September 19, 2016

Via Electronic Filing on ARB Website

Mary Nichols, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Comments on Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market Based Compliance Mechanisms

Dear Board Chair Nichols:

On behalf of the undersigned environmental justice and environmental organizations, we submit these comments on the Proposed Amendments to the California Cap on Greenhouse Gas Emissions and Market Based Compliance Mechanisms (hereafter "Proposed Amendments"). The environmental justice groups and community organizations listed below work directly with low-income residents and residents of color who are disproportionately impacted by industrial pollution, toxic air emissions, and climate change. We do not support Cap and Trade because it places unjust burdens on low-income communities and communities of color. Climate change solutions must protect all Californians, starting with those already overburdened by air pollution and climate change.

Cap and Trade ignores the reality that location matters and disproportionately harms communities of color and low income communities. Reductions of greenhouse gases on-site reduce co-pollutants, such as fine particulate matter (PM2.5) and air toxics, emitted into the surrounding community – a benefit that is forgone when that facility buys allowances or offsets. At worst, co-pollutants increase when a facility increases its greenhouse gas pollution. Over two-thirds of California's low-income African Americans and about 60% of low-income Latinos and Asian/Pacific Islanders live within six miles of a Cap and Trade facility.[1]

Cap and trade is like a house built on a foundation of sand. The recent collapse of the allowance market, with a vast oversupply of allowances, exposes the inadequacy of Cap and Trade where so much of the "reductions" have occurred through heavy use of offsets (mostly out of state) and changes in imported electricity. *See* Section I, *infra*. Further, refinery emissions data show increased emissions in several communities during the first compliance period[2] while many of those refineries are among the Top-10 users of those offsets.[3] All of this comes at the undeniable expense of those communities living amongst these major sources of greenhouse gas and co-pollutant emissions.

The State Board should not continue the Cap and Trade Program post-2020 and should instead institute a program of direct emissions reductions that will benefit the health and welfare of California communities. Assembly Bill 32 limited the State Board's authority to implement Cap and Trade by codifying a sunset date for the program. Furthermore, the Legislature in Senate Bill 32 directed the State Board to ensure that disadvantaged communities benefit – not suffer – from climate policy. The State Board "shall achieve the state's more stringent greenhouse gas emission reductions *in a manner that benefits* the state's most disadvantaged communities and is transparent and accountable to the public and the Legislature." Stats. 2016, ch. 249, § 1, subdivision (d), p. 88 (emphasis added). In Assembly Bill 197, the Legislature directed the State Board to *prioritize* direct emissions reductions.

The threats posed by climate change to our health, communities and livelihoods are permanent and real, and so must our efforts to stop these threats be permanent and real. Cap and Trade, with pollution trading and heavy use of questionable and mostly out-of-state offsets cannot accomplish this objective. The facts unequivocally demonstrate that Cap and Trade, with all of its loopholes, distortions, and exceptions does not "work" and does not reflect the kind of equitable and just approach we need to solve our climate problems. The State Board's goals of low-cost and flexibility should never trump environmental justice values or the collective statutory schemes of AB 32, SB 32, and AB 197, all of which call for climate policy with environmental justice at its core.

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[1] Manuel Pastor, *et. al*, Minding the Climate Gap (2010) at 9, Figure 2, attached as Exhibit 1.

[2] California Environmental Justice Alliance, Summary of Refinery Emissions Data, attached as Exhibit 2.

[3] California Environmental Justice Alliance, Top 10 Offsets Users in California, available at http://caleja.org/2016/02/stop-redd-from-harming-communities-locally-and-globally/

I. Cap and Trade Implementation Data Indicate Communities of Color are Adversely and Disproportionately Affected.

Last week, the California Environmental Justice Alliance released a report assessing the inequalities in the location of greenhouse gas-emitting facilities and the amount of greenhouse gases and particulate matter ("PM10") emitted by facilities regulated under Cap and Trade.[4] The report also provides a preliminary evaluation of changes in localized greenhouse gas emissions from large point sources since the advent of the program. The report found:

1. On average, neighborhoods with a facility within 2.5 miles have a 22 percent higher proportion of residents of color and 21 percent higher proportion of residents living in poverty than neighborhoods that are not within 2.5 miles of a facility.
2. These communities are home to a higher proportion of residents of color and people living in poverty than communities with no or few facilities nearby. Indeed, the higher the number of proximate facilities, the larger the share of low-income residents and communities of color.
3. The neighborhoods within 2.5 miles of the 66 largest greenhouse gas and PM10 emitters have a 16% higher proportion of residents of color and 11% higher proportion of residents living in poverty than neighborhoods that are not within 2.5 miles of such a facility.
4. The first compliance period reporting data (2013-2014) show that the cement, in-state electricity generation, oil & gas production or supplier, and hydrogen plant sectors have increased greenhouse gas emissions over the baseline period (2011-2012).
5. The amount of emissions "offset" credits exceed the reduction in allowable greenhouse gas emissions (the "cap") between 2013 and 2014 and were mostly linked to projects outside of California.

The report raises significant concerns and discloses new data that should foreclose the Air Board from extending the Cap and Trade program. The report demonstrates three fundamental points that environmental justice advocates have raised for years: (1) Cap and Trade disparately affects communities of color; (2) Cap and Trade denies communities the benefits of on-site reductions; and (3) greenhouse gas reductions attributed to Cap and Trade occur primarily outside of California.[5] It concludes:

> Preliminary analysis of the equity and emissions impacts of California's cap-and-trade program indicates that regulated GHG emission facilities tend to be located in neighborhoods with higher proportions of residents of color and those living in poverty. There is a correlation between GHG emissions and particulate matter levels, suggesting a disparate pattern of localized emissions by race/ethnicity and poverty rate. In addition, facilities that emit the highest levels of both GHGs and particulate matter are similarly

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[4] Lara J. Cushing, *et al.*, A PRELIMINARY ENVIRONMENTAL EQUITY ASSESSMENT OF CALIFORNIA'S CAP AND TRADE PROGRAM, attached as Exhibit 3.

[5] Claimed reductions from imported electricity generation remain suspect given the State Board's creation of safe harbor exemptions from the resource shuffling prohibition, which allow greenhouse gas emissions to continue in fact as leakage. *See* Danny Cullenward, BULLETIN OF THE ATOMIC SCIENTISTS, 2014, Vol. 70(5) 35–44, attached as Exhibit 4.

> more likely to be located in communities with higher proportions of residents of color and those living in poverty. This suggests that public health and environmental equity co-benefits could be enhanced if there were more GHG reductions among the larger emitting facilities that are located in disadvantaged communities. Currently, there is little in the design of cap-and-trade to insure this set of localized results. Moreover, while the cap-and-trade program has been in effect for a relatively short time period, preliminary evidence suggests that in-state GHG emissions from regulated companies have increased on average for several industry sectors and that many emissions reductions associated with the program were located outside of California. Large emitters that might be of most public health concern were the most likely to use offset projects to meet their obligations under the cap-and-trade program.[6]

The State Board has to date not taken action to assess or prevent these impacts, and instead has consistently demonstrated its intent to prevent the public from accessing facility-specific climate data. When promulgating the Cap and Trade regulations in 2011, the State Board claimed that it would assess and prevent adverse impacts through an Adaptive Management Plan. The Initial Statement of Reasons ("ISOR") admits that to date, the State Board has not finalized or implemented the Adaptive Management Plan. ISOR at 302. Moreover, the State Board has taken the position that the public may not access critical Cap and Trade compliance and trading data, claiming that compliance with Cap and Trade constitutes "confidential business information."[7]

II. The State Board has no Authority to Extend Cap and Trade after 2020.

The State Board lacks authority to act on these proposed regulations. Staff propose amendments to various provisions of the Cap and Trade regulations to extend the program beyond the year 2020. *See, e.g.* ISOR at 149 (describing changes to section 95841 to establish allowance budgets for the years 2021 to 2050); ISOR at 299 (describing Appendix C to set dates for auctions and reporting for the years 2021 to 2050). A fundamental principle of administrative law dictates that agencies only have those powers delegated by the Legislature. The State Board's authority to implement the Cap and Trade program expires on December 31, 2020 and the Board has no authority to adopt regulations to extend the program beyond that date. Health & Safety Code §§ 38562(c), 38570.

ARB staff have claimed that AB 32 authorizes these regulations because of language in Part 3 of AB 32 related to the statewide greenhouse gas limit (the level of emissions in 1990). "It is the intent of the Legislature that the statewide greenhouse gas emissions limit continue in existence and be used to maintain and continue reductions in emissions of greenhouse gases beyond 2020." Health & Safety Code § 38551(b). Grasping on to the words "continue reductions," the staff believe they can extend Cap and Trade to 2030 and then all the way to 2050. This provision, however, must be understood in the context of the statutory scheme as a whole. The very next subsection of section 38551 directs the State Board to make recommendations to the Governor and the Legislature on how to continue reductions, and does not give the State Board the authority to take those actions *sua sponte*. "The state board shall make

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[6] Lara J. Cushing, *et al.*, A PRELIMINARY ENVIRONMENTAL EQUITY ASSESSMENT OF CALIFORNIA'S CAP AND TRADE PROGRAM at 7-9, attached as Exhibit 3.
[7] *See, e.g.* Email from Edie Chang to Brent Newell, dated August 19, 2015, attached as Exhibit 5.

recommendations to the Governor and the Legislature on *how* to continue reductions of greenhouse gas emissions beyond 2020." Health & Safety Code § 38551(c) (emphasis added).

Nor has the Legislature acted to extend the State Board's authority. During the 2015 legislative session, the version of Assembly Bill 1288 (Atkins) containing an extension of the State Board's authority to implement Cap and Trade beyond December 31, 2020 did not become law. During the 2016 legislative session, Senate Bill 32 became law and requires the State Board to achieve a 40 percent reduction in greenhouse gas emissions below 1990 levels by 2030. Stats. 2016, ch. 249, § 2, p. 88 (codified as Health & Safety Code § 38566). No provision of Senate Bill 32 amended section 38562(c) or otherwise authorized the State Board to implement Cap and Trade after the year 2020. Accordingly, the State Board lacks the authority to adopt the Proposed Amendments and should not proceed absent direction from the Legislature.

III. The State Board Must Prioritize Direct Emissions Reductions.

Assembly Bill 197 recently became law and expressly directs the State Board to prioritize direct emissions reductions at large stationary sources. The ISOR rejects direct emissions reductions in favor of Cap and Trade without any effort to identify or prioritize those regulatory strategies. ISOR at 306-307. The State Board has no authority to disregard direct emissions reduction strategies for the purposes of meeting the additional reductions required by Senate Bill 32. Rather, the Board must prioritize "emissions reduction rules and regulations that result in direct emission reductions at large stationary sources of greenhouse gas emissions[.]" Stats. 2016, ch. 250, § 5, subdivision (a), p. 92 (codified as Health & Safety Code § 38562.5(a)). The State Board may not proceed with the Proposed Amendments, which plainly do not comport with AB 197.

IV. The State Board may not rely on Cap and Trade for Compliance with the Clean Power Plan.

The ISOR reflects staff's proposal to use the post-2020 Cap and Trade program as the compliance demonstration for the Clean Power Plan. ISOR at 12. Further, staff propose a state measures plan, which means that the Cap and Trade program will be used for compliance purposes but not itself be federally enforceable. ISOR at 22. The Clean Power Plan allows states to submit a "state measures" plan, but that plan must meet the same integrity elements as federally enforceable measures. 80 Fed. Reg. 64662, 64836/2 (Oct. 23, 2015). California must demonstrate "adequate legal authority and funding to implement the state plan and any associated measures." *Id.*; *see also* 80 Fed. Reg. at 64848/3; 40 C.F.R. § 60.5745(a)(9). For the reasons set forth above in Section II, the State Board has no legal authority under state law to implement Cap and Trade after 2020 and therefore may not use Cap and Trade as a means for compliance with the Clean Power Plan.

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V. Conclusion

The recent report highlights the disparity and impacts of the current Cap and Trade Program. Rather than perpetuate this injustice, we urge the State Board to reject the Proposed Amendments extending the Cap and Trade program beyond 2020. Thank you for your time and courtesy.

Sincerely,

Brent Newell
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Center on Race, Poverty & the Environment

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Dr. Adrienne L. Hollis, Esq.
Environmental Justice Leadership Forum
on Climate Change

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Exhibit 1

Minding the Climate Gap

What's at Stake if California's Climate Law isn't Done Right and Right Away

Manuel Pastor, Ph.D. | Rachel Morello-Frosch, Ph.D., MPH | James Sadd, Ph.D. | Justin Scoggins, M.S.

Acknowledgments

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Introduction

The California Global Warming Act (AB 32) – a cutting edge policy that no one expected to pass so quickly and with so much bipartisan support – proposes to cut green house gas emissions to 1990 levels by 2020. The successful implementation of such a standard would mean reducing carbon emissions from major polluters around the state – cement refineries, power plants, and oil refineries top among them. It's a clear victory for all Californians, it would seem – but the underlying picture may be a bit more complicated.

As we have shown in a recent report entitled *The Climate Gap* (Morello-Frosch, et al. 2009), climate change is not affecting all people equally: communities of color and low-income communities suffer the greatest negative health and economic consequences. Among the many disparate impacts, these communities are more vulnerable to heat incidents, more exposed to air pollution, and may be more affected by the economic dislocations of ongoing climate change.

While reducing greenhouse gas emissions will benefit all Californians, a carbon reduction system that does not take co-pollutants into account could likely result in significantly varying benefits for different populations. Those who are most likely to suffer the negative consequences of a short-sighted carbon trading system are the communities of color and the low-income communities already facing the greatest impacts of climate change – widening instead of narrowing the climate gap.

Consider the La Paloma power plant and the Exxon Mobil refinery in Torrance. The La Paloma power plant sits about 35 miles west of Bakersfield in an abandoned oil field just outside the small town of McKittrick (population 160) with less than 600 residents in the surrounding six miles, and no other facilities in the immediate vicinity. The Exxon Mobil refinery, on the other hand, is one of many facilities affecting nearly 800,000 people in the encircling six miles. While these facilities share one similarity – according to recently released 2008 GHG emissions data from the California Air Resources Board, they both emit between 2.5 and 3 million tons of carbon dioxide each year – La Paloma releases 48.6 tons of asthma and cancer causing particulate matter per year while Exxon Mobil emits 352.2 tons. This staggering health risk is important to people who live in Torrance's dense neighborhoods, yet this fact is often ignored in the debates about how we might best implement AB 32.

Why is the difference between reducing emissions at La Paloma and in Torrance overlooked in the discussion about mitigating climate change? Part of the reason is that too much of the discussion stays at the macro-level: climate change is imagined as ozone layer erosion, heat waves, and sea level rises. So while the catastrophic potential of climate change is well documented, the story of the climate gap – the often unequal impact the climate crisis has on people of color and the poor in the United States – is just starting to be told. Until recently, systemic efforts to combat climate change have focused primarily on reducing carbon with little, if any, regard for where the reductions take place and who they might affect. In this view, reducing greenhouse gas emissions – no matter where it occurs – is the central objective of policy change.

People, however, do live somewhere – and it is at the local and not the macro level where changes from new policy will be most immediately felt. When smoke stacks in low-income communities belch less carbon, they also emit less particulate matter, sulfuric oxides, and nitrous oxides. When truck operators retrofit their units to reduce emissions, children's asthma rates are likely to fall along the traffic corridors that they impact. Paying attention to the climate gap – focusing on the co-pollutants and the potential co-benefits of greenhouse gas reductions – is important for public health. And lifting this issue up can give California not only a chance to address its historic pattern of environmental inequity but also the opportunity to implement a climate change policy that will be replicated throughout the nation.

Additionally, the economic opportunity that could be realized by reducing air pollution in dense neighborhoods is also enormous. All Californians are affected by higher insurance premiums, medical costs and lost productivity due to the many illnesses caused by air pollution, and all stand to benefit from an equitable system that would work toward minimizing these costs as opposed to adding to this growing burden. Not only does it make economic sense, but the text of AB 32 itself also requires CARB in designing any market-based mechanisms for GHG reductions to consider the localized impacts in communities that are already impacted by air pollution, prevent any increase in co-pollutants, and maximize the co-benefits of co-pollutant reductions.[1]

This report seeks to analyze co-pollutants and co-benefits, with an eye toward thinking through policy designs that could help maximize public health and close the climate gap. We begin below by discussing why geographic inequality in greenhouse gas (GHG) reduction is likely under any market-based scheme and why it matters for public health. We then describe the necessary baseline for any analysis, indicating how some major facilities that emit significant GHGs – power plants, petroleum refineries, and cement plants – affect their neighbors, and who (and how many) those neighbors are. We then take on a trickier task: assessing the potential impacts of a cap-and-trade program in California. Because we cannot see into the market's future, we take a simpler approach: we identify which industries and their associated facilities are driving environmental inequity, and use this to suggest how policy-makers could take this into account in fulfilling AB 32's requirement to both reduce overall emissions *and* protect climate gap neighborhoods.

AB 32 has heralded a new era of regulatory action to reduce greenhouse gas emissions, and California finds itself once again leading the country in the area of environmental protection. As proud as we should be of that, we must be mindful that the state is deeply plagued by issues of environmental inequity, and that if our new climate change regulations are not designed to address the growing climate gap, the suffering of those who bear the brunt of this burden may grow. Numerous studies demonstrate that air pollution burdens tend to fall disproportionately on those who are the least privileged and the most vulnerable. We do not need to perpetuate and worsen this trend. Instead, we can lift up issues of public health and fair environmental policies to ensure that the implementation of AB 32 is a success for all Californians and a model for the nation and a world looking for viable paths to environmental, social and economic sustainability.

The Problem

California is at the forefront of dealing with climate change, by setting new standards, driving toward energy efficiency, encouraging renewables, and even working to rebalance the mix of land uses and transportation that have produced our well-documented sprawl. Within the context of our myriad efforts, the state has committed to the development of a "cap-and-trade" system in which GHG emissions from the facilities of certain polluting industries would be capped and emissions permits or "allowances" would be allocated (through auction, a fee, for free, or otherwise) to create a market for carbon emissions. In such a system, once the allowances are distributed for any compliance period, emitters of greenhouse gases whose emissions exceed their allowances may purchase allowances from other facilities – those who are reducing emissions beyond their own goals – rather than taking on the cost of reducing emissions from their own facilities. Another option, though highly controversial, is that they could cover their excess GHG emissions through the purchase of "offsets," which are basically projects or activities that yield a net GHG emissions reduction for which the ownership of the reduction can be transferred.

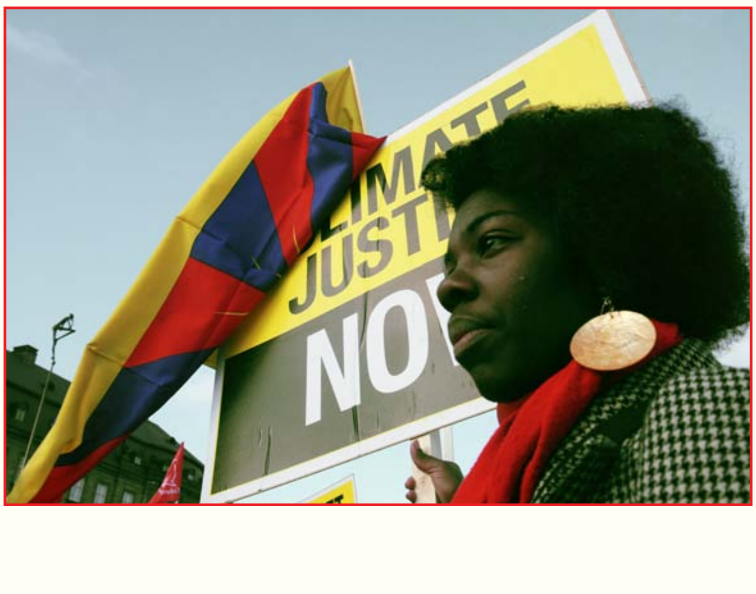
The arguments for cap-and-trade revolve around a narrow concept of industrial efficiency – if it is less costly for some firms to meet reduction goals, they should move first and fastest, and this will reduce the overall burden of compliance and perhaps speed the attainment of stricter GHG emissions targets overall (i.e. “the cap”). Some also argue that such a system could encourage technological innovation as firms seek to either buy fewer permits or chase the profit opportunities inherent in reducing their own emissions and offering their unused permits to other firms that cannot reduce as quickly. In this view, the market is being harnessed for public good, with the incentive structure providing businesses a positive reason to participate in making the intentions of AB 32 real as well as the flexibility to meet goals.

Opponents of cap-and-trade worry that enforcement of such a market system is not feasible and that the market will inevitably be gamed, leading to a sinkhole of financial resources with little regulatory oversight; opponents point to the subprime mortgage crisis and the recent economic meltdown as examples of trading markets that went haywire with little accountability. Others have noted that some experiences with cap-and-trade, as in the early implementation in the European Union, did not lead to significant GHG reductions. Still others object to program design, particularly the notions of handing out allowances *gratis* to polluting firms – something that is *de facto* a mass transfer of wealth from the general public to private polluters – and the use of offsets, which could displace actual emissions reductions in California through, for example, slowing deforestation somewhere across the globe.

While these are legitimate concerns this report explores a more limited and focused issue: whether or not implementation of cap-and-trade in California might fail to capture public health benefits, or even make an already inequitable situation worse, thereby failing to maximize the social good to the same extent that might be obtained from a different or better-designed system.

To see this, it is important to recognize that cap-and-trade is inherently unequal. The cap part is, of course, equal: everyone gains from a regional reduction in GHG and the slowdown in climate change that might be induced. But the trade part is inherently unequal – or why would anyone trade? Indeed, trading is justified on the grounds that reducing pollution is more efficient in some locations compared to others, and thus *where* reductions will occur is a decision such a system leaves in the hands of the market and businesspeople – neither of which have any incentive to lower emissions in order to benefit the low-income and minority communities hit hardest by concentrated pollution.

Some argue that the location of the emissions reduction is not important – reductions in GHG benefit the planet no matter where they occur. But since GHG emissions are usually accompanied by releases of other pollutants, there could be very different impacts on the health of residents living near plants that choose, under cap-and-trade, to either reduce emissions or purchase their way out of that requirement. Therefore, the reductions made at the lowest marginal price might be efficient in



terms of the costs and benefits to the industrial economy, but would likely be enormously inefficient in a real sense if they fail to completely account for all external costs such as health impacts. Any carbon trading plan blind to the effects of co-pollutants would be deeply flawed in ignoring significant health impacts and the associated costs, such as the economic burden that could be shifted to other sectors, such as the healthcare system.

This public health concern has been among the arguments made by members of the Environmental Justice Advisory Committee (EJAC) – a group made up of leaders representing the communities most impacted by pollution in the state and itself a product of the AB 32 legislation intended to advise the California Air Resources Board (CARB). EJAC has, among other things, been concerned that the Scoping Plan for AB 32 calls for a cap-and-trade regulatory mechanism, which on its own, has no way to ensure the protection or improvement of environmentally degraded or stressed neighborhoods.

The public health issue arises in part because while cap-and-trade tries to price in one externality – carbon and other GHG emissions – it does not price in all externalities, including the health and other impacts of co-pollutants. While quantifying such economic externalities is not our focus, Groosman et al. (2009) have found the health co-benefits alone from co-pollutant reductions due to a nationwide cap on carbon emissions *may be greater than the cost of making such reductions itself* – without even considering the large-scale benefits of slowing climate change. In a study of the co-benefits of carbon emissions reductions in the European Union, Berk et al. (2006) reached similar conclusions.

There are reasonable arguments that other regulations, such as the Clean Air Act, can tame co-pollutant emissions and that one does not want to overload a new carbon trading system. Yet it is not clear why the introduction of a whole new market in carbon trading is not in and of itself sufficiently complicated that building in a few safeguards to protect stressed communities would be the straw that breaks the regulatory camel's back. Moreover, given the well-founded skepticism of existing regulations that is held by many Environmental Justice (EJ) communities based on historical experiences, it is also not clear why the inclusion of safeguards would not make political sense as well.

Of course, whether one wants to think about such safeguards at all depends on whether or not a market system actually does have the realistic potential to introduce uneven benefits in public health – and the rest of this document is devoted to assessing whether such a scenario is possible. Thus, we need to investigate the current distribution of plants with regard to race, income and population density in order to see whether this is a concern worthy of public policy (and not just academic) consideration. Although we believe it is, we would also offer a few caveats to the case we will make.

First, some have dismissed concerns around uneven emissions reductions, arguing that because of other regulations, cap-and-trade will never produce "hot spots" – that is, places where emissions of both GHG and co-pollutants actually increase (an outcome that actually occurred in Southern California, for example, in a poorly designed system that allowed NO_x emissions trading between mobile and stationary sources, and led refineries to purchase and decommission "clunkers" rather than clean up near fenceline communities; see Drury, et al. 1999). Thus, any form of trading should meet the limited requirement in AB 32 that any market system should "prevent any increase in the emissions of toxic air contaminants or criteria air pollutants."[2]

We do think that there is a possibility of "hot spots," particularly if plants below current regulatory emissions requirements for co-pollutants might eventually be sunsetted and so operators step up production (and emissions) in the interim (just as one might run an aging appliance past its prime knowing that it will soon be replaced). This is by no means an extreme view: the potential for "hot spots" is acknowledged by some who are against imposing any sort of health- or EJ-based constraints on the cap-and-trade system. Schatzki and Stavins (2009), for example, argue for mechanisms to address EJ concerns over cap-and-trade that are external to the the sytem itself (and particularly stress the use of traditional regulations for co-pollutants) but do concur that cap-and-trade could lead to an increase in local co-pollutant emissions, even if there is a net reduction statewide. However, we do not contend that this is the most likely outcome and believe that the main problem is one of missed opportunity: that we will fail to achieve and target public health benefits from GHG reductions in the communities that need them the most.

Second, while we focus here on cap-and-trade, the concerns we raise are equally applicable to the carbon fee system proposed by some cap-and-trade opponents. Although regulatory oversight is more straightforward in a fee-based system, here too, polluters can decide whether to reduce emissions or pay to pollute. We focus on cap-and-trade because it is the primary mechanism being discussed on both the state and federal policy agendas. The issues raised here are relevant to the potential gaps left by any market-based tool – cap-and-trade, carbon fee or a hybrid – and CARB must assess the potential for market-based mechanisms to worsen existing public health disparities before it develops such a regulatory framework.

Finally, we are *not* suggesting that considering inequitable health impacts in the development of a market-based carbon reduction plan is the only (or even the most important) piece of the puzzle in addressing the “climate gap”. There are many other areas of concern – such as the economic impacts on consumers, the job opportunities for low-skill workers, the role of urban heat islands, and the nature of our logistic and social preparation for extreme weather events. Still, we think that the public health piece is an important component within a larger climate justice debate.

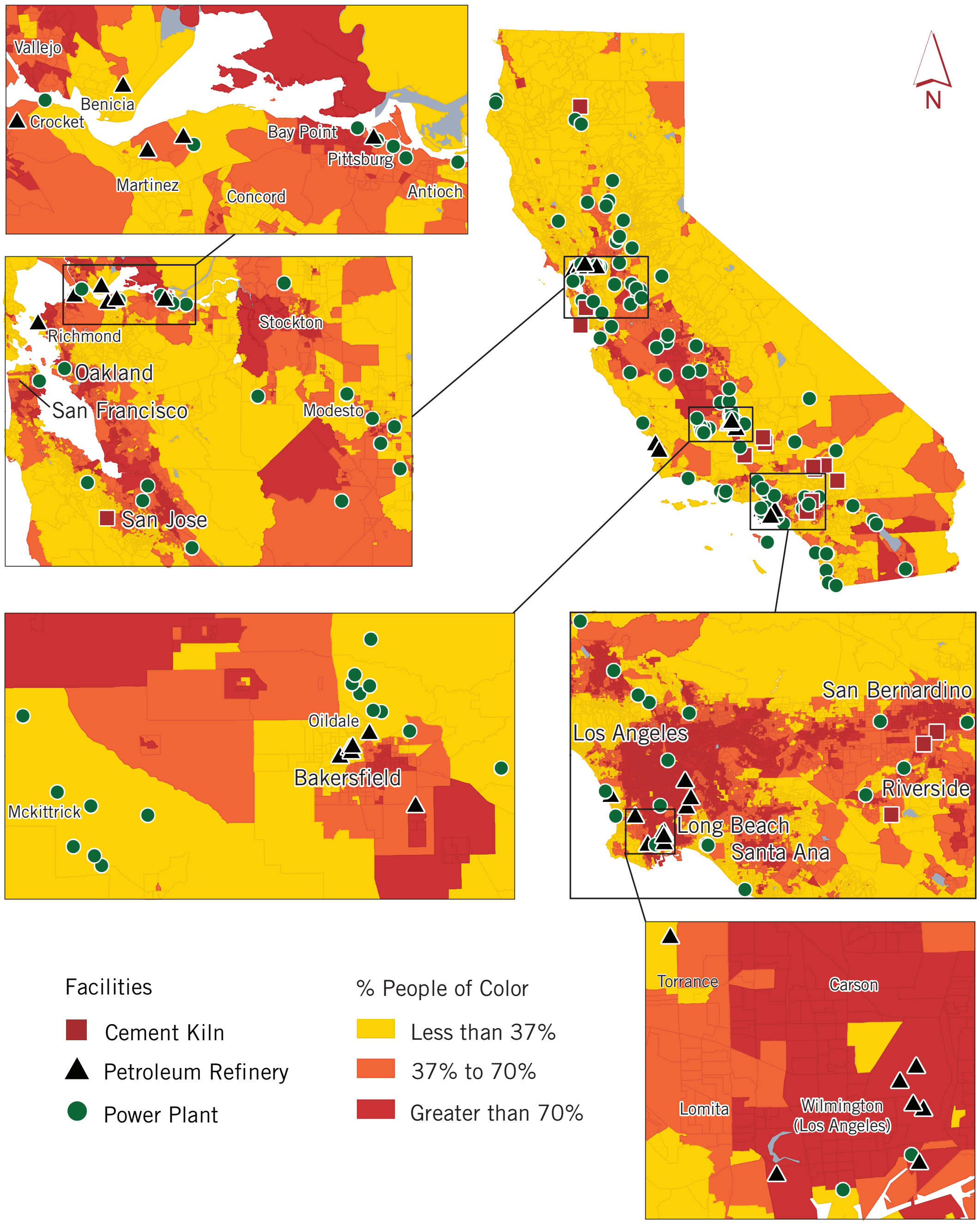
The Data

To connect climate change indicators with neighborhood disparities, we combined several data sources. We specifically performed GIS spatial analysis using demographic and emissions data, working down to detailed neighborhood measures needed to understand local health impacts.

Following a method developed by the Natural Resources Defense Council (NRDC) (Bailey et al. 2008), we pulled together emissions data on industries that are known to emit large quantities of CO_2 – petroleum refineries, cement plants, and power plants.[3] Together, the facilities included in our analysis from these sectors account for about 20 percent of the state’s GHG emissions and will be the first group to come under regulation. We extracted data from two sources: the 2006 CARB Emissions Inventory[4] for information on co-pollutants (NO_x and PM_{10}) and the 2008 GHG emission from CARB’s first annual release under the state’s mandatory GHG Reporting Program.[5] The power plant data only includes those oil and natural gas plants who reported to the California Energy Commission (CEC) in 2007 that they produced at least 50 online megawatts, and all other plants that may not have met that criteria but were either coal-fired or among the top 20 polluters of nitrous oxides (NO_x), particulate matter (PM_{10}), or carbon dioxide equivalent (CO2e). Petroleum refineries and cement plants data are from 2006, and the resulting overall dataset includes 146 facilities, once restricted to those for which co-pollutant emissions information could be obtained from a total of 154 facilities considered. This set of facilities overlaid on racial demographics can be seen in Figure 1.

The process of attaching emissions to the facility location is similar to that followed by NRDC using an earlier version of the data to understand the regional health benefits of reducing emissions from these sources. Because we were interested in local health impacts, we conducted two additional steps in the preparation of this new iteration of the data.

Figure 1: Major GHG-Emitting Facilities in California



First, we used a variety of means to verify the address locations of the facilities indicated in the databases – a vital step since the purpose here is to consider local effects. While addresses were provided in the CARB Emissions Inventory for all facilities, these didn't always match the actual locations, sometimes because they were for the company headquarters instead of the actual refinery or plant. To determine correct locations, we cross-referenced the addresses given by CARB Emissions Inventory with data from the GHG Reporting Program, the CEC power plants database, and a dataset of facility locations from the U.S. Environmental Protection Agency (EPA), which provided geographic coordinates in addition to addresses, and then used aerial imagery[6] in Google Earth to visually confirm that the deduced coordinates were correct; in cases where they were not, we used the air photos to first find the facilities and then derive a set of coordinates that matched the emissions source at the facility. For a few facilities that seemed to be nowhere near their given coordinates or given address, we found their actual physical location through web-research, official documentation (e.g. permit history), and making phone calls to the parent companies.

Second, we verified NRDC's calculations of how the facilities impact the health of their neighbors, and updated it with more recent, 2006 data. NRDC researchers had created a "health impacts index" (for the formula, see the Technical Appendix) that quantifies, using health endpoint factors, how each facility's NO_x and $PM_{2.5}$ emissions increases premature mortality in the region, or more specifically, the local air basin.[7] The index is quite useful as a broader geographic measure of health impacts posed by a facility. At smaller scales, it must be used carefully. We use it in combination with population-weighted NO_x and PM_{10} emissions at varying distances from a facility for facility level analysis. For neighborhood level analysis, we use only proximity at various distances along with total co-pollutant emissions as indicators of health risk or burden.

We then gathered demographic and socioeconomic data on the neighborhoods surrounding facilities, using the 2000 Census data (Summary Files 1 and 3). We used block groups as the unit of analysis because it is the lowest level at which income information is available. Block groups consist of some number of similar blocks and in California have an average population of about 1,500. They are drawn to represent fairly homogenous populations in terms of demographic and economic characteristics, making them a good approximation of a neighborhood. They are more geographically detailed than census tracts, which are the next higher level of geographic aggregation in the census, and less detailed than census blocks, which are the lowest level of geography but one at which only basic demographic information is available.

Matching people in block groups with facilities is complicated. Facility addresses are a single point on a map but block groups are polygonal "aerial units" – that is, they have dimension. Thus, there are many instances in which a block group is only partially contained within a given distance of a facility (e.g., with a portion that is within one mile of a facility but with the remainder more than one mile away from that facility). A further complication is that block groups do not have evenly distributed populations – just think of a typical neighborhood wherein there might be several residential blocks adjacent to a mini-mall. Given that proximity is a central component to how co-pollutants affect people's health, how do we determine a definite measure of proximity?

We settled this dilemma in two ways. First, we considered where people were situated within each block group, attempting to gauge how many were within the specified distance of a facility, and second, we varied these distances to test the sensitivity of our measurements. On the first consideration, we created circular buffers around each facility and used them to capture census blocks – the components of block groups – to determine neighborhood proximity. Blocks that fell completely inside the buffer circle were counted as being proximate to the facility. Blocks that fell only partially inside the buffer circle were only considered proximate to the facility if the buffer circle captured the geographic center of the block (usually encompassing about half its area). We then tallied up the populations of the captured blocks to get the total share of the block group's population that was within the buffer circle, and used that number to appropriately "down-weight" any association between a facility and a block group that was only partially captured by a buffer circle. If, for example, six of a block groups' ten blocks were inside a facility's buffer circle and they accounted for 75 percent of the block group's population, then only 75 percent of the block group's population was associated with the facility and 75 percent of the facility's emissions were associated with the block group. This approach ensured a focus on where people actually live in relation to a facility and its emissions.

We also varied the perimeters to test for sensitivity. We specifically utilized half mile, one mile, two and a half mile, five mile, and six mile buffers to account for whether the inclusion of additional block groups moving away from the facility made a difference in terms of our analytical results. The broadest of these distances, six miles, is used by the California Energy Commission when it attempts to determine whether or not there are environmental justice communities located nearby any proposed location for a power plant. The other tighter distances have been utilized in much of the environmental justice literature to determine which neighborhoods might be considered proximate to, say, a facility listed in the Toxic Release Inventory maintained by the U.S. Environmental Protection Agency.

While we do not, in this report, delve into how tight the relationship is between distance and co-pollutant effect, one reason for drawing multiple buffers of different radii is because of the large variation in the size of the facilities subject to analysis. While they are represented as points on a map, some facilities may cover a large area and may have multiple points of emission, in which case a one mile buffer drawn from the center of the identified stack or plant address may, in reality, barely reach the perimeter of the lot containing the facility. By running all analyses under various distances and identifying consistent conclusions, we can discount the distorting effect that variation in facility size may have on our findings.

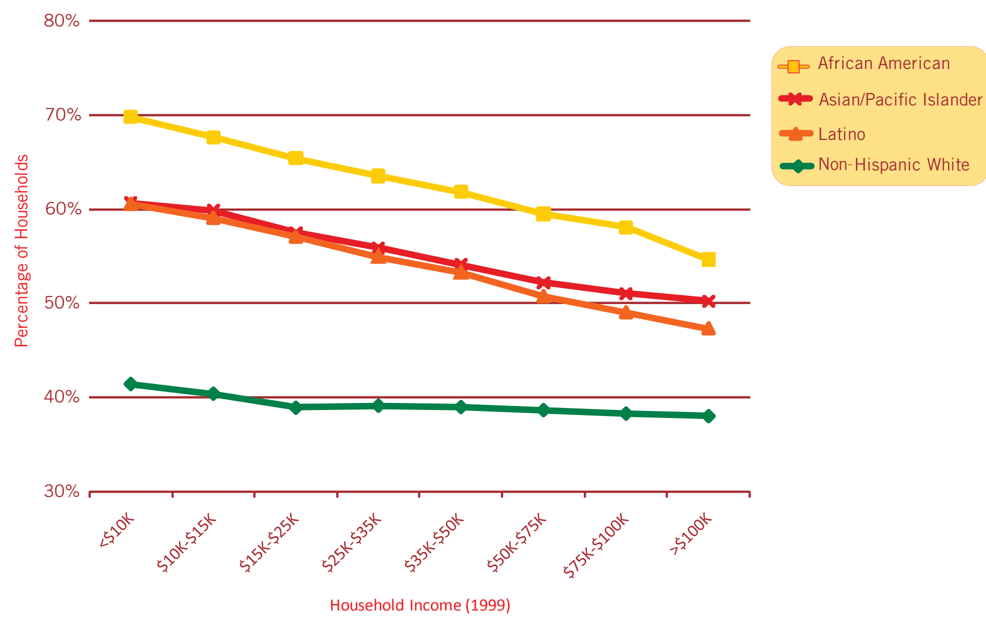
We use these geographic procedures to provide a picture of what each community looks like in terms of co-pollutant burden, and what each facility looks like in terms of the socioeconomic characteristics of its neighbors. Where a block falls within the reach of several faculties, its share of the block group is associated with each of those facilities to paint a cumulative picture. These aggregate portrayals enable us to examine neighborhood level patterns of environmental disparity and the facilities driving such patterns, the extent to which the co-pollutants of facilities burden nearby populations, and the effect of changes in emissions that might be anticipated under a cap-and-trade program.

The Neighborhoods

Unequal emissions burdens from this set of large GHG emitting facilities by race or ethnicity may seem like an obvious point given that existing environmental justice analyses of other sources of pollution in California and Southern California have already shown disparities for stationary as well as mobile sources of air toxics (see, for example Pastor, Sadd, and Morello-Frosch 2004). However, the large GHG emitters subject to this analysis are a different kind of air pollution source and one cannot presume that patterns will hold without empirical verification.

As it turns out, we find a familiar story: the neighborhood analysis reveals the facilities are unevenly distributed across space, with a disproportionate share in communities that include more people of color and more poor families.

Figure 2: Percentage Households Within 6 Miles of any Facility by Income and Race/Ethnicity, California



However, the data shows an interesting nuance not always shown in other studies. With regard to large GHG emitters, in California, there are distinct differences by ethnicity that seem to trump income differences.

Figure 2 shows the order of burden with the six mile distance range across income brackets and race. The likelihood of proximity is highest for African-Americans, then Asians, then Latinos, and finally non-Hispanic white. At the lower end of the income distribution, racial disparities are the largest, with African Americans having more than two-thirds of their lower-income households located near a facility. It is not much better for Latinos or Asians, particularly when compared to whites, whose share of households within six miles of a facility hovers around 40 percent across all income levels. Figure 2 makes clear that while it is true for all groups that the likelihood of living near a facility declines as income rises (as does the racial disparity between groups), there remain difference by race at each and every level of income. And while the focus here is on the six mile distance, this pattern is the same at other distances.

While Figure 2 looks at the likelihood of a particular group living within six miles of a facility, Table 1 offers a more nuanced view: the composition of the neighborhoods within each of the buffers. The first five columns of the table present statistics for sets of block groups near any large GHG emitting facility by various distances; the same set of statistics is calculated for all block groups further than six miles away from a facility for purposes of comparison (column six). As discussed above, considering the results at a variety of distances helps ensure that conclusions are based on actual trends instead of statistical flukes.

The table shows that nearly half of all Californians live within six miles of a facility (46 percent), but they

Table 1: Average Characteristics by Distance from a Facility

	< Half Mile	< 1 Mile	< 2.5 Miles	< 5 Miles	< 6 Miles	> 6 Miles
Total Population	96,362	575,014	4,368,581	12,844,279	15,492,631	18,226,753
% of California Population	0.3%	1.7%	13.3%	38.8%	45.9%	54.1%
People Per Square Mile	1,002	1,325	1,841	1,802	1,779	125
Non-Hispanic White	42.6%	41.2%	37.4%	37.5%	38.0%	54.0%
People of Color	57.4%	58.8%	62.6%	62.5%	62.0%	46.0%
African American	8.7%	8.2%	8.3%	8.5%	8.6%	4.6%
Latino	35.0%	38.1%	40.2%	38.6%	37.5%	28.1%
Asian/Pacific Islander	10.2%	8.9%	10.6%	12.0%	12.6%	9.7%
1980's and 1990's Immigrants	19.1%	20.3%	20.9%	21.3%	21.4%	15.4%
People Below Poverty Level	16.5%	16.3%	16.8%	16.9%	16.6%	12.2%
Children (under 18 years)	24.0%	26.8%	28.5%	28.1%	27.7%	27.0%
Renters	56.0%	52.8%	50.3%	49.6%	49.4%	37.8%
Per Capita Income (1999)	$21,399	$20,794	$20,043	$20,950	$21,186	$24,013
Relative Median Household Income (CA median = 100)	87.7	87.7	90.4	93.5	94.0	105.0

are disproportionately people of color – 62 percent of nearby residents are people of color as compared to the 38 percent who are non-Hispanic white. African Americans live disproportionately close to facilities; their share of the population within half a mile of a facility is about twice their share of the population living outside of the six-mile range. The Latino community share is highest at the two and a half mile range, where they make up about 40 percent of that proximate population as compared to only 28 percent of those more than six miles away. Asian Pacific Islanders are also overrepresented within six miles of a facility, with the disproportionality most marked in the farthest reaches.

Beyond race and ethnicity, there are troubling trends for other vulnerable populations: immigrants, youth and the poor. Immigrants from the 1980's and 1990's are overrepresented within the six mile range, with a pattern similar to that seen in the "people of color" category. Children in poverty (not shown), along with all people in poverty, are both disproportionately near facilities – around 23 percent and 17 percent within six miles versus 16.3 percent and 12.2 percent more than six miles away, respectively, with only slight variation within the six mile radius. Though not shown in the table, we also examined figures utilizing 150 percent of the poverty line (since some argue this is a better measure of low income for a high-cost state like California) and found the same pattern. As for other income measures, there are more renters, lower per capita incomes, and lower household incomes near polluting facilities.

In looking at the pattern, the two and a half mile radius is, we think, of special interest, partly because it captures a much more reasonable share of the overall California population (just over 13 percent) and represents a balance between stretching too far (six miles) and too tight (the half mile radius in which we capture very few people and are not allowing for the ways in which co-pollutants can travel well beyond plant boundaries). It is also the distance at which the highest correlation was found between the population-weighted co-pollutant emissions (person-tons of co-pollutants) we later consider and the air basin-wide health impacts index utilized by NRDC. The snapshot reveals that this is also a distance at which many of the disparities are the most pronounced.

While the demographic indicators in Table 1 are useful, they do not account for the relative burdens the neighborhoods carry. Columns one through

Table 2: Average Characteristics by PM_{10} Emissions from Facilities Within 6 Miles

	High Emissions	Middle Range	Low Emissions	No Facilities Within 6 Miles
Total Population	2,317,884	10,940,640	2,234,107	18,226,753
% of California Population	6.9%	32.4%	6.6%	54.1%
People Per Square Mile	2,638	1,746	1,425	125
Non-Hispanic White	34.4%	37.7%	43.5%	54.0%
People of Color	65.6%	62.3%	56.5%	46.0%
African American	15.9%	7.8%	4.9%	4.6%
Latino	34.5%	38.8%	33.9%	28.1%
Asian/Pacific Islander	11.7%	12.5%	14.3%	9.7%
1980's and 1990's Immigrants	18.7%	22.2%	20.2%	15.4%
People Below Poverty Level	17.5%	16.3%	16.8%	12.2%
Children (under 18 years)	31.1%	30.5%	30.5%	29.4%
Renters	50.6%	49.6%	47.3%	37.8%
Per Capita Income (1999)	$20,986	$21,482	$19,945	$24,013
Relative Median Household Income (CA median = 100)	90.8	95.8	88.4	105.0

five, for example, only break up neighborhoods according to whether they have *any* facility inside the specified distance, but some neighborhoods are within range of several facilities, and not all facilities emit the same amount of pollution. Because in-depth emissions modeling is beyond the scope of this project – although the results we offer up suggest it might be useful for a next phase – we instead employ a fairly simple methodology in which we sum up the tons of co-pollutant emissions for each co-pollutant by neighborhood (block group) from all facilities within six miles, and classify these neighborhoods into three categories: High Emissions (greater than average), Middle Range (about average) and Low Emissions (less than average), with the breaks derived through looking at the mean and what is called a standard deviation (see the appendix for details). The results of this approach are shown in Table 2. The comparison group, here, is the same used in Table 1, those neighborhoods in the greater than six mile range. We focus here on PM_{10} because is it a well known co-pollutant with serious health effects including respiratory problems, cardiovascular disease and premature death.[8]

Gauging relative emissions burdens by breaking up the neighborhoods by total emissions from *all* facilities rather than by proximity to *any* facility, we find some differences, particularly in racial composition, that did not show up in the first part of Table 1, while others that did show up are strengthened and still others change in different ways. African Americans are drastically overrepresented in the High Emission group of neighborhoods, making up about 16 percent of the population – more than three times their share in either the Low Emissions group of neighborhoods or neighborhoods outside the six mile range of any facility. Latinos have their highest population representation in the middle range of emissions, and while Asians are over represented at each emissions level, their share is the highest in the places with lower emissions. As a group, there is a disparate pattern for all people of color: they make up about 46 percent of the population outside the six mile range, 57 percent of those in Low Emission areas, and 66 percent of those in High Emission areas. Again, while we only show the results at the six mile range, they are similar at other distances, including the two and a half mile distance which becomes the focus below.

While all the areas with emissions have lower income levels than in the rest of the state, and poverty generally rises with the level of emissions, one result may seem surprising: both the High Emissions *and* the Low Emissions neighborhoods have slightly lower levels of per capita and household income than the Middle Range neighborhoods. The reason seems to be that the Low Emissions areas – which have facilities but less clustering of facilities and/or facilities with lower emissions – tend to be more rural, which is geographically associated with lower-income.

In any case, the data suggests that, on average, communities of color tend to be situated near the facilities with the highest emissions, or clusters of facilities whose combined emissions add up, while pre-dominantly Anglo or mixed communities tend to live either around facilities with less emissions or beyond the range altogether. Place matters, and existing residential patterns leave communities of color more exposed to facilities that are responsible for the greatest share of co-pollutant emissions. The question, now, is how to ensure that emissions are reduced where the burdens are the largest (i.e. those neighborhoods in the High Emissions category), and in so doing, ensure that "co-benefits" go to communities on the least advantaged side of the climate gap. To begin answering this question, we try to determine which industries are driving the emission trends.

The Industries

To understand what cap-and-trade could mean for environmental justice, we assessed which sectors and which facilities pose the greatest threat to their neighbors' health and where emissions reductions would accordingly provide the greatest benefit. This analysis reveals the distribution of responsibility by sector and facility. Such an analysis may inform the debate by helping to quantify the worst case and best case scenarios for environmental justice with regard to these facilities. For example, if the responsibility for the inequity is spread evenly across sectors and facilities, then exactly which ones curb their GHG emissions is less important for promoting environmental justice; therefore, cap-and-trade is unlikely to be a cause for public health concern because reductions anywhere would ameliorate the overall disparate pattern. If, on the other hand, the inequity is largely due to a small set of facilities, or largely restricted to a particular sector, then those facilities or that sector's purchase of allowances or failure to make reductions could significantly exacerbate existing inequalities. Trades among these facilities would be of highest concern.

Of course, the real gold standard in this task would involve forecasting how and where trades would occur (or, in the case of fees, predicting which firms would choose to pay rather than reduce emissions). However, this kind of predicting would require good financial and economic data on firms that is difficult to acquire and complicated to model. Further, it would mean making assumptions about the details of AB 32 implementation that have yet to be determined, such as how many allowances would be auctioned and at what price to which sectors. While this analysis can have value, it is beyond the scope of this report. Instead we focus on the disparities that facilities are already causing and what policy makers and regulators should take into account when creating safeguards against health-impacting trades that could widen the climate gap.

To measure the contribution of each facility to environmental disparities, we account for three measures. First, we determine how many Californians are impacted by any particular facility, utilizing information on the density of surrounding neighborhoods. Second, we take into account the total tons of co-pollutant emissions from the facility as a gauge of relative health burden. Third, we measure the racial/ethnic composition of the impacted population. These three factors in combination help us gauge the magnitude of disparity by sector, and later by facility; we focus here on PM_{10} emissions due to the regulatory emphasis on the established adverse health effects of particulates (and since the results for NO_x are similar to those of PM, they are omitted from reporting for the sake of brevity).

Figure 3 starts the analysis by counting up the populations within ranges of facilities and giving the total for sectors. Note that while power plants will affect more people overall due to their sheer number, refineries generally have the highest proximate population within the different ranges for the average facility. Power plants in California may also be the least harmful in terms of health impacts and least inequitably distributed by race. Despite the fact that there are more people living within a six mile radius of power plants than other facilities – primarily because there are so many more power plants than refineries or cement kilns – the 108 plants release the lowest tonnage of co-pollutants (see Figure 4

Figure 3: Average Population per Facility (in Thousands) By Distance from Facility in California

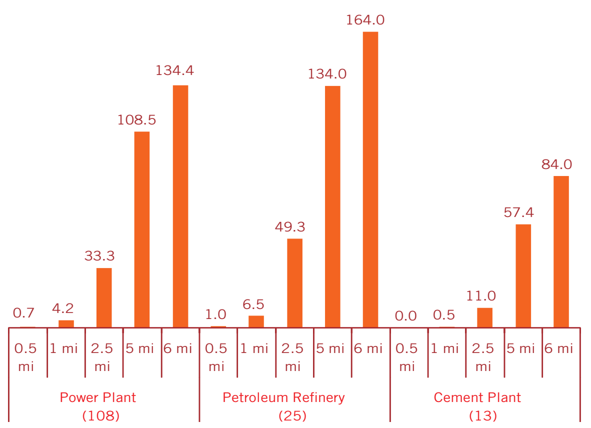
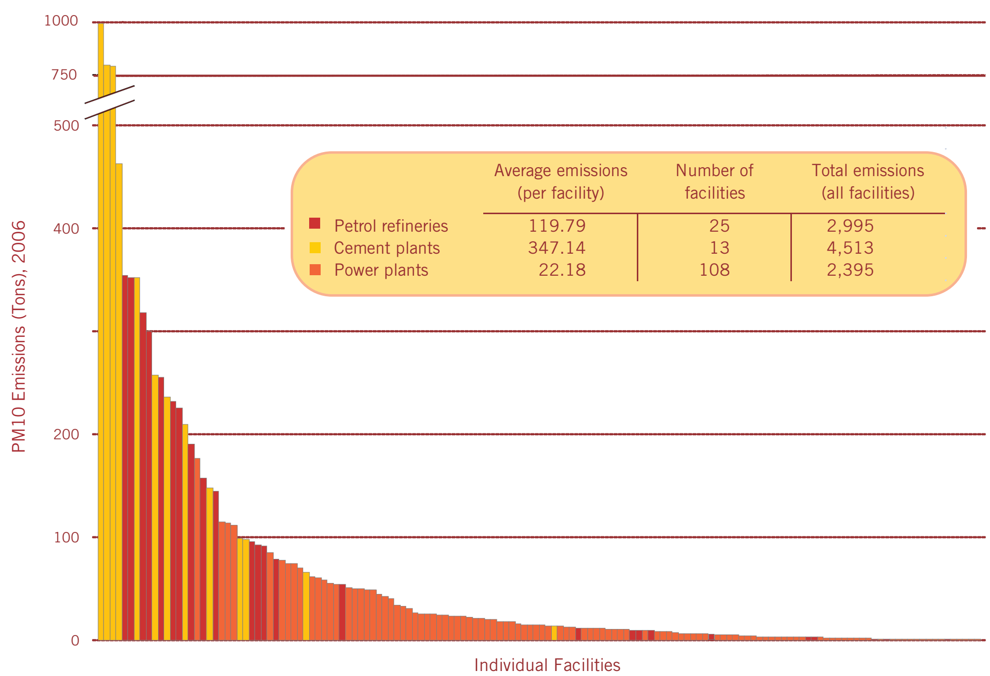


Figure 4: PM_{10} Emissions (Tons) by Facility

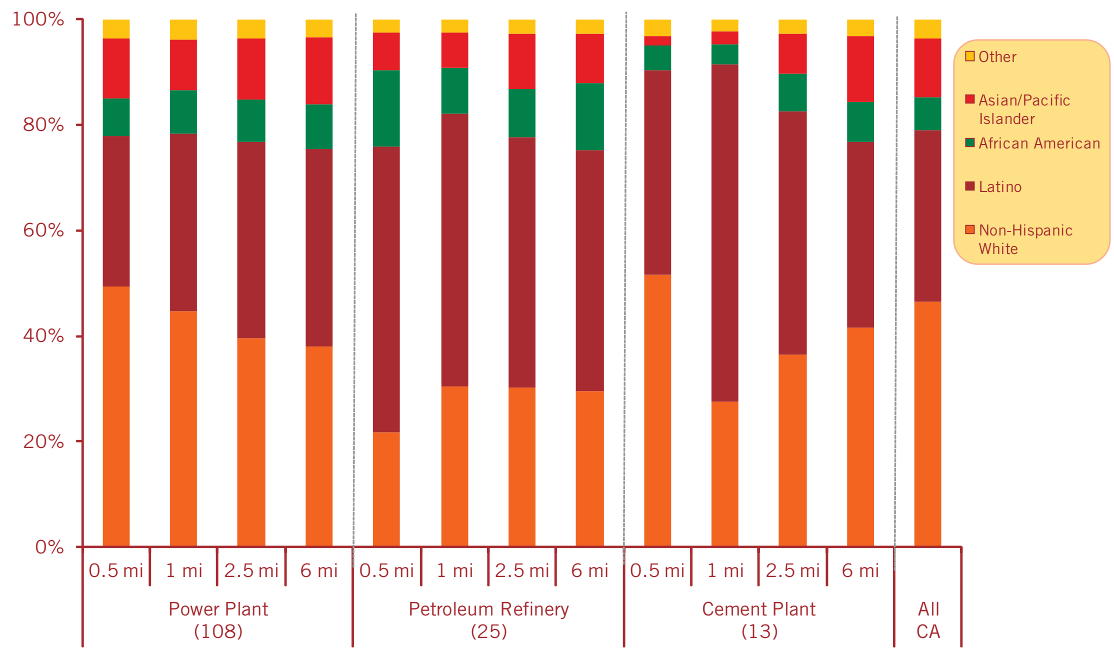


	Average emissions (per facility)	Number of facilities	Total emissions (all facilities)
Petrol refineries	119.79	25	2,995
Cement plants	347.14	13	4,513
Power plants	22.18	108	2,395

in which we order the various types of facilities by their PM emissions from most to least – the power plants show up most frequently in the long tail of the distribution where emissions are lowest while cement plants and refineries show up more frequently in the early part of the distribution where emissions are much higher, resulting in combined emission by sector being highest for cement plants, followed by refineries, and lowest for power plants). Power plants also affect the lowest share of non-white residents, particularly at the nearer distances (Figure 5).[9] This is not to deny rather spectacular cases, including the recent attempt to expand a power plant in Vernon that gave rise to significant resistance from adjoining communities. Such resistance made sense: the current Vernon plant is the top power plant contributor to environmental inequity by race in California, due partly to its proximity to a predominantly immigrant population living in an area of high population density.

Petroleum refineries offer a more problematic picture. They are, on average, located in more densely populated areas (Figure 3) that are consistently home to communities of color (Figure 5). The total minority share ranges between 70 and 78 percent (depending on the particular distance) within six miles of the facility – on average, easily the most disproportionate of the three sectors. Particularly notable, blacks make up a large share in the closest distance buffers, more so than for cement plants and power plants. At the half mile distance, the African American share is more than double their share of the state population (14 percent as compared to 6 percent) and at the one mile distance it is one and a half times as high. Refineries are also unique in that their associated demographics are quite consistent

Figure 5: Racial/Ethnic Composition of Population by Distance from Facility California



throughout the surrounding geography, at least beyond the immediate half mile range. They tend to have much higher co-pollutant emissions than power plants, but lower than cement plants (Figure 4).

Although cement plants are few and affect few (Figure 3), they are by far the dirtiest (again, see the distribution as well as the average emissions figures in Figure 4). At the closest range of half a mile, non-Hispanic Whites are actually slightly overrepresented as compared to the state. However, the number of people in this range of cement plants is very small (about 300 people in all). When we consider the much larger population within one mile (about 6,500 people) the minority population is large, due almost exclusively to the high concentration of Latinos who make up 64 percent of the population (Figure 5). The percentage minority declines rapidly moving further away from cement facilities due exclusively to a steep decline in the Latino share of the population, supplemented by a steep increase in the non-Hispanic White share, and despite both a steep increase in the Asian/Pacific Islander share and a more modest increase in the African American share.

The Disparities

Closing the climate gap requires measuring the factors that contribute to any disparity in environmental burdens. To evaluate the contribution of each facility to the overall pattern of environmental disparity, we developed a single metric of disparity that combines the total impacted population, PM emissions, and the racial/ethnic composition of the surrounding neighborhoods. Such a measure can characterize the individual impact of one facility, but it also allows us to aggregate by sector or across all facilities in the state. It captures the difference in relative impact between a facility located in a sparsely populated area with a population that is 90 percent minority but whose emissions are moderate, and a facility in a densely populated area that is 70 percent minority, but with very high emissions.

The index we developed – the "pollution disparity index" – measures the relative co-pollutant burden on communities of color, as compared with non-Hispanic white communities. We start our calculations at the facility level. Using the socioeconomic neighborhood characteristics that have been attached to each facility, we approximate the local PM_{10} emissions burden as the population-weighted PM_{10} emissions (i.e. total person-tons of PM_{10}) for people of color and non-Hispanic whites. Using such a population-weighted emissions measure means that a facility may have a higher score for people of color even if it has a lower share of people of color in the vicinity because, although the community of color is a lower percentage, it is larger in population and around a facility with higher emissions. We then subtract the population-weighted PM_{10} emissions for non-Hispanic whites from those for people of color (after adjusting the weights by dividing by the number of each group in the state), which gives us the pollution disparity index for that facility, or a measurement of environmental injustice (See the Technical Appendix for details). If the pollution disparity index is added up across all facilities in the state, the result is equal to the statewide difference – or disparity – in average PM_{10} emissions burden between people of color and non-Hispanic whites.

Every facility in our data set is given a pollution disparity index at the varying buffer distances used throughout this analysis (half mile, one mile, two and a half mile, five mile, and six mile), with the characteristics of the "neighborhood" determined by the distance from the facility. The pollution disparity index can then be used to aggregate (at discrete distances bands) for different levels of analysis – it can be combined by sector or across the facilities in a particular region to get the combined contribution of that group of facilities to the statewide disparity in average PM_{10} emissions burden between people of color and non-Hispanic whites caused by all facilities under analysis.

While we cover many technical details of this calculation in the Technical Appendix, a few are worth noting here. First, the measure of population-weighted PM_{10} emissions upon which the pollution disparity index is based should be viewed only as a relative measure that compares the impact of facilities and their disparity within each buffer distance and not across them (similar to the Risk Screening Environmental Indicators risk score developed by the U.S. EPA; see Ash, et al. 2009). Second, the pollution disparity index can have positive and negative values. This depends on the demographics of the neighborhood near the facility; if the share of the state's people of color residing near the facility is greater than the share of the state's non-Hispanic white population residing near the facility, then the score will be positive (if reverse is true, it will be negative). Third, we are effectively assuming in this calculation that beyond six miles, there are no emissions. In practice this is not true, but as mentioned earlier, doing complex emissions dispersion modeling is beyond the scope of this report. Finally, the pollution disparity index is just that – an index of demographic disparity in local pollution burden and not a pure measure of local pollution burden. Thus, while it is useful for highlighting the most disparate facilities, it should be considered in practice along with overall local pollution burden (e.g. population-weighted PM_{10} for all people) as we do below.

The formula for the pollution disparity index also allows for determining average emissions burdens for individual ethnic groups. To do this, we calculate the population-weighted PM_{10} emissions for each ethnic group around each facility, divide it by the state population for each group, and then sum it up to the California level, at each buffer distance. The resulting average burdens are summarized in Table 3; there, the emissions burdens rise with distance because we are "allowing" a wider range of facilities to have an impact on any particular community.

The difference between the average value for each group and that for non-Hispanic whites at each distance in Table 3 is a measure of statewide disparity in PM_{10} emissions burden between that group and non-Hispanic whites at that particular distance. To determine relative differences in emissions burden, which allows us to compare the degree of disparity across the distances, we simply divide the average value for each racial/ethnic group by that for non-Hispanic whites at each distance. The resulting relative PM_{10} emissions burdens are reported in Figure 6.

With the exceptions of Asians at the half and one mile distances, and African Americans at the one mile distance, there are persistent gaps at each level; the relative emissions burden for all people of color combined is always above that for non-Hispanic whites (which is always equal to one in the graph). The trend for Latinos is similar to the trend for all people of color, which is not surprising given that Latinos constitute the overwhelming majority of non-

Table 3: Population-Weighted Average Annual PM_{10} Emissions (Tons) Burden by Race/Ethnicity

	Half Mile	1 Mile	2.5 Miles	5 Miles	6 Miles
Non-Hispanic White	0.07	0.67	6.73	29.55	41.51
African American	0.10	0.64	11.55	75.23	115.03
Latino	0.11	0.88	11.93	48.61	66.37
Asian/Pacific Islander	0.07	0.54	11.26	47.62	63.57
All People of Color	0.10	0.77	11.54	51.08	70.98

Figure 6: Relative Racial/Ethnic Inequities Compared to Non-Hispanic Whites in PM_{10} Emissions Burden from Large GHG-Emitting Facilities by Buffer Distance

whites. They have the greatest emissions burden of any group up to the two and a half mile range where it levels off and declines slightly, while the emissions burden for African Americans soars dramatically to nearly three times the level for non-Hispanic whites at the six mile range. As for Asians, once we move beyond the one mile range, there are also persistent differences. Following the pattern for Latinos, as distance increases beyond the two and a half mile range, the disparity for all people of color combined levels off.

The Sectors

Given the disparity in PM emissions burdens for people of color seen in Figure 6, we decided to examine whether power plants, refineries, or cement plants were driving the overall trend. For this analysis, we focus on the two and a half mile distance threshold. We think this is a reasonable distance for portraying our results in terms of emissions burden – and it is also the case that the population-weighted emissions burden at two and a half miles is the most highly correlated among the different buffer distances with the air basin-wide Health impacts index, giving us some confidence in this choice of radius. In any case, the relative contribution of the various sectors and facilities to statewide inequity as measured by the pollution disparity index is not particularly sensitive to the buffers (with the exception of the half mile distance due to the very small populations captured in that range), so focusing in on one distance illustrates the overall pattern and allows for brevity in the presentation.

Figure 7 begins this analysis by graphically displaying the difference in emissions burdens between people of color and non-Hispanic whites seen in the third column of Table 3. Figure 8 then calculates which sectors are accounting for the PM emissions loads of each group and for the difference between them. From this, we can see that while refineries account for the majority of PM_{10} emissions burden for all people, they account for a much larger share (about 93 percent) of the difference in emissions burden between people of color and non-Hispanic whites.

Which facilities are driving this difference in emissions burden? Because the statewide difference is simply the sum of the pollution disparity index across all facilities, we are able to rank the facilities by the index in Figure 9. The ranking confirms that refineries are driving the difference, as they are eight of the top ten contributors to co-pollutant emissions disparity. Moreover, the top eight facilities overall actually add up to the entire difference; if you took all the facilities below that, you'd have an even distribution of PM_{10} emissions burden by race, since some facilities (displayed at the bottom of the distribution in that figure) disproportionately burden whites. The full distribution also shows that a vast majority of facilities have a score near zero. In short, a few facilities, mostly petroleum refineries, account for most of the observed inequity.

The geographic location of the top ten facilities is depicted in Figure 10. There we can see that nearly all are in Southern California, with only one in the San Francisco Bay Area – the Chevron refinery in Richmond, which ranks sixth in pollution disparity. In Southern California, we see that it is mainly a cluster of refineries around the Los Angeles and Long Beach ports that are driving the pattern of disparity, with five of the remaining top ten facilities located in or adjacent to the port-side neighborhood of Wilmington (part of Los Angeles City). These include the BP refinery in Carson, which takes first place in disparity, and the Tesoro Wilmington Refinery, which comes in second. The rest of the top ten facilities include two refineries (the Paramount Refinery in Paramount and the ExxonMobil Torrance Refinery in Torrance), one power plant (the Malburg Generating Station in Vernon), and one cement plant (the California Portland Cement Company Colton Plant in Colton).

Figure 7: Population-Weighted Average Annual Particulate (PM_{10}) Emissions Burden (Tons) by Race/Ethnicity for Facilities within 2.5 Miles

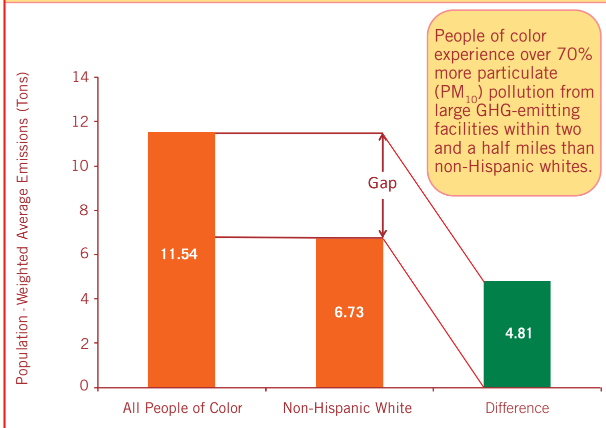


Figure 8: Population-Weighted Average Annual Particulate (PM_{10}) Emissions Burden (Tons) by Facility Category and Race/Ethnicity for Facilities within 2.5 Miles

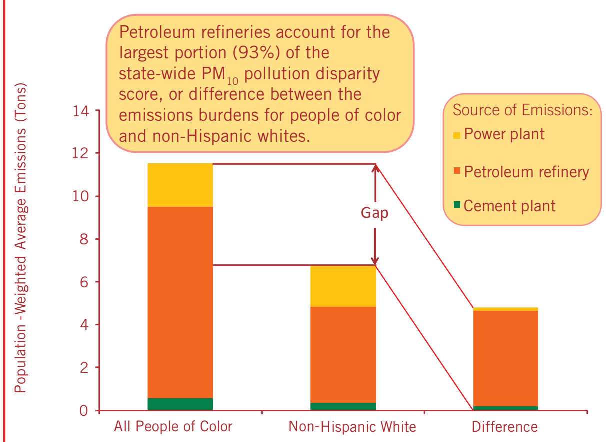
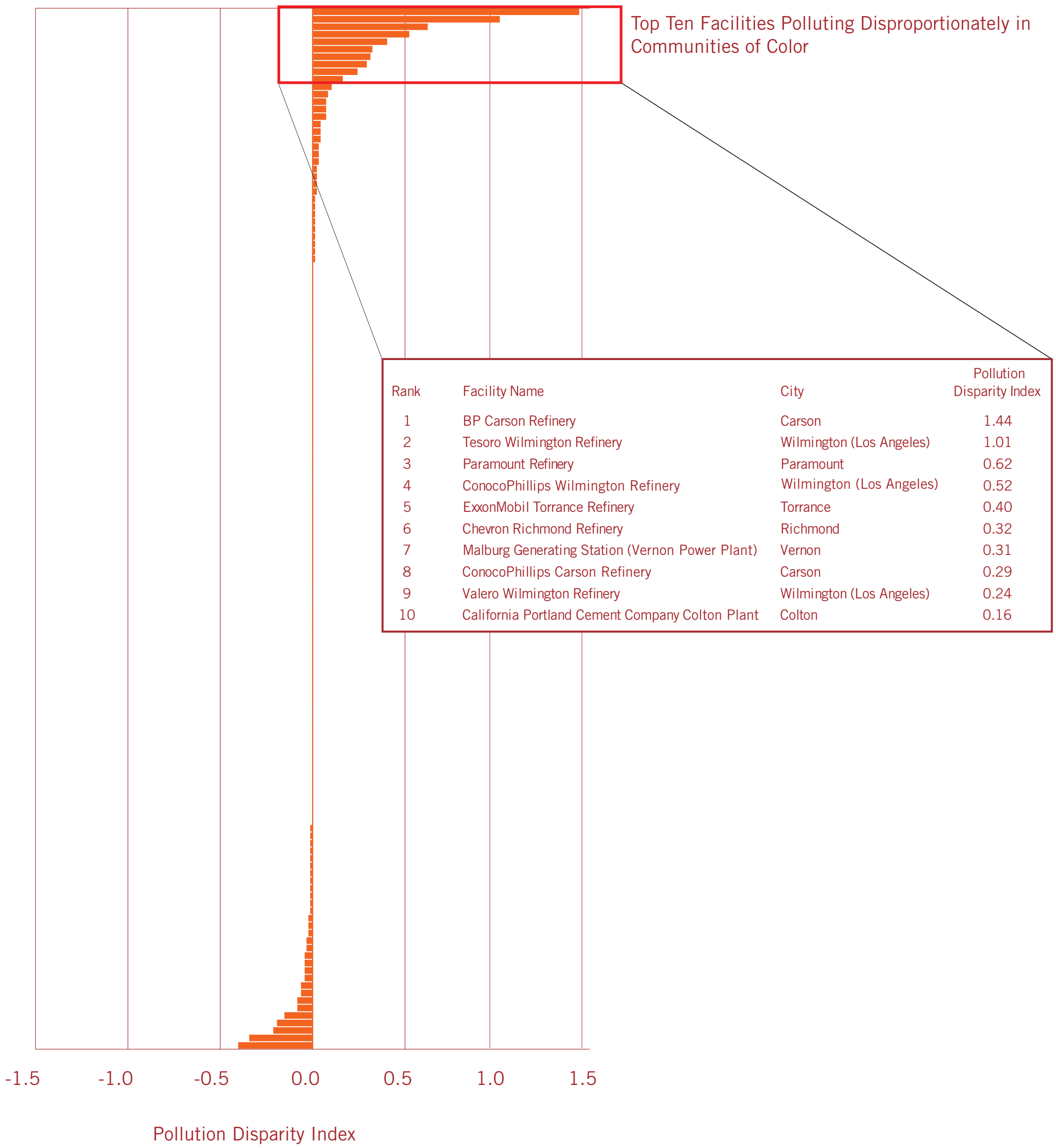
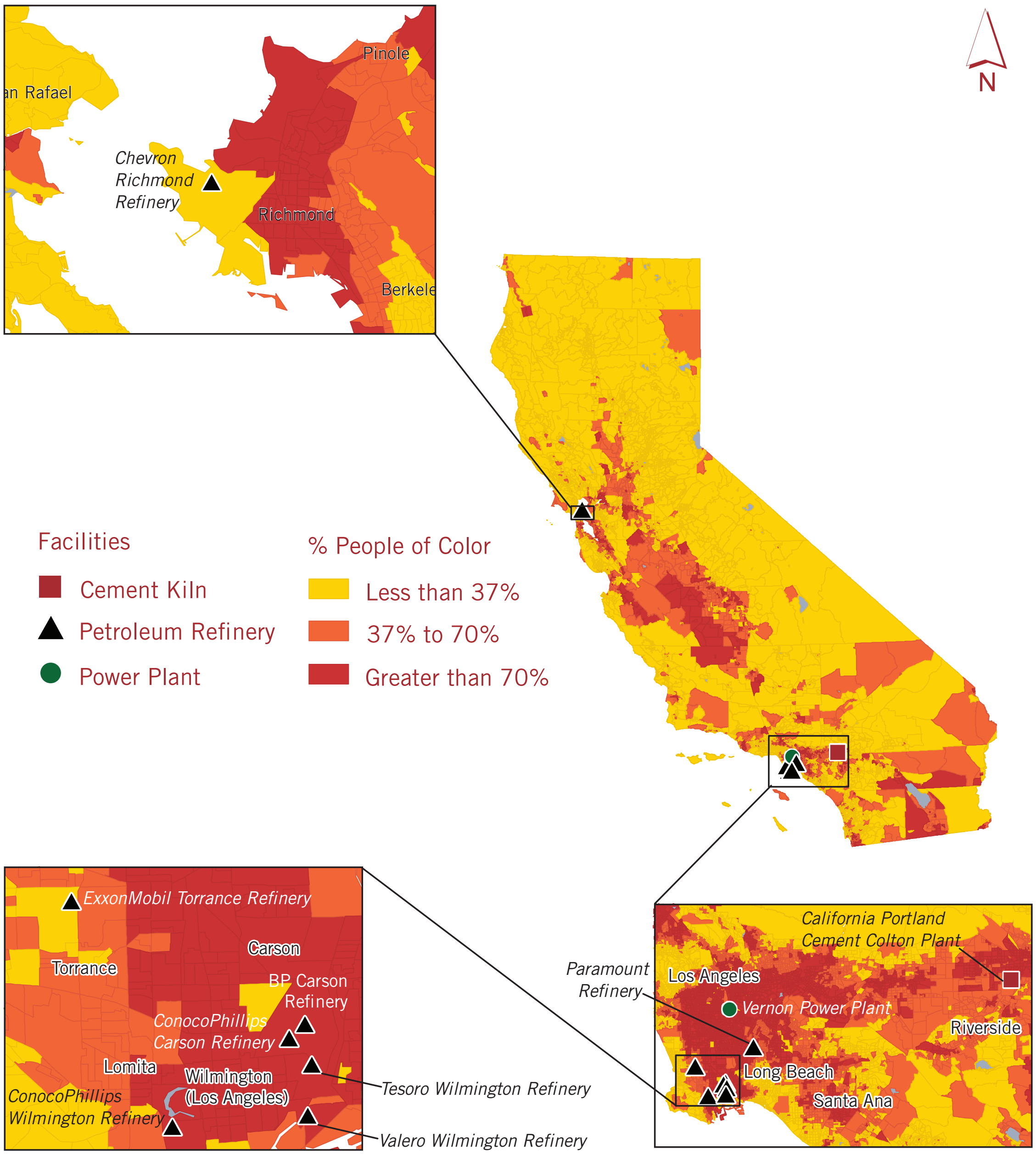


Figure 9: Distribution of the Pollution Disparity Index for PM_{10} at 2.5 Miles Across All Major GHG-Emitting Facilities



Rank	Facility Name	City	Pollution Disparity Index
1	BP Carson Refinery	Carson	1.44
2	Tesoro Wilmington Refinery	Wilmington (Los Angeles)	1.01
3	Paramount Refinery	Paramount	0.62
4	ConocoPhillips Wilmington Refinery	Wilmington (Los Angeles)	0.52
5	ExxonMobil Torrance Refinery	Torrance	0.40
6	Chevron Richmond Refinery	Richmond	0.32
7	Malburg Generating Station (Vernon Power Plant)	Vernon	0.31
8	ConocoPhillips Carson Refinery	Carson	0.29
9	Valero Wilmington Refinery	Wilmington (Los Angeles)	0.24
10	California Portland Cement Company Colton Plant	Colton	0.16

Figure 10: Map of Top Ten Facilities in Pollution Disparity



The Risks

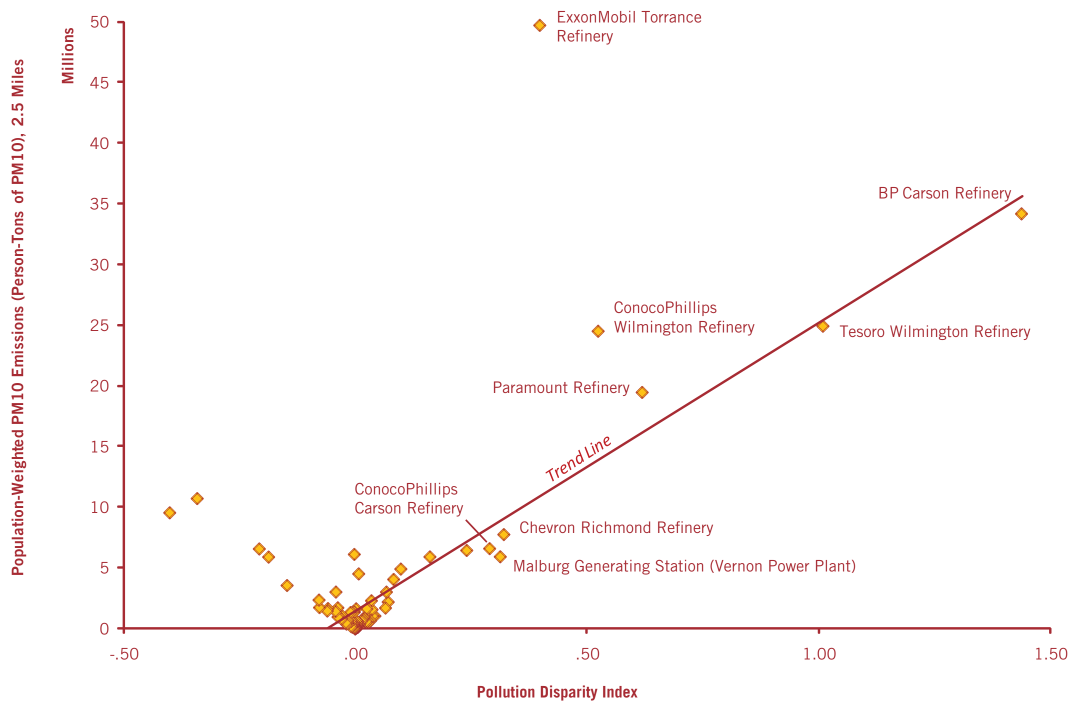
What does all this mean for lowering carbon emissions, protecting public health and closing the climate gap? How should these findings affect CARB's implementation of AB 32? What are the broader implications for market-oriented policies that might eventually emerge at the national level?

The first point made by this analysis is that some trades or allowance allocations *could* widen the climate gap by worsening disparities in emissions burdens by race/ethnicity. The second point is that while there are legitimate concerns about outcomes resulting from trades or the distribution of allowances *within* a sector – such as when a power plant that impacts a large number of people in low-income communities of color eschews reductions in favor of buying credits from a power plant that is nowhere near any population of size or outbidding that power plant in an allowance auction – the real concern might be trade and allowance distribution *between* sectors.

The third point that emerges from this work is the fact that it is a relatively small number of facilities that are driving most of the disparity in emissions; while this could be a problem, the concentration of "bad actors" also suggests that regulatory efforts could be carried out in an administratively feasible and cost efficient way to maximize public health benefits of GHG reduction strategies in the communities that need them the most.

Another point, which is of great importance for policy, is that targeting these facilities would help everyone. Recall, for example, that we employed the two and a half mile distance buffer in our analysis partly because of the strong correlation between population-weighted co-pollutant emissions at that distance and the health impacts index for the air basin derived using the measure indicated in Bailey et al. (2008). In Figure 11, we plot that measure

Figure 11: PM_{10} Emissions Burden and Racial/Ethnic Inequity by Facility



against the pollution disparity index. There we can see that the two measures generally have a positive relationship – the higher the emissions burden the higher the inequity – and it is a handful of facilities with extreme values that are really driving the positive correlation (as they did in our analysis of disparity by race). The pattern suggests both that these are the sites of concern *and* that focusing on disproportionality will also have strong impacts on overall health (or vice versa). For example, in absence of the top eight facilities in terms of the pollution disparity index (labeled in Figure 11), co-pollutant emissions would be more or less evenly distributed by race/ethnicity *and* overall emissions burden would be significantly reduced.

Table 4 illustrates this in a slightly different way by showing the top ten percent of the facilities studied ranked by the aforementioned health impacts index (which is more regional in scope). There we see many of the same facilities that were identified as the most disparate by race/ethnicity in Figure 9, with eight of the ten most disparate facilities also ranking highly in terms of potential health impacts.

Clearly, facilities have to be located somewhere and not all sites will find it cost-efficient to be the first to reduce their emissions. These facilities will be among those purchasing relatively more credits and the last to realize co-pollutant reductions in their neighborhoods. While we have not demonstrated conclusively that the disparity by race *will* sharpen, we have shown that this type of disparity *could* sharpen.

The text of AB 32 unmistakably lifts up health benefits from reduced co-pollutants as an important objective of the legislation, and the California Air Resources Board has long indicated a serious concern about promoting equitable environmental outcomes as part of its overall program of activities. With the issues of overall burden and disproportionate burden intimately related, CARB could craft safeguards that ensure market strategies address these concerns and help close the climate gap.

The Policy Choices

So what would an environmentally just GHG reduction strategy look like? We suggest a menu of market-based and regulatory approaches that could work toward a more equitable outcome.

Table 4: Top Ten Percent of California's Major Greenhouse Gas-Emitting Facilities Ranked by the Health Impacts Index

Rank	Facility Name	City	Health Impacts Index
1	ExxonMobil Torrance Refinery	Torrance	54.4
2	Tesoro Wilmington Refinery	Wilmington (Los Angeles)	50.0
3	BP Carson Refinery	Carson	46.3
4	Chevron El Segundo Refinery	El Segundo	41.2
5	ConocoPhillips Wilmington Refinery	Wilmington (Los Angeles)	30.3
6	Shell Martinez Refinery	Martinez	27.1
7	Valero Benicia Refinery	Benicia	19.1
8	Mountainview Power Plant	San Bernardino	17.5
9	Chevron Richmond Refinery	Richmond	17.3
10	California Portland Cement Company Colton Plant	Colton	14.1
11	Paramount Refinery	Paramount	13.8
12	Valero Wilmington Refinery	Wilmington (Los Angeles)	13.0
13	Cemex Victorville/White Mountain Quarry	Apple Valley	12.5
14	Tesoro Golden Eagle Refinery	Martinez	12.1
15	Etiwanda Generating Station	Rancho Cucamonga	11.1

First, one theoretically ideal but perhaps logistically challenging approach would entail pricing in the co-pollutants along with carbon. In this case, allowances might get extra credit (or carbon fees might be priced differently) depending on the ratio of co-pollutants to GHG. Suppose, for example, that a carbon fee was higher (or allowances were more expensive) if co-pollutants were more prevalent and/or population densities were greater; this could induce deeper GHG reductions in locations where health benefits would be maximized.

This is an elegant idea but one that would involve significant complexity in allowance design, could create problems in a trading system (which is easier if allowances are homogenous units measured only by their carbon emissions), and could significantly complicate the administration and compliance for either a trading or fee system. A simpler approach might be to vary permit prices (or fees) by the average relationship between co-pollutants and GHGs in different sectors, but this would be highly inefficient because it does not consider the substantial variation in marginal health co-benefits from GHG reduction that appears to exist at the facility level.

We see four other strategies that might make sense and be easier to implement.

The first strategy involves identification of those facilities that either have very high co-pollutant levels or make a very significant contribution to the pattern of environmental disparity in the state. These facilities – which should be small in number – would be restricted in allowance allocations, purchases of allowances from other facilities, and use of offsets, required instead to reduce emissions locally to meet their contribution to achieving the statewide carbon cap. While this might limit the market, it would be a small imposition on the system as a whole and would target only a handful of facilities. In a fee system, these facilities could be restricted in their capacity to pay fees rather than change operations.

A second strategy involves the creation of trading zones, based not on whether the facility imposes a significant burden but whether the adjacent areas are currently overburdened by emissions. Zonal restrictions on trading were used in the second phase of the RECLAIM program in Southern California, in which inland facilities were allowed to purchase credits from coastal facilities (where pollution was highest) as well as other inland facilities but coastal facilities were prohibited from making out-of-zone buys (Fowlie, Holland and Mansur 2009). This imposes some inefficiency but it is not administratively complex and it could be justified by the associated environmental benefits. However, as Kaswan (2009) suggests, certainty in achieving actual reductions in prioritized areas would largely depend on how allowances were distributed, with trading playing a small role, for example, if facilities are able to purchase all the allowances they need for any compliance period at auction or if they are able to rely on offsets to make up the difference between allowances holding and emissions. Thus, for this strategy to be effective it would have to be coupled with limits on overall allowance allocations and use of offsets in such zones to ensure that the total quantity of emissions allowed in the zonal market amounted to a net reduction of sufficient size. The zonal restrictions on trading would then prevent any increase above that level and likely lead to further reductions.

A third strategy involves the imposition of surcharges on allowances or fees in highly impacted areas, with the funds being returned for environmental and other improvements in those same areas. In this case, some facilities that are not the worst offenders – but share responsibility for the highest impacts because of their location – would be forced to contribute as well. This would create a tight nexus between the surcharge and the improvement and would be justified by the potential health benefits that could be realized (Boyce 2009).

A fourth strategy involves the creation of a community benefits fund, based as a share of all the monies collected from allowance auctions or fees that could target emissions improvements in neighborhoods that are overburdened, regardless of whether they are in the same location as the sources. Such neighborhoods could be identified through examining dimensions such as the proximity to hazards, exposure to various sorts of air pollution, and community-based social vulnerability; we have been working with the support of the California Air Resources Board to develop exactly such a typology. While the geographic nexus between the emitters and the communities receiving benefits might be looser in this scheme – unlike in the surcharge approach – it would be more efficient in achieving health and other benefits (money collected is spent where it is most needed not only where it is collected). Neighborhoods need not be limited to pollution issues in how they spend the funds but could rather improve park space, job training, and other identified needs.

The basic concept of a community benefits fund finds support even amongst some who are critical of any tinkering with carbon market mechanisms (e.g. Schatzki and Stavins 2009). A benefits fund is also aligned with the notion of compensating lower-income consumers for the higher energy prices that will be triggered by limiting carbon (Boyce and Riddle 2007). All of this would be made more possible if the state was to take up the recommendation of the Economic and Allocation Advisory Committee (EAAC 2010) that indicated that the Air Resources Board "rely principally, and perhaps exclusively, on auctioning as the method for distributing allowances." A full auction would make the system much closer to a carbon fee system and, as EAAC notes, have several other attractive features. Finally, legislation currently in progress in the state legislature (AB 1405) could make a community benefits fund real: it would force the state to direct a portion of any revenues generated under AB 32 – whether from fees or auction revenues – to communities that are historically disadvantaged in terms of both economic and environmental health.

There are therefore real policy opportunities to close the climate gap. At the very least, CARB needs to create a mechanism for monitoring allowance allocations and trades or fee payments, and assess the impact on co-pollutants as facilities make their choice about how to contribute to achieving the overall cap. The research above has demonstrated a point that is really quite obvious: cap-and-trade is inherently unequal – and if it weren't, no trades would take place. Given that, we should all be interested in exactly the pattern of geographic inequality that will emerge and whether it will exacerbate or ameliorate the pattern of environmental disparity that has marked the state and helped to produce the climate gap.

Minding the Gap

California is at a crossroads. With a world in peril and public health at risk, the state has chosen to lead in the global fight to reduce greenhouse gas emissions, rescue our economy, and protect the planet for generations to come.

The state has also chosen to make equitable environmental outcomes central to its approach to these issues. An Environmental Justice Advisory Committee (EJAC) was written explicitly into the AB 32 legislation and while there have been tensions between the committee and the state, particularly related to cap-and-trade as a viable GHG reduction strategy, there is clearly a shared concern that implementation of AB 32 be done in a way that is fair to all communities.

As California takes steps to respond to the climate crisis, closing the climate gap needs to be a higher priority, starting with making sure GHG reduction policies don't leave anyone behind and don't unintentionally widen the climate gap.

The research reviewed here suggests that the concerns of environmental justice advocates about the unequal impacts of cap-and-trade are not misplaced. The major facilities that will be regulated under any carbon reduction program are more frequently located near people of color and lower-income communities, with a handful of petroleum refineries making a significant contribution to the pattern of inequity. While we cannot predict the exact direction of trades, we do know that it is quite possible that an unconstrained market system will, at a minimum, fail to realize the full benefits of co-pollutant reduction and, at a maximum, worsen the current pattern of inequality.

Ensuring that a market-oriented regulatory system – either cap-and-trade or fees – avoids widening the climate gap is essential. A series of simple strategies – prohibit facilities from making trades with and restrict allowance allocations and offset uses with significant health impacts, impose a surcharge in locations where health benefits could be high, limit trades by zone depending on overall pollution burden, or develop a compensation system that could redirect revenues to climate gap communities to address health and other concerns – are all relatively simple to design and implement and should be considered as part of the policy menu. In addition, the state should consider the development of a monitoring system that tracks trades and offset use (or fee payments) to ensure that a market system does not contribute to the inequities depicted here, and to enable other mitigation policies to be triggered as needed.

The stakes are high and the time is now. In order to successfully make the monumental economic and social shifts required to address the climate change challenge, we need to engage diverse constituencies in ways that take into account everyone's needs and health concerns. New and more inclusive GHG reduction policies can protect our communities and the planet. California faces a big challenge but also a big opportunity. We are poised to lead not only in curbing climate change, but also in closing the climate gap. As other states and the nation move forward, the impact of this work will multiply. We should get this right – and fair – from the beginning.

Notes

[1] See California Health & Safety Code §38570(b).

[2] Ibid. §38570(b)(2).

[3] For a description of how the dataset was constructed, see "Appendix A: Co-Benefits Analysis Methods" at: http://www.nrdc.org/globalWarming/boosting/boostinga.pdf

[4] The emissions inventory can be accessed at: http://www.arb.ca.gov/ei/emissiondata.htm

[5] The 2008 GHG emissions data can be accessed at: http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-reports.htm

[6] TeleAtlas, 2007.

[7] Health endpoint factors are the estimated number of tons per year of a particular pollutant that can be associated with each case of a health endpoint (in this case premature mortality) in within a particular geographic area (in this case air basins). See www.arb.ca.gov/planning/gmerp/march21plan/docs/health_analysis_supplement.pdf for the more information, including the health endpoint factors for each air basin.

[8] See USEPA, AIRTrends 1995 Summary at: http://www.epa.gov/airtrends/aqtrnd95/pm10.html

[9] For Figure 5, in order to simplify the graph, the racial composition of people living near the different facility types at the five mile distance is not shown. It was chosen as the distance band to omit because it had a racial composition that was nearly identical to the composition at the six mile distance band, which is shown.

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Executive Summary, Page 1: La Paloma power plant and Exxon Mobile Refinery in Torrance, CA, TeleAtlas, 2010.

Executive Summary, Page 3: Tesoro Wilmington Refinery, 9/25/09, Photo by Jesse Marquez.

Technical Appendix

Constructing the Health Impact Index

Based on Bailey et al. (2008), we used the NO_x and PM_{10} emissions to calculate a health impacts index for each facility, which represents the relative potential health impact of the facilities included in the analysis (see Bailey et al. 2008 for assumptions and limitations). The only difference is that we used PM_{10} rather than total PM because it is considered more closely tied to health endpoints. The NOX and PM_{10} data come from the 2006 ARB Emissions Inventory for stationary sources and can be accessed at: http://www.arb.ca.gov/app/emsinv/emssumcat.php. The index also relies on health endpoint factors which are the estimated number of tons per year of a particular pollutant (here, NO_x and PM_{10}) that can be associated with each case of a health endpoint (here, premature mortality) within a particular geographic area (here, air basins). The formula for the health impacts index is:

$$HI_i = \left(NO_x / HEP_{AB}\right) + \left(PM_{2.5} / HEP_{AB}\right)$$

Where: HI_i = Health Impacts Index

NO_x = NO_x emissions in 2006

$PM_{2.5}$ = PM_{10} emissions in 2006 divided by the ratio of PM_{10} to $PM_{2.5}$

HEP_{AB} = Air basin specific health endpoint factor for premature mortality

Matching Block Groups and Facilities

The challenge of matching neighborhoods and facilities is this: facilities are points in space and block groups are areal units. Mohai and Saha (2006) found in their study of geographic methodology that the method employed to describe the spatial relationship of point-location environmental hazards and surrounding populations is the primary reason for the varied results found in many studies relying on similar data and geographic coverage. The "classic" approach, used in most studies, connects census tracts to a hazardous waste treatment, storage, or disposal facility (TSDF) if such a facility is located within the boundaries of the tract itself, making it a "host tract." This approach does not account for people residing in nearby, but non-host tracts, that could well possibly live, on average, about the same distance from the facility. These discrepancies are particularly important given the tendency for TSDFs to be located near tract boundaries (which are often defined by roads) and the large variation in the size and spatial distribution of populations within census tracts.

Instead, Mohai and Saha recommend a distance-based approach where tracts become associated with a facility if they fall within a specified distance of the facility as measured by either one of the tract boundaries, its centroid, or half of its geographic area. We employ a distance-based approach at the block group level that incorporates population weighing. We specifically drilled down to census block level to get the most geographically detailed population information publicly available and, as noted in the text, estimated the share of each block group's population that fell within each buffer distance of each facility. Thus, rather than expressing the block group-facility association in binary terms (i.e., proximate or not), in cases where a buffer intersects the boundaries of a block group, it is expressed as a percentage or fractional association that is equivalent to the share of the block group population captured. In our opinion, such "population weighting" using block-level population information is important because even at the relatively detailed block group level of geography, an evenly distributed population within the block group is uncommon; half of the area of a block group does not necessarily include half the population. Thus, this method should result in a more accurate representation of the number of people and the characteristics those who live near facilities.

Emissions Categorizations

We chose the PM_{10} emission categories shown in Table 2 based on standard deviations from the mean. The means and standard deviations used were calculated at the block group level for the natural log of the summed emissions from all facilities within six miles of each block group, across all block groups within six miles of any facility. The natural log function is commonly used to normalize measures that exhibit a "long tail" or exponential distribution – which describes the measure of summed emissions.

Among all block groups within six miles of any facility, we defined High Emissions block groups as those with emissions over one standard deviation above, Middle Range block groups as those with emissions within one standard deviation of the mean (plus or minus), and Low Emissions block groups as those with emissions under one standard deviation below the mean.

Constructing the Pollution Disparity Index

The pollution disparity index used in this report, which was calculated at the facility level, can be described as a measure of the contribution each facility makes to the statewide difference in average co-pollutant emissions burden between people of color and non-Hispanic whites from the facilities included in our analysis, for a particular distance from the facilities. The derivation below describes how the statewide difference in emissions burden can be decomposed into the facility-level index. Note that while we used PM_{10} as the pollutant and people of color and non-Hispanic whites as the population groups, by making slight adjustments to the below equation, the index and associated statewide difference in emissions burden could be calculated to reflect disparity in emissions of any other pollutant and/or between any other two population groups defined by race/ethnicity, income, or any other measurable characteristic.

In the derivation shown below, POC stands for total people of color, NHW stands for total non-Hispanic whites, d is distance, i is any facility in California included in the analysis, and CA means for the entire state of California.

Total statewide PM_{10} emissions burden associated with the facilities included in our analysis can be calculated as the population-weighted sum of PM_{10} emissions across all facilities i within a certain distance d (i.e. total person-tons of PM_{10}). Average local PM_{10} emissions burden at distance d, calculated separately for each group, is measured essentially as a simple population-weighted average of PM_{10} emissions across all facilities i, using the population within distance d of each facility as the weight, but with one modification: the sum of the weights (the denominators above) is set to the total California population for each group rather than the sum across facilities. This weighting scheme implicitly sets the PM_{10} emissions to zero for all people beyond distance d of any facility, and is

$$CA\ difference\ in\ average\ PM10\ burden_{(POC-NHW)d}$$

$$= [average\ POC\ PM10\ burden_d] - [average\ NHW\ PM10\ burden_d]$$

$$= \left[\frac{\sum_{i=1}^{n} POC_i \times PM10_{i,d}}{POC_{CA}}\right] - \left[\frac{\sum_{i=1}^{n} NHW_i \times PM10_{i,d}}{NHW_{CA}}\right]$$

$$= \sum_{i=1}^{n}\left[\frac{POC_i \times PM10_{i,d}}{POC_{CA}}\right] - \sum_{i=1}^{n}\left[\frac{NHW_i \times PM10_{i,d}}{NHW_{CA}}\right]$$

$$= \left[\frac{POC_{1,d} \times PM10_{1,d}}{POC_{CA}} + \frac{POC_{2,d} \times PM10_{2,d}}{POC_{CA}} + \ldots \frac{POC_{n,d} \times PM10_{n,d}}{POC_{CA}}\right] - \left[\frac{NHW_{1,d} \times PM10_{1,d}}{NHW_{CA}} + \frac{NHW_{2,d} \times PM10_{2,d}}{NHW_{CA}} + \ldots \frac{NHW_{n,d} \times PM10_{n,d}}{NHW_{CA}}\right]$$

$$= \left[\frac{POC_{1,d} \times PM10_{1,d}}{POC_{CA}} - \frac{NHW_{1,d} \times PM10_{1,d}}{NHW_{CA}}\right] + \left[\frac{POC_{2,d} \times PM10_{2,d}}{POC_{CA}} - \frac{NHW_{2,d} \times PM10_{2,d}}{NHW_{CA}}\right] + \ldots \left[\frac{POC_{n,d} \times PM10_{n,d}}{POC_{CA}} - \frac{NHW_{n,d} \times PM10_{n,d}}{NHW_{CA}}\right]$$

imposed so that disparities are figured relative to the statewide population rather than to the population within distance d of any facility.

While this is not a realistic assumption – in reality PM_{10} and other emissions disperse and de-concentrate at varying rates around a facility – in lieu of "fate-and-transport" modeling, this is our best estimate. Our method tests a variety of distances under the assumption that the PM_{10} concentration is constant within each buffer and zero outside the buffer. If similar disparities are found across distance bands and there is a similar composition of sectors and facilities that are driving disparity at each distance, then we expect a more sophisticated model would draw similar conclusions to those drawn from this methodology.

In the last line of the derivation, each bracketed term represents the contribution (positive or negative) of each facility i to the overall statewide difference in person-tons of PM_{10} between people of color and non-Hispanic whites, and is what we have termed the pollution disparity index. A positive or negative index value is determined by the representation of each group near the facility; if the share of the state's people of color residing near the facility is greater than the share of the state's non-Hispanic white population residing near the facility, then term will be positive. If reverse is true, it will be negative.

While the statewide difference expresses environmental disparity in co-pollutant emissions from the facilities included in our analysis at the state level, the pollution disparity index tells of each facility's contribution to that measure of statewide disparity, which is experienced at the local level. The facility-level index can be summed up across any group of facilities by type or locale (e.g., across all power plants in the state or across all facilities in a particular county, city, or neighborhood) to get a measure of the contribution that group of facilities makes to the statewide difference.

Finally, we emphasize that the approximation of "emissions burden" we use here is just that – an approximation. "Exposure" as used in the public health field typically implies modeling of emissions to determine concentrations at the neighborhood level, taking into account distance from the facility, how emissions are released, and local wind and atmospheric patterns, among other factors. Instead, emissions burden and the pollution disparity index rely on a rough approximation based on total co-pollutant emissions and the number of people within a particular distance from the facility.

About the Research Team

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Minding the Climate Gap Report

Exhibit 2

Refinery	Emitter covered GHG emissions, 2013-14 (metric tons CO2eq)	Emitter covered GHG emissions, 2011-12 (metric tons CO2eq)	Change in emitter covered GHG emissions, 2013-14 vs. 2011-12 (metric tons CO2eq)	% change relative to 2011-12
Tesoro Refining & Marketing Company LLC - Los Angeles Refinery - Carson	10,776,883	8,983,862	1,793,021	20%
Tesoro Refining and Marketing Co. - Martinez	4,778,043	4,490,437	287,606	6%
Phillips 66 Company - Los Angeles Refinery - Carson Plant	1,892,589	1,796,159	96,430	5%
Phillips 66 Company - Los Angeles Refinery - Wilmington Plant	3,933,130	3,852,141	80,989	2%
Phillips 66 Company - Santa Maria Refinery	502,518	479,929	22,589	5%
Kern Oil Refinery	286,515	275,632	10,883	4%
Lunday-Thagard Company	70,102	62,965	7,137	11%
San Joaquin Refining Company	187,437	187,444	-7	0%
Edgington Oil Company	11	461	-450	-98%
Ultramar Inc - Valero	1,870,699	1,927,135	-56,436	-3%
Chevron Products Company - El Segundo Refinery, 90245	6,527,778	6,646,701	-118,923	-2%
Valero Refining Company - California, Benicia Refinery and Benicia Asphalt Plant	5,447,322	5,577,029	-129,707	-2%
Shell Oil Products US - Martinez	8,158,766	8,316,879	-158,113	-2%
Phillips 66 Company - San Francisco Refinery	2,639,333	2,822,075	-182,742	-6%
Paramount Petroleum Corporation Refinery	58,855	253,431	-194,576	-77%
Alon Bakersfield Refinery - Areas 1&2	50,804	322,112	-271,308	-84%
ExxonMobil Oil Corporation - Torrance Refinery	5,864,802	6,152,615	-287,813	-5%
Chevron Products Company - Richmond Refinery, 94802	8,034,694	8,407,150	-372,456	-4%

Exhibit 3

RESEARCH BRIEF - SEPTEMBER 2016

A PRELIMINARY ENVIRONMENTAL EQUITY ASSESSMENT OF CALIFORNIA'S CAP-AND-TRADE PROGRAM

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OVERVIEW

California's cap-and-trade program is a key strategy for achieving reductions in greenhouse gas (GHG) emissions under AB32, the California Global Warming Solutions Act. For residents living near large industrial facilities, AB32 offered the possibility that along with reductions in GHGs, emissions of other harmful pollutants would also be decreased in their neighborhoods. Carbon dioxide (CO_2), the primary GHG, indirectly impacts health by causing climate change but is not directly harmful to health in the communities where it is emitted. However, GHG emissions are usually accompanied by releases of other pollutants such as particulate matter (PM_{10}) and air toxics that can directly harm the health of nearby residents.

In this brief, we assess inequalities in the location of GHG-emitting facilities and in the amount of GHGs and PM_{10} emitted by facilities regulated under cap-and-trade. We also provide a preliminary evaluation of changes in localized GHG emissions from large point sources since the advent of the program in 2013. To do this, we combined pollutant emissions data from California's mandatory GHG and criteria pollutant reporting systems,[1,2] data on neighborhood demographics from the American Community Survey, cumulative environmental health impacts from the California Environmental Protection Agency's CalEnviroScreen tool, and information from the California Air Resources Board (CARB) about how regulated companies fulfilled their obligations under the first compliance period (2013-14) of the cap-and-trade program. Our methodology is described in greater detail in the appendix to this report.

In this analysis, we focus primarily on what are called "emitter covered emissions," which correspond to localized, in-state emissions (derived mostly from fossil fuels) from industries that are subject to regulation under cap-and-trade. The cap-and-trade program also regulates out-of-state emissions associated with electricity imported into the state and, beginning in 2015, began regulating distributed emissions that result from the burning of fuels such as gasoline and natural gas in off-site locations (e.g., in the engines of vehicles and in homes).

We found that regulated GHG-emitting facilities are located in neighborhoods with higher proportions of residents of color and residents living in poverty. In addition, facilities that emit the highest levels of both GHGs and PM_{10} are also more likely to be located in communities with higher proportions of residents of color and residents living in poverty. This suggests that the public health and environmental equity co-benefits of California's cap-and-trade program could be enhanced if there were more emissions reductions among the larger emitting facilities that are located in disadvantaged communities. In terms of GHG emission trends, in-state emissions have increased on average for several industry sectors since the advent of the cap-and-trade program, with many high emitting companies using offset projects located outside of California to meet their compliance obligations. Enhanced data collection and availability can strengthen efforts to track future changes in GHG and co-pollutant emissions and inform decision making in ways that incentivize deeper in-state reductions in GHGs and better maximize public health benefits and environmental equity goals.

FINDINGS

1. Facilities that emit localized GHGs are located in more disadvantaged communities.

On average, neighborhoods with a facility that emitted localized GHGs within 2.5 miles[3] have a 22 percent higher proportion of residents of color and 21 percent higher proportion of residents living in poverty than neighborhoods that are not within 2.5 miles of such a facility. Neighborhoods within 2.5 miles of a facility are also more than twice as likely to be among the worst statewide in terms of their CalEnviroScreen score, a relative ranking of cumulative impact based on indicators of social and environmental stressors to health (**Table 1**[4]).

TABLE 1
Characteristics of Neighborhoods within 2.5 miles of GHG-emitting Facilities (N=255 facilities)

	Block groups with at least one facility within 2.5 miles (N=6,397)	Block groups with no facilities within 2.5 miles (N=16,705)
Mean % People of Color	66%	54%
Mean % People Living Below Twice the Poverty Level	41%	34%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	17%	7%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	31%	15%

2. Many of California's residential communities are within 2.5 miles of more than one GHG-emitting facility (Figure 1[5]).

These communities are home to a higher proportion of residents of color and people living in poverty than communities with no or few facilities nearby. Indeed, the higher the number of proximate facilities, the larger the share of low-income residents and residents of color (**Figure 2**).

FIGURE 1
Residential Proximity to Facilities Reporting Emitter Covered GHG Emissions during the 2013-14 Compliance Period (N=321 facilities)

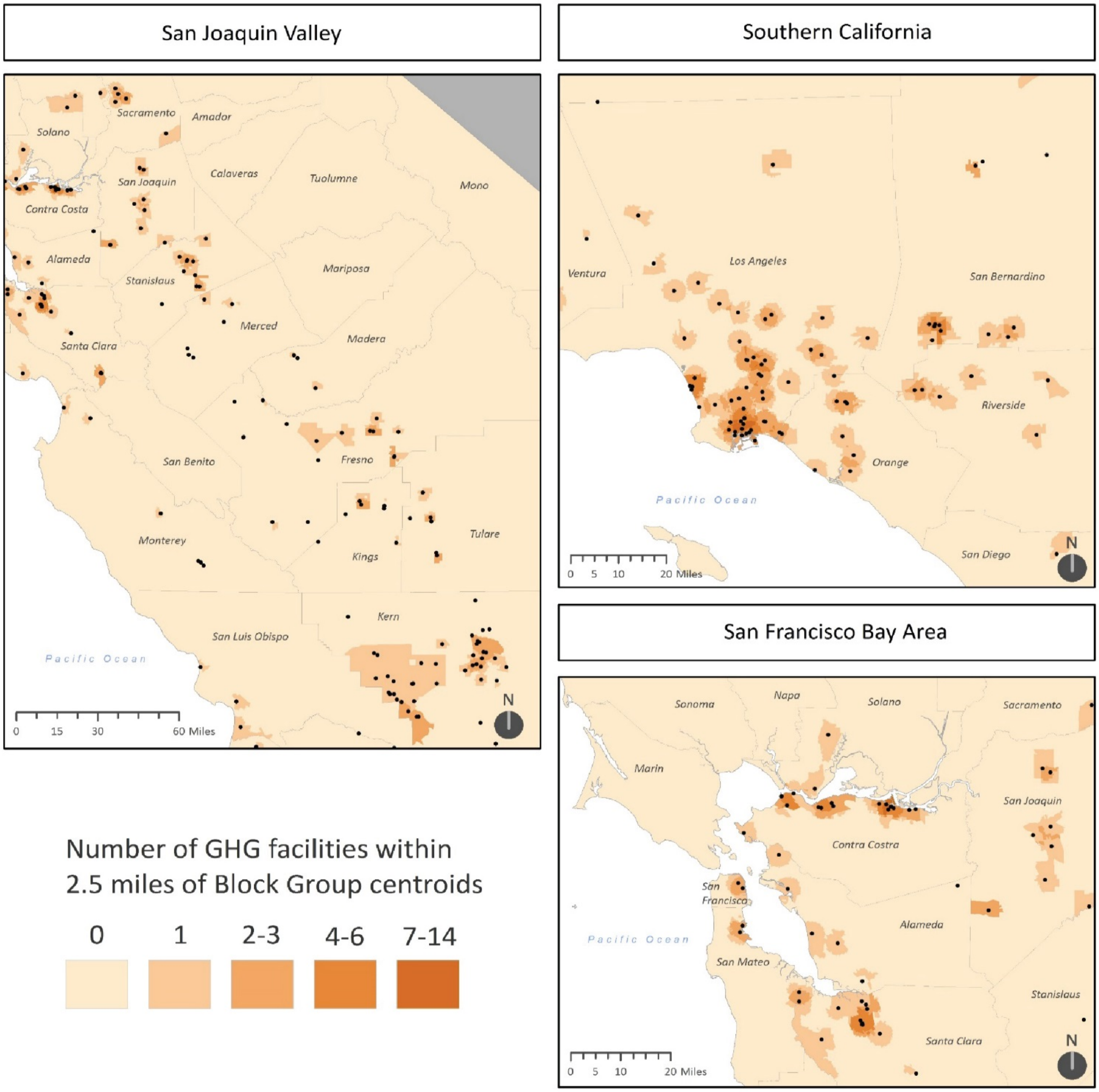
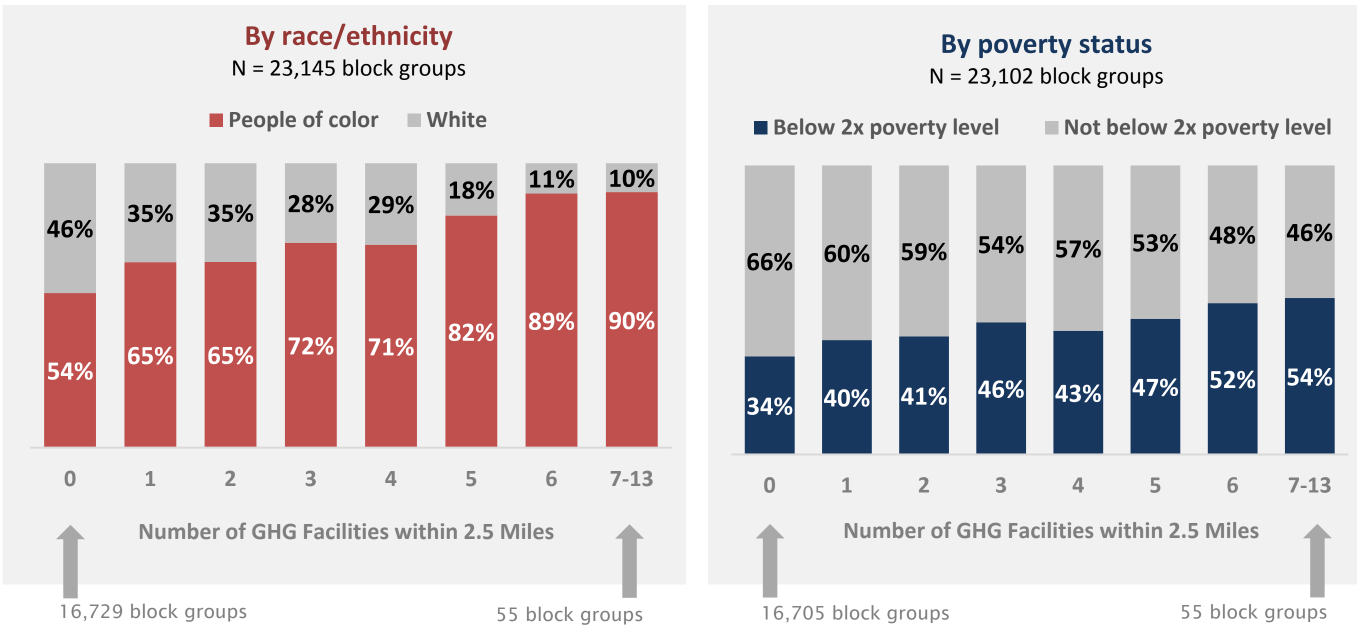


FIGURE 2
Demographics in Block Groups near GHG-emitting Facilities (N=255 facilities)



3. While GHG emissions do not generally have direct health impacts, co-pollutants such as particulate matter (PM_{10}) do. Such emissions are correlated (Figure 3[6]), with large GHG emitters reporting that they emit more particulate matter. The largest emitters of both GHGs and PM_{10} also tend to be located near neighborhoods with higher proportions of disadvantaged residents (Table 2[7]).

The neighborhoods within 2.5 miles of the 66 largest GHG and PM_{10} emitters (defined as the top third in emissions of both PM_{10} and GHGs and highlighted in orange in **Figure 3**) have a 16 percent higher proportion of residents of color and 11 percent higher proportion of residents living in poverty than neighborhoods that are not within 2.5 miles of such a facility (**Table 2**). Compared to other parts of the state, nearly twice as many neighborhoods within 2.5 miles of these highest-emitting facilities are also among the worst statewide in terms of their CalEnviroScreen score. We also found that 40 (61 percent) of these high-emitting facilities reported increases in their localized GHG emissions in 2013-14 relative to 2011-12, versus 51 percent of facilities overall. Neighborhoods near the top-emitting facilities that increased emissions had higher proportions of people of color than neighborhoods near top-emitting facilities that decreased their emissions (**Table 6** in the Appendix).

FIGURE 3
Correlation between Emitter Covered GHG Emissions and Particulate Matter (N=317 facilities)

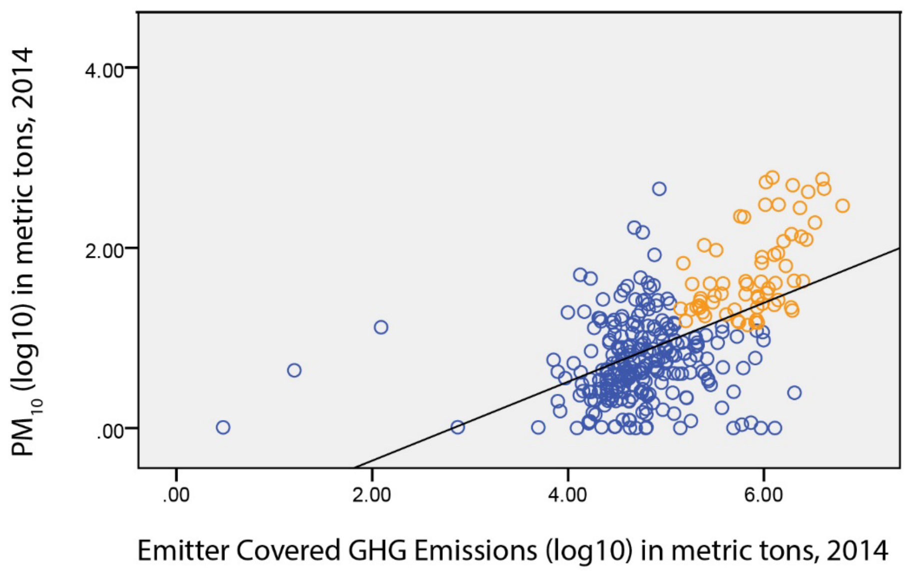


TABLE 2
Characteristics of Neighborhoods within 2.5 miles of the top GHG- and PM_{10}- Emitting Facilities (N=66 facilities)

	Block groups within 2.5 miles of the largest GHG and PM_{10} emitters (N=1,290)	All other block groups (N=21,812)
Mean % People of Color	66%	57%
Mean % People Living Below Twice the Poverty Level	40%	36%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	18%	9%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	35%	19%

4. While overall, GHG emissions in California have continued to drop from a peak in 2001, we find that, on average, many industry sectors covered under cap-and-trade report increases in localized in-state GHG emissions since the program came into effect in 2013.[8]

Only a portion of the state's total GHG emissions are regulated under the cap-and-trade system. For example, the industrial and electrical sectors accounted for about 41 percent of the state's estimated total GHGs emissions in 2014.[9] (The remainder originated from sectors such as transportation, commercial and residential buildings, and agriculture.) As a result, overall emissions and emissions regulated under cap-and-trade can exhibit slightly different patterns. Moreover, not all emissions regulated under the cap-and-trade program occur in-state. For example, according to CARB's 2016 Edition of the California GHG Emission Inventory, emissions from electrical power decreased by 1.6 percent between 2013 and 2014. However, when these emissions are disaggregated, we see that it is the emissions associated with *imported* electricity that decreased, while emissions from *in-state* electrical power generation actually increased.[8]

Figure 4 shows the distribution of the change in localized GHG emissions regulated under cap-and-trade for two time periods: the two years prior and the two years after the program came into effect. We present the range in emissions changes reported by individual facilities within seven industry sectors for 2013-14 versus 2011-12; this includes the median (50th percentile), mean (average), and 10th to 90th percentile of changes in emitter covered emissions for 314 GHG facilities. For example, six of the nine cement plants included in **Figure 4** reported increases in emissions during 2013-14 relative to 2011-12. The median value corresponds to the 143,295-ton increase reported by the cement plant in the middle of the distribution (5th highest emitting facility out of the nine total). Similarly, the 25th and 75th percentiles correspond to the increases reported by the 3rd and 7th highest emitting facilities. The facilities with the minimum and maximum emissions changes are not shown in this graph to make it more legible; for example, the Cemex Victorville cement plant reported an increase of over 843,000 tons, an amount that far exceeds the range portrayed in **Figure 4**.

FIGURE 4
Change in Emitter Covered GHG Emissions by Industry Sector (N=314 facilities)

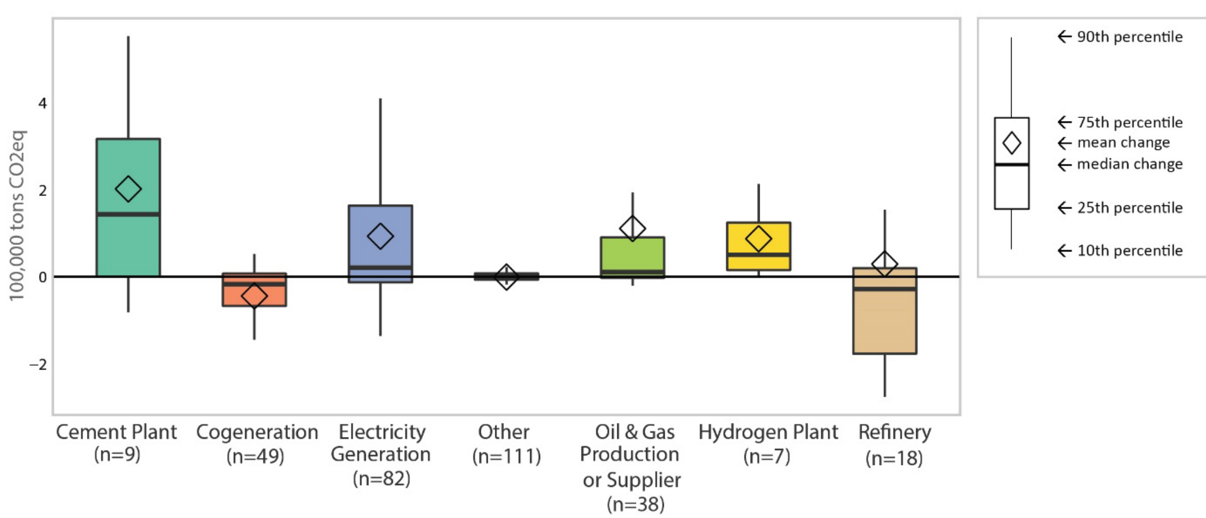
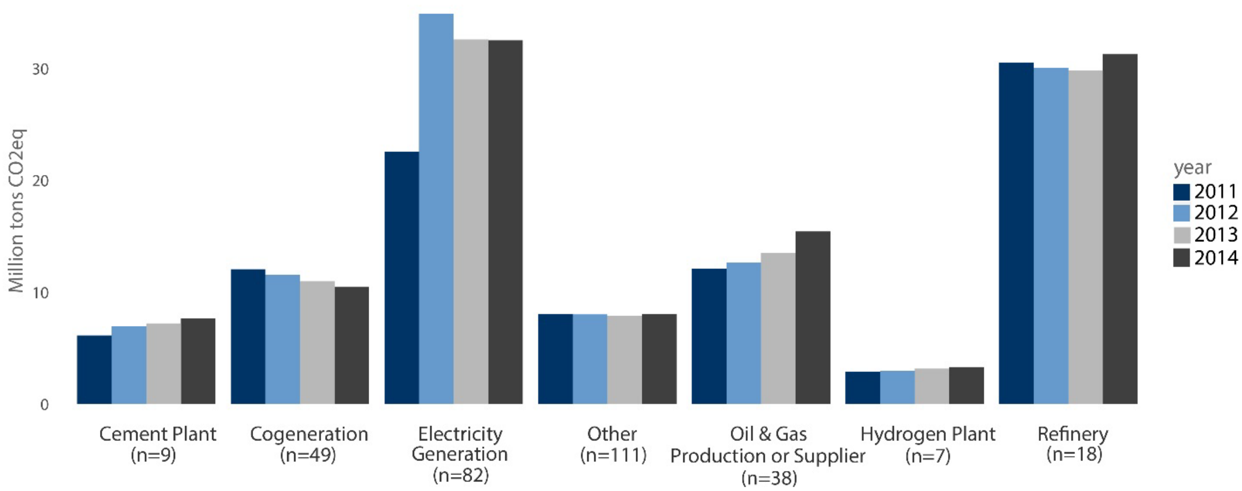


Figure 5 shows temporal trends in total emitter covered emissions (the sum of emissions from all individual facilities) by industry sector for 2011-2014. The number of facilities can change from year to year due to shutdowns, startups, and changes in emissions that affect whether facilities are required to report GHG emissions to CARB. In both **Figure 4** and **Figure 5**, we included only those facilities that: 1) report to the inventory every year during the four-year period, and 2) report at least some emitter covered emissions during those same four years. Again, the upward trend in several sectors is notable.

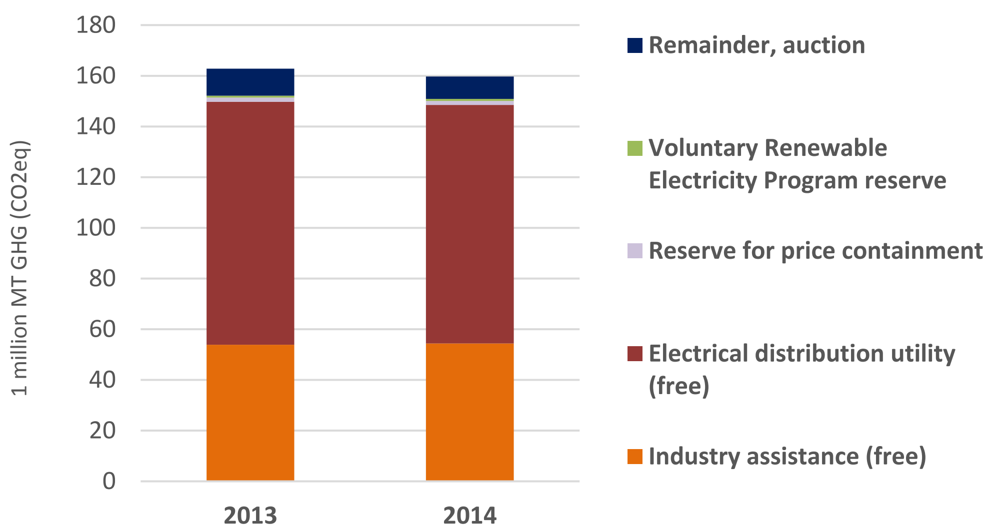
FIGURE 5
Temporal Changes in Total Emitter Covered GHG Emissions by Industry Sector



5. Between 2013 and 2014, more emissions "offset" credits were used than the total reduction in allowable GHG emissions (the "cap"). These offsets were primarily linked to projects outside of California, and large emitters of GHGs were more likely to use offset credits to meet their obligations under cap-and-trade.

The cap-and-trade program requires regulated companies to surrender one compliance instrument—in the form of an allowance or offset credit—for every ton of qualifying GHGs they emit during each compliance period. These instruments are bought and sold on the carbon market. The total number of allowances is set by the "cap," which decreases by roughly 3 percent per year in order to meet GHG reduction targets. In 2013 and 2014, most allowances were given to companies for free for leakage prevention, for transition assistance, and on behalf of ratepayers (**Figure 6**). Additional offset credits were generated from projects that ostensibly reduce GHGs in ways that may cost less than making changes at a regulated facility.

FIGURE 6
Allocation of Allowances



Regulated companies are allowed to "pay" for up to 8 percent of their GHG emissions using such offset credits. The majority of the offset credits (76 percent) used to date were generated by out-of-state projects (**Figure 7**). **Figure 8** shows that most offset credits were generated from projects related to forestry (46 percent)[10] and the destruction of ozone-depleting substances (46 percent). Furthermore, over 15 percent of offset credits used during the first compliance period were generated by projects undertaken before final regulations for the cap-and-trade program were issued in 2011, calling into question whether these GHG reductions can be attributed to California's program, or whether they might have happened anyway.

FIGURE 7
Origin of Offset Credits

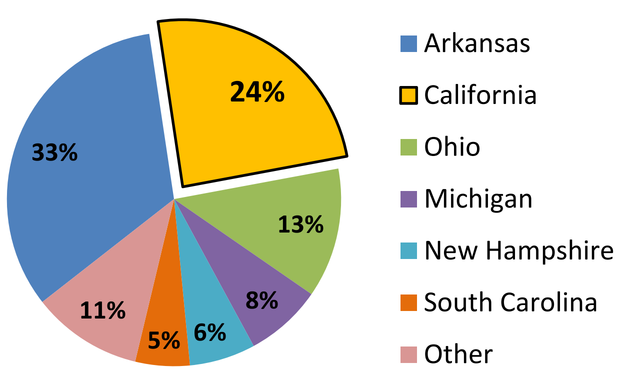
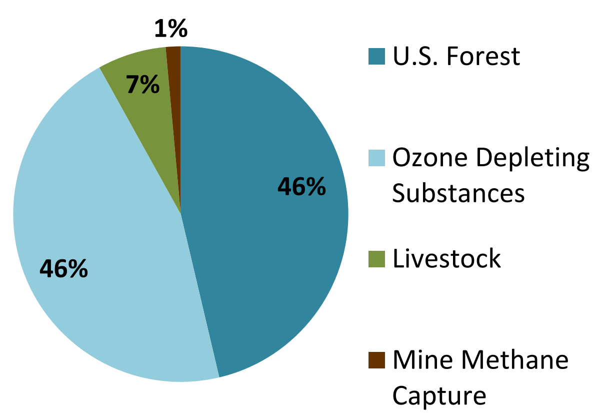


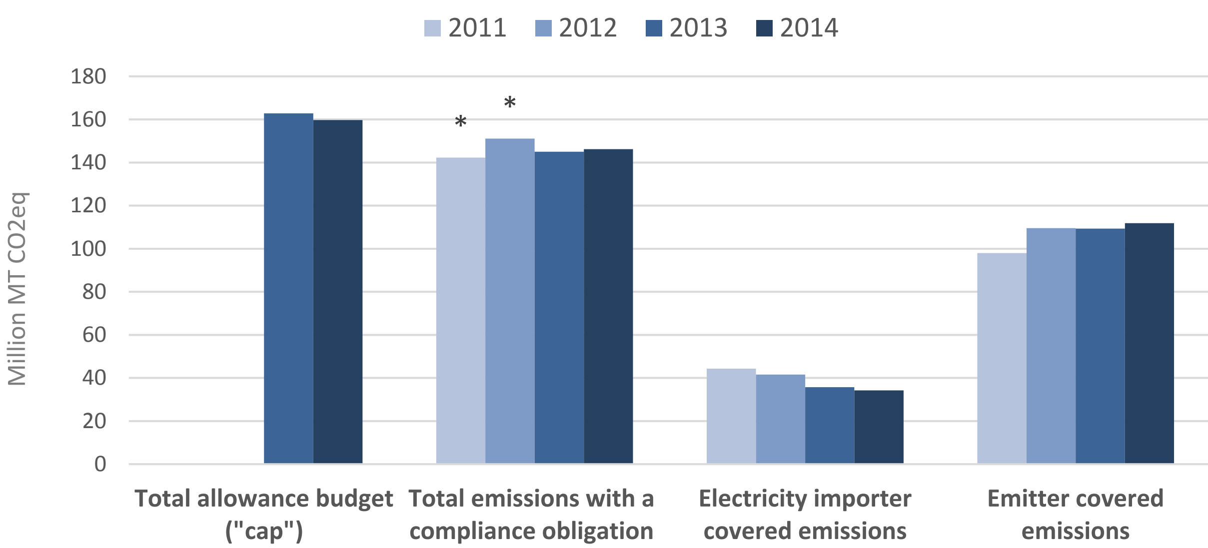
FIGURE 8
Offset Credits by Project Type



During the first compliance period of 2013-14, the total emissions that were subject to a compliance obligation (the second set of columns in **Figure 9**) were lower than the cap set by the allowance budget (left-most set of columns in **Figure 9**). This total includes both the emitter covered emissions that have been the focus of our analysis so far (right-most set of columns in **Figure 9**) and out-of-state emissions associated with imported electricity (which went down every year during the four-year period as shown by the third set of columns in **Figure 9**). Offset credits worth more than 12 million tons of CO_{2eq} were utilized to meet these obligations. These offsets represent 4.4 percent of the total compliance obligation of all regulated companies and over four times the targeted reduction in GHG emissions from 2013 to 2014 as established by the cap (**Figure 10**).

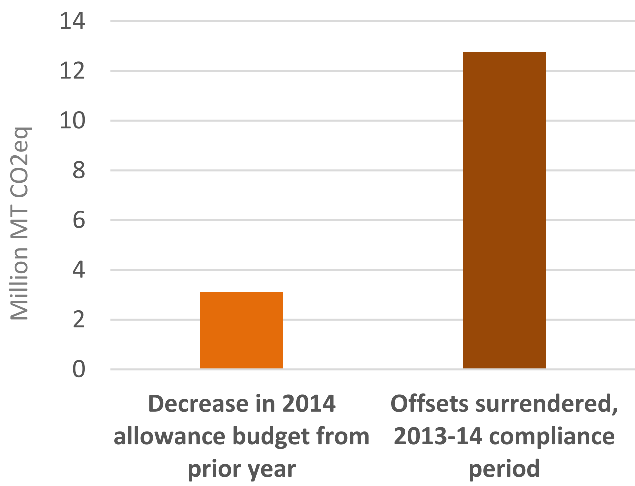
We found that the majority of companies did not use offset credits to meet their compliance obligation; however, those companies that *did* use offsets tended to have larger quantities of GHG emissions. The top 10 users of offsets account for 36 percent of the total covered emissions and 65 percent of the offsets used. These top offset users included Chevron (1.66 million offsets), Calpine Energy Services (1.55 million offsets), Tesoro (1.39 million offsets), SoCal Edison (1.04 million offsets), Shell (0.62 million offsets), PG&E (0.44 million offsets), Valero (0.43 million offsets), La Paloma Generating Company (0.40 million offsets), San Diego Gas & Electric (0.39 million offsets), and NRG Power (0.33 million offsets).

FIGURE 9
Total GHG Budget



* *Only emissions during 2013 and 2014 were subject to a compliance obligation. Estimates of comparable emissions during 2011 and 2012 were derived by summing the "emitter covered" and "electricity importer covered" emissions reported by regulated facilities for those years.*

FIGURE 10
Offset Credits vs. Decrease in Allowance Cap



CONCLUSIONS

California's efforts to slow climate change by reducing GHG emissions can bring about additional significant co-benefits to health, particularly in disadvantaged communities. Preliminary analysis of the equity implications of California's cap-and-trade program indicates that regulated GHG-emitting facilities tend to be located in neighborhoods with higher proportions of residents of color and residents living in poverty. There is a correlation between emissions of GHGs and PM_{10}, and facilities that emit the highest levels of both GHGs and PM_{10} are similarly more likely to be located in communities with higher proportions of residents of color and residents living in poverty. This suggests that the public health and environmental equity co-benefits of California's cap-and-trade program could be enhanced if there were more emissions reductions among the larger emitting facilities that are located in disadvantaged communities.

Currently, there is little in the design of cap-and-trade to ensure this set of localized results. Indeed, while the cap-and-trade program has been in effect for a relatively short time period, preliminary evidence suggests that in-state GHG emissions from regulated companies have increased on average for several industry sectors and that many emissions reductions associated with the program were linked to offset projects located outside of California. Large GHG emitters that might be of most public health concern were the most likely to use offset projects to meet their obligations under the cap-and-trade program.

Further research is needed before firm policy conclusions can be drawn from this preliminary analysis. As regulated industries adapt to future reductions in the emissions cap, California is likely to see more reductions in localized GHG and co-pollutant emissions. Thus far, the state has achieved overall emissions reductions in large part by using offsets and replacing more GHG-intensive imported electricity with cleaner, in-state generation. Steeper in-state GHG reductions can be expected going forward if the use of offsets were to be restricted and the opportunity to reduce emissions by replacing imported electricity with in-state generation becomes exhausted.

However, ongoing evaluation of temporal and spatial trends in emissions reductions will be critical to assessing the impact of the cap-and-trade program. Several recommendations would strengthen future analyses and facilitate better tracking of the public health and environmental equity aspects of the cap-and-trade program going forward.

These include:

- Building better linkages between state facility-level databases on GHG and co-pollutant emissions. To conduct this preliminary analysis, we had to do a series of matches between datasets with different facility ID codes (see Appendix for details). Harmonization of facility ID codes between relevant data sources could be built into facility emissions reporting requirements going forward in order to facilitate analysis of temporal and spatial GHG and co-pollutant emissions trends.
- Publicly releasing data on facility- and company-specific allowance allocations.
- Tracking and making data available on facility- and company-specific allowance trading patterns.

Good quality, publicly accessible data and robust analysis will be critical to informing policy discussions and improving regulatory implementation of California's climate law in ways that incentivize deeper in-state GHG reductions and that achieve both sustainability and environmental equity goals.

ACKNOWLEDGEMENTS

We thank USC PERE Data Manager Justin Scoggins, Graduate Research Assistant Melody Ng, and Communications Specialist Gladys Malibiran for their assistance in the production of this brief; the California Environmental Justice Alliance for helpful feedback on an early version of this brief; and the Energy Foundation (grant number G-1507-23494), the Institute for New Economic Thinking (grant number INO1500008), and the Resource Legacy Fund for their support of this work.

APPENDIX

This appendix includes a description of the methods used in our preliminary environmental equity assessment of California's cap-and-trade program. We also present supplemental analyses, including a comparison of neighborhood demographics near regulated GHG facilities using different buffer distances to define proximity.

Methods

GREENHOUSE GAS EMISSIONS

To start, we downloaded annual, facility-specific GHG emissions data for 2011-2014 from the Mandatory Reporting of Greenhouse Gas Emissions (MRR) program.[1] The MRR includes self-reported estimates of annual emissions of greenhouse gases (GHGs)—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated GHGs—from regulated industries that have been verified by an independent third party. Emissions are given in units of CO_2-equivalents, a metric that combines the quantity of individual gases emitted with the potency of each gas in terms of its contribution to climate change over a 100-year time frame (also known as "global warming potential"). Our analysis focused on one class of emissions included in this database called "emitter covered emissions," which corresponds to localized, in-state emissions resulting from "the combustion of fossil fuels, chemical and physical processes, vented emissions…and emissions from suppliers of carbon dioxide"[11] as well as emissions of GHGs other than CO_2 from biogenic fuel combustion. The term "covered" refers to the fact that these emissions are subject to a compliance obligation under the cap-and-trade program; releases of CO_2 that result from the combustion of biogenic fuels, for example, are exempted. The cap-and-trade program also regulates out-of-state emissions associated with electricity imported into the state and, beginning in 2015, began regulating distributed emissions that result from the burning of fuels such as gasoline and natural gas in off-site locations (e.g., in the engines of vehicles and in homes); although we did not analyze distributed emissions in this report, this category of emissions will be a future research topic.

The number of facilities reporting to the MRR can change from year to year due to shutdowns, startups, and changes in emissions that affect whether facilities are required to report. In our analysis of trends in emissions across industry sectors, we excluded facilities that did not report to the emissions inventory every year during 2011-14, as well as facilities that reported no emitter covered emissions during the four-year period. Facilities were categorized according to the sector reported in the MRR with slight modifications to reduce the number of categories. Facilities described as a refinery alone or in combination with any of the following were categorized as a refinery: hydrogen plant, CO_2 supplier, or transportation fuel supplier. Facilities described as "other combustion source" or "other combustion source/ CO_2 supplier" were categorized as "other."

We determined or confirmed the geographic location of each facility using a variety of data sources and methods. Geographic point locations for some facilities were obtained directly from the California Air Resources Board (CARB), and facility addresses reported in CARB's online GHG visualization tool were geocoded.[12] We located some sites using individual internet searches. All locations inside California were visually confirmed, and point locations were adjusted for accuracy using aerial imagery in Google Earth Pro.

CO-POLLUTANT DATA (PM_{10})

We obtained emissions of criteria air pollutants from the California Emission Inventory Development and Reporting Systems (CEIDARS) database for years 2011-14.[2] Reporting requirements, including the way in which facilities are defined, the numeric identifier attached to each facility, and the frequency of reporting, differ between CEIDARS and the MRR GHG database. This presents a challenge for combining emissions estimates from the two sources. In particular, criteria air pollutants are not required to be reported annually, and emissions estimates contained in the 2014 CEIDARS database may correspond to estimates from prior years. We joined data on PM_{10} emissions from the 2014 CEIDARS with GHG emissions information from the MRR GHG database based on the facility name, city, and ZIP code. For some GHG facilities listed in the MRR GHG database, we obtained addresses from CARB's Facility GHG Emissions Visualization and Analysis Tool.[12] Since the CEIDARS database also contains addresses, we were able to use the address field to confirm and find additional matches. When all variables (facility name, city, and ZIP code) did not match between the two data sources, matches were confirmed by hand through internet searches of company websites and online databases containing facility names and addresses.

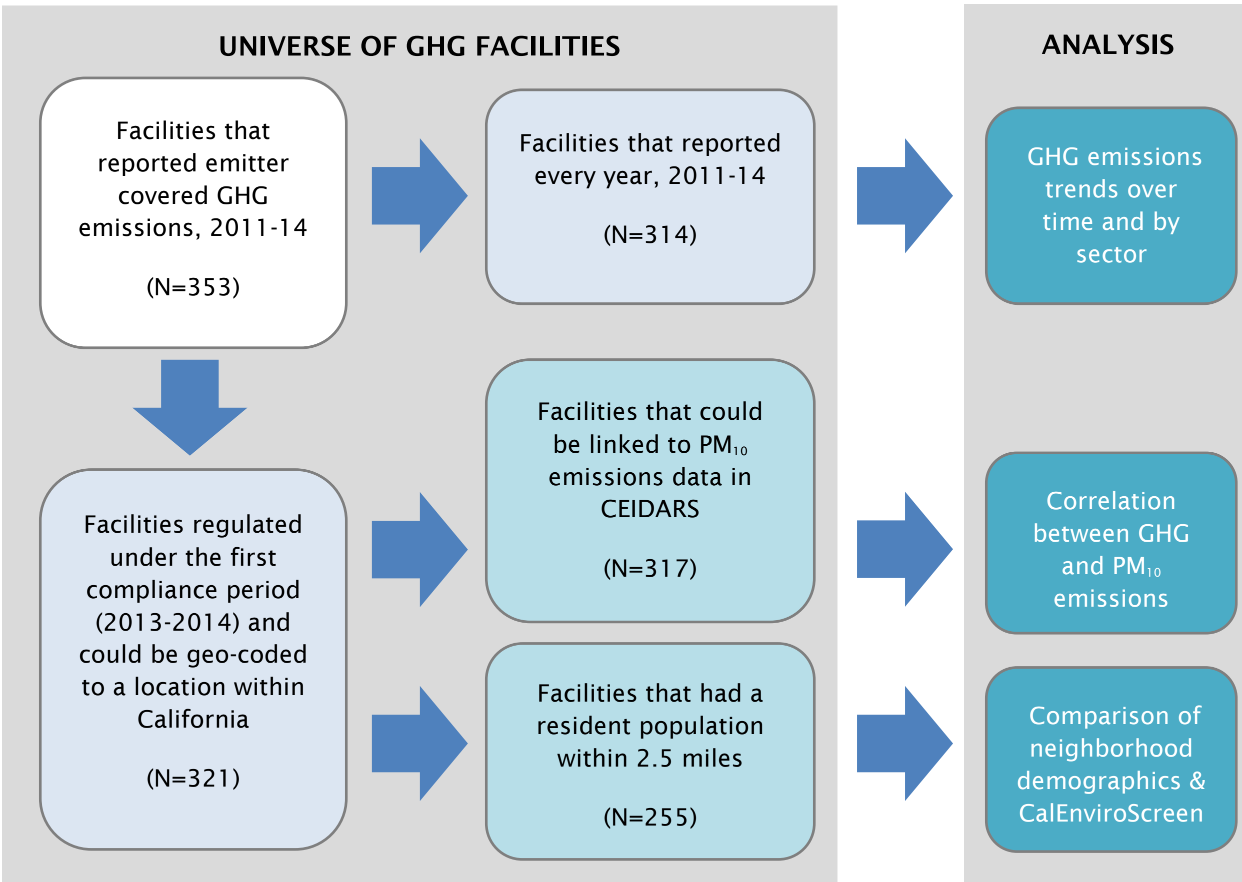
NEIGHBORHOOD DEMOGRAPHICS AND CUMULATIVE IMPACT

We defined neighborhoods on the basis of 2010 vintage Census block group boundaries provided by the U.S. Census.[13] Block group centroids were created by using the point-to-polygon tool in ArcGIS and the distance between block group centroids and GHG facility locations was calculated using the point-distance tool in ArcGIS (ESRI, Redlands, CA).

Demographic information for each block group was obtained from the 2014 5-year American Community Survey estimates. White individuals were defined as those who self-identified as white but not Hispanic. People of color were defined as all other individuals, including those who identified as multiracial or of Hispanic ethnicity. Poverty was defined as twice the federal poverty level (FPL) to reflect increases in the cost of living since the FPL was established and California's high cost of living.

CalEnviroScreen is a state-level screening tool developed by the California Environmental Protection Agency that helps identify California communities that are disproportionately burdened by multiple sources of pollution.[14] It includes indicators of proximity to environmental hazards and population vulnerability to derive a relative score of cumulative environmental health impact. We assigned block groups the most recent CalEnviroScreen score of their census tract in order to compare CalEnviroScreen rankings near GHG facilities to the rest of the state. **Figure 11** summarizes the construction of our facility-level dataset.

FIGURE 11 – Construction of the Dataset



ALLOWANCES AND OFFSETS

Unlike the emissions data, information on the allocation of allowances and ways in which regulated industries are complying with the cap-and-trade program is reported on an industry- and company-specific basis, rather than at the facility level. One company may own several regulated facilities. Information on the allocation of allowances was compiled from the California Code of Regulations (17 CA ADC § 95841 and 17 CCR § 95870) and CARB publications on the public allocation of allowances and estimates of state-owned allowances.[15] We obtained the number of allowances and offsets surrendered by each company at the completion of the first compliance period from CARB's 2013-14 Compliance Report.[16] Information on individual offset projects was compiled from CARB documents on offsets issued as of August 10, 2016[17] and individual project descriptions provided in the American Carbon Registry and Climate Action Reserve carbon offset registries.[18]

Supplemental Analyses

Consistent with the findings presented in **Table 1** in the main text, **Table 3** shows that neighborhoods within 1.5 miles of a facility with localized GHG emissions have a 16 percent higher proportion of residents of color, a 26 percent higher proportion of residents living in poverty, and a higher likelihood of scoring among the worst statewide in terms of their CalEnviroScreen score than neighborhoods that are not within 1.5 miles of such a facility. **Table 4** and **Table 5** show similar trends when neighborhoods up to a larger distance of 3.5 and 6 miles away are considered. These results confirm that the findings presented in our main analysis were not sensitive to our choice of buffer distance.

TABLE 3
Characteristics of Neighborhoods within 1.5 miles of GHG-emitting Facilities
(N=255 facilities)

	Block groups with at least one facility within 1.5 miles (N=2,710)	Block groups with no facilities within 1.5 miles (N=20,392)
Mean % People of Color	66%	57%
Mean % People Living Below Twice the Poverty Level	44%	35%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	20%	9%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	36%	18%

TABLE 4
Characteristics of Neighborhoods within 3.5 miles of GHG-emitting Facilities
(N=255 facilities)

	Block groups with at least one facility within 3.5 miles (N=9,991)	Block groups with no facilities within 3.5 miles (N=13,111)
Mean % People of Color	66%	51%
Mean % People Living Below Twice the Poverty Level	39%	33%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	15%	6%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	29%	13%

TABLE 5

Characteristics of Neighborhoods within 6 miles of GHG-emitting Facilities (N=255 facilities)

	Block groups with at least one facility within 6 miles (N=16,365)	Block groups with no facilities within 6 miles (N=6,737)
Mean % People of Color	65%	41%
Mean % People Living Below Twice the Poverty Level	37%	32%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	13%	3%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	25%	7%

In the main text, we defined the 66 largest GHG and PM_{10} emitting facilities as those that were within the top third in terms of their 2014 emissions of both PM_{10} and localized GHGs, and highlighted them in orange in **Figure 2**. We found that 40 (61 percent) of these high-emitting facilities reported increases in their localized GHG emissions in 2013-14 relative to 2011-12, versus 51 percent of facilities overall. Neighborhoods near the top-emitting facilities that increased emissions had higher proportions of people of color than neighborhoods near top-emitting facilities that decreased their emissions (**Table 6**).

TABLE 6

Characteristics of Neighborhoods near top GHG- and PM_{10}-Emitting Facilities that Increased and Decreased GHG Emissions (N=66 facilities[19])

	Block groups within 2.5 miles of at least one top emitting facility that increased GHG emissions (N=675)	Block groups within 2.5 miles of at least one top emitting facility that decreased GHG emissions (N=669)
Mean % People of Color	74%	58%
Mean % People Living Below Twice the Poverty Level	46%	34%
% of Block Groups in a "Top 10%" CalEnviroScreen tract	25%	14%
% of Block Groups in a "Top 20%" CalEnviroScreen tract	46%	28%

ENDNOTES

[1] Mandatory Reporting of Greenhouse Gas Emissions (MRR), http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm.
[2] CEIDARS, http://www.arb.ca.gov/ei/disclaim.htm; http://www.arb.ca.gov/ei/drei/maintain/dbstruct.htm.
[3] GHG facilities were limited to those that report emitter covered emissions during the first compliance period of cap-and-trade (2013-14), could be geo-coded in California, and had a resident population within 2.5 miles (N=255). We define neighborhoods using Census block groups. Residential proximity to a GHG facility was based on the distance between the facility location and each block group's centroid. We chose a 2.5 mile distance due to its common use in other environmental justice analyses. The Appendix gives results using alternative distance buffers.
[4] For calculations in Table 1, we used the universe of block groups for which there are valid data (i.e., non-missing data) for all four measures shown. However, the results were the same when we included all block groups with valid data for each measure on an individual basis.
[5] The map in Figure 1 shows 66 additional facilities that are not included in Table 1 and Figure 2 because they are not within 2.5 miles of a block group centroid with a resident population. See Figure 11 in the Appendix for details.
[6] Because there are several PM_{10} values that are between zero and one metric ton, in Figure 3 we added 1 to the PM_{10} value for all facilities prior to taking the log10 to avoid reporting negative values.
[7] Similar to Table 1, for calculations in Table 2, we used the universe of block groups for which there are valid data (i.e., non-missing data) for all four measures shown. However, the results were the same when we include all block groups with valid data for each measure on an individual basis.
[8] The results were qualitatively similar when we compared 2014 emissions to 2012 emissions. That is, the median and mean for each industry sector were in the same direction as shown in Figure 4 (above, near, or below zero), with one major exception: electricity generators on average decreased their emitter covered emissions in 2014 relative to 2012.
[9] California GHG Emission Inventory, 2016 Edition, http://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2014/ghg_inventory_trends_00-14_20160617.pdf.
[10] Some have critiqued the appropriateness of forestry projects for carbon offset purposes. For example, tree planting projects can take decades to reach maturity in terms of their ability to sequester carbon. Younger trees sequester less carbon and often take decades to fully mature. Moreover, it is challenging to measure and quantify the ability of forestry projects to sequester carbon over time. In particular, the permanence of forestry projects cannot be guaranteed as they remain susceptible to fire, disease, natural decay, clearing, or mismanagement. Forestry projects are also vulnerable to "leakage." This refers to the fact that, unless global demand for wood products goes down, a reduction in logging in one location can simply result in greater deforestation in another location.
(See http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=0 and http://www.web.uvic.ca/~repa/publications/REPA%20working%20papers/WorkingPaper2007-02.pdf for overviews of these issues.)
[11] https://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/2014-ghg-emissions-2015-11-04.xlsx
[12] http://www.arb.ca.gov/ei/tools/ghg_visualization/
[13] https://www.census.gov/geo/maps-data/data/cbf/cbf_blkgrp.html
[14] http://oehha.ca.gov/calenviroscreen/report/calenviroscreen-version-20
[15] http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/publicallocation.htm; http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/edu-ng-allowancedistribution/electricity-allocation.pdf; http://www.arb.ca.gov/cc/capandtrade/stateauction.htm
[16] http://www.arb.ca.gov/cc/capandtrade/2013-2014compliancereport.xlsx
[17] http://www.arb.ca.gov/cc/capandtrade/offsets/issuance/arb_offset_credit_issuance_table.pdf
[18] http://americancarbonregistry.org; http://www.climateactionreserve.org
[19] 66 GHG facilities fell in the top third in terms of both PM_{10} and localized GHG emissions. We found that 40 of these facilities increased localized GHG emissions, 23 decreased emissions, and three did not report to the database all four years (2011-2014) so we could not determine an increase or decrease.

Exhibit 4

Bulletin of the Atomic Scientists

IT IS 5 MINUTES TO MIDNIGHT

Feature

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How California's carbon market actually works

Danny Cullenward

Abstract

Almost 10 years ago, California's legislature passed Assembly Bill 32, the Global Warming Solutions Act of 2006. AB 32 set the most ambitious legally binding climate policy in the United States, requiring that California's greenhouse gas emissions return to 1990 levels by the year 2020. The centerpiece of the state's efforts—in rhetorical terms, if not practical ones—is a comprehensive carbon market, which California's leaders promote as a model policy for controlling carbon pollution. Over the course of the past 18 months, however, California quietly changed its approach to a critical rule affecting the carbon market's integrity. Under the new rule, utilities are rewarded for swapping contracts on the Western electricity grid, without actually reducing greenhouse gas emissions to the atmosphere. Now that the Environmental Protection Agency is preparing to regulate greenhouse gases from power plants, many are looking to the Golden State for best climate policy practices. On that score, California's experience offers cautionary insights into the challenges of using carbon markets to reduce greenhouse gas emissions.

Keywords

California, cap-and-trade, carbon market, climate policy, emissions, leakage, resource shuffling

For years, Southern California Edison imported electricity from the Four Corners Power Plant, a coal-fired facility in northwestern New Mexico. When California's groundbreaking carbon market took effect in 2013, Edison, like all other in-state utilities, became responsible for the climate pollution from its generating fleet. A few months later, the company sold its interest in the coal plant to an Arizona utility (APS, 2013). Whatever replacement supplies Edison selects will be cleaner than coal, the most carbon-intensive fossil fuel, and Edison will report reduced emissions in California's carbon market.

At first this sounds like a positive story: Policy puts price on carbon, pollution falls. But this transaction will not reduce net greenhouse gas emissions to the atmosphere. The coal plant will keep emitting pollution just as before—only now it serves customers in Arizona, not California.

As it has with many other environmental issues before, California aims to set an example for the United States on climate policy. The key to its success, according to state officials, is a comprehensive carbon market—featuring "good policy design, clear oversight and strong enforcement" (Nichols, 2014). Ironically, one of the most visible consequences of the market's first year is a rush to swap coal power imports for cleaner replacements, limiting the extent to which California's policy leadership actually helps the climate. Is this perverse outcome the unavoidable consequence of California acting without its neighbors' support, or could the state have done more to ensure that its market creates real environmental benefits?

An efficient theory

The slow birth of American climate policy coincides with a transition in the way our country manages its environmental problems. Most of our national environmental laws were drafted at a time when both political parties supported government regulation of the private sector. That was, of course, a different era. Since then, the center of national political opinion has shifted dramatically in favor of the free market. And that trend is visible in contemporary environmental policy, which, over the last few decades, has moved away from traditional regulatory approaches to controlling pollution. Flexible, market-based mechanisms are now the preferred route.

The thinking goes something like this: Rather than impose specific requirements on individual companies or industries, it is more efficient for the government to set economy-wide policy targets and let the private sector find the cheapest way to meet them. In theory, this not only increases the flexibility of regulated industries' compliance options but also reduces the policy's administrative complexity. Thus, if done right, economic approaches to environmental policy should result in a win-win.

Enter a uniquely American invention, the carbon market—also known as emissions trading or cap-and-trade.[1] The idea is simple, though the practice is not. Economic theory says that all a government needs to do is: set a quantitative cap on emissions; create and freely distribute or auction emissions permits, with the total number of permits equal to the cap; and require polluters to turn in a permit for each unit of pollution they emit. With this framework in place, the government steps back to let the private sector do what it does best: trade permits to minimize costs.

The most critical component of a carbon market is the cap. Typically, the cap is expressed as a maximum quantity of emissions allowed in any given year, with each year's limit declining toward a long-term goal. Think of it like a game of musical chairs—with carbon pollution as the players, and the chairs representing emissions permits. At the end of every year, the music stops and the players must seat themselves. When there are more people than chairs, market forces dictate who leaves the game and who can stay; the government's role in this analogy is only to set up the rules and remove the correct number of chairs at each stage. So long as the government counts the right number of chairs, everything should work out fine.

California's climate policy

After the United States withdrew from the Kyoto Protocol and elected George W. Bush, whose administration strongly opposed legally binding federal climate policy, momentum shifted to the states. California moved to claim its traditional role as an environmental policy leader by passing AB 32, the Global Warming Solutions Act of 2006. Most notably, this bill requires California's emissions to fall to 1990 levels by the year 2020. AB 32 also designated a primary regulator, the California Air Resources Board (CARB), making CARB responsible for developing specific policies and measures that would lead California to its 2020 target.

The key to understanding California's climate policy system lies in recognizing the overlapping structure of the instruments that CARB and other agencies eventually adopted. Arguably the state's best-known climate policy is its comprehensive carbon market, which CARB designed and implements. At the same time, California has a number of robust regulatory programs that apply to sectors that are also covered by the carbon market. For example, California has one of the strongest renewable portfolio standards (requiring utilities to purchase 33 percent of their electricity from renewable sources by 2020), as well as world-class energy efficiency programs and a clean transportation fuels policy.

Climate experts refer to these programs as "complementary policies"—a phrasing that suggests they exist to support the primary instrument, a carbon market. In practice, however, the complementary policies do most of the work. When CARB created its plan for meeting California's 2020 emissions target, it relied on complementary policies for approximately 80 percent of the reductions, leaving a mere 20 percent to "additional reductions" in the sectors covered by the state carbon market (CARB, 2008)—meaning that most of the emissions reductions are being accomplished by individual policies, not driven by the comprehensive market price on carbon. As my colleague Michael Wara (2014) explains elsewhere in this issue, the complementary policies effectively hide the true cost of California's climate policy: Because most of the necessary emissions reductions are required by separate regulation, rather than left to the carbon market, the carbon price reflects only a fraction of the state's climate policy efforts.[2]

California's market design

California benefits from the experience of the emissions trading systems that came before it. By carefully observing the early years of the European Union's Emissions Trading Scheme (ETS), for example, CARB was able to avoid many of the hiccups that confronted its predecessors. These successes are all the more laudable because California has implemented the most comprehensive market to date. While the northeastern states' Regional Greenhouse Gas Initiative controls only emissions from power plants, California's market currently covers the power and industrial sectors (as does the European ETS), and will expand next year to include the transportation fuels and natural gas sectors. All told, this will encompass about 85 percent of the state's total emissions—a comprehensive policy by any standard.

On the other hand, California faces many new challenges that previous markets never had to address. In particular, the state must contend with the fact that it is only a small part of a regional electricity transmission grid stretching from the Pacific Ocean to the Rocky Mountains. The scale of the Western grid matters because California is a significant net importer of electricity. Recognizing that the emissions profile of its electricity imports is part of California's carbon footprint, regulators rightly included electricity imports in the cap-and-trade program. But geography introduced new headaches. Because California is the only western state that prices its greenhouse gas emissions, utilities and power traders now face an incentive to swap their high-emitting imports for cleaner replacements—a practice known as resource shuffling. (Recall the earlier example of Southern California Edison divesting its interest in a New Mexico-based coal power plant: Emissions reported in California go down, but emissions across the western United States do not change.)

If utilities are allowed to shuffle electric power imports, the emissions reductions they report in California's carbon market will not reflect reduced emissions to the atmosphere. Instead, the dirty resources California utilities divest will continue polluting the air under new, unregulated ownership. Given this dilemma, what should carbon market regulators do?[3]

A quiet coup

As it happens, the California Legislature anticipated these concerns. When the legislature delegated broad authority to CARB to create climate policy, it also issued guidelines that the regulator must incorporate in its policies. Specifically, state law requires that "to the extent feasible," climate regulations must "minimize leakage."[4] California law defines leakage as "a reduction in emissions of greenhouse gases within the state that is offset by an increase in emissions of greenhouse gases outside the state."[5]

In plain English, this requirement means that CARB should not give credit to actions that merely shift the responsibility for greenhouse gas emissions beyond state borders. Instead, AB 32 dictates that CARB should only recognize net reductions in emissions to the atmosphere. For a time, CARB followed this instruction. Its initial carbon market regulations banned resource shuffling, and went so far as to require companies' executives to attest that they were not engaged in this practice.[6]

But this approach proved controversial. In the months leading up to the beginning of the market's first compliance period, several stakeholders objected to the resource shuffling rules and began agitating for reforms. The first public proposal came from California's investor-owned utilities, which in September 2012 advocated a series of exemptions to the prohibition on resource shuffling (Joint Utilities Group, 2012). The following month, CARB directed its staff to develop modifications to the resource shuffling regulations, providing 13 fully developed "safe harbor" exemptions to the definition of resource shuffling (CARB, 2012a)—directly comparable to, if not more permissive than, the Joint Utilities Group proposal. A few weeks later, CARB staff released a new regulatory guidance document that incorporated these safe harbors, almost word for word (CARB, 2012b).

When a regulator issues a guidance document that publicly describes how to interpret its rules, that description provides a legal defense to any private party that reasonably relies upon it. After all, it would be extremely unfair if following the regulator's own advice could get one in legal trouble. But consider what this meant for the carbon market. On the eve of the program's launch in January 2013, the regulator quietly rewrote its own rules through informal guidance documents. Formally, its regulations prohibited resource shuffling. Yet CARB's own guidance document indicated that this straightforward prohibition would not apply to 13 broad categories of transactions. Thus, when the market began operation in 2013, its practical function had already diverged from its formal legal rules.

The market springs a leak

My colleague David Weiskopf and I had been studying CARB's resource shuffling rules during this tumultuous time. We recognized that CARB faced an incredibly difficult task in writing effective and legally permissible cross-border accounting rules, yet we were surprised at the scope of CARB's informal guidance document. We believed that a compromise was possible, to give utilities clear and flexible rules without undermining the environmental integrity of the market.

Meanwhile, we were deeply concerned that the informal guidance document effectively revoked the prohibition on resource shuffling. We published our analysis of the safe harbors and the leakage risks they created in July 2013 (Cullenward and Weiskopf, 2013). Most important, we described how several of the safe harbors were broader than the underlying prohibition. In addition, we pointed out that two safe harbors explicitly allowed California utilities to divest their long-term contracts with out-of-state coal power plants.

As it happens, these coal power imports account for a significant portion of California's emissions. We calculated that if California utilities relied on the safe harbors to divest from just six coal power plants, they could cause between 108 and 187 million tons of carbon dioxide to leak out of California's market—a quantity that is roughly equivalent to the expected size of the market, after accounting for the likely impact of the complementary policies. Furthermore, we realized that our analysis was consistent with calculations from CARB's own economic advisory committee, called EMAC, which found that resource shuffling of all types could lead to leakage of between 120 and 360 million tons of carbon dioxide (Borenstein et al., 2013). (The EMAC report did not assess whether the safe harbors would enable leakage; it looked only at what the effects of resource shuffling would be if there were no prohibition against it.)

In addition to presenting our concerns, we also developed a complete regulatory text to implement an alternative approach to controlling resource shuffling. Even if our suggestions could have been helpful, they probably arrived too late. That same month, CARB hosted a workshop to consider draft regulatory amendments that would codify the safe harbors into law. As it became clear that CARB would proceed without any public acknowledgement of the leakage problem, I wrote an op-ed in the *San Jose Mercury News* raising the issues described here (Cullenward, 2013a), as well as two comment letters addressing the technical and legal questions in the formal administrative process (Cullenward, 2013b, 2014a).

Over the following months, three of the six coal power plants that Weiskopf and I identified became involved in resource-shuffling-related transactions, leaking between 30 and 60 million tons of carbon dioxide out of California's carbon market (Cullenward, 2014b).

Two of these contracts have already left the regulatory system, while a third—under which the Los Angeles utility LADWP imports power from the coal-fired Navajo Generating Station on tribal lands in Arizona—is on its way out. In a regulatory filing connected with its purchase of replacement power, LADWP even disclosed that a benefit of divestment from the Navajo Generating Station would be "relieving LADWP from having to purchase emission credits" in the carbon market (LADWP, 2013: 3). Yet, as I pointed out in my second comment letter to CARB (Cullenward, 2014a), there is little doubt that the utility's divestment plan fits squarely in one or more of the safe harbors, and therefore does not violate CARB's guidance. By the time CARB unanimously voted to approve its new regulations, it had substantial evidence that its safe harbors were facilitating significant leakage—despite AB 32's clear requirements to the contrary.

A weak cap

What does leakage mean for California's climate policy? First and foremost, it means the "cap" in cap-and-trade is much less than it seems.

Return for a minute to the analogy of carbon markets as a game of musical chairs. Earlier, I suggested that so long as the government sets out the right number of chairs (a shrinking supply of emissions permits), the game should run smoothly. But resource shuffling essentially allows players to leave the game—say, by offering them an open spot on a comfortable couch in a nearby room. If resource shuffling is allowed, counting the number of chairs no longer provides reliable information about the environmental performance of the system.

And that's the major flaw in California's system. Now that resource shuffling is happening, we know that California's supposed reductions reflect bad bookkeeping, because the market cap is no longer firm. If the remaining coal power imports leave the carbon market, or if utilities take full advantage of the other safe-harbor provisions, a significant majority of the market's apparent emissions reductions will be attributable to leakage, not progress.

Although the market is no longer producing the net emissions reductions for which it was designed, it does have other, positive impacts. Notably, it sets a minimum price, which was $11.34 per metric ton of carbon dioxide in July 2014. The price had previously ranged from approximately $13 to $20 per ton, but began a steady decline in approximately July 2013. As this article went to press, it rested slightly above the price floor, as can be seen at the California Carbon Dashboard website (http://calcarbondash.org). These data show that an oversupply of emissions permits—caused in no small part by reduced demand due to resource shuffling—has crashed the market price down to its legal minimum.

Curiously, so long as these conditions persist, the market actually looks like a carbon tax. In other words, after years of complex negotiations, emissions trading, and hundreds of pages of market rules, California's market operates much like the carbon tax (or "fee") policies preferred by both moderate Republicans (Paulson, 2014; Shultz and Becker, 2013) and grassroots environmentalists (Citizens' Climate Lobby, 2014)—only without the transparency and accountability mechanisms that motivate many of these advocates' positions.[7] Perhaps simplicity is a virtue in climate policy after all.

In all fairness, California has managed to create the highest price on carbon pollution in the United States. It also has robust energy policies that are encouraging the expanded use of clean and efficient resources. These are all significant accomplishments, but the carbon price is still too low to do much good. We know it is lower than the actual cost of California's clean energy policies—for example, CARB reports that California's clean fuels policy credits were trading between $63 and $79 per metric ton of carbon dioxide during the last three months of 2013 (CARB, 2014), well above the carbon market price—and therefore the carbon market is not driving compliance in those sectors. In any case, the market price is certainly lower than the levels needed for the long-term transformation of the energy system.

A cautionary tale

Can anything be done about the failure of California's flagship carbon market to live up to expectations? Yes, but the political challenges are far greater than the technical issues. At this point, there is only one solution that can preserve the market's integrity: CARB must observe the leakage that results from its permissive resource shuffling rules, then tighten the overall market cap accordingly. (In my musical chairs analogy, this means removing a chair for every person who leaves the game before the music stops.) But acknowledging and resolving the problem will likely increase the carbon market price, and hence political opposition.

Some stakeholders prefer to place hope in new developments in state and federal climate policy. They argue that resource shuffling will be less of a problem if enough of California's neighbors adopt their own climate regulations. For example, the leaders of California, Oregon, Washington, and British Columbia signed an agreement to harmonize their approach to climate policy (Center for Climate and Energy Solutions, 2013). There is little chance, however, of a similar agreement with southwestern states, where most of California's legacy coal power imports originate. Waiting for the Environmental Protection Agency to act isn't an option, either. Assuming that the EPA's proposed rules are finalized and survive intense litigation, they won't produce results until after 2020, the current end date for California's legally binding market. (Moreover, the proposed federal rules do not apply to tribal lands, yet two of the three coal-fired power plants that have already leaked from California's market are located in Navajo territory.) Thus, the prospects for California's neighbors to independently resolve this problem are dim.

Even if CARB fails to address the leakage issue, California's experience offers useful insights into the politics of climate policy—though the precise lessons depend on one's point of view. The optimistic perspective looks something like this: Perhaps the flaws in the current plan reflect realistic concessions on the road to deep, long-term emissions reductions. (State policy makers are currently discussing how to set a goal for 2030 and have a nonbinding aspirational target of reducing emissions 80 percent below 1990 levels by 2050.) Even the most proactive government officials have to navigate a maze of political obstacles, technically complex issues, and the constant threat of litigation—especially when working on controversial issues such as climate policy, which challenges powerful established interests.

Sometimes policy makers make mistakes, and sometimes they make compromises. Whatever the case here, the good news is that a state can only rely on leakage once: After the high-emitting resources are gone, there are no more opportunities for resource shuffling. Instead of fighting over complex market rules, climate policy makers should focus on raising the minimum market price in future reforms. Their critics should remember that the complementary policies are unaffected by a weak market cap.

Taking a less optimistic perspective, one might question the credibility of the market regulators. At the end of the day, CARB let the utilities write their own rules. Whether CARB intended to rely on leakage to artificially lower the market price, or simply didn't understand what its economic advisers were saying about the probable consequences of these reforms, it deferred to the industry it was charged with regulating. Political realists who worry about costs should also be concerned with the environmental performance of policy instruments designed to keep costs low; California will need these policies to work if it is to achieve long-term climate targets. Equally important is consistency with the rule of law, which will be necessary to strengthen climate policy over the coming decades. From this perspective, relying on questionable accounting tricks is hardly the mark of a strong regulator that is prepared to impose tough rules for 2030 and beyond.

If there is a broader lesson in California's experience, it is this: The political and technical challenges of implementing climate policy are greater than most people appreciate—even within the expert community, which tends to view carbon markets as both eminently tractable (Newell et al., 2014) and politically expedient (Stavins, 2014). It is not enough to pass legislation or propose new regulations. Indeed, that is only the beginning.

Acknowledgements

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Notes

1. Many people incorrectly think of the carbon market as a European invention because the European Union was the first to apply it to climate policy. Europe did create the world's largest carbon market, the EU Emissions Trading Scheme, as part of its Kyoto Protocol obligations (Ellerman et al., 2007). Nevertheless, emissions trading actually got its start in the United States. For example, the US Environmental Protection Agency developed cap-and-trade markets to control lead in gasoline in the 1980s (Stavins, 2014) and for sulfur dioxide pollution from power plants in the 1990s (Ellerman et al., 2000).
2. This is not to say that California's climate policy is too expensive. My point is merely that the apparent cost observed in the carbon market is significantly lower than the true cost.
3. This challenge is not unique to California; it applies to nearly all sub-national carbon markets, including the Regional Greenhouse Gas Initiative and the pilot programs in China (Cullenward and Wara, 2014). So long as the carbon market is smaller than the region's electricity market, cross-border accounting issues will be present.
4. See California Health and Safety Code (2014: §§ 35852(b), (b)(8)).

5. See Legislative Counsel of California (2014: § 38505(j)).
6. See California Code of Regulations (2014: § 95852(b)(2)). The attestation requirement was suspended soon after adoption and recently repealed in its entirety.
7. Although advocates of these policies use different terminologies, they share the common goal of putting a price on emissions—for all practical purposes, a tax. But framing matters in politics. Citizens' Climate Lobby eschews "tax" and prefers "fee and dividend," returning all revenue back to households. Shultz and Becker promote a "revenue-neutral carbon tax," which they distinguish from other taxes by requiring that all revenues be returned to individual (and potentially corporate) taxpayers. Finally, others, like Paulson, refer simply to a carbon tax, without specifying how the revenue would be used.

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Author biography

Danny Cullenward is the inaugural Philomathia Research Fellow at the Berkeley Energy and Climate Institute (BECI) at the University of California, Berkeley, USA. An energy economist and lawyer by training, his work focuses on the design and implementation of science-based climate policy. Cullenward has been working on carbon markets for 10 years. In 2013, he represented climate scientists before the Ninth Circuit, successfully defending the constitutionality of California's climate policy. He holds a PhD in Environment & Resources (E-IPER) from Stanford University and a JD from Stanford Law School.

Exhibit 5

From: Chang, Edie@ARB
To: Brent Newell
Subject: RE: C&T Adaptive Management Plan
Date: Wednesday, August 19, 2015 6:08:21 PM

Hi Brent – we don't release information about transactions within the C&T program because that information is considered market sensitive. There is information posted on our website about allowance allocation (http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/v2015allocation.pdf) and auction participation (http://www.arb.ca.gov/cc/capandtrade/auction/may-2015/summary_results_report.pdf and http://www.arb.ca.gov/cc/capandtrade/auction/may-2015/ca_proceeds_report.pdf .

As I mentioned in my note, we're going to starting some outreach in the fall on AM. We've haven't taken actions on adaptive management to date.

Thanks,
Edie

From: Brent Newell [mailto:bnewell@crpe-ej.org]
Sent: Tuesday, August 18, 2015 5:28 AM
To: Chang, Edie@ARB
Subject: RE: C&T Adaptive Management Plan

Edie,

Please send me information (1) on where facilities obtained their allowances/offsets for the 2013 compliance event; and (2) any actions ARB has taken pursuant to the Adaptive Management Plan in response to the 2013 compliance event.

Thanks!

PLEASE NOTE OUR NEW ADDRESS

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"TRUE PEACE IS NOT MERELY THE ABSENCE OF TENSION; IT IS THE PRESENCE OF JUSTICE." – DR. MARTIN LUTHER KING

CRPE CENTER ON RACE, POVERTY & THE ENVIRONMENT

PROVIDING LEGAL AND TECHNICAL ASSISTANCE TO THE GRASSROOTS MOVEMENT FOR ENVIRONMENTAL JUSTICE

From: Chang, Edie@ARB [mailto:edie.chang@arb.ca.gov]
Sent: Friday, August 14, 2015 10:26 AM
To: Brent Newell
Subject: RE: C&T Adaptive Management Plan

HI Brent – I've attached links to the cap and trade data that is available.

Reported and verified GHG emissions data is available here. The latest data posted is 2013. We will be posting the 2014 data in November. We've been collecting data under the reporting reg since 2008 and I think it's available on that website. http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm

We have had one compliance event so far - in November of 2014. At that time, entities were required to submit allowances to cover 30% of their 2013 emissions. This is the report from that compliance event. You can see how many compliance instruments (allowances and offset) each entity submitted and also what offsets were used. Our next compliance event is November 2015 at which time allowances to cover the remaining 70% of 2013 emissions and 100% of 2014 emissions will be due. We will post a similar report after that compliance event.
http://www.arb.ca.gov/cc/capandtrade/2013compliancereport.xlsx

This is a report that shows the total compliance instruments that have been issued.
http://www.arb.ca.gov/cc/capandtrade/complianceinstrumentreport.xlsx

We're continuing to work on our adaptive management plan and will be starting some outreach in the fall. Let me know if you have any questions,
Edie

From: Brent Newell [mailto:bnewell@crpe-ej.org]
Sent: Thursday, August 13, 2015 3:39 PM
To: Chang, Edie@ARB
Subject: C&T Adaptive Management Plan

Edie,

I hope all is well. On the CAA 111(d) call in July you mentioned that ARB had analyzed cap and trade program data for 2013 as part of the Adaptive Management Plan. I would like to receive that data, especially data that shows how each source met its compliance obligation (e.g. through surrendering allowances, buying offsets, etc.). I'd also like to receive source specific emissions data to understand how each source has increased or decreased its emissions under cap and trade.

Please advise.

Thanks,
Brent

Please note our new address

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"True peace is not merely the absence of tension; it is the presence of justice." – Dr. Martin Luther King

Providing Legal and Technical Assistance to the Grassroots Movement for Environmental Justice