

Addressing Environmental Justice Concerns in the Design of California's Climate Policy

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Under California's Global Warming Solutions Act of 2006 (AB 32), the California Air Resources Board (CARB) is required to consider various policy outcomes related to environmental justice, including concerns related to the impacts of GHG regulations on co-pollutant emissions, such as criteria and toxic air pollutants, and the economic impacts of GHG regulations on low-income communities. Three key questions arise in addressing these concerns:

- Should a GHG cap-and-trade system be abandoned due to environmental justice concerns?
- Should restrictions be added to a GHG cap-and-trade system to address environmental justice concerns?
- Or are there better ways to address environmental justice concerns in implementing AB 32?

To address these questions, we have undertaken a careful assessment that considers the relationship between GHG and co-pollutant emissions, the current criteria and toxic pollutant regulatory framework, and the tradeoffs offered by alternative approaches to achieving AB 32's GHG targets.

We find that achievement of AB 32's environmental justice goals does not require eliminating a GHG cap-and-trade system or modifying it through geographic constraints on trading or limits of use of offset credits. Such actions could even work against the achievement of environmental justice goals. Rather, the problems of reducing GHG emissions and addressing environmental justice concerns are best accomplished through policies designed to tackle each problem separately. This approach would design a GHG cap-and-trade system to cost-effectively guarantee achievement of GHG emission targets, while addressing co-pollutants through separate policies that could involve new initiatives or the strengthening of existing co-pollutant policies, including those that focus on improving air quality in the most affected communities. These policies would be most effective if they are implemented within the existing framework for regulating these co-pollutants, rather than through GHG regulations that can only indirectly influence co-pollutant emissions. Further, through decisions about how to distribute GHG emission allowances or allowance auction revenue, a cap-and-trade system provides policymakers with flexibility to mitigate climate policy's economic impact on particular communities, and even support particular efforts to address air quality concerns.

A cap-and-trade system offers many benefits to the achievement of environmental justice goals. While a cap-and-trade system cannot guarantee air quality improvement in every California community, neither can alternative approaches to reducing GHG emissions. However, a cap-and-trade system is widely anticipated to achieve broad co-pollutant reductions that will improve California's air quality. And, by minimizing the economic impact of meeting GHG targets, a cap-and-trade system promotes the adoption of more stringent future GHG emission targets that can lead to further air quality improvements. A GHG cap-and-trade system can also achieve certain reductions in co-pollutant emissions that cannot be achieved by other regulatory approaches. Thus, from the standpoint of addressing environmental justice concerns, it is better to pair a GHG cap-and-trade system with complementary targeted policies than to abandon a cap-and-trade system in

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favor of prescriptive GHG regulations that will certainly be more costly, may or may not have greater impacts on co-pollutants, and may not achieve California's GHG target.

While some propose placing various restrictions or conditions on emission allowance trading in a GHG cap-and-trade system in order to achieve particular environmental justice objectives, such modifications would have highly uncertain impacts on air quality because of the complex and varied relationships between GHG and co-pollutant emissions. Not only does the relationship between GHG and co-pollutant emissions vary widely across sources, but so does the relationship between reductions in GHG and co-pollutant emission achieved by various abatement options. Further, unlike the benefits from reducing GHG emissions, the health and environmental benefits from reducing co-pollutants can vary substantially depending on where and when those reductions occur. At the same time, such restrictions or conditions would necessarily increase the cost of achieving California's GHG emissions target, and, depending on their design, could even raise the energy and other goods prices in regions with poor air quality that are targeted by the proposed restrictions.

By contrast, there are many advantages to addressing co-pollutants within the existing co-pollutant regulatory framework. First, because it can directly target particular pollutants, sources, or regions, this regulatory framework is better designed to achieve specific co-pollutant goals than an approach that pursues such reductions indirectly through GHG regulations.

Second, the existing co-pollutant framework can be easily modified to capture ancillary benefits from reducing GHG emissions, thus ensuring that desirable opportunities to *both* improve air quality *and* reduce GHGs are identified and implemented (to the extent such actions are not already undertaken through the GHG cap-and-trade system.) Specifically, in developing or revising criteria and toxic pollutant regulations, regulators can consider whether potential ancillary benefits from associated GHG reductions suggest a reason to adjust any of those regulations.

Third, pursuing such opportunities through the existing air quality regulatory framework would also avoid the need for a host of new source- and sector-specific GHG regulations that would otherwise be unnecessary with a GHG cap-and-trade system in place.

Finally, compared with an approach that relies on traditional prescriptive regulations, a cap-and-trade system is better positioned to address the economic dimension of environmental justice concerns. Along with lowering climate policy's overall cost, through decisions about the allocation of emission allowances or auction revenue, a GHG cap-and-trade system offers policymakers flexibility to address distributional concerns about economic impacts on particular communities without affecting the policy's total cost or environmental effectiveness.

Past experience has shown that complementing a cap-and-trade system with additional targeted policy initiatives can successfully address specific policy concerns without sacrificing a cap-and-trade system's cost-effectiveness. The Clean Air Act Amendments of 1990 enacted the SO₂ allowance trading program and a separate program of economic relief for coal miners that were negatively affected by the resulting switch to low-sulfur coal. The cap-and-trade program is widely credited with significantly reducing the costs of the achieving reductions in SO₂ emissions, while economic relief for coal miners was achieved at a comparatively small cost.

Therefore, our analysis and this past experience shows that California can more effectively address the risks and opportunities that climate policy poses for air quality through separate policies that specifically target the co-pollutants of concern, rather than by adjusting a GHG cap-and-trade system's design with the hope of achieving particular air quality objectives. A cap-and-trade system also offers unique opportunities to address distributional concerns related to implementation of climate policy, including the economic dimension of environmental justice concerns.

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I. Introduction

Under California's Global Warming Solutions Act of 2006 (AB 32), the California Air Resources Board (CARB) must develop regulations to reduce the state's greenhouse gas (GHG) emissions to 1990 levels by 2020. In establishing these regulations, CARB is required to consider many criteria that are set out in AB 32. One important criterion is that CARB's regulations must be cost-effective.¹

However, CARB must also consider other criteria, several of which reflect concern for environmental justice and, more broadly, for the opportunities and risks that climate policy presents for state and local air quality.² In particular, AB 32 stipulates that, to the extent feasible, CARB shall: ensure that the regulations do not "disproportionately impact low-income communities"; ensure that the regulations "complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions"; and "consider overall societal benefits [of regulations], including reductions in other air pollutants."³ AB 32 also establishes specific additional criteria for any market-based compliance mechanisms that CARB might adopt, such as a cap-and-trade system. Specifically, AB 32 requires that, to the extent feasible, CARB shall: "consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution"; "design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants"; and "maximize additional environmental and economic benefits for California, as appropriate."⁴

The above criteria relating to air quality concerns focus on the implications of GHG regulations for GHG co-pollutants, such as criteria and toxic air pollutants, which are often emitted along with GHGs.⁵ The criteria in AB 32 relating to air quality concerns do not focus on GHG emissions *per se* because, as CARB notes in its September 2008 public health analysis of its

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¹ California Health and Safety Code, §38560.

² California law defines environmental justice as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws and policies." California Government Code, §65040.12.

³ California Health and Safety Code, §38562.

⁴ California Health and Safety Code, §38570.

⁵ Criteria air pollutants are six common air pollutants for which the federal government establishes National Ambient Air Quality Standards. They include particulate matter (PM), ground-level ozone, carbon monoxide (CO), sulfur oxides (SO_x), nitrogen oxides (NO_x), and lead.

Draft Scoping Plan, GHG emissions have no direct public health impacts.⁶ While climate change resulting from GHG emissions will have geographically varied environmental and public health impacts, those impacts will not depend on where the GHGs that contribute to climate change are emitted because GHGs are global pollutants that mix uniformly in the global atmosphere. Likewise, GHG emission reductions will have the same mitigating impact on climate change and on its associated environmental and public health impacts regardless of where in the world, let alone where in California, those reductions occur.

With respect to AB 32's primary goal of reducing GHG emissions, a GHG cap-and-trade system is uniquely positioned to help California cost-effectively guarantee achievement of its 2020 emissions target. By design, a cap-and-trade system provides greater certainty that a particular emissions target will be met than other regulatory approaches. This is the case because a cap-and-trade system imposes a firm overall cap on emissions from regulated sources. By contrast, other approaches, such as uniform standards, cannot guarantee the achievement of particular emission targets. Cap-and-trade systems also achieve emission reductions cost-effectively by providing regulated sources with the flexibility to determine how, when, and where emission reductions are achieved, subject to the constraint that the overall emissions cap is met. In the context of climate policy, the flexibility offered by a cap-and-trade system has the potential to generate substantial cost savings because of the wide variety of sources that emit GHGs, the significant variation in their emission reduction costs, and the uncertainty that exists regarding the least costly means of reducing GHG emissions.

A cap-and-trade system is widely recognized as a cost-effective policy instrument for reducing GHG emissions. However, there is less consensus regarding whether and how a GHG cap-and-trade system should be implemented in California in light of environmental justice concerns. Given that there has been little rigorous assessment of these questions to date, we seek to contribute to the policy debate by evaluating the implications of environmental justice concerns for the use of a GHG cap-and-trade system in California. In particular, in assessing the implications of environmental justice concerns for the design of California climate policy, we focus on two key aspects of those concerns: the impact of climate policy on state and local air quality, and the economic impact of climate policy on low-income households.

We proceed by briefly summarizing some of the key environmental justice concerns related to climate policy in Section II. Section III reviews the current regulatory framework for the criteria and toxic co-pollutants that are often emitted alongside GHGs. Section IV examines the relationships between GHG and co-pollutant emissions, and between the options for reducing them; and Section V explores the impact that a cap-and-trade system would have on statewide co-pollutant emissions, as well as on local ambient concentrations of those co-pollutants. Then, drawing on the foundation established in the earlier sections, Section VI describes our proposal for effectively addressing environmental justice concerns in the context of implementing AB 32. Section VII concludes.

⁶ California Air Resources Board (CARB), *Climate Change Draft Scoping Plan: Public Health Analysis Supplement*, September 2008, p. A-13.

II. Key Environmental Justice Concerns Related to Climate Policy

Our paper focuses on the implications of two key environmental justice concerns for the design of California's climate policy: climate policy's impacts on air quality through its effects on GHG co-pollutants, and climate policy's economic impacts.⁷ Because actions taken to reduce GHG emissions can also reduce emissions of GHG co-pollutants, such as criteria or toxic air pollutants, the implementation of AB 32 could yield ancillary benefits by improving state and local air quality while also reducing GHG emissions. However, some have expressed concerns regarding the geographic distribution of climate policy's impacts on co-pollutant emissions. For example, some have suggested that CARB should aim to ensure that all communities, and particularly low-income communities, equitably share in the ancillary benefits from reductions in GHG co-pollutants.⁸ At the same time, others have raised concerns that air quality in particular communities might actually be adversely affected by regulations implemented under AB 32.⁹

Another important environmental justice concern regarding the implementation of climate policy relates to climate policy's economic impact on low-income communities. By increasing the cost of supplying energy and energy-intensive goods and services, climate policy will impose direct costs on households. In fact, there is a broad consensus among economists that the vast majority of the cost of climate policy will be borne by households and consumers in the form of higher prices for energy (e.g., electricity and transportation fuels), higher prices for energy consuming goods (e.g., vehicles), and higher prices for various other goods and services.

While all households will face greater economic burdens as a result of climate policy, low-income households will face disproportionately large burdens because they spend a larger share of their income on energy and energy-intensive products than do higher-income households. For example, a recent Congressional Budget Office analysis found that households whose income placed them among the lowest 20 percent of all U.S. households spent, on average, more than 20 percent of their 2006 income on energy (including electricity, natural gas and gasoline). By contrast, households whose income placed them among the top 20 percent of all U.S. households spent, on average, just 4 percent of their 2006 income on energy.¹⁰

⁷ While our paper focuses on the implications of climate *policy* for air quality and for economic burdens on low-income households, some groups have also expressed concerns about likely differential impacts of climate *change* on particular communities. However, the geographic distribution of the impacts of climate change will not depend on where GHGs are emitted, and therefore cannot be influenced by emission reduction policies implemented under AB 32. Rather, these concerns should inform policymaking related to how California adapts to climate change.

⁸ For example, see Alice Kaswan, "Re: Designing a Cap-and-Trade Program to Comply with AB 32's Environmental Justice Requirements," March 31, 2008; and Alice Kaswan, "Environmental Justice and Domestic Climate Change Policy," *Environmental Law Reporter* 38 (May 2008): 10287-10315.

⁹ For example, see Coalition for Clean Air, "AB 32 Community Benefits Fund to Reduce Cumulative and Disproportionate Impacts," (undated); Californians Against Waste, *et al.*, "Cap and Auction Design Position Paper," April 1, 2008; and Alice Kaswan, March 2008.

¹⁰ Congressional Budget Office, "Options for Offsetting the Economic Impact on Low- and Moderate-Income Households of a Cap-and-Trade Program for Carbon Dioxide Emissions," June 17, 2008.

III. The Existing Regulatory Framework for Criteria and Toxic Air Pollutants

The opportunities and risks that the implementation of AB 32 presents for GHG co-pollutants will be significantly influenced by the existing array of federal, state, and regional regulations that target those co-pollutants. Emission standards are one of the key policy instruments used at federal, state, and regional levels to limit criteria and toxic air pollutants. The standards applicable to a specific emissions source depend on many different factors, including the type of pollutant, whether the source is a new or existing source, and whether the region in which the source is located is in compliance with ambient air quality standards.

The regulatory framework for criteria air pollutants includes mechanisms designed to adjust regulations to protect local and regional air quality. The National Ambient Air Quality Standards (NAAQS) are one of the most important of these mechanisms. If a region fails to meet the NAAQS, measures must be designed to bring the region into compliance as a part of the State Implementation Plan ("SIP"). The California SIP combines statewide measures – such as those aimed at transportation and some consumer products – with local measures aimed primarily at stationary sources. The stringency of federal criteria air pollutant emission standards are also tied to ambient concentrations of those pollutants. For example, federal standards for new emissions sources are more stringent in regions that are not in attainment with the NAAQS.

Air toxics regulations largely consist of equipment- or facility-level standards to achieve maximum emission reductions taking into account technical feasibility and cost.¹¹ In addition, California's Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) requires certain stationary sources to report their emissions of specific toxic pollutants, identifies high priority facilities that must conduct risk assessments, and requires emission reductions from facilities whose emissions pose health risks exceeding certain levels.¹² CARB has complemented these requirements with policies to achieve targeted reductions from certain types of sources, particularly from diesel emissions sources in the transportation sector.¹³ Many air quality management districts (AQMDs) have also developed policies and programs aimed at reducing exposure to toxic pollutants. For example, the South Coast AQMD (SCAQMD) has developed and will periodically update its Air Toxics Control Plan, which identifies various strategies to reduce exposure to toxic pollutants, the majority of which have been implemented.¹⁴

State and AQMD air quality programs reflect environmental justice concerns. For example, SCAQMD indicates that its Air Toxic Control Plan "is an outgrowth of the Environmental Justice principles and the Environmental Justice Initiatives adopted by the

¹¹ In California, these standards reflect both federal Clean Air Act requirements and state requirements from the Toxic Air Containment Identification and Control Act (AB 1807), under which substances are identified as airborne toxics and then controlled through emission standards. Elaine Chang, Laki Tisopoulos, and Jill Whynot, "White Paper on Potential Control Strategies to Address Cumulative Impacts from Air Pollution," August 2003.

¹² Some of these requirements are the result of amendments to AB 2588 incorporated in the Facility Air Toxic Containment Risk Audit and Reduction Plan (AB 1731).

¹³ Examples include the Diesel Risk Reduction Program and the Goods Movement Emission Reduction Plan.

¹⁴ South Coast Air Quality Management District (SCAQMD), *An Air Toxics Control Plan for the Next Ten Years*, Final Draft, March 2000. A subsequent report notes that "to date, the majority of the strategies [in the Air Toxics Plan] have been implemented, making significant progress in many areas." Chang *et al.*, August 2003.

Governing Board.”¹⁵ Also, SCAQMD has an Environmental Justice Workplan with multiple initiatives designed to identify and mitigate adverse health risks at the community level, and to provide communities with venues for providing input into regulatory and policy decisions.¹⁶ These measures accompany other actions taken by policymakers to further develop tools and regulations to address chronically high exposures in particular communities, including AB 2588, SCAQMD's Multiple Air Toxics Exposure Study (MATES), SCAQMD's proposed PM Emissions Hot Spots - Localized Control Program,¹⁷ and on-going efforts to develop cumulative impact policies and strategies.¹⁸

The existing regulatory framework for criteria and toxic pollutants in California is among the most stringent in the country, and it has achieved significant emission reductions. For example, between 1990 and 2005, despite a 24 percent increase in population and a 38 percent increase in vehicle miles traveled, statewide emissions decreased by 29 percent for nitrogen oxides (NOX), 41 percent for sulfur oxides (SOX), 56 percent for carbon monoxide (CO), and 49 percent for reactive organic gases (ROG).¹⁹ Also, from 1990 to 2000, the average cancer risk associated with toxic emissions declined from 1,696 to 1,005 per million in the South Coast Air Basin, and from 1230 to 586 per million in the San Joaquin Valley Air Basin.²⁰

Despite these improvements, poor air quality remains a serious concern. For example, the South Coast and San Joaquin Valley Air Basins have not yet met the NAAQS for particulate matter and ozone. Thus, concerns about environmental justice in designing California's climate policy occur against this backdrop of an existing regulatory framework that has significantly improved California's air quality, but has not yet achieved all air quality objectives.

¹⁵ SCAQMD, March 2000, p. 1.

¹⁶ SCAQMD, "Environmental Justice Workplan 2003-4 Summary," August 12, 2004.

¹⁷ SCAQMD Governing Board, *Final 2007 Air Quality Management Plan*, June 2007.

¹⁸ Regional, state, and federal regulators are working on policies to address cumulative air pollution impacts from multiple sources. For example, such policies might first identify locations facing high cumulative impacts and then target sources to achieve reductions in pollutant exposures at those locations.

¹⁹ CARB, *California Almanac of Emissions and Air Quality*, 2008 Edition, August 11, 2008, pp. 3-2 - 3-3.

²⁰ These risk measures reflect the number of excess cancers per million, given a lifetime (70 year) exposure to average annual toxic concentrations. CARB, August 2008, pp. 5-53 and 5-69.

IV. The Relationship Between GHG and Co-Pollutant Emissions and Reduction Measures

In evaluating the implications of air quality concerns for climate policy design, two key relationships between GHGs and their co-pollutants need to be considered: the relationship between GHG and co-pollutant emissions across different emissions sources, and the relationship between measures that can reduce GHG emissions and measures that can reduce co-pollutant emissions. As this section describes, these relationships are far more complex and variable across emissions sources than the term "co-pollutant" might suggest. Consequently, any effective effort to address co-pollutant concerns under AB 32 must be designed in a manner that accounts for this complexity and variation.

A. The Relationship Between GHG and Co-Pollutant Emissions

While many sources generate both GHG and co-pollutant emissions, the relative contribution of different *types of sources* to statewide emissions can vary substantially by pollutant. Table 1 presents the contribution of different emissions sources to statewide GHG and criteria pollutant emissions.²¹

As Table 1 indicates, while energy production and manufacturing facilities collectively account for 34 percent of the state's GHG emissions, they account for less than 5 percent of total criteria pollutant emissions and similarly small shares of individual criteria pollutant emissions. By contrast, transportation and mobile sources account for 44 percent of statewide GHG emissions and roughly half of the state's criteria pollutant emissions.²²

As suggested by the differences in various sources contribution to statewide emissions in Table 1, there is substantial variation in the relationship between GHG and co-pollutant emissions across sources. Based on emissions data in Table 1, Table 2 presents the average relationships between GHG emissions and emissions of three criteria pollutants (ROG, NO_x, and PM_{2.5}) for some of the source categories shown in Table 1. As Table 2 reveals, these relationships can differ dramatically across sources. For example, on average, fuel combustion in electricity generation and petroleum refining generates less than one pound of NO_x emissions per metric ton of GHG emissions. By contrast, fuel combustion in other manufacturing and industrial sectors generates about five pounds of NO_x emissions per metric ton of GHG emissions, and fuel use by heavy-duty trucks generates about 25 pounds of NO_x per metric ton of GHG.²³

²¹ This and subsequent tables reflect our best effort in summarizing data on GHG and co-pollutant emissions from various emissions sources. In some cases, it is impossible to match GHG and co-pollutant emissions exactly for particular groups of sources because of differences in source categorization across emissions databases. As a result, for some line items in these tables, the sources reflected in the criteria or toxics data may differ somewhat from those reflected in the GHG data. The difficulty in matching GHG and co-pollutant emissions from particular sources contributes to uncertainty about the relationship between GHG and co-pollutant emissions. Nonetheless, these tables offer considerable insight regarding the relative contributions of various sources to emissions of different pollutants, and the significant variability in relationships between GHG and co-pollutant emissions across sources.

²² CARB has stated that "[m]obile sources are the largest contributor to PM_{2.5} and ozone-forming emissions." CARB, *Air Resources Board's Proposed State Strategy for California's 2007 State Implementation Plan*, Revised Draft, April 2007, p. 41.

²³ Because they relate 2005 criteria emissions to 2004 GHG emissions, while they reveal important differences in the relationship between criteria and GHG emissions across sources, the precise ratios may not be accurate.

Table 1. Annual GHG and Criteria Pollutant Emissions from California Sources¹

Emissions Source ²	Greenhouse Gases (Million Metric Tons CO ₂ -e and Percent of Total)		Criteria Pollutants (Thousand Tons and Percent of Total)						Total of All Criteria Pollutants ³	
			ROG		NO _x		PM _{2.5}			
Energy Production and Manufacturing										
Electricity Generation										
Power Only	34.3	8.2%	0.9	0.1%	9.7	0.7%	2.0	0.6%	40.4	0.3%
Combined Heat and Power ⁴	30.1	7.2%	1.3	0.1%	7.7	0.6%	1.2	0.4%	29.3	0.3%
Total	64.4	15.4%	2.3	0.1%	17.5	1.3%	3.1	0.9%	69.7	0.6%
Petroleum Refining										
Fuel Combustion	29.1	7.0%	0.7	0.0%	9.2	0.7%	1.3	0.4%	22.5	0.2%
Process ⁵	5.8	1.4%	4.5	0.3%	2.2	0.2%	0.8	0.2%	29.0	0.2%
Total	34.9	8.3%	5.3	0.3%	11.4	0.9%	2.1	0.6%	51.5	0.4%
Oil and Gas Production										
Fuel Combustion	14.0	3.3%	1.1	0.1%	7.2	0.5%	0.7	0.2%	22.6	0.2%
Process ⁵	0.8	0.2%	15.4	0.9%	1.0	0.1%	0.0	0.0%	32.2	0.3%
Total	14.8	3.5%	16.5	1.0%	8.2	0.6%	0.7	0.2%	54.8	0.5%
Other Manufacturing and Industrial										
Fuel Combustion	19.3	4.6%	3.1	0.2%	45.4	3.4%	3.2	1.0%	102.1	0.9%
Process ⁵	8.2	2.0%	72.7	4.3%	29.7	2.2%	21.6	6.6%	255.4	2.2%
Total	27.4	6.6%	75.8	4.5%	75.1	5.7%	24.9	7.6%	357.5	3.1%
Fuel Combustion Total	126.8	30.3%	7.2	0.4%	79.4	6.0%	8.4	2.5%	216.9	1.9%
Process Total	14.7	3.5%	92.6	5.5%	32.9	2.5%	22.4	6.8%	316.6	2.7%
Energy Production and Manufacturing Total	141.5	33.8%	99.8	5.9%	112.2	8.5%	30.8	9.4%	533.5	4.6%
Transportation and Mobile Sources										
On-Road Heavy-Duty Vehicles	35.7	8.5%	75.9	4.5%	450.3	33.9%	15.1	4.6%	1,231.1	10.6%
On-Road Light-Duty Trucks	72.1	17.2%	82.4	4.9%	104.2	7.9%	3.4	1.0%	1,114.5	9.6%
On-Road Passenger Cars	63.1	15.1%	116.4	6.9%	93.8	7.1%	3.4	1.0%	1,309.5	11.3%
Other Transportation	11.5	2.8%	252.0	14.9%	474.7	35.8%	29.8	9.1%	2,209.7	19.0%
Transportation and Mobile Sources Total	182.4	43.6%	526.7	31.2%	1,123.0	84.6%	51.7	15.7%	5,864.7	50.4%
Other Sources										
Fuel Combustion	46.7	11.2%	22.4	1.3%	51.8	3.9%	43.3	13.2%	460.8	4.0%
Non Combustion	48.0	11.5%	1,037.8	61.5%	39.7	3.0%	202.6	61.7%	4,767.7	41.0%
Other Sources Total	94.7	22.6%	1,060.2	62.9%	91.6	6.9%	245.9	74.9%	5,228.5	45.0%
STATEWIDE TOTAL	418.5	100%	1,686.6	100%	1,326.9	100%	328.4	100%	11,626.7	100%

Notes:

- [1] Emissions reflect 2004 GHG emissions and 2005 criteria pollutant emissions, which are the most recent years of data available for each type of emissions at the necessary level of detail. GHG emissions shown here exclude out-of-state emissions that are included in California's GHG inventory, such as from imported electricity.
- [2] Documentation of the underlying emissions sources included in each source category is available from the authors upon request.
- [3] "Total of all criteria pollutants" includes emissions of ROG, NO_x, and PM_{2.5}, as well as CO, PM other than PM_{2.5}, SO_x, and organic gas compounds other than ROG.
- [4] Combined heat and power (CHP) includes all emissions from CHP sources, some of which may be associated with facilities in other source categories (e.g. petroleum refining).
- [5] Process emissions include all emissions that are not labeled by CARB as emissions associated with fuel combustion.

Sources:

- [1] CARB Greenhouse Gas Emissions Inventory (<http://www.arb.ca.gov/cc/inventory/data/data.htm>).
- [2] CARB criteria pollutant emissions data obtained from CARB.



Table 2. Average Relationships between Criteria Pollutant and GHG Emissions for Select Sources (Pounds of Criteria Pollutant Emissions per Metric Ton of GHG Emissions)

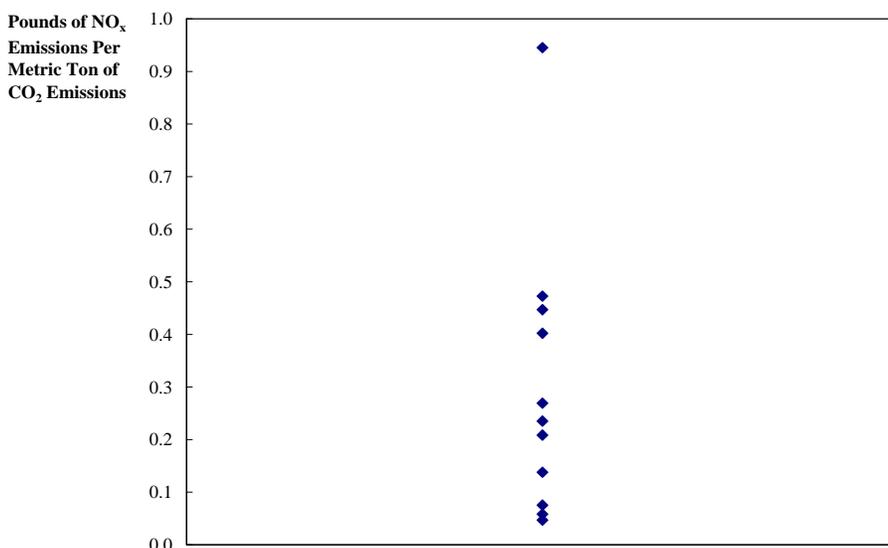
Emissions Source	ROG	NO_x	PM_{2.5}
Electricity Generation	0.07	0.54	0.10
Petroleum Refining Fuel Combustion	0.05	0.63	0.09
Other Manufacturing and Industrial Fuel Combustion	0.32	4.72	0.34
On-Road Heavy-Duty Vehicles	4.26	25.25	0.85
On-Road Passenger Cars	3.69	2.97	0.11

Source:

[1] Calculations based on data presented in Table 1.

Moreover, the average relationships depicted in Table 2 conceal substantial variation within each category of sources. For example, Figure 1 presents the NO_x emissions per metric ton of carbon dioxide (CO₂) emissions from a sample of 11 natural gas power plants in the South Coast Air Quality Management District.²⁴ Collectively, these 11 plants account for about 10 percent of California’s in-state electricity sector GHG emissions. As Figure 1 depicts, within this small sample of plants in the same air quality district, there is a 20-fold difference across the plants with respect to the amount of NO_x emissions generated per ton of CO₂ emissions. However, as it examines just natural gas power plants, Figure 1 understates the variation in the relationships between GHG and co-pollutant emissions that exist across the broad array of facilities that would be subject to GHG regulation.

Figure 1. Variation in NO_x Emissions per Metric Ton of CO₂ Emissions across a Sample of 11 Natural Gas Power Plants in the South Coast Air Quality Management District



Sources: California Air Resources Board Emissions Inventory (<http://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php>), and U.S. EPA eGRID database (<http://www.epa.gov/solar/energy-resources/egrid/index.html>).

²⁴ To highlight variation within a group of seemingly similar sources in the same air quality district, our sample includes all power plants in the South Coast Air Quality Management District whose primary fuel is natural gas and for which we could match CO₂ emissions data (from U.S. EPA) with NO_x emissions data (from CARB).

Table 1 also highlights important differences in the contribution of different *types of activities* to GHG and criteria pollutant emissions. For example, at energy production and manufacturing facilities, while fuel combustion accounts for nearly 90 percent of GHG emissions, it accounts for less than half of their total criteria emissions. The remaining emissions from these facilities result from various other operations (i.e., “process” emissions).

A second type of co-pollutant is toxic air pollutants. Table 3 presents statewide emissions of five key toxic air pollutants across three broad categories of emissions sources.²⁵ As Table 3 indicates, the contribution of various sources to toxic air pollutant emissions also differs substantially from their contribution to GHG emissions. For example, whereas the contribution of stationary sources to statewide GHG emissions is roughly comparable to that of transportation and mobile sources, stationary sources (which, in Table 3, include but are not limited to energy production and manufacturing facilities) account for a far smaller share of emissions of several toxic air pollutants than do transportation and mobile sources.

Table 3. 2006 Toxic Air Pollutant Emissions from California Sources (Tons per Year and Percent of Total)

Emissions Source ¹	1,3 - Butadiene		Benzene		Diesel PM		Formaldehyde		Hexavalent Chromium	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
Stationary Sources ²	15.5	0.4%	1,231.2	10.2%	1,228.5	2.9%	1,877.4	8.1%	0.2	41.6%
Transportation and Mobile	2,279.0	56.7%	10,661.1	88.4%	41,166.3	97.1%	19,273.7	83.2%	0.3	56.2%
Other Sources	1,725.7	42.9%	168.4	1.4%	0.0	0.0%	2,004.9	8.7%	0.0	2.2%
STATEWIDE TOTAL	4,020.2	100%	12,060.7	100%	42,394.8	100%	23,156.0	100%	0.5	100%

Notes:

- [1] The emissions source categories reflect CARB's toxic emissions inventory categorizations. Stationary sources include point and aggregated stationary sources. Transportation and mobile includes on-road diesel, on-road gasoline, other mobile diesel, other mobile gasoline, and other mobile. Other sources include areawide and natural sources.
- [2] Stationary source emissions include but are not limited to emissions from energy production and manufacturing facilities whose GHG and criteria pollutant emissions are reported in Table 1.

Source:

- [1] The California Toxics Inventory (CTI), last visited July 30, 2008 (<http://www.arb.ca.gov/toxics/cti/cti.htm>).

While Table 3 presents each type of source's share of total emission levels for key toxic air pollutants, measurements focusing on the aggregate health risks of toxic air pollutants offer similar insights. For example, SCAQMD reports that, in 1998, on-road transportation sources accounted for 51 percent of health-related air toxic risks, off-road sources accounted for 44 percent of such risks, and stationary sources accounted for just 5 percent.²⁶ These health risks arise primarily from diesel particulate emissions, which are emitted largely by transportation sources and account for 83 percent of the South Coast's health-related air toxic risks.²⁷

The contributions of different sources to criteria and toxic air pollutants in some of California's AQMD's that have yet to achieve compliance are similar to the statewide contributions depicted in Tables 1 and 3. Table 4 presents the contribution of various sources to criteria pollutant emissions in the South Coast and San Joaquin Air Quality Management Districts, two regions within California that are out of compliance with both PM_{2.5} and ozone standards. Table 5 presents the contribution of various sources to individual toxic air pollutants

²⁵ The five toxic air pollutants included in Table 2 account for over 96 percent of the total cancer risk from air toxics in the South Coast Air Basin. SCAQMD, *Multiple Air Toxics Exposures Study (MATES III)*, Draft Final Report, Table 4-6, July 2008.

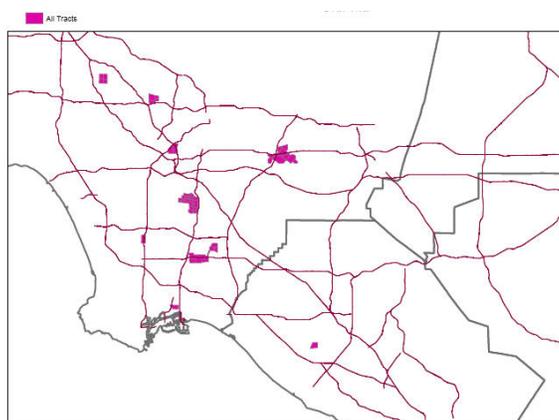
²⁶ SCAQMD, March 2000, p. 17.

²⁷ SCAQMD, July 2008, Appendix IX-86.

in the South Coast Air Quality Management District. Both Table 4 and Table 5 show that energy production and manufacturing facilities account for relatively small proportions of criteria pollutants (4 percent in the South Coast and 6 percent in San Joaquin) and toxic air pollutants, while transportation and other sources account for the vast majority of those pollutants.

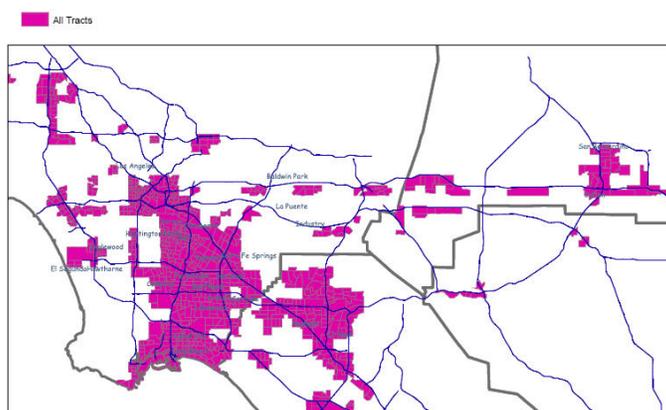
Differences in the relative contributions of stationary and transportation sources to air quality are further illustrated in Figures 2 and 3. These figures report estimates of the cancer risks associated with emissions from stationary and mobile sources at the level of individual Census tracts in the South Coast Air Quality Management District.²⁸ Figure 2 shows tracts where cancer risks from stationary source emissions exceed 200 per million, while Figure 3 shows tracts where cancer risks from mobile source emissions exceed 1,000 per million. As these figures illustrate, emissions from mobile sources, such as vehicles, are far greater contributors to cancer risks in the South Coast Air Quality Management District than are emissions from stationary sources.

Figure 2. Census Tracts with Cancer Risk from Stationary Source Emissions Exceeding 200 per Million



Source: South Coast Air Quality Management District (<http://www.aqmd.gov/rules/CIWG/maps.html>).

Figure 3. Census Tracts with Cancer Risk from Mobile Source Emissions Exceeding 1,000 per Million



Source: South Coast Air Quality Management District.

²⁸ Census tracts are geographic areas delineated by the U.S. Census Bureau that “usually have between 2,500 and 8,000 persons and, when first delineated, are designed to be homogeneous with respect to population characteristics, economic status, and living conditions.” U.S. Census Bureau, “Census Tracts and Block Numbering Areas,” (http://www.census.gov/geo/www/cen_tract.html).

Table 4. Sources of Criteria Pollutant Emissions in the South Coast and San Joaquin Air Quality Management Districts

Emissions Source	South Coast (Percent of Total for Each Pollutant)				San Joaquin (Percent of Total for Each Pollutant)			
	ROG	NO _x	PM _{2.5}	Total of All Criteria Pollutants	ROG	NO _x	PM _{2.5}	Total of All Criteria Pollutants
Energy Production and Manufacturing								
Electricity Generation								
Power Only	0.0%	0.3%	0.7%	0.3%	0.1%	1.2%	0.8%	0.4%
Combined Heat and Power	0.0%	0.1%	0.0%	0.0%	0.1%	0.7%	0.5%	0.2%
Total	0.1%	0.3%	0.8%	0.3%	0.1%	1.8%	1.3%	0.6%
Petroleum Refining								
Fuel Combustion	0.1%	0.7%	1.2%	0.3%	0.1%	0.4%	0.3%	0.1%
Process	0.4%	0.5%	0.9%	0.5%	0.3%	0.0%	0.1%	0.1%
Total	0.5%	1.2%	2.1%	0.7%	0.4%	0.4%	0.4%	0.2%
Oil and Gas Production								
Fuel Combustion	0.0%	0.1%	0.1%	0.1%	0.2%	1.7%	1.2%	0.7%
Process	0.2%	0.0%	0.0%	0.0%	4.4%	0.0%	0.0%	1.0%
Total	0.2%	0.1%	0.1%	0.1%	4.7%	1.7%	1.2%	1.7%
Other Manufacturing and Industrial								
Fuel Combustion	0.2%	1.7%	1.2%	0.5%	0.4%	8.2%	1.7%	1.9%
Process	7.0%	0.3%	11.6%	2.7%	5.1%	3.2%	7.6%	2.0%
Total	7.2%	2.0%	12.8%	3.2%	5.5%	11.4%	9.4%	3.9%
Fuel Combustion Total	0.4%	2.8%	3.3%	1.1%	0.9%	12.1%	4.5%	3.3%
Process Total	7.5%	0.8%	12.5%	3.2%	9.8%	3.2%	7.7%	3.0%
Energy Production and Manufacturing Total	7.9%	3.7%	15.8%	4.4%	10.7%	15.3%	12.3%	6.3%
Transportation and Mobile Sources								
On-Road Heavy-Duty Vehicles	9.2%	36.8%	9.2%	17.1%	5.9%	44.8%	7.6%	12.7%
On-Road Light-Duty Trucks	9.3%	9.9%	3.0%	15.0%	4.0%	4.8%	0.7%	6.6%
On-Road Passenger Cars	15.8%	10.2%	3.3%	20.7%	4.4%	3.6%	0.6%	6.4%
Other Transportation	26.7%	34.1%	15.2%	25.3%	12.5%	25.6%	6.8%	13.9%
Transportation and Mobile Sources Total	61.0%	90.9%	30.7%	78.2%	26.8%	78.8%	15.7%	39.7%
Other Sources								
Fuel Combustion	0.7%	4.6%	7.6%	1.9%	1.1%	2.3%	8.6%	2.7%
Non Combustion	30.4%	0.8%	45.9%	15.5%	61.4%	3.6%	63.5%	51.3%
Other Sources Total	31.1%	5.4%	53.5%	17.5%	62.5%	5.9%	72.1%	54.0%
DISTRICT TOTAL	100%	100%	100%	100%	100%	100%	100%	100%

Notes:

[1] See notes to Table 1.

Source:

[1] CARB criteria emissions data obtained from CARB.



Table 5 Sources of Toxic Air Pollutant Emissions in the South Coast Air Quality Management District

Emissions Source	1,3 Butadiene	Benzene	Diesel PM	Formaldehyde	Hexavalent Chromium
Energy Production and Manufacturing					
Electricity Generation					
Power Only	0.0%	0.0%	0.0%	0.0%	0.0%
Combined Heat and Power	0.0%	0.0%	0.0%	0.1%	1.0%
Total	0.0%	0.1%	0.0%	0.1%	1.0%
Petroleum Refining					
Combustion	0.0%	0.3%	0.1%	0.6%	0.2%
Process	0.0%	0.6%	0.0%	0.0%	0.0%
Total	0.0%	0.9%	0.1%	0.6%	0.2%
Oil and Gas Production					
Combustion	0.0%	0.0%	0.0%	0.4%	0.2%
Process	0.0%	0.1%	0.0%	0.3%	0.0%
Total	0.0%	0.1%	0.0%	0.7%	0.2%
Other Manufacturing and Industrial					
Fuel Combustion	0.0%	0.3%	0.3%	0.6%	0.2%
Process	6.4%	1.1%	0.0%	0.1%	22.2%
Total	6.5%	1.4%	0.3%	0.7%	22.4%
Fuel Combustion Total	0.0%	0.7%	0.4%	1.8%	1.6%
Process Total	6.4%	1.8%	0.0%	0.3%	22.2%
Energy Production and Manufacturing Total	6.5%	2.5%	0.4%	2.1%	23.9%
Transportation and Mobile Sources					
On-Road Heavy-Duty Cars	7.1%	7.8%	17.5%	10.5%	2.7%
On-Road Light-Duty Trucks	9.0%	9.2%	0.1%	3.1%	8.4%
On-Road Passenger Cars	3.0%	3.0%	0.1%	1.2%	1.4%
Other Transportation	71.7%	75.1%	80.6%	78.9%	40.9%
Transportation and Mobile Sources Total	90.9%	95.1%	98.3%	93.7%	53.5%
Other Sources					
Fuel Combustion	0.3%	1.3%	1.3%	2.6%	1.9%
Non Combustion	2.3%	1.1%	0.0%	1.7%	20.8%
Other Sources Total	2.7%	2.4%	1.3%	4.3%	22.6%
SOUTH COAST TOTAL	100%	100%	100%	100%	100%
ESTIMATED CONTRIBUTION TO CUMULATIVE RISK FROM ALL AIR TOXIC EMISSIONS	3.6%	5.2%	82.5%	2.5%	2.7%

Source:

[1] South Coast Air Quality Management District, MATES III, Table 4-6 and Appendix VIII.



The data in the preceding tables and figures illustrate that, whether viewed in terms of emissions or health risks, there is significant complexity and variation in the relationship between GHG and co-pollutant emissions across different emissions sources and across different combustion and non-combustion activities at those sources. As a result of this variation, sources that are the key contributors of one type of emission may differ from the sources that are key contributors of another emission. For example, while the transportation sector is a key (if not the key) source of emissions for many co-pollutants, accounting for 80 percent of state-wide NO_x emissions and more than 50 percent of state-wide total criteria pollutant and key toxic pollutant emissions, it is one among many important sources of GHG emissions. In contrast, while fuel combustion at large energy production and manufacturing facilities (including electricity generation, petroleum refining, oil and gas production, and other manufacturing and industrial facilities) accounts for more than 30 percent of GHG emissions, it account for less than two percent of total criteria pollutant emissions.

B. The Relationship Between GHG and Co-Pollutant Emission Reduction Measures

Just as there is substantial variation in the relationship between GHG emissions and co-pollutant emissions across various emissions sources, there is also substantial variation and complexity in the relationship between the GHG and co-pollutant emission reductions that can be achieved through various abatement measures. Measures aimed at reducing GHG emissions may result in some co-pollutant reductions, no co-pollutant reductions, or even increases in co-pollutant emissions. Further, while some measures can reduce both GHG and co-pollutant emissions, many effective means of reducing co-pollutant emissions have no implications for GHG emissions and, in some cases, can even increase GHG emissions.

At least in the near-term, CO₂ emission reductions from stationary and mobile sources will have to be achieved predominantly, if not entirely, by reducing fossil fuel use or (where possible) by shifting from more carbon-intensive to less carbon-intensive fuels.²⁹ While such measures can reduce criteria and toxic air pollutant emissions, significant reductions in those co-pollutant emissions also can be achieved by a variety of measures, such as “end-of-pipe” control technologies, that do not reduce fuel use and therefore do not reduce GHG emissions. Over the past few decades, these latter pollution control measures have achieved substantial reductions in criteria and toxic pollutant emissions from many sources in California even as those sources’ GHG emissions have continued to increase.

Consistent with past regulatory efforts, most of the measures identified by recent state and regional regulatory plans as effective means of further reducing criteria and toxic pollutants do not involve reducing fuel use. For example, criteria and toxic pollutant control measures for large stationary sources included in California’s SIP and in the South Coast Air Quality Management District’s Air Toxics Control Plan do not focus on reducing criteria and toxic pollutants by reducing fuel combustion. Likewise, policies aiming to reduce criteria and toxic pollutant emissions from the transportation sector generally require changes in fuel formulation along with the use of vehicle emission reduction technologies, rather than reductions in fuel consumption or reductions in the carbon-intensity of fuel. For example, reductions in heavy-

²⁹ While carbon capture and storage can reduce CO₂ emissions from certain large stationary sources without reducing fossil fuel use, it likely will be at least a decade before that technology is adopted on any meaningful scale; and, when it is, it likely will largely, if not entirely, be adopted at new facilities rather than at existing facilities.

duty truck emissions are a key component of newly proposed emission reduction measures in California's SIP, accounting for nearly 25 percent of the South Coast's and almost 75 percent of San Joaquin's NO_x reductions by 2014.³⁰ Although they will achieve significant reductions in criteria pollutants, it is possible that these measures could actually increase GHG emissions by reducing vehicle fuel economy and requiring greater energy use at refineries that produce diesel fuel.³¹

Efforts to reduce heavy-duty truck emissions highlight another important aspect of the relationship between GHG emission reduction measures and co-pollutant emission reduction measures: some co-pollutant emission reduction measures require energy, and can therefore increase GHG emissions. Other measures, such as some methods of reducing NO_x emissions from power plants, can reduce the efficiency with which fuels are converted into electricity or other useful forms of energy, which can also lead to increased GHG emissions. As this suggests, it is also the case that some means of reducing GHG emissions can actually increase co-pollutant emissions. Moreover, even though they may, on net, achieve statewide reductions in co-pollutant emissions, some measures that reduce GHG emissions may increase co-pollutant emissions in particular locations. For example, reductions in GHG emissions achieved by shifting electricity generation to less emissions-intensive plants nonetheless may lead to localized increases in co-pollutant emissions nearby the plants experiencing increased utilization.

Thus, as the above discussion indicates, just as there is substantial variation and complexity in the relationship between GHG and co-pollutant emissions across emissions sources, there is also substantial variation and complexity in the relative effect of various abatement measures on GHG and co-pollutant emissions.

³⁰ CARB, April 2007; San Joaquin Valley Unified Air Pollution Control District, *2007 Ozone Plan*, April 2007; and SCAQMD Governing Board, June 2007.

³¹ CARB states that "[p]roposed measures to reduce emissions from diesel-fueled engines could require the use of new diesel engines, engine modifications, add-on control devices such as diesel particulate filters, oxidation catalysts and selective catalytic reduction (SCR) systems, low-sulfur fuel, alternative fuel formulations, or other strategies. These strategies have the potential to slightly reduce fuel economy and increase greenhouse gas emissions." CARB also notes that the process of "regenerating" diesel particulate filters requires heat energy which may lead to increased GHG emissions. CARB, April 2007, Appendix E, p. 18.

V. The Implications of a GHG Cap-and-Trade System for Co-Pollutants

In evaluating the role that a GHG cap-and-trade system could play in a climate policy that effectively addresses environmental justice concerns, two implications of a GHG cap-and-trade system for GHG co-pollutants are particularly relevant to consider: its impact on statewide co-pollutant emissions, and its localized impacts on co-pollutant emissions. We address each below.³²

A. Implications for Statewide Co-Pollutant Emissions

Opportunities to reduce GHG co-pollutants through climate policy are often raised in the context of discussing various source- or sector-specific GHG regulations. Yet, it is important not to lose site of the fact that, by reducing California's GHG emissions, a GHG cap-and-trade system is most likely to also reduce statewide co-pollutant emissions. In assessing a GHG cap-and-trade system's implications for statewide co-pollutant emissions, it is essential to recognize that such a system would be layered on top of existing regulations of co-pollutant emissions, and would in no way relieve facilities from any legal obligation to comply with those existing regulations.³³ Rather, implementation of a GHG cap-and-trade system would introduce a cost for emitting GHGs (i.e., the allowance price) on top of facilities' existing regulatory requirements for other pollutants. As such, it would introduce a strong incentive for *all* covered facilities to reduce their GHG emissions, and hence their co-pollutant emissions.

A GHG cap-and-trade system offers many advantages over other regulatory approaches with respect to its ability to reduce co-pollutant emissions. First, a cap-and-trade system can create incentives for reductions in GHG emissions – and hence co-pollutants – from a far broader set of sources and activities than any other traditional regulatory approach could feasibly target. In particular, a GHG cap-and-trade system could be designed to place a cost on every ton of energy-related CO₂ emissions from all facilities and vehicles throughout the state. By comparison, achieving similarly broad coverage of emissions sources through source- or sector-specific emission standards would be far more administratively costly, if not infeasible, and would take far more time to implement fully.

³² Given this paper's focus, while we examine the implications of a GHG cap-and-trade system for co-pollutant emissions, we do not address criticisms that some have levied regarding a GHG cap-and-trade system's effectiveness in reducing GHG emissions. However, it should be noted that many such criticisms draw on historical experiences with cap-and-trade systems in ways that confuse the efficacy of the policy instrument with the implications of particular design choices that policymakers have made in implementing that instrument. For example, many have criticized the European Union's Emissions Trading Scheme for not achieving an absolute reduction in GHG emissions during its first phase of operation. Yet, this outcome reflected a political choice about the level of the emissions cap, not a failure of the cap-and-trade system itself. While cap-and-trade systems offer policymakers a powerful tool to guarantee the cost-effective achievement of a chosen emissions target, the effects of a particular system will depend fundamentally on key design choices. Of course, the effects of traditional command-and-control regulations also depend on precisely how policymakers choose to implement them.

³³ The fact that a GHG cap-and-trade system would be layered on top of existing co-pollutant regulations distinguishes it from some prior market-based policies, such as the SCAQMD's RECLAIM program, which some environmental justice organizations have criticized. RECLAIM established a cap-and-trade system for nitrogen oxide and sulfur oxide emissions from facilities that fell under SCAQMD's jurisdiction. Contrary to what would occur if facilities were placed under a GHG cap-and-trade system, facilities placed under RECLAIM were no longer subject to other existing regulations that targeted nitrogen oxide and sulfur oxide emissions.

Second, a cap-and-trade system can encourage certain activities that reduce both GHG and co-pollutant emissions, but that may be impossible either to encourage or to require through other regulatory approaches. For example, by imposing a cost on all emissions, a cap-and-trade system can encourage firms to accelerate the replacement of inefficient, higher-emitting facilities or equipment. Also, in some cases, regulators may be unwilling to adopt uniform standards that require certain emission reduction technologies because of the high cost or infeasibility of adopting these technologies at a portion of the affected facilities. By contrast, the incentives created by a cap-and-trade system can encourage the adoption of these technologies at facilities where adoption of these technologies would be less costly.

Finally, a cap-and-trade system can spur companies to adopt innovative emission reduction measures that could not be anticipated by, and would not be encouraged under traditional regulatory approaches.

B. Implications for Local Ambient Concentrations of Co-Pollutants

While a GHG cap-and-trade system would lead to overall reductions in statewide co-pollutant emissions, its impact on co-pollutant emissions in specific locations would vary. Given this variation, under some circumstances it is possible that a GHG cap-and-trade system could lead to an increase in ambient co-pollutant concentrations in particular isolated locations. However, as we describe below, the likelihood of this happening is low. Furthermore, this risk would also be present if California instead relied exclusively on traditional command-and-control regulations of GHG emissions.

CARB has proposed a GHG cap-and-trade system that would increase the cost of emitting GHGs for every fossil fuel user in California.³⁴ As a result, under that system, every fossil fuel user in California would face an incentive to reduce its GHG emissions, and hence its co-pollutant emissions. Nonetheless, it is possible that a cap-and-trade system may cause GHG and co-pollutant emissions to increase at some facilities. This could occur if a facility is less emissions-intensive than its competitors, and can thereby displace some of the production of its more emissions-intensive competitors that experience greater costs under the cap-and-trade system. For example, a GHG cap-and-trade system could make electricity co-generation more economically attractive than is currently the case, and may thereby encourage the development of some co-generation projects that otherwise would not be pursued.

Although a GHG cap-and-trade system may lead to increased emissions from some facilities, traditional command-and-control regulations can have the same effect. By increasing the cost of building new facilities or operating certain existing facilities in a particular industry, traditional command-and-control regulations may cause other existing facilities to operate at higher levels or for longer periods of time than they otherwise would. For example, research has found that, by increasing the cost of building new electric power plants, federal emission standards for new plants have increased the longevity of existing plants by as much as 20

³⁴ A cap-and-trade system increases the cost of emitting GHGs even if allowances are freely distributed (rather than auctioned). That is, even if an emissions source were to receive freely distributed allowances, for each ton of GHGs it emits, it would face the cost of foregoing revenue that it could otherwise earn by selling unused allowances.

percent.³⁵ Furthermore, neither a cap-and-trade system nor traditional command-and-control regulations would have any effect on the location of new emissions sources. Thus, air quality impacts associated with the siting of new emissions sources could not be controlled by any of the alternative approaches to regulating GHG emissions, and therefore need to be addressed within other regulatory frameworks.

It is also important to recognize that local ambient pollutant concentrations – not emissions from any one facility – are the key concern with respect to GHG co-pollutants. Thus, to the extent that a GHG cap-and-trade system leads to an increase in any one facility's co-pollutant emissions, this increase would have to offset the cap-and-trade system's general downward pressure on co-pollutant emissions from all other local emissions sources in order to yield a net increase in local ambient concentrations of particular co-pollutants.

A few considerations suggest that such an outcome is unlikely. First, the stationary sources that might increase their emissions under a GHG cap-and-trade system would tend to be the most efficient (and least GHG-intensive) within their respective industries. To the extent that these more efficient facilities also tend to have lower co-pollutant emissions, then these potential increases in GHG emissions may have very limited effects on local co-pollutant emissions. Second, weighing against any increases in emissions from isolated facilities, a GHG cap-and-trade system would reduce emissions at other stationary sources within the same geographic area, thus offsetting any increases from isolated facilities. In fact, some of these facilities may be more emissions-intensive than the facilities that experience increased emissions, particularly as more-emissions intensive facilities are most likely to reduce emissions due to their higher GHG allowance costs. Third, the GHG cap-and-trade system proposed by CARB could also reduce emissions from the transportation sector, which accounts for a far greater share of the state's criteria and toxic air pollutants than do stationary emissions sources. Thus, it is likely that a GHG cap-and-trade system would actually *decrease ambient concentrations* of co-pollutants throughout the state even if it leads to isolated increases in *emissions* from particular facilities.

While there likely will be variation in the extent to which a GHG cap-and-trade system reduces ambient co-pollutant concentrations across the state, this would be the case with any other regulatory approach. Moreover, there is no reason to believe that a cap-and-trade system would lead to lesser reductions in areas with higher existing emission levels, or in particular types of communities.

Experience with previous cap-and-trade systems suggests that emission reductions may be greatest from facilities with the highest initial emission levels, and that a community's characteristics have no effect on the extent of emission reductions that they experience. A study of emission reductions under the South Coast Air Quality Management District's RECLAIM cap-and-trade system suggests that emission reductions tended to be greater at larger, higher emitting facilities than at smaller facilities.³⁶ That same study also found that there was no relationship between the amount of reductions achieved by an emissions source under the cap-and-trade system and the income, race, or ethnicity of the surrounding neighborhood.

³⁵ For example, see Michael Maloney and Gordon Brady, "Capital Turnover and Marketable Pollution Rights," *Journal of Law and Economics* 31, no. 1 (1988): 203-226; Randy Nelson, Tom Tietenberg, and Michael Donihue, "Differential Environmental Regulation: Effects on Electric Utility Capital Turnover and Emissions," *Review of Economics and Statistics* 75, no. 2 (1993): 368-373; and Robert N., Stavins, "Vintage-Differentiated Environmental Regulation." *Stanford Environmental Law Journal*, Volume 25, Number 1 (Winter 2006), pp. 29-63..

³⁶ Meredith Fowlie, Stephen Holland, and Erin Mansur, "Evaluating Emissions Trading Using a Nearest (Polluting) Neighbor Estimator," October 12, 2008.

Studies of the nationwide cap-and-trade system for sulfur dioxide emissions under the U.S. Acid Rain Program have reached similar conclusions. Facilities with the highest emissions prior to the program's implementation undertook the greatest emission reductions under the Program. Furthermore, while the program reduced PM_{2.5} concentrations in counties throughout the country, there has been no systematic relationship between the extent of reductions that a particular county experienced and the county's average household income.³⁷

VI. A Proposal for Addressing Environmental Justice Concerns in the Design of California Climate Policy

A GHG cap-and-trade system designed to minimize the cost of reducing GHG emissions can be a central element of a California climate policy that achieves AB 32's GHG target while effectively addressing environmental justice concerns. First, a GHG cap-and-trade system can itself play an important role in improving air quality by reducing state-wide co-pollutant emissions. However, to the extent that further air quality gains or protections are sought through AB32 implementation, the most effective approach to achieving such gains while cost-effectively achieving AB 32's GHG emission targets is not to attempt to achieve both goals through a single policy. Instead, such goals should be achieved by combining a GHG cap-and-trade system with separate, but complementary, policies that can capitalize fully on the best opportunities to improve air quality and to protect against any localized air quality risks that climate policy may inadvertently create.

The design of and need for these complementary policies will depend on many factors. Well designed policies should reflect multiple considerations, including the nature of ambient pollution problems (e.g., geography, key pollutants, and sources) and the costs and effectiveness of alternative mitigation strategies or technologies.³⁸ The need for these policies will depend upon the specific policies implemented to achieve AB 32's goals and the extent to which they have (or are anticipated to have) adverse air quality impacts in total for particular communities (including those arising from particular policies or programs), or achieve reductions in GHG co-pollutant emissions sufficient to accomplish AB 32's co-pollutant goals. However, such complementary policies – which could include additional emissions monitoring, regulations, and other initiatives – would be most effective if they are implemented within and, where

³⁷ Clean Air Markets Division, Office of Air and Radiation, U.S. Environmental Protection Agency, *The Acid Rain Program and Environmental Justice: Staff Analysis*, September 2005; Byron Swift, "Emissions Trading and Hot Spots: A Review of Major Programs," *Environment Reporter* 35, no. 19 (2004); and Jason Cockburn, "Emissions Trading and Environmental Justice: Distributive Fairness and the USA's Acid Rain Programme," *Environmental Conservation* 28, no. 4 (2001): 323-332.

³⁸ Although environmental justice concerns often reflect ambient pollution concentrations in particular communities, this does not necessarily imply that the most effective approach to mitigating such concentrations is through reductions in the emissions of stationary sources located in such communities. As discussed previously, transportation sources are a key source of co-pollutant emissions (e.g., see Tables 1 and 2 and Figures 3 and 4) and are often emphasized within state and regional regulatory plans. For example, the most recent State Implementation Plan for achieving compliance with federal ambient pollution standards, reflecting a combination of state and regional air quality district controls and programs, focuses largely on mobile sources, rather than stationary sources. For example, see CARB, "Staff Report Proposed 2007 State Implementation Plan for the South Coast Air Basin - PM_{2.5} Annual Average and 8-Hour Ozone National Ambient Air Quality Standards", California Environmental Protection Agency, September 21, 2007.

needed, expand upon the existing regulatory framework for criteria and toxic GHG co-pollutants.³⁹

Our proposal would also provide a framework in which CARB can assess whether certain policies might be desirable because of the combined benefits achieved by reducing both GHG *and* co-pollutant emissions. However, rather than alter the design of GHG regulations with the hope of identifying such policies, CARB can more effectively capitalize on opportunities to improve air quality while reducing GHGs by assessing whether criteria or toxic air pollutant regulations should be strengthened because of ancillary benefits of *GHG reductions* that those regulations might offer.⁴⁰ Likewise, CARB could direct local air districts to do the same. In addition to systematically accounting for reductions in GHG emissions when in developing or revising criteria and toxic air pollutant regulations in the future, in implementing AB 32, CARB and local air districts could conduct a one-time review to determine if any adjustments to existing criteria or toxic air pollutant regulations are warranted given the reductions in GHG emissions that those regulations might create. In making these determinations, the GHG allowance price in a California cap-and-trade system (or projections thereof) could be used as a readily available measure of the value of any ancillary benefits that criteria or toxic air pollutant regulations could offer by reducing GHG emissions from sources covered by that GHG cap-and-trade system.⁴¹

In addition to addressing GHG co-pollutants, our proposal would help address the economic dimension of environmental justice concerns by minimizing the overall economic impact of regulations implemented under AB 32. Moreover, California could take additional steps to address both the economic and environmental dimensions of environmental justice concerns through decisions about how to allocate emission allowances (or auction revenue) in a GHG cap-and-trade system. For example, to the extent that allowances are auctioned, the resulting revenue could be distributed in a manner designed to mitigate the economic impact of

³⁹ Elements of our proposal are consistent with the Market Advisory Committee's recommendations: "Still, it is crucial to monitor very closely the emissions of local pollutants to track any possible increases. The Committee urges CARB to reinforce the efforts of local air quality management districts ... by closely evaluating the impact that emissions trading is having on criteria emissions or air toxics. The California Health and Safety Code section 39602 designates CARB as the California agency responsible for coordinating and reviewing the activities of local air districts in the state. Section 41503.2 articulates procedures that can be taken by CARB to revise a district's plan if it is found to be deficient. The Committee urges CARB to exercise this authority by reviewing local air district enforcement efforts and revising local air district actions as necessary to prevent any 'backsliding' on the standards for local air quality." Market Advisory Committee, *Recommendations of the Market Advisory Committee to the California Air Resources Board*, June 30, 2007, p. 9.

⁴⁰ Here and elsewhere in this paper, we use the term "ancillary benefits" to refer to any benefits from a regulation other than the benefits that are the primary motivation for that regulation. For example, whereas the ancillary benefits from a GHG regulation may include reductions in criteria pollutant emissions, the ancillary benefits from a criteria pollutant regulation may include reductions in GHG emissions.

⁴¹ This allowance price reflects the value of GHG emission reduction costs that can be avoided as a result of GHG reductions achieved by particular criteria or toxic air pollutant regulations. This price is an appropriate measure of the ancillary benefits from any GHG reductions achieved by criteria or toxic air pollutant regulations that target sources covered by a GHG cap-and-trade system. This is the case because, while the direct GHG reductions that those criteria or toxic air pollutant regulations could achieve would avoid the need for some other GHG reductions from capped sources, they would not alter the overall level of GHG emissions from all capped sources.

climate policy on low-income households, and to fund efforts to improve air quality or health services in particular communities.

Our proposal differs from other proposals to address environmental justice concerns in the context of implementing AB 32. One proposal is to abandon a GHG cap-and-trade system in favor of GHG regulations that attempt simultaneously to reduce GHG emissions and improve air quality.⁴² Another type of proposal is to adopt a GHG cap-and-trade system, but at the same time employing additional GHG regulations or altering the cap-and-trade system's design to achieve particular air quality goals.

Compared with these alternatives, our proposal will better address both the environmental and economic dimensions of environmental justice concerns. This conclusion is premised on four key points that we develop in the remainder of this section.

First, by layering a cost-effective GHG cap-and-trade system on top of efforts that specifically target air quality concerns, California can reduce GHG emissions and improve air quality more effectively and at lower cost than it could by trying to design GHG regulations that attempt simultaneously to reduce GHGs and address air quality concerns.

Second, to the extent that desirable opportunities exist for targeted regulations that simultaneously improve air quality and reduce GHG emissions, they can be identified and implemented more effectively by considering the benefits of GHG emission reductions when developing or revising air quality regulations than by trying to account for the benefits of reductions in criteria or toxic air pollutants when developing GHG regulations.

Third, given the complex and highly varied relationships between GHG and co-pollutant emissions across emissions sources, efforts to achieve air quality objectives through adjustments to a GHG cap-and-trade system's design will have highly uncertain impacts on air quality while certainly increasing costs. Such adjustments will also be prone to unintended consequences.

Fourth, in addition to lowering climate policy's overall cost, a GHG cap-and-trade system offers unparalleled flexibility to address important distributional concerns about economic and environmental impacts on particular communities without affecting that system's overall cost or environmental effectiveness.

We develop these four points below.

A. Effectively Addressing Co-Pollutant Emission Reduction Opportunities and Risks

By adopting a policy framework in which a GHG cap-and-trade system is implemented in parallel with policies that specifically target GHG co-pollutants, California can achieve any desired air quality objectives. Such a system can also be largely cost-effective. While a cap-and-trade system can achieve all cost-effective GHG emission reductions, policies targeting GHG co-pollutants can, if appropriately designed, identify and capture cost-effective opportunities to

⁴² Some have proposed imposing a carbon tax in lieu of a cap-and-trade system as a means of better addressing environmental justice concerns. However, assuming that both systems achieved the same state-wide GHG emissions, the geographic distribution of GHG emissions and associated co-pollutants under a carbon tax would not differ from that under a cap-and-trade system. Further, a cap-and-trade system, if appropriately administered and enforced, would provide greater certainty about the achievement of particular state-wide emission targets.

reduce GHG co-pollutants.⁴³ Any emission reduction measures that are not undertaken as a consequence of the GHG cap-and-trade system, but are cost-effective because of the combined benefits of GHG *and* co-pollutant emission reductions, could be identified and implemented by adapting co-pollutant regulations to account for any associated reductions in GHG emissions such regulations might generate.

On the other hand, were California to abandon a GHG cap-and-trade system in favor of GHG regulations that simultaneously seek to reduce GHG emissions and address GHG co-pollutant concerns, it would forego the cap-and-trade system's cost savings and environmental benefits in favor of regulations that will certainly be more costly, may or may not have greater impacts on GHG co-pollutants, and may not achieve the state's GHG emissions target.

Addressing related pollutants from particular sources through separate regulations for each pollutant is by no means a new approach. In fact, this approach is widely employed in state and federal air quality regulations. However, the flexibility inherent in a GHG cap-and-trade system makes this approach particularly attractive in the context of addressing GHGs and their co-pollutants. In particular, because of this flexibility, a GHG cap-and-trade system can be overlaid on top of initiatives and regulations that specifically target GHG co-pollutants in a manner that guarantees the cost-effective achievement of the GHG emissions cap without interfering with the performance of those policies targeting GHG co-pollutants.

While a GHG cap-and-trade system can play a central role in an AB 32 policy framework that effectively addresses both GHGs and GHG co-pollutants, the desire that some have expressed to shape GHG regulations to account for co-pollutant impacts reflects two facts that should be considered in implementing AB 32. First, some promising measures that reduce both GHGs and GHG co-pollutants may only be identified if policymakers consider the impacts of potential regulations on both GHGs and co-pollutants. Second, regulations focusing on just one pollutant may inadvertently lead to increases in emissions of another pollutant. In effect, in implementing AB 32, consideration should be given to both the opportunities and risks that the need to reduce GHGs presents for efforts to improve air quality. However, as we describe below, there are several reasons why this is best done in the context of the existing regulatory framework for criteria and toxic air pollutants rather than through GHG regulations.⁴⁴

⁴³ Any emission reductions opportunities that cannot be achieved through the mechanisms available to reducing co-pollutant emissions could not be targeted through such complementary programs. For example, because emission standards are less effective than market based systems at encouraging reductions in use, co-pollutant policies could not target reductions through reductions in use, which might be more cost-effective than alternatives.

⁴⁴ That is, we do not believe that GHG regulations or policies should be motivated by efforts to reduce GHG co-pollutants. Yet, there are other motivations for implementing some additional GHG regulations and policies underneath a GHG cap-and-trade system. For example, certain regulatory standards may be warranted in order to overcome market failures that might otherwise prevent the realization of some cost-effective GHG reduction opportunities under a cap-and-trade system alone. While such additional regulations or policies should not be motivated by efforts to reduce co-pollutants, given the opportunity to pursue co-pollutant reductions through more direct means, in assessing the merits of any such additional regulations or policies, it is appropriate to account for any effects they may have on co-pollutants as part of a full assessment of the impact of those regulations or policies.

1. GHG Benefits are More Easily Identified within the Context of Co-Pollutant Regulations than the Identification of Co-pollutant Benefits within the Context of GHG Policy

To the extent that desirable opportunities exist that could improve air quality and reduce GHG emissions at the same time, those same opportunities could be identified either in developing GHG regulations or in developing or revising air quality regulations. Under the former approach, in developing GHG regulations, regulators could identify such opportunities by considering the ancillary benefits from reductions in criteria or toxic air pollutants that those regulations could bring about. Under the latter approach, in developing or revising criteria and toxic air pollutant regulations, regulators could identify the same opportunities by considering the ancillary benefits from GHG reduction that those regulations could bring about.

Given that there is already a regulatory framework that specifically targets the GHG co-pollutants of concern, it would be far more administratively efficient to identify any desirable opportunities to reduce both GHG and GHG co-pollutant emissions in the context of developing or revising air quality regulations, rather than in the context of developing GHG regulations. Such an approach could avoid the need for a host of new source- or sector-specific GHG regulations that would otherwise be unnecessary if a GHG cap-and-trade system were adopted.

Moreover, in practice, it likely would be far easier for regulators to identify such opportunities in the context of developing or revising air quality regulations than it would be in the context of developing GHG regulations. Specifically, key differences in the environmental and health impacts of GHGs and GHG co-pollutants make it easier to account for the ancillary benefit of GHG reduction when assessing air quality regulations than to account for benefits of reductions in criteria or toxic air pollutants when assessing GHG regulations (see Figure 4).

Figure 4. Comparison of the Difficulties of Measuring Ancillary Benefits of GHG Reductions in the Context of Air Quality Regulations with the Difficulties of Measuring Ancillary Benefits of Criteria or Toxic Air Pollutant Reduction in the Context of GHG Regulations

	GHG Emission Reduction Benefits (Arising from Criteria or Toxic Air Pollutant Regulations)	Criteria and Toxic Air Pollutant Emission Reduction Benefits (Arising from GHG Regulations)
Geographical and Temporal Variation in Ancillary Benefits	Constant regardless of where or when emission reductions occur	Vary depending on where and when emission reductions occur
Ease of Measuring Ancillary Benefits	With a GHG cap-and-trade system, a market price is readily available to value ancillary benefit of reductions in capped sources’ GHG emissions	No precise measure is readily available

The ancillary benefits from GHG reductions that could result from criteria or toxic air pollutant regulations will be the same regardless of where or when those GHG reductions occur. This is the case because GHGs are global pollutants and because the extent of climate change will depend on cumulative GHG emissions over decades, not on emissions in any particular month or year. Also, if a GHG cap-and-trade system is established, the allowance price in that system would provide a readily available value to use in measuring the ancillary benefits from GHG reductions that can be achieved by criteria or toxic air pollutant regulations that target sources covered by that cap-and-trade system.⁴⁵ Thus, ancillary benefits from GHG reductions can be easily accounted for in evaluating air quality regulations.

By contrast, given the nature of the environmental and health impacts associated with criteria and toxic air pollutant emissions, ancillary benefits from reductions in those emissions vary depending on both where and when they occur. For example, the ancillary benefits from reducing one ton of nitrogen oxides differ depending on whether that reduction occurs in Humboldt County or Los Angeles County, and depending on whether it occurs in January or June. Also, there is no readily available measure of the value of the ancillary benefits from reductions in criteria and toxic air pollutants in any particular location or at any particular point in time. Consequently, properly accounting for ancillary benefits from reductions in criteria and toxic air pollutants in the context of developing state GHG regulations would require significantly more complex analyses than would otherwise be necessary to assess climate policy options.

2. The Existing Co-Pollutant Regulatory Framework Offers the Most Effective and Certain Framework for Pursuing Co-Pollutant Benefits

In addition to the fact that it will be easier to identify measures that simultaneously reduce GHGs and GHG co-pollutants in the context of developing or revising air quality regulations, that regulatory framework would also offer a more effective means of implementing any identified opportunities to reduce GHG co-pollutants. By establishing regulations that specifically set requirements for GHG co-pollutant emissions rather than for GHG emissions, such a framework could ensure that the targeted co-pollutant reductions are achieved. At the same time, the GHG cap-and-trade system would ensure that the state's GHG emissions target is achieved irrespective of the specific impacts of those co-pollutant regulations on GHG emissions. By contrast, if regulators attempt to achieve desired GHG co-pollutant reductions indirectly through GHG regulations, then there would be less certainty that the desired co-pollutant reductions would come to fruition. For example, if sources have multiple means of complying with the GHG regulations, they may choose an approach that does not achieve the desired level of co-pollutant emission reductions.

While adjustments to the existing air quality regulatory framework offer a better means of realizing opportunities to simultaneously improve air quality and reduce GHG emissions, in some cases they may offer the *only* means of realizing those opportunities because of interactions between potential GHG regulations and existing air quality regulations. In particular, given the design of some existing air quality regulations, reductions in fuel use resulting from some GHG regulations will not necessarily lead to corresponding reductions in GHG co-pollutants.

Some regulations are designed to adjust their stringency to compensate for changes in market or regulatory conditions. Such adjustments, however, can thwart efforts to achieve co-pollutant reductions from the implementation of unrelated policies, such as AB 32's climate

⁴⁵ See note 41.

policies. For example, the Pavley vehicle GHG standards will significantly reduce fuel use and GHG emissions by improving vehicle fuel economy. Yet, despite the fact that vehicles are a significant source of criteria air pollutants, CARB's own analysis recognizes that these fuel economy improvements may not reduce vehicle criteria pollutant emissions.⁴⁶ This unexpected outcome arises because existing vehicle criteria pollutant standards establish emission limits per mile traveled, not per gallon of fuel consumed; and the pollution control technologies that are employed to meet those per-mile standards can be adjusted to reflect the increased contribution of fuel economy improvements to meeting those standards. Therefore, to the extent that fuel economy improvements present any new opportunities to achieve additional reductions in criteria pollutants, those opportunities could *only* be realized through adjustments to existing vehicle criteria pollutant standards.⁴⁷ Likewise, GHG regulations that reduce NO_x emissions from facilities covered by SCAQMD's RECLAIM cap-and-trade system may not reduce overall NO_x emissions in the South Coast Air Basin unless there is a corresponding reduction in RECLAIM's NO_x emissions cap.

3. Identifying Co-Pollutant Risks from Climate Policy

While it will be important for California to capitalize on opportunities that climate policy presents to improve air quality, it also will be important to monitor and protect against any risks that the implementation of climate policy may pose for air quality. However, these risks are not isolated to a GHG cap-and-trade system, as even prescriptive GHG regulations present risks of unintended impacts on air quality. More broadly, climate policy is just one of many significant regulatory and market developments influencing the production and use of energy that will affect GHG co-pollutant emissions in the coming years. For example, recent changes in energy prices may have more substantial implications for GHG co-pollutant emissions – at least in the near-term – than would a GHG cap-and-trade system. Therefore, any effective effort to manage the risks that these various developments present for air quality would best be conducted in the context of the existing air quality regulatory framework, and should be attuned to, but not singularly focused on the implications of climate policy.

B. Problems with Proposals to Adjust a GHG Cap-and-Trade System's Design to Address Air Quality Concerns and Objectives

As we described above, while a GHG cap-and-trade system can be complemented by efforts specifically addressing the opportunities and risks that climate policy presents for continued improvements in air quality, that cap-and-trade system should be designed in a manner that minimizes the cost of reducing GHG emissions. Among other features, such a design would allow unrestricted trading of emission allowances within the cap-and-trade

⁴⁶ CARB states that "the staff analysis concluded that the [Pavley vehicle GHG standards] will have a negligible impact on criteria pollutant emissions." CARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles*, August 6, 2004, p. 166.

⁴⁷ By contrast, reductions in vehicle miles traveled, which a cap-and-trade system would encourage, can reduce vehicle criteria pollutant emissions even without any adjustments to existing criteria pollutant emission standards.

system, and would allow for the use of offsets as long as those offsets meet rigorous and sensible standards to ensure their quality.⁴⁸

While others share our conclusion that a GHG cap-and-trade system can play a central role in a California climate policy that addresses environmental justice concerns, some have proposed certain modifications to such a system's design with the goal of advancing particular objectives relating to impacts on GHG co-pollutants.⁴⁹ We discuss two types of proposals below: spatial constraints on allowance trading and restrictions on offset use.

1. Spatial Constraints on Allowance Trading

One type of proposed modification would account for co-pollutants by imposing some sort of spatial constraint on allowance use that corresponds to the variation in local air quality. For example, facility-specific GHG emission caps could be established for facilities in "hot spot" locations. Such a cap might, for example, be set at the level of those facilities' historical GHG emissions.⁵⁰ Under this proposal, affected facilities would have to limit their emissions to their assigned cap (i.e., they could not purchase additional allowances to cover any emissions in excess of their cap). Other proposals would impose other types of requirements on facilities in geographic air quality zones.⁵¹

All of these proposals would increase the cost of achieving California's GHG emissions target by encouraging or requiring certain facilities to undertake GHG emission reductions even when other facilities could achieve additional reductions at lower cost. In addition, depending on their design, some proposals could create differences in GHG allowance prices between regions in California, with allowance prices in regions with more stringent co-pollutant requirements rising relative to regions with less stringent co-pollutant requirements. Given the pass-through of some portion of these costs into the prices of consumer goods, these modifications could raise prices for energy (and energy-intensive goods) in locales or regions with poorer air quality relative to the rest of the state. This potential effect suggests a direct tradeoff between efforts to address local co-pollutants through a cap-and-trade system, and the economic consequences of such efforts. Therefore, careful consideration needs to be given to whether these proposals would, in fact, achieve the desired impacts on GHG co-pollutants, and whether those impacts would be sufficiently large to justify their economic consequences.

The various proposed modifications might be appropriate for a cap-and-trade system that directly regulates the specific GHG co-pollutants of concern, as the modifications might then directly affect GHG co-pollutant emissions in the desired way. But, even cap-and-trade systems directly targeting air pollutants have typically not attempted account for spatial variation in either the reduction costs or environmental and health impacts. One notable exception is the RECLAIM program, which regulates NO_x and SO_x emissions in two zones in the SCAQMD. The RECLAIM program differs in many important respects from a statewide GHG cap-and-trade system. For example, RECLAIM covers only a relatively small number of stationary sources, while a statewide GHG cap-and-trade system would all sources, including

⁴⁸ Such a design would also permit unrestricted banking of allowances, and, subject to particular safeguards, it could also permit borrowing of allowances.

⁴⁹ For example, *see* Coalition for Clean Air (undated); Californians Against Waste *et al.*, April 2008; and Kaswan, March 2008.

⁵⁰ Kaswan, March 2008.

⁵¹ Boyce, August 2009; Coalition for Clean Air (undated); Kaswan, March 2008.

non-stationary (e.g., transportation) sources, in the state.⁵² In addition, RECLAIM regulates emissions at the source, while many GHG emissions under a cap-and-trade system would be regulated upstream or midstream of actual emissions. Thus, developing a "zonal" cap-and-trade system modeled after the RECLAIM program would require many additional modifications to the cap-and-trade system that could greatly increase the cost and complexity of administering the program.

More importantly, by adjusting a GHG cap-and-trade system's design to achieve desired impacts on GHG co-pollutants, the proposed modifications would be targeting co-pollutants emissions indirectly through the highly complex and varied relationships between GHG and co-pollutant emissions. Because of the complex and varied relationships between GHG and co-pollutant emissions, while the proposed modifications would necessarily increase the cost of a GHG cap-and-trade system, they would have highly variable and uncertain impacts on air quality. Consequently, their adoption would represent a significant departure from the existing practice of adopting emission control measures only after careful analysis of their efficacy and of whether or not they represent a cost-effective means of improving air quality.

Potentially compounding these issues, modifications aimed at targeting ancillary benefits in particular locales could lead to unintended consequences both within and outside of the targeted area. While the proposed modifications may, on net, achieve reductions in GHG emissions at targeted facilities, they may inadvertently increase GHG emissions from other sources that are either not subject to or are less affected by those restrictions or conditions. For example, restrictions on allowance use that decrease emissions at one facility will relax the state-wide emission cap and lead to increases in emissions from other sources. Therefore, even if they achieve additional reductions in GHG co-pollutant emissions from some sources, such modifications may lead to increased co-pollutant emissions from other sources. These shifts could even increase emissions at other facilities in targeted locales also subject to restrictions on allowance use, but where those restrictions are not yet binding. Moreover, given the complex and varied relationships between GHG and co-pollutant emissions across emissions sources, it is possible that some of the direct co-pollutant emission reductions that the modifications achieve could be more than offset by indirect increases in co-pollutant emissions that occur in response to those reductions. As we discussed previously, there is reason to be concerned about such a possibility. If GHG emissions shift from more efficient facilities, with low-co-pollutant emission intensity, to less-efficient facilities, with higher emissions intensity, then the outcome of restrictions on GHG allowance use could be a net increase in co-pollutant emissions.

In light of these indirect effects, policymakers would need to consider any offsetting increases in GHG co-pollutant emissions that could result from proposed restrictions or conditions on particular facilities' participation in a GHG cap-and-trade system. In the end, given these indirect effects and the complex and varied relationships between GHG and co-pollutant emissions, any effort to ensure that particular restrictions or conditions achieve their objectives likely would introduce such complexity that it would beg the question of why co-pollutant concerns are not being addressed head on. That is, if the objective of particular modifications to a GHG cap-and-trade system is to improve air quality in the context of implementing AB 32, along with running the risk of being counterproductive in absolute terms, these modifications clearly would be less effective than complementing a GHG cap-and-trade system with separate initiatives specifically targeting the co-pollutants and locations of concern.

⁵² As of 2006, RECLAIM regulated 311 facilities. EPA Clean Markets Division, "An Overview of the Regional Clean Air Incentives Markets (RECLAIM)", Staff Paper, August 14, 2006.

2. Constraints on GHG Offset Credits

In addition to proposing various restrictions or conditions on certain facilities' participation in a California GHG cap-and-trade system, some have also proposed limitations on the use of GHG offset credits in such a system if those credits are generated outside of California. Some have argued for such limitations, at least in part, on the basis that they would enhance the air quality benefits derived from a California GHG cap-and-trade system by requiring more GHG emission reductions within California than would occur without a limit on offsets.⁵³

In assessing such proposals, it is important to emphasize that, even if offset credits are allowed in a California cap-and-trade system, that system can still create a significant incentive for emission reductions within California. For example, while facilities in the European Union's Emissions Trading Scheme (EU ETS) are allowed to use offset credits, those facilities still face a significant incentive to reduce their own emissions, in the form of the EU ETS allowance price, which is equal to about \$20 per ton of CO₂ (as of October 2009).

The use of offset credits would displace only the highest cost emission reduction measures within California that otherwise would be necessary to meet the emissions cap. Because of the difficulty of determining which specific reductions throughout the state would be displaced by offsets and which would not, the effects of any offset limits on air quality would be even less certain and difficult to predict than the other restrictions or conditions described above. At the same time, such limits would necessarily increase the cost of California's cap-and-trade system. Moreover, by increasing GHG emission allowance prices, such limits would increase energy prices in California. Not only would higher energy prices increase the economic impact of climate policy upon California households and businesses (including low-income populations), but it could increase the leakage of GHG emissions from in-state sources to out-of-state sources. Thus, any limits on the use of offsets would not only impose costs on Californians in return for air quality impacts that could not be quantified with any precision, they might also compromise California's efforts to limit global GHG emissions by exacerbating emissions leakage. Consequently, like other proposed restrictions and conditions described above, a policy that seeks to improve air quality by limiting the use of GHG offsets clearly would be inferior to one that places rigorous standards on the quality of offsets but does not restrict their use, and simultaneously pursues air quality improvements through complementary initiatives that specifically target the co-pollutants of concern.

C. Addressing the Economic Dimension of Environmental Justice Concerns

Along with offering an effective means of addressing air quality concerns in the context of implementing AB 32, our proposal also offers an effective means of addressing the economic dimension of environmental justice concerns because it includes a GHG cap-and-trade system as a central element of its design. In addition to minimizing the overall cost of achieving

⁵³ Limitations on the use of offset credits have also been proposed on the grounds that those credits may not represent real, permanent, and additional GHG reductions. If this is the case, their use under a California cap-and-trade system may lead to a net increase in global GHG concentrations. The concern over the quality of offsets is a serious one. However, as two scholars that have been critical of the quality of offset credits in the Clean Development Mechanism describe, the appropriate solution to this concern is not to limit the use of offset credits, but rather to establish standards that ensure their quality. Michael Wara and David Victor, "A Realistic Policy on International Carbon Offsets," *Stanford University Program on Energy and Sustainable Development*, Working Paper no. 74, April 2008, p. 20.

California's GHG emissions target, a GHG cap-and-trade system can also give policymakers significant flexibility to control how the economic impacts of climate policy are distributed across households.

Through their decisions about how to distribute emission allowances or the revenue generated from auctioning some of those allowances, policymakers can take steps to mitigate the economic impacts that climate policy would otherwise have on low-income households. For example, they could use some allowances or auction revenue to fund energy assistance programs or energy efficiency investments, or to reduce the overall tax burden faced by low-income households.⁵⁴ In fact, allowance allocation decisions need not be limited to addressing the economic dimension of environmental justice concerns. Some allowances or auction revenue could be directed toward funding or creating incentives for measures designed to improve air quality or health services in particular communities of concern.

If policymakers determine that they would like to target ancillary benefit goals beyond the co-pollutant reductions AB 32 is anticipated to achieve, use of auction revenue to fund such measures (as described above) would be a significantly less costly approach than the modifications to a GHG cap-and-trade system that have been proposed to achieve these goals. For example, if restrictions or limitations on allowance use were avoided by using auction revenues to target local air quality problems (or respond to any adverse conditions that might arise from AB 32 policies), then potentially costly and complex modifications to the cap-and-trade system affecting the entire state could be avoided.

D. A Historical Precedent: The Clean Air Act Amendments of 1990

The general approach outlined above has a noteworthy historical precedent: the federal Acid Rain Program under Title IV of the Clean Air Act Amendments of 1990, which established a cap-and-trade system for SO₂ emissions from power plants. By the early 1980s, it had become clear that additional regulations were needed to reduce SO₂ emissions from existing coal-fired power plants. Yet, a key concern in the development of policies to reduce SO₂ emissions was the localized impact that such policies could have on certain coal mining communities. This concern arose from the fact that one of the more cost-effective means of reducing SO₂ emissions involved switching from high-sulfur coal, which was primarily produced in Appalachia and the Midwest, to low-sulfur coal, which was primarily produced in the West. As a result, for several years, competing policy concerns undermined several attempts to adopt new regulations that would achieve the needed emission reductions.

The Clean Air Act Amendments of 1990 struck a balance between these competing policy concerns by adopting a cost-effective SO₂ cap-and-trade system and complementing that system with a separate narrowly targeted measure to mitigate impacts on coal miners.⁵⁵ In particular, while the cap-and-trade system gave regulated entities the flexibility to seek out and implement the least costly emission reduction measures, including switching to low-sulfur coal, the Amendments also established the Clean Air Employment Transition Assistance (CAETA)

⁵⁴ For a discussion of these and other approaches to mitigating economic impacts on low-income households, see Congressional Budget Office, June 2008.

⁵⁵ For discussions of the development of this cap-and-trade system, and the political context in which it emerged, see John Buntin, "Cleaning up the 'Big Dirties': The Problem of Acid Rain," Kennedy School of Government Case Program C15-99-1514.0, 1999; and Paul Joskow and Richard Schmalensee, "The Political Economy of Market-Based Environmental Policy: The U.S. Acid Rain Program," *Journal of Law and Economics* 41, no. 1 (1998): 37-83.

program, which provided assistance to displaced coal miners as well as any other workers displaced by their firm's compliance with the Clean Air Act. In addition, Congress used decisions about how to allocate allowances under the cap-and-trade system as another opportunity to address particular localized distributional concerns. For example, one "bonus" allocation provision provided additional emission allowances to utilities in Ohio, Indiana, and Illinois – three of the states expected to bear much of the emission reduction costs that were necessary to meet the national emissions cap.

Thus, an approach much like that which we have proposed for California ended an impasse in Washington that had delayed air quality improvements for years. Today, the Acid Rain Program is widely viewed as one of the most successful U.S. environmental policies of the past four decades, having achieved a 40 percent reduction in power plant SO₂ emissions from 1990 levels, and having brought about those reductions much faster than was anticipated.⁵⁶

VII. Conclusion

Environmental justice concerns deserve serious consideration in the implementation of any major environmental policy, and climate policy is no exception. Yet, contrary to the impression given by some discussions of those concerns, California need not choose between addressing environmental justice concerns and implementing a GHG cap-and-trade system that could cost-effectively achieve California's GHG emissions target. Rather, a GHG cap-and-trade system can, in fact, play a central role in a climate policy that cost-effectively reduces California's GHG emissions while effectively addressing environmental justice concerns.

One of the key environmental justice concerns relates to capitalizing on the opportunities that climate policy may present to reduce GHG co-pollutants, such as criteria and toxic air pollutants, and addressing any potential risks that climate policy may pose through its impacts on those co-pollutants. Yet, the relationship between GHG emissions and GHG co-pollutant emissions is far more complex and varied than the term "co-pollutant" might suggest. Moreover, unlike the benefits from reducing GHG emissions, the benefits from reducing GHG co-pollutant emissions can vary substantially depending on where and when those reductions occur. Therefore, environmental justice concerns about co-pollutant impacts can best be addressed by an approach that pairs a GHG cap-and-trade system designed to minimize the cost of reducing GHG emissions with complementary policies that specifically focus on the potential opportunities and risks associated with climate policy's impacts on air quality. In turn, such complementary policies would be most effective if they are implemented within the existing regulatory framework for criteria and toxic air pollutants. This can be accomplished by systematically accounting for the ancillary benefits of GHG reductions in developing and revising criteria and toxic air pollutant regulations. Particularly given that a regulatory framework for criteria and toxic air pollutants is already in place, such an approach offers a means of addressing GHG co-pollutants that would be far more efficient, effective, and targeted than any effort to address those co-pollutants indirectly through GHG regulations.

Through its use of a GHG cap-and-trade system, this approach would also give policymakers the opportunity to use the distribution of emission allowances or allowance auction revenue as a means of mitigating climate policy's economic impact on particular communities, and even as a means of encouraging or funding particular efforts to address localized air quality and health concerns. Thus, the approach that we have outlined in this

⁵⁶ U.S. EPA, *Acid Rain and Related Programs: 2006 Progress Report*, 2007, EPA-430-R-07-011, pp. 3-4.

paper could effectively address both the environmental and economic dimensions of environmental justice concerns while minimizing the cost of achieving California's GHG emissions target.