compliance-offset protocols for U.S. forest projects, urban forest projects, ozone-depleting substances projects, mine methane capture projects, and rice cultivation projects.[257]

CARB works with multiple partners to regulate the market, such as an independent market monitor and a market surveillance committee to monitor all auctions, holding and trading of allowances and offset credits, and covered businesses' activities in related markets.[258] CARB also works with the California Attorney General's Office and multiple economic agencies to develop and enforce program regulations.[259]

3.6.2 Industrial Standards

There is legitimate concern that the current California's cap-and-trade program is not stringent enough for the state to meet its 2030 and aspirational 2050 targets. Fifty-two percent of covered facilities—including cement and power plants and oil and gas producers and suppliers—increased their average annual emissions during the first two compliance periods.[260] An analysis performed by ProPublica found that greenhouse gas emissions from California's oil and gas industry have not declined, but rather rose by 3.5% since the program began.[261] Critics have suggested that California set early caps too high and allowed firms to bank some 200 million credits (many of which have been issued to firms for free).[262] Firms have also been allowed to purchase a certain number of offsets, and some have questioned whether such offsets represent real emissions reductions.[263]

Emissions limits on GHG emissions at industrial facilities can spur additional emissions cuts. However, under California law, local regulators are not permitted to pass GHG emissions limits more stringent than federal standards.[264] As part of the deal to extend the cap-and-trade program beyond 2020 (AB 398), local AQMDs were prohibited from directly regulating GHG emissions at facilities covered under the state cap-and-trade program.[265] We nonetheless believe that such emissions limits are an important companion to cap-and-trade regulation. As a case study, we describe draft Bay Area AQMD GHG emissions limits on petroleum refineries that were rendered moot by AB 398.

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[256] Cal. Air. Res. Bd., Cap-and-Trade: Market Oversight and Enforcement (Oct. 20, 2011), https://ww3.arb.ca.gov/cc/capandtrade/marketmonitoring/marketmonitoring.htm.

[257] Cal. Air Res. Bd., 2017 Climate Change Scoping Plan Update (Jan. 20, 2017).

[258] Cal. Air. Res. Bd., Market Program Monitoring (June 14, 2019), https://ww3.arb.ca.gov/cc/capandtrade/marketmonitoring/marketmonitoring.htm.

[259] *Id.* CARB works with the Commodity Futures Trading Commission, the California Independent System operator, and the Federal Energy Regulatory Commission.

[260] Lisa Song, *Cap and Trade is Supposed to Solve Climate Change, but Oil and Gas Company Emissions Are Up*, ProPublica (Nov. 15, 2019).

[261] *Id.*

[262] See Alan Durning & Yoram Bauman, *17 Things to Know About California's Carbon Cap*, Sightline (May 22, 2014).

[263] See Kevin Stark, *Researchers Press California to Strengthen Landmark Climate Law*, KQED (Aug. 27, 2019).

[264] A.B. 398, 2017-18 Leg. (Cal. 2017).

[265] Cal. Health & Safety Code § 38594(b)(West)(AB 398, 2017)("A district shall not adopt or implement an emission reduction rule for carbon dioxide from stationary sources that are also subject to a market-based compliance mechanism adopted by the state board..." [or use] "This bill...would, until January 1, 2031, prohibit an air district from adopting or implementing an emission reduction rule for carbon dioxide from stationary sources that are also subject to a specified market-based compliance mechanism").

The BAAQMD Refinery Rule and Refinery Emissions Reduction Strategy

Of California's seventeen oil refineries, five are located within the Bay Area. Oil refineries are the largest source of industrial greenhouse gas emissions in the Bay Area, totaling two-thirds of industrial and 16% of total regional GHG emissions.[266] Oil refineries are also notorious sources of traditional air pollutants and toxic air contaminants in the Bay Area and elsewhere. A report from CalEPA and California Office of Environmental Health Hazard Assessment analyzed 188 chemicals released from refinery facilities and recommended that the state more carefully monitor the fifteen toxic air contaminants and three traditional air pollutants (nitrogen oxide, particulate matter, and sulfur dioxide) around refinery sites.[267]

Under BAAQMD's Bay Area Refinery Emissions Reduction Strategy, oil refineries are subject to more than twenty specific BAAQMD regulations and programs to reach BAAQMD's goal of reducing traditional air pollutant emissions from refineries by 20%, or as much as feasible, by 2020.[268] One of the strategy's proposed regulations was the Refinery Rule. The Refinery Rule would have limited greenhouse gas emissions (and thus control for some level of co-occurring traditional air pollutants) from all Bay Area petroleum refineries by setting an annual greenhouse gas cap at each facility and a mechanism for BAAQMD to decrease the cap over time.[269]

Unfortunately, the Refinery Rule was one of the local control measures preempted by AB 398. This is despite the fact that the California Air Resources Board had explicitly expressed support for the Refinery Rule, commenting that it would not have interfered with refineries' ability to participate in cap and trade and thus would be consistent with the AB 32 Scoping Plan.[270] In fact, BAAQMD was one of the local jurisdictions that opposed AB 398 in part because the bill would prevent its ability to more stringently regulate local air pollution.[271]

Now, BAAQMD focuses on the other pieces of the Refinery Emissions Reduction Strategy that decrease the emission of all pollutants from refineries without setting a cap. Refineries were already subject to multiple regulations limiting their process and monitoring and limiting traditional air pollutants and toxic air contaminants.[272] The BAAQMD 2017 Clean Air Plan adds new rules that track petroleum refinery emissions and limit particulate matter.[273]

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[266] Bay Area Air Quality Mgmt. Dist., Regulation 12, Rule 16: Petroleum Refining Greenhouse Gas Emission Limits (June 2017).

[267] Jared Blumenfield & Lauren Zeisa, *Analysis of Refinery Chemical Emissions and Health Effects*, Cal. Envtl. Prot. Agency & Off. of Envtl. Health Hazard Assessment (Mar. 2019).

[268] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1 (Apr. 19, 2017).

[269] Bay Area Air Quality Mgmt. Dist., Regulation 12, Rule 16: Petroleum Refining Greenhouse Gas Emission Limits (June 2017).

[270] *Id.*

[271] Katy Murphy, *Debate Rages Over California Cap-and-Trade Deal, Concession to Big Oil*, Mercury News (July 11, 2017). A senior policy advisor at the BAAQMD commented that "we find it painful to be in a position where we're having to oppose a goal that we support so strongly."

[272] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1 (Apr. 19, 2017). These rules include limiting and creating new source review to address particulate matter; revising the air toxics "Hot Spot" program and creating new source review for toxic air contaminants; and specifying processes around metal melting, natural gas processing and distribution, open burning, calcining, using cement kilns, and using refinery heaters and boilers.

[273] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1 (Apr. 19, 2017).

3.7 Incentives

3.7.1 Cap-and-Trade Funds

Revenue from California's cap-and-trade program is deposited into the state's Greenhouse Gas Reduction Fund (GGRF) to be used to subsidize California Climate Investments projects outside of the cap-and-trade program that reduce greenhouse gas emissions, strengthen the economy, and improve public health and the environment. The GGRF prioritizes subsidizing projects in disadvantaged communities, low-income communities, and low-income households.[274]

The GGRF is managed by CARB. Revenue from the GGRF that is allocated to CARB is used to subsidize four large programs: community air protection, funding agricultural replacement measures for emission reductions, low carbon transportation, and prescribed fire smoke monitoring.[275] According to the 2020 California Climate Investments annual report, cap-and-trade auction proceeds have cumulatively funded over 150,000 projects installing efficiency measures in homes, over 287,000 rebates issued for zero-emission and plug-in hybrid vehicles, and more than 600 transit agency projects to expand transit options.[276] Also, 57% of all funding has been used for projects benefiting disadvantaged and low-income communities.[277]

The value of California Climate Investments projects extends beyond reducing GHG emissions. These programs also have co-benefits such as reducing air pollution and developing sustainable communities. In 2019 alone, California Climate Investments projects reduced 12,300 tons of NO_x emissions, 1,100 tons of $PM_{2.5}$ emissions, and 430 tons of diesel PM emissions.[278] These projects saved 433 GWh of energy and 169 million gallons of gas and diesel fuel.[279]

TABLE 15
2019 Co-Benefits from a Subset of California Climate Investments Projects

Co-benefits	Outcomes from 2019 Investments
Reduced NO_x emissions	12,300 tons
Reduced diesel particulate matter (PM) emissions	430 tons
Reduced $PM_{2.5}$ emissions	1,100 tons
Reduced reactive organic gas emissions	1,600 tons
Affordable housing created	1,800 units
Land preserved, restored, or treated	184,000 acres
Waste diverted from landfills	489,000 tons
Energy Saved	433 GWh
Fuel Use Avoided	169 million gallons (gas & diesel)
Trees Planted	2.2 million

Source: Cal. Air. Res. Bd., Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds 28 (Mar. 2020).

[274] A.B. 1550, 2015-16 Leg. (Cal. 2016). A.B. 1550 requires that at least 25 percent of GGRF funds go to subsidize projects located within disadvantaged communities, and that at least an additional five percent of GGRF funds go to subsidize projects that benefit low-income households.

[275] Cal. Air Res. Bd., Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds iv (Mar. 2020).

[276] *Id.* at ii.

[277] *Id.*

[278] *Id.* at 28.

[279] *Id.*

The table below lists cumulative appropriations for California Climate Investments in various sectors:

TABLE 16
Cumulative Appropriations for California Climate Investments

Administering Agency	Program	Appropriations ($M)		
		Cumulative Appropriations, Prior to FY19-20	FY19-20	Cumulative Total
California Air Resources Board	Community Air Protection	$556	$291	$847
	Fluorinated Gases Emission Reduction Incentives	—	$1	$1
	Funding Agricultural Replacement Measures for Emission Reductions	$197	$65	$262
	Low-Carbon Transportation	$1,724	$492	$2,216
	Prescribed Fire Smoke Monitoring	$6	$2	$8
	Woodsmoke Reduction	$8	—	$8
California Coastal Commission	Coastal Resilience Planning	$3	$2	$5
California Conservation Corps	Training and Workforce Development	$27	$14	$41
California Department of Fish and Wildlife	Wetlands and Watershed Restoration	$46	<$1	$47
California Department of Food and Agriculture	Dairy Methane	$260	$34	$294
	Healthy Soils	$13	$28	$41
	Renewable Alternative Fuels	$3	—	$3
	State Water Efficiency & Enhancement	$66	—	$66
California Department of Forestry and Fire Protection	Community Fire Planning & Preparedness	—	$10	$10
	Fire Prevention	$107	$85	$192
	Forest Carbon Plan Implementation	$25	$35	$60
	Sustainable Forests	$454	$170	$624
California Department of Resources Recycling and Recovery	Waste Diversion	$134	$25	$159
California Department of Transportation	Active Transportation	$10	—	$10
	Low-Carbon Transit Operations	$459	$66	$525
California Department of Water Resources	State Water Project Turbines	$20	—	$20
	Water-Energy Grant	$50	—	$50
California Energy Commission	Food Production Investment	$124	—	$124
	Low-Carbon Fuel Production	$13	—	$13
	Renewable Energy for Agriculture	$10	—	$10
California Environmental Protection Agency	Transition to a Carbon-Neutral Economy	—	$3	$3
California Governor's Office of Emergency Services Wildfire	Response and Readiness	$50	$1	$51
California High-Speed Rail Authority	High-Speed Rail Project	$2,523	$330	$2,853

TABLE 16
Cumulative Appropriations for California Climate Investments (cont.)

Administering Agency	Program	Appropriations ($M)		
		Cumulative Appropriations, Prior to FY19-20	FY19-20	Cumulative Total
California Natural Resources Agency	Regional Forest and Fire Capacity	$20	—	$20
	Urban Greening	$127	$30	$157
California State Coastal Conservancy	Climate Ready	$7	—	$7
California State Transportation Agency	Transit and Intercity Rail Capital	$1,029	$132	$1,161
California State Water Resources Control Board	Safe and Affordable Funding for Equity and Resilience Drinking Water	—	$100	$100
California Strategic Growth Council	Affordable Housing and Sustainable Communities	$1,877	$263	$2,140
	Sustainable Agricultural Lands Conservation			
	Climate Change Research	$29	$5	$34
	Technical Assistance	$4	$2	$6
	Transformative Climate Communities	$190	$60	$250
California Wildlife Conservation Board	Climate Adaptation and Resiliency	$20		$20
California Workforce Development Board	Low Carbon Economy Workforce	—	$35	$35
San Francisco Bay Conservation and Development Commission	Climate Resilience Planning	$1	$2	$3
	Total	**$10,395**	**$2,292**	**$12,687**

Source: Cal. Air. Res. Bd., Annual Report to the Legislature on California Climate Investments Using Cap-and-Trade Auction Proceeds iv – v (Mar. 2020).

Below are two examples of the projects supported by California's cap-and-trade funds.

Cap-and-Trade Funding for High Speed Rail

Since 2014, the California legislature has appropriated 25% of the annual proceeds of the cap-and-trade program to support the development of the state's High-Speed Rail Project.[280] In 2017, the legislature extended funding through cap and trade through 2030.[281] The cumulative appropriations for the high speed rail to date amounts to over USD $2.5 billion,[282] funding things like its administration and planning, architectural and engineering design, right-of-way acquisition, and rail infrastructure construction.[283]

The High-Speed Rail Project is intended to connect the larger regions of the state, and will be rolled out in phases.[284] Phase One will connect Los Angeles to San Francisco along with other major Central Valley

[280] *Id.*; Cal. High-Speed Rail Auth., Capital Costs & Funding, https://www.hsr.ca.gov/about/capital_costs_funding/ (last visited May 20, 2020).

[281] A.B. 398, 2017-18 Leg. (Cal. 2017).

[282] Cal. Climate Investments, About California Climate Investments, http://www.caclimateinvestments.ca.gov/about-cci (last visited May 20, 2020).

[283] Cal. Air Res. Bd., CCI Funded Programs, https://ww2.arb.ca.gov/our-work/programs/california-climate-investments/cci-funded-programs#Transportation (last visited May 20, 2020).

[284] Cal. Climate Investments, High-Speed Rail Project, http://www.caclimateinvestments.ca.gov/hsr (last visited May 20, 2020).

cities, with the ability to travel between Northern and Southern California in under three hours.[285] The total Phase One cost is estimated to be USD $77.3 billion, with the cap-and-trade funds helping with a portion of the total costs.[286] Phase One currently has an anticipated completion schedule of 2033.[287] Phase Two is planned to extend to Sacramento and San Diego as well, to cover a total of 800 miles and twenty-four separate stations.[288]

The California High-Speed Rail Authority has also committed to zero-net direct greenhouse gas emissions in constructing the rail, starting with a group of urban forestry projects.[289] In partnership with CAL FIRE, the Authority has awarded USD $2.5 million in tree planting grants to offset the emissions associated with constructing the first portion of the rail system.[290] The rail is expected to reduce over 233 billion vehicle miles, and reduce GHG emissions by 64 million tons of CO_2.[291] In addition to the rail's environmental impact, the cap-and-trade funding has helped create USD $1.5 billion of activity in disadvantaged communities, and added 21,000 jobs in such communities.[292]

Cap-and-Trade Funding for Affordable Housing

Another example of a program that cap-and-trade funding supports is California's Affordable Housing and Sustainable Communities Program (AHSC), which aims to create healthy communities and reduce emissions by increasing the supply of affordable housing.[293] This program is administered by the Strategic Growth Council, and implemented by the California Department of Housing and Community Development.[294] Specifically, the housing is located in areas that encourage residents to walk, bike, and use public transit, which has resulted in a reduction of 3.1 million tons of CO_2 emissions.[295] Local government agencies, nonprofit and for-profit housing developers, joint powers authorities, Indian tribes, and school districts may all apply to receive the funds from this program.[296] As of 2020, over 9,000 affordable homes have been provided to families in need.[297] In conjunction with projects on sustainable agricultural lands conservation, the cumulative appropriations from cap-and-trade funding for the affordable housing

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[285] *Id.*

[286] Cal. High-Speed Rail Auth., Cal. High-Speed Rail Auth., Capital Costs & Funding, https://www.hsr.ca.gov/about/capital_costs_funding/.

[287] *Id.*

[288] Cal. Climate Investments, High-Speed Rail Project, http://www.caclimateinvestments.ca.gov/hsr (last visited May 20, 2020).

[289] Cal. High-Speed Rail Auth., Sustainability, https://www.hsr.ca.gov/programs/green_practices/sustainability.aspx (last visited May 20, 2020).

[290] *Id.*

[291] *Id.*

[292] Cal. High-Speed Rail Auth., Get the Facts, https://hsr.ca.gov/get_the_facts/ (last visited May 20, 2020).

[293] Cal. Climate Investments, Affordable Housing and Sustainable Communities, http://www.caclimateinvestments.ca.gov/ahsc (last visited May 20, 2020).

[294] *Id.*

[295] Cal Climate Investments, Sierra Village Affordable Housing Project, Tulare County, http://www.caclimateinvestments.ca.gov/2018-profiles/2018/2/10/sierra-village-affordable-housing-project-tulare-county; Cal. Strategic Growth Council, Our Vision, http://sgc.ca.gov/vision/.

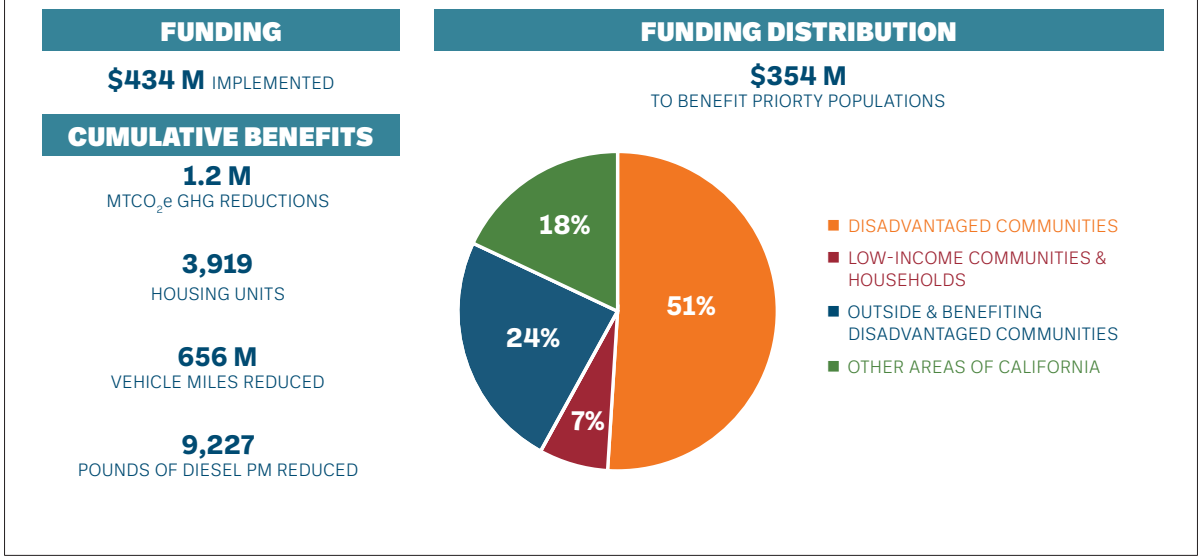
[296] *Id.*

[297] Cal. Strategic Growth Council, Our Vision, http://sgc.ca.gov/vision/.

project amounts to over USD $1.8 billion to date.[298] These funds go towards transit-oriented development, intermodal affordable housing, transit capital projects, active transportation and completion of streets, and local planning and implementation.[299]

FIGURE 20

Greenhouse Gas Reduction Fund Summary for the Affordable Housing & Sustainable Communities Program



Sources: Cal. Climate Investments, Affordable Housing and Sustainable Communities, http://www.caclimateinvestments.ca.gov/ahsc.

Sierra Village is an example of one of the projects that the Affordable Housing and Sustainable Communities (AHSC) funds. It will offer forty-four affordable homes as part of an apartment in a rural California community, with easy access to bike lanes and sidewalks.[300] In addition, the project will also feature solar and water conservation features, a vanpool program, and other transportation improvements to the low-income families that will be living in the village.[301] The City of Redding, located in northern California, is another example of a community that was funded through AHSC.[302] Specifically, the city was awarded USD $20 million to support the development of the Block 7 Net Zero Housing and Downtown Activation Project which will build seventy-eight new homes and over 12,000 square feet of commercial retail space in the downtown area of the city. The project includes four miles of bike lanes, half a mile of sidewalks, and other greening elements to complete a river trail from a park to downtown. Finally, there will be a bike share program and funding for active transportation education.

[298] Cal. Climate Investments, About California Climate Investments, http://www.caclimateinvestments.ca.gov/about-cci (last visited May 20, 2020).

[299] Cal. Air Res. Bd., CCI Funded Programs, https://ww2.arb.ca.gov/our-work/programs/california-climate-investments/cci-funded-programs#Transportation (last visited May 20, 2020).

[300] Cal Climate Investments, Sierra Village Affordable Housing Project, Tulare County, http://www.caclimateinvestments.ca.gov/2018-profiles/2018/2/10/sierra-village-affordable-housing-project-tulare-county.

[301] *Id.*

[302] Cal. Strategic Growth Council, 2019 Profiles: Affordable Housing and Sustainable Communities in Redding, http://www.caclimateinvestments.ca.gov/2019-profiles/ahsc (last visited May 20, 2020).

3.8 Environmental Justice

Notions of environmental justice, which considers the racial and economic distributional consequences of environmental regulation, have become a more important part of the environmental regulatory landscape in California in recent years. Critics argue, however, that current measures in this regard are insufficient. A comprehensive treatment of this debate is beyond the scope of this report. We highlight this issue only to note how distributive concerns (*e.g.,* whether disadvantaged communities face disproportionate harm from air pollution) have entered the regulatory debate in California. We describe two illustrative examples below, including AB 617—one of the most important California environmental justice laws in recent years.

3.8.1 AB 617 (2017)

AB 617 (2017) requires CARB to create a uniform statewide system for stationary sources to report their traditional air pollutant and toxic air contaminant emissions and creates a community emissions reduction program for communities exposed to these emissions.[303] Supporters of AB 617 argued that the bill addresses local air quality and climate pollution.[304] Opponents of AB 617 argued that the bill does not meaningfully reform air quality policy because it does not require specific constraints and leaves too much discretion to local air districts to determine best available retrofit control technology.[305]

CARB established the Community Air Protection Program to comply with AB 617 by administering community air grants to community-based organizations for technical assistance.[306] Grants are used for community engagement and outreach, hiring consultants and technical experts, travel and logistics support, community-operated monitoring support, and data collection and analysis.[307]

In FY 2017-2018, CARB received sixty-five applications requesting a combined USD $18.9 million in funding under the Community Air Grants Program.[308] CARB awarded twenty-eight projects a total of USD $10 million in funding.[309] This included the USD $5 million appropriated in the FY 2017-2018 State budget and USD $5 million out of an additional USD $10 million appropriated in the FY 2018-2019 State budget.[310] Each proposed project was awarded between USD $97,000 and $500,000 for a timeline of one to three years.[311] All grant awards were for projects located in disadvantaged or low-income communities.[312]

There is also USD $245 million for incentive funding of continued support of early actions under AB 617 in the FY 2018-2019 State budget.[313] Distribution of this funding will include a separate public process.[314]

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[303] A.B. 617, 2017–18 Leg. (Cal. 2017).

[304] David E. Garcia, AB 617 07/17/17 - *California Senate Floor Analyses* 6 (July 17, 2017).

[305] *Id.*

[306] Cal. Air Res. Board, Community Air Protection Program (2019), https://ww2.arb.ca.gov/capp (last visited June 28, 2020).

[307] *Id.*

[308] Cal. Air Res. Board, Final Community Air Protection Blueprint 7 (Oct. 2018).

[309] *Id.*

[310] *Id.*

[311] Cal. Air Res. Board, AB 617 Community Air Grants Summary of Proposed Projects (Oct. 2018) https://ww2.arb.ca.gov/our-work/programs/community-air-protection-program/community-air-grants/proposed-awardees (last visited June 28, 2020).

[312] *Id.*

[313] Cal. Air Res. Board, Final Community Air Protection Blueprint 7 (Oct. 2018).

[314] *Id.*

3.8.2 AB 1550 (2016)

AB 1550 (2016) requires that at least 25% of GGRF funds be spent on projects within disadvantaged communities, and that at least an additional 5% be spent on projects that benefit low-income households.[315] Supporters of AB 1550 argue that the amount allocated reflects the state's population, as CalEnviroScreen classifies 25% of the state's population as living in disadvantaged communities.[316] Supporters also point out that low-income Californians often lack adequate and affordable transportation and housing choices.[317] Opponents of AB 1550 argue that the bill would expand the state's reliance on a flawed definition of disadvantaged communities that excludes many communities with poor socio-economic conditions.[318] The major environmental organizations, environmental justice groups, and interfaith communities, amongst others, supported AB 1550, while BAAQMD Legislative Committee, the California Chamber of Commerce, the California Taxpayers Association, and the Metropolitan Transportation Commission all opposed AB 1550.[319]

[315] A.B. 1550, 2015–16 Leg. (Cal. 2016).

[316] Rebecca Newhouse, AB 1550 08/24/16 - California Senate Floor Analyses 8 (Aug. 24, 2016).

[317] *Id.* at 8.

[318] *Id.* at 8–9.

[319] *Id.* at 6–8.

CHAPTER FOUR — RECOMMENDATIONS

Chapter Four makes a number of recommendations for the consideration of Chinese policymakers.

As a conceptual matter, there is little downside to taking a coordinated, multi-pollutant approach to air and climate regulation. The benefits are clear. Coordinated governance can reduce cost, improve outcomes, and reduce inadvertent mistakes that hinder the achievement of policy goals. Achieving these benefits is not necessarily easy. It requires planners and regulators to put in the hard work to create effective coordinated planning and regulation practices that break down silos among diverse actors and think more broadly to identify and act on potential co-benefits. The evidence suggests that the benefits of such an approach far outweigh the costs.

1. Embrace a Multi-Pollutant Coordinated Governance Approach

a. Commit to multi-pollutant coordinated planning and governance for air quality and climate change regulation.
b. Prioritize co-benefits in air quality and climate change planning. Incorporate consideration of air toxic pollutant co-benefits as well.
c. Incorporate electrification, low-carbon energy, and energy efficiency thinking into air quality regulation.
d. Avoid air pollution measures that would make climate change regulation more difficult to achieve (such as investments in natural gas trucking and related infrastructure) and avoid climate change measures that exacerbate air quality problems (such as trading mechanisms that create pollution "hot spots" around industrial facilities).

2. Develop Processes & Procedures for a Multi-Pollutant Coordinated Governance Approach

a. Ensure robust *monitoring*, *emissions inventories*, and *modeling* as foundations for air and climate change planning.
b. Require analysis of traditional air pollutant, GHG, and toxics co-benefits in air quality and climate change planning and make public disclosure of this analysis mandatory.
c. Create transparent, participatory processes to improve planning quality and legitimacy.
d. Take California's 2016 Mobile Source Strategy and the Bay Area AQMD 2017 Clean Air Plan as models of coordinated governance.
e. Build in environmental justice and distributional concerns and other key values into air quality and climate change planning.
f. Create processes to coordinate disparate regulatory actors that control different aspects of the regulatory process.

3. Adopt Rules and Policies that Generate the Highest Air and Climate Co-Benefits

a. Implement measures that promote electrification in all sectors (transportation, industry, buildings, etc.), reduce fossil fuel use, and increase renewable energy deployment.
b. Think creatively about measures that help motivated actors to circumvent gaps in authority (e.g., the indirect source rule allowing local air regulators indirectly to mitigate trucking-related emissions, or use "carrots" and educational methods to promote favored practices where regulatory authority is unavailable).
c. Develop a diverse range of enforcement and compliance mechanisms to ensure implementation.
d. Use transparency and public participation to enhance policy development and

implementation.

e. Enlist government leaders, all relevant agencies (economic planning, environment, energy, transportation, science & technology, financial institutions, and others), prosecutors, police, courts, civil society groups, media, scholars, private industry, insurers, consumers, and others in the work of coordinated governance.
f. Work with California and U.S. partners to share information and engage in research on realizing these measures in practice.

Consider the following laws, policies, and measures to implement coordinated governance of air and climate pollutants.

g. *Transportation*
    i. **ZEV program** — Targets or sales quotas for zero-emission light-, medium-, and heavy-duty vehicles.
    ii. **Fuel efficiency standards for vehicles.** — Standards to improve fuel efficiency and promote technology development.
    iii. **Low-carbon fuel standard** — Program to reduce life-cycle carbon intensity of fuels and promote electrification.
    iv. **Other standards** — Strict traditional air pollutant and GHG standards for light-, medium- and heavy-duty vehicles. Indirect source rule to address transportation emissions centered around ports, warehouses, etc.
    v. **Incentives for ZEV vehicles** — Grants, subsidies, HOV lanes, charging infrastructure support.
    vi. **Disincentives for fossil fuel vehicles** — Licensing fees for fossil-fuel vehicles, gas tax, congestion pricing for fossil-fuel vehicles.
    vii. **Transportation planning** — Environmental impact assessment to reduce vehicle miles traveled (VMT) using CEQA-like mechanisms/procedures.
    viii. **Off-road vehicles, ports, rail, and aviation** — Incentives (e.g., priority access for electric vehicles) and legal standards (e.g., requiring use of on-shore power when docked) to promote technological change and pollution reduction.
h. *Energy Generation and Consumption*
    i. **Renewable portfolio standards** — Standards that promote deployment of non-fossil energy to achieve 100% electricity from renewable sources.
    ii. **Clean Power Plan-like standards** — Standards that promote reduced consumption of fossil-fuel in the electricity sector.
    iii. **Energy efficiency standards for buildings** — Standards that promote net zero emission buildings.
    iv. **Energy efficiency standards for appliances** — Standards that reduce the rate of energy consumption from appliances.
i. *Industry*
    i. **Carbon cap and trade** — An economy-wide cap-and-trade system for GHGs.
    ii. **GHG standards for industrial facilities** — Standards that limit industrial GHG emissions.
j. *Incentives* — A fund (derived from fees and other sources) that is used to pay for measures with high levels of air quality and climate change co-benefits.
k. *Environmental Justice* — Policies that improve the distributional fairness of environmental measures.

APPENDIX A — VISION FOR CLEAN AIR: MOBILE SOURCE MODELING

Since 2012, California has used a model known as the *Vision for Clean Air* to integrate air quality and climate change planning. The focus of *Vision* modeling has been mobile sources and associated energy production. California's 2016 Mobile Source Strategy contains extensive documentation of the use of the *Vision* model to inform statewide mobile source planning. The model produces quantitative scenarios that examine "the nature of the technology and fuel transformation needed to meet... multiple air quality and greenhouse gas milestones between now and 2050."[320] The model enables consideration of traditional air pollutants, GHGs, and air toxics. In explaining the need for this sort of modeling, 2012 documentation for the *Vision* model explains that:

> Under the Clean Air Act, traditional air quality planning typically focuses on the emissions reductions expected in a single future year from regulations adopted in the immediate three to five years. *Vision for Clean Air* takes a broader approach and uses scenarios to illustrate the change needed in multiple milestone years to meet future emissions targets. . . . This long-term approach is more common in greenhouse gas analyses. The advantage of long-term planning is that it reveals the scope of advanced technologies needed, how quickly the technologies need to come online, and the key decision points for technology development and deployment along the way.[321]

This is not a model that attempts to predict the future, but rather serves as a planning tool.[322] The scenarios consider "technology, energy, and efficiency assumptions that change over time" to inform decision-makers of what could be possible.[323]

The *Vision* tool has gone through several iterations. *Vision 1.0* was released in 2012, with additional California-specific data and methodologies, and an expanded ability to analyze GHG and criteria pollutants.[324] *Vision 2.0* was rolled out in 2014, building on the prior framework.[325] Specifically, *Vision 2.0* incorporated CARB's adopted policies and integrates greenhouse gas and criteria emissions to inform how reduction goals can be met.[326] *Vision 2.1*, the most recent version, includes the final version of CARB's 2014 emissions inventories (EMFAC) and updated scenario assumptions.[327] This is the version used for the 2016 Mobile Source Strategy assessment.[328]

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[320] Cal. Air Res. Bd., Vision for Clean Air: A Framework for Air Quality and Climate Planning Public Review Draft 7 (June 27, 2012).

[321] *Id.* at 7-8 .

[322] *Id.*

[323] *Id.* at 8.

[324] Cal. Air Res. Bd., Mobile Source Strategy 157 (May 2016).

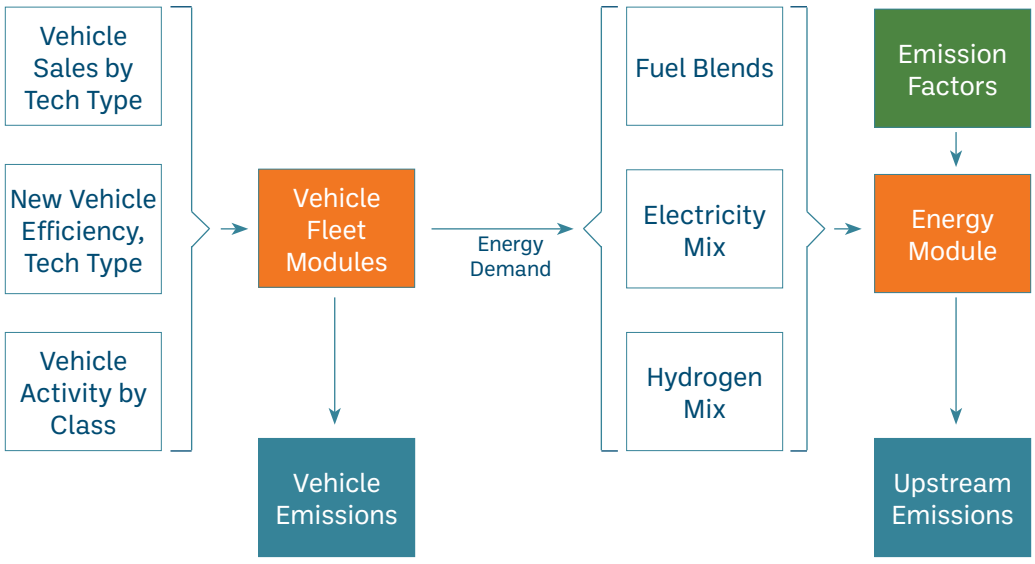
[325] *Id.* at 158.

[326] *Id.*

[327] Cal. Air Res. Bd., Vision 2.1 Scenario Modeling System: General Model Documentation 2 (Feb. 2017).

[328] *Id.*

FIGURE 21
Vision Model Framework



Source: Cal. Air Res. Bd., Mobile Source Strategy 31 (May 2016).

In terms of inputs, the *Vision* model takes in detailed data from CARB's inventories, including its emissions inventories of on-road and off-road mobile sources. These are categorized into separate "vehicle fleet modules" where scenarios can be run for individual mobile source sectors. The inputs are aggregated into a central module that calculates output emissions.[329] *Vision 2.1* includes a suite of six model components:

1. Passenger Vehicle Module
2. Heavy Duty Vehicle Module - includes baseline, SIP measures, and Cleaner Technologies & Fuels scenarios as well as an expanded Heavy Duty Vehicle ZEV scenario.
3. Off-Road Module
4. Locomotive Module
5. Ocean Going Vessels Module
6. Energy Module

Each module provides scenario-planning tools for different areas. For example, the energy module performs operations necessary to calculate upstream effects of fulfilling the energy demands of mobile and stationary sources.[330] The passenger and heavy-duty vehicle modules are scenario planning tools for on-road vehicles.[331] The inventory data is used as a baseline, and *Vision* allows for modification of vehicle population, efficiency, or emissions factors. Variables that can be controlled include population, survival, sales, vehicle miles travelled (VMT), number of trips, emission control, deterioration, and fuel/energy efficiency.[332] The outputs for these modules are aggregated into seven geographic regions.

In addition, the modules run on assumptions that reflect all adopted and implemented policies for different

[329] *Id.* at 4.

[330] *Id.* at 24.

[331] *Id.* at 5.

[332] *Id.* at 5, 8 – 9.

scenarios.[333] The multi-pollutant results inform subsequent scenarios. For example, the on-road heavy-duty modules run on assumptions based on the Federal and California only Low-NO_x Engine Standards, Medium and Heavy-Duty Greenhouse Gas Phase 2 Standards, Advanced Clean Transit, and Last Mile Delivery (LMD).[334] The on-road light-duty modules run Advanced Clean Cars 2 for its state implementation plan scenario.[335] Meanwhile, the Cleaner Technology and Fuels scenario, which explored further NO_x reductions had assumptions including a linear growth of in-state produced biofuels and a linear expansion of renewable hydrogen.[336]

TABLE 17
Vision Assumptions for Cleaner Technologies & Fuels Scenario

Measure	Assumptions
On-Road Heavy-Duty	
Federal Low-NO_x Engine Standards	Assumed National Standard starting in 2024 that is 90 percent lower NO_x than 2010 Std trucks
California Low-NO_x Engine Standards	Assumed California Standard starting in 2024 that is 90 percent lower NO_x than 2010 Std trucks
Medium and Heavy-Duty GHG Phase 2	Assumed benefits phase in from 2018 to 2027. Efficiency improvements from 5 to 25 percent depending on vocation
Advanced Clean Transit	• Assumed Urban Bus ZEV sales, both battery and fuel cell technologies, begin in 2018 and increase to 100 percent of all sales in 2030. • Assumed 100 percent purchases of Low-NO_x standard starting model years 2018 and 2020 for natural gas and diesel buses, respectively.
Last Mile Delivery	Assumed 2.5 percent of Class 3-7 new sales in local fleets to be ZEV, both battery and fuel cell technologies, starting 2020. The penetration rate ramp up to 10 percent in 2025.
On-Road Light-Duty	
Advanced Clean Cars 2	• Assumed combined LDA/LDT2 ZEV/PHEV sales increase from 18 percent to 40 percent between 2025 and 2030, and reach 100 percent by 2050. • Assumed MDV ZEV/PHEV sales beginning in 2025, ramping up to 10 percent by 2030, and reach 50 percent by 2050. • Assumed increased fuel efficiency (~2.9 percent per year) for gasoline vehicles starting 2025. • Assumed new SULEV NO_x standard phased in between 2025 and 2030 for gasoline LDAs. 100 percent SULEV20 sales by 2030. • Assumed VMT reductions ramping up to 15 percent below 2050 baseline VMT in 2050. • Assumed extended electric range for PHEVs after 2025 from 40 percent to 60 percent eVMT by 2050.

Source: Cal. Air Res. Bd., Mobile Source Strategy 166 (May 2016).

[333] Cal. Air Res. Bd., Mobile Source Strategy 165 (May 2016).

[334] *Id.* at 166.

[335] *Id.*

[336] Cal. Air Res. Bd., Vision 2.1 Scenario Modeling System: General Model Documentation, at 29.

TABLE 18
Vision Assumptions for SIP Measures Scenario

Measure	Assumptions
On-Road Heavy-Duty	
Same as Cleaner Technologies and Fuels	
On-Road Light-Duty	
Advanced Clean Cars 2	• Assumed combined LDA/LDT2 ZEV/PHEV sales increase from 18 percent to 40 percent between 2025 and 2030. • Assumed MDV ZEV/PHEV sales beginning in 2025, ramping up to 10 percent by 2030. • Assumed increased fuel efficiency (~2.9 percent per year) 2025 to 2035 for gasoline vehicles. • Assumed new SULEV NOx standard phased in between 2025 and 2030 for gasoline LDAs. 100 percent SULEV20 sales by 2030
Off-Road Equipment	
Zero-Emission Off-Road Forklift Regulation Phase 1	Assumed electrification of diesel and LSI forklifts less than 65 horsepower starts in 2028 through natural and accelerated turnover and nearly 2/3 of the targeted population will be electrified by 2035.
Zero-Emission Airport Ground Support Equipment	Assumed all new sales of belt loaders, baggage tugs, and cargo tractors are electric-powered starting 2023.
Fuel	
Low-Emission Diesel Requirement	Assumed 50 percent of the diesel pool is renewable by 2030. Assumed NO_x and PM benefits for non-SCR equipped vehicles ~13 percent NO_x reduction and 25 percent PM reduction. Also assumes an overall ~14 percent reduction in diesel carbon intensity.
Off-Road Federal and International Category	
More Stringent National Locomotive Emission Standards	Assumed remanufacturing of the locomotive fleet such that 95 percent of line-haul locomotive activity is represented by Tier 4 and Tier 5 locomotives by 2031 with phase-in starting in 2023. The Tier 5 emission standard was represented in the model by increasing the Tier 5 locomotive distribution in the total tier distribution by ~4.0 percent per year over the baseline distribution starting in 2025 with an equal reduction in the Tier 4 distribution.
Tier 4 Vessel Standards	Assumed new main and auxiliary engines will achieve a 70 percent reduction in NO_x starting with calendar year 2025. No reductions to PM were assumed.
At-Berth Regulation Amendments	Assumed At-Berth Regulation expanded to include some of the following vessel types: auto, bulk cargo, general cargo, roro and tankers. Reductions start in 2022 at 10 percent compliance and ramp up to 50 percent by 2032.

Source: Cal. Air Res. Bd., Mobile Source Strategy 167 (May 2016).

APPENDIX B — BAY AREA AIR QUALITY MANAGEMENT DISTRICT 2017 CLEAN AIR PLAN

With a proven track record of reducing traditional air pollutants and greenhouse gas emissions using co-control strategies, the BAAQMD experience serves as a good example of coordinated multi-pollutant planning at the regional level. The BAAQMD was created in 1955 as the first regional air quality agency in the U.S., and has jurisdiction over the San Francisco Bay air basin.[337] Its twenty-four-person board of directors and 340 staff members oversee air quality planning for the over 5 million people who live within the air basin.[338] The BAAQMD began explicitly using co-control strategies as part of its 2010 Clean Air Plan as a way to most efficiently meet both its goals of protecting public health and climate and to maintain a consistent approach towards achieving its long-range vision of successfully transitioning into a post-carbon economy.[339] Through its combination of co-control measures for key sources of pollutants, the BAAQMD continues to increase emission reductions of ozone, particulate matter, toxic air contaminants, and greenhouse gases.[340] The BAAQMD notes that, although it is only a regional agency, it hopes to serve as an example of "metropolitan-scale solutions…that may be replicated throughout California, the United States and beyond."[341]

The 2017 Clean Air Plan sets out eighty-five individual, specific control measures to reduce emissions from different sectors to achieve its goals and vision.[342] Across all sectors, the 2017 Clean Air Plan uses the same goals, vision, and priorities. Like its other work, the 2017 Clean Air Plan sets the goals to protect both public health and the climate in achieving its vision of successfully transitioning into a post-carbon economy.[343] The control measures in the 2017 Clean Air Plan reflect BAAQMD priorities to:

- Reduce criteria air pollutants and toxic air contaminants from all key sources;
- Reduce emissions of "super greenhouse gases";
- Decrease demand for fossil fuel by;
  - Increasing efficiency of industrial processes, energy, and transportation systems, and
  - Reducing demand for vehicle travel and high-carbon goods and services;
- Decarbonize our energy system by;
  - Making electricity supply carbon-free, and
  - Electrifying the transportation and building sectors.[344]

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[337] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at ES-1.

[338] Bay Area Air Quality Mgmt. Dist., History of the Air District, https://www.baaqmd.gov/about-the-air-district/history-of-air-district (last visited May 20, 2020). The San Francisco Bay air basin encompasses the counties of San Francisco, San Mateo, Santa Clara, Alameda, Contra Cost, Marin, and Napa, as well as parts of the counties of Sonoma and Solano. These nine counties have a combined population of over 5.8 million. *See* U.S. Census Bureau, American Community Survey 1-Year Estimate Table S0101 (2018).

[339] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at ES-2.

[340] *Id.* at 2/10 to 2/26.

[341] *Id.* at ES/2.

[342] *Id.* at ES/5.

[343] *Id.* at ES/3.

[344] *Id.* at 1/19. The 2017 Clean Air Plan includes both carbon dioxide and other greenhouse gases as climate pollutants it addresses with its control measures. The 2017 Clean Air Plan defines super greenhouse gases as those greenhouse gases that have a very high global warming potential. The 2017 Clean Air Plan also categorizes methane, black carbon, and F-gases including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride as super greenhouse gases.

These measures expressly integrate consideration of traditional air pollutants, toxic air contaminants, and greenhouse gases. To protect health, the 2017 Clean Air Plan will help the BAAQMD attain all state and national air quality standards for criteria pollutants and eliminate disparities among Bay Area communities in cancer health risk from toxic air contaminants.[345] To protect the climate, the 2017 Clean Air Plan will help the BAAQMD reduce Bay Area greenhouse gas emissions by 80% below 1990 levels by 2050.[346] And the BAAQMD estimates that in implementing these measures, the region will save approximately USD $736 million per year in health costs and USD $350 million per year in climate-related costs, providing additional financial motivation to do so.[347]

The measures in the 2017 Clean Air Plan cover stationary (industrial) sources, transportation, energy, buildings, agriculture, natural and working lands, waste management, water, and "super greenhouse gases," as well as some "further study" measures which may be implemented in the next plan.[348]

Key elements of these strategies include the following.[349]

- **Stationary Sources.** To address stationary sources, the control measures add to a region-wide strategy to reduce combustion and improve combustion efficiency at industrial facilities, focusing on the largest sources of industrial emissions: oil refineries, power plants, and cement plants.[350] Stationary source measures would also reduce methane emissions from landfills and petroleum production and distribution as well as reduce toxic air contaminant emissions by adopting more stringent thresholds at facilities.[351]

- **Transportation.** To address transportation sources, the control measures reduce demand for motor vehicle travel by promoting other travel methods, adopting electric vehicles and other low-carbon technology, and implementing pricing mechanisms.[352]

- **Buildings and Energy.** And to address sources of greenhouse gas emissions from buildings and energy, measures would support renewable energy production, expand community choice, improve energy and water efficiency, and promote switching from natural gas to electricity for building heating within the region.[353]

As most of the traditional air pollutant and greenhouse gas emissions in the San Francisco air basin are emitted by stationary and mobile (transportation) sources, the 2017 Clean Air Plan focuses its control measures on these two sectors.[354]

- The 2017 Clean Air Plan provides forty stationary source measures that focus mainly on reducing combustion from and increasing efficiency at industrial facilities through requiring facility-specific

[345] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1 at 1/2.

[346] *Id.*

[347] *Id.* at ES/7.

[348] *Id.* at ES/5.

[349] *Id.*

[350] *Id.*

[351] *Id.*

[352] *Id.*

[353] *Id.* at ES/6.

[354] *Id.* at 2/13 – 2/22, 3/16.

improvements like increased emissions tracking, limiting leaks and flares, and enhancing new source review of facilities.[355]

- The 2017 Clean Air Plan provides twenty-three transportation measures that focus on reducing demand for motor vehicle travel and implementing pricing mechanisms through more system-wide improvements like increasing funding for transit services, altering land use strategies, and performing indirect source review.[356]

But because of the BAAQMD's status as a regional agency, it faces limitations on the types of transportation measures that it can require. Many tools that the BAAQMD could otherwise use to regulate mobile sources are preempted under state and federal law. Under current law, CARB (the state-level air resources board) has the authority to regulate greenhouse gas emissions from motor vehicles and other mobile sources in California, the U.S. EPA has the authority to regulate greenhouse gas emissions from locomotives, ships, and aircraft.[357] Similarly, under current law, CARB has the authority to create fuel specifications for motor vehicles, while the California Bureau of Automotive Repair has the authority to set in-use engine performance standards.[358] But although CARB generally has the primary responsibility in regulating mobile source emissions, its diesel particulate matter air toxic control measures allow the BAAQMD to take part in enforcing these regulations, and so BAAQMD entered into an agreement with CARB to help enforce those measures through the creation of its Mobile Source Compliance Plan.[359] But for the other reasons mentioned above, the 2017 Clean Air Plan utilizes more incentive-based transportation measures in comparison to its more "command-and-control"-oriented stationary source measures.

The tables below list the stationary source and transportation source emission control measures included in the 2017 Clean Air Plan, and each measure's projected air pollutant emission reductions:

[355] Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 2 (Apr. 19, 2017) at SS-1 – SS-122.

[356] *Id.* at TR-1 – TR-100.

[357] *Id.* at 4/20.

[358] *Id.*

[359] *Id.* at 4/13.

TABLE 19
Emission Impacts from Control Measures (Stationary Source)

Control Measure Number	Control Measure Title	Estimated Emission Reductions							Annual Dollar Benefits (USD/yr)
		2030 Criteria Air Pollutants (lbs/day)					2030 Greenhouse Gases (MT CO_2e/yr)		
		ROG	NO_x	$PM_{2.5}$	SO_2	NH_3	100-yr time frame	20-yr time frame	
Stationary Source Sector									
SS1	Fluid Catalytic Cracking in Refineries			1,222		241			High
SS2	Equipment Leaks	4,546					340	860	Medium
SS3	Cooling Towers	4,720							Medium
SS4	Refinery Flares	60			90				Low
SS5	Sulfur Recovery Units				900				Medium
SS6	Refinery Fuel Gas				6,000				Medium
SS7	Sulfuric Acid Plants				2,800				Medium
SS8	Sulfur Dioxide from Coke Calcining				2,356				Medium
SS9	Enhanced NSR Enforcement for Changes in Crude Slate								
SS10	Petroleum Refining Emissions Tracking								
SS11	Petroleum Refining Facility-Wide Emission Limits								
SS12	Petroleum Refining Climate Impact Limits								
SS13	Oil and Gas Production, Processing and Storage						35,530	89,870	Medium
SS14	Methane from Capped Wells						19	47	Low
SS15	Natural Gas Processing and Distribution						283,062	715,980	High
SS16	Basin-Wide Methane Strategy								
SS17	GHG BACT Threshold								
SS18	Basin-Wide Combustion Strategy			604			1,600,000	1,600,000	High
SS19	Portland Cement				4,493		85,055	85,055	High
SS20	Air Toxics Risk Cap and Reduction from Existing Facilities								

TABLE 19
Emission Impacts from Control Measures (cont.)

Control Measure Number	Control Measure Title	Estimated Emission Reductions							Annual Dollar Benefits (USD/yr)
		2030 Criteria Air Pollutants (lbs/day)					2030 Greenhouse Gases (MT CO_2e/yr)		
		ROG	NO_x	$PM_{2.5}$	SO_2	NH_3	100-yr time frame	20-yr time frame	
Stationary Source Sector									
SS21	New Source Reveiw for Toxics								
SS22	Stationary Gas Turbines		1,500						Medium
SS23	Biogas Flares		572						Low
SS24	Sulfur Content Limits of Liquid Fuels								
SS25	Coatings, Solvents, Lubricants, Sealants and Adhesives								
SS26	Surface Prep and Cleaning Solvent								
SS27	Digital Printing								
SS28	LPG, Propane, Butane	5,000							Meduim
SS29	Asphaltic Concrete	400							Low
SS30	Residential Fan Type Furnaces		13,200						High
SS31	General PM Emission Limitation			300					High
SS32	Emergency Backup Generators						2	2	Low
SS33	Commercial Cooking Equipment			340					
SS34	Wood Smoke			60					Medium
SS35	PM from Bulk Material storage, Handling and Transport, Including Coke and Coal			4					Low
SS36	PM from Track Out			360					High
SS37	PM from Asphalt Operations			175					High
SS38	Fugitive Dust			500					High
SS39	Enhanced Air Quality Monitoring								
SS40	Odors								

Source: Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at H/3 – H/5.

TABLE 20
Emission Impacts from Control Measures (Transportation Sources)

Control Measure Number	Control Measure Title	Estimated Emission Reductions							Annual Dollar Benefits (USD/yr)
		2030 Criteria Air Pollutants (lbs/day)					2030 Greenhouse Gases (MT CO_2e/yr)		
		ROG	NO_x	$PM_{2.5}$	SO_2	NH_3	100-yr time frame	20-yr time frame	
TRANSPORTATION Source Sector									
TR1	Clean Air Teleworking	620	389	509			319,517	319,517	High
TR2	Trip Reduction Programs	41	24	10			20,066	20,066	Medium
TR3	Local and Regional Bus Service	3	2	2			1,536	1,536	Low
TR4	Local and Regional Rail Service	134	68	110			69,070	69,070	High
TR5	Transit Efficiency and Use	6	6	4			2,906	2,906	Low
TR6	Freeway and Arterial Operations	19	18	42			27,364	27,364	Medium
TR7	Safe Routes to Schools and Transit	0.39	0.25	0.33			203	203	Low
TR8	Ridesharing, Last Mile Connection	0.34	0.22	0.29			176	176	Low
TR9	Bicycle Access and Pedestrian Facilities	17	14	14			9,128	9,128	Medium
TR10	Land Use Strategies	43	27	35			22,275	22,275	Medium
TR11	Value Pricing	534	335	438			274,947	274,947	High
TR12	Smart Driving	825	518	677			425,247	425,247	High
TR13	Parking Policies	0.59	0.37	0.48			306	306	Low
TR14	Cars and Light Trucks	64	64	14			3,963	3,963	Medium
TR15	Public Outreach								
TR16	Indirect Source Review								
TR17	Planes								
TR18	Goods Movement								
TR19	Medium and Heavy Duty Trucks	44	362	10			138,306	138,306	Medium
TR20	Ocean Going Vessels		38						Low
TR21	Commercial Harbor Craft	0	29	2			1,313	1,313	Low
TR22	Construction, Freight and Farming Equipment	1	59	2			1,931	1,931	Low
TR23	Lawn Care Equipment	2,835	315	630			21,854	21,854	Low

Source: Bay Area Air Quality Mgmt. Dist., Final 2017 Clean Air Plan Vol. 1, at H/5 – H/7.

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