

Minding the Climate Gap

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



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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 system 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.

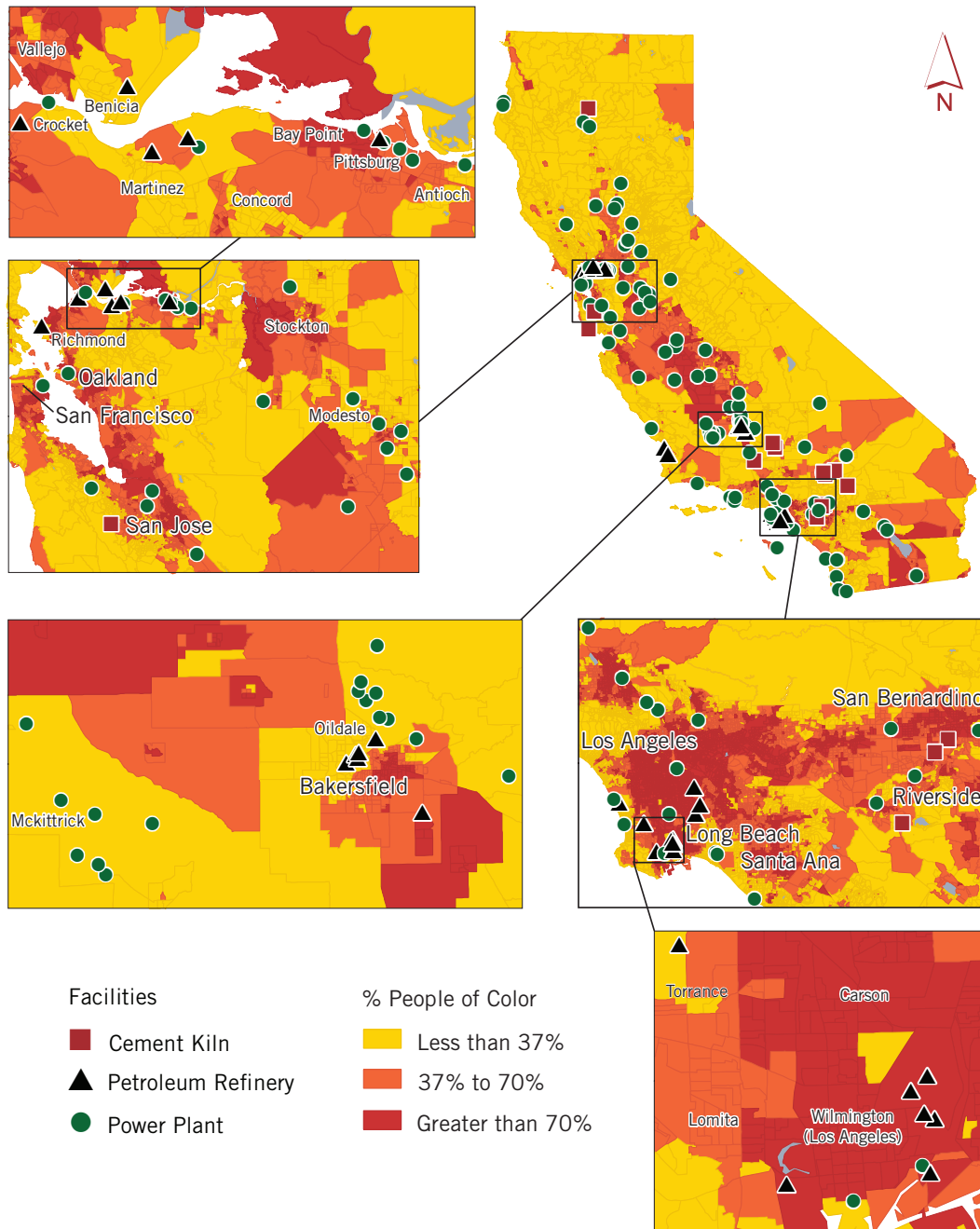
The Data

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 CO₂ – 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 Inventory⁴ for information on co-pollutants (NO_x and PM₁₀) 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 (PM₁₀), 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 imagery⁶ 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 $\text{PM}_{2.5}$ 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.

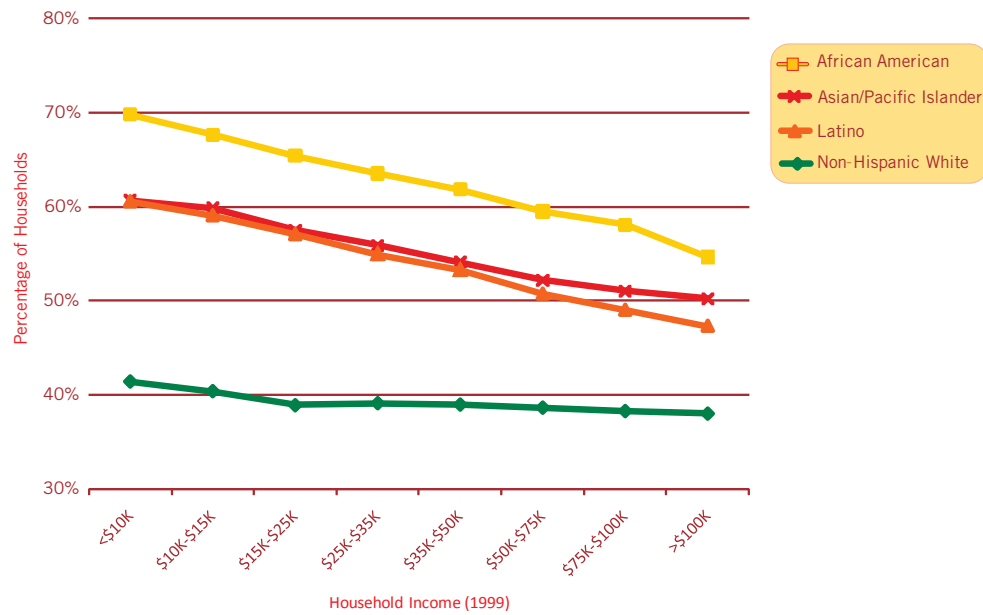
We use these geographic procedures to provide a picture of what each community looks like in terms of co-pollutant burden, and what each facility looks like in terms of the socioeconomic characteristics of its neighbors. Where a block falls within the reach of several facilities, its share of the block 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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: Average Population per Facility (in Thousands) By Distance from Facility in California

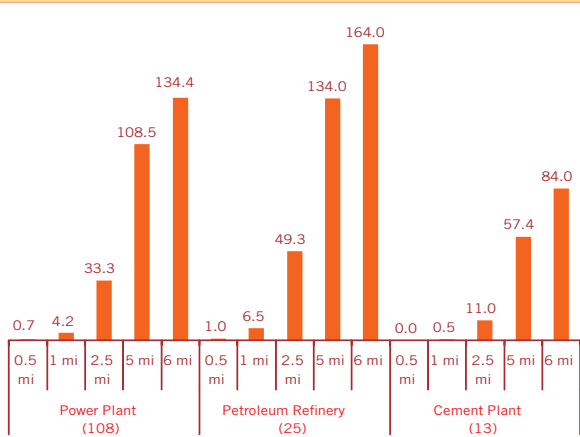
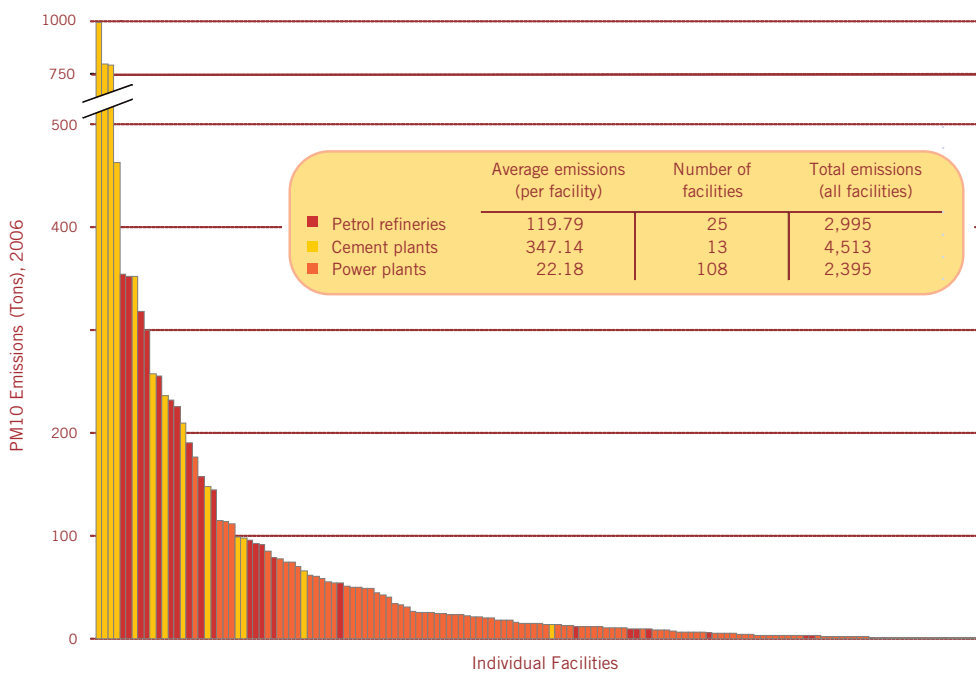


Figure 3 starts the analysis by counting up the populations within ranges of facilities and giving the total for sectors. Note that while power plants will affect more people overall due to their sheer number, refineries generally have the highest proximate population within the different ranges for 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 4: PM₁₀ Emissions (Tons) by Facility

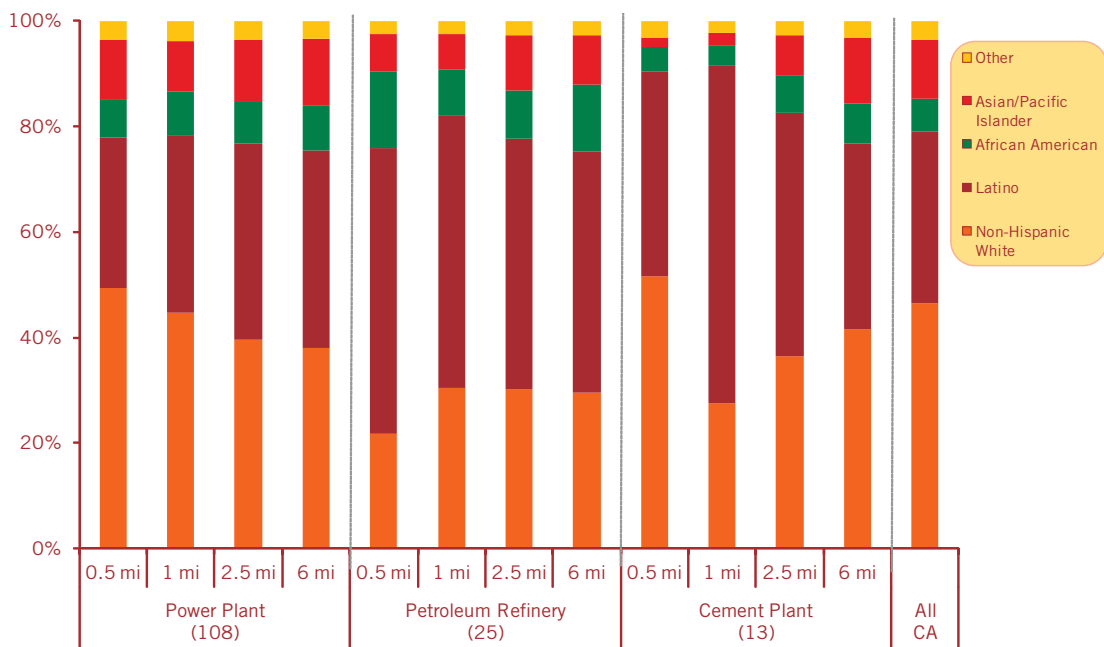


in which we order the various types of facilities by their PM emissions from most to least – the power plants show up most frequently in the long tail of the distribution where emissions are lowest while cement plants and refineries show up more frequently in the early part of the distribution where 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 PM₁₀ emissions burden as the population-weighted PM₁₀ emissions (i.e. total person-tons of PM₁₀) 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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.

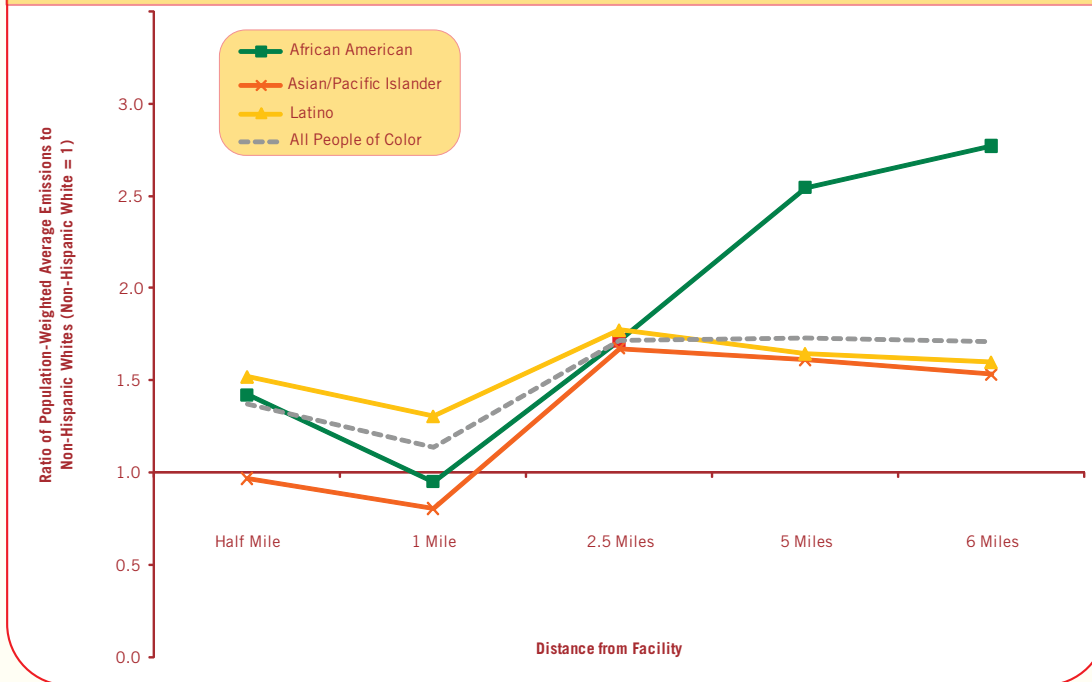
The difference between the average value for each group and that for non-Hispanic whites at each distance in Table 3 is a measure of statewide disparity in PM₁₀ emissions burden between that group and non-Hispanic whites at that particular distance. To determine relative differences in emissions burden, 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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 PM₁₀ 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

Figure 7: Population-Weighted Average Annual Particulate (PM₁₀) Emissions Burden (Tons) by Race/Ethnicity for Facilities within 2.5 Miles

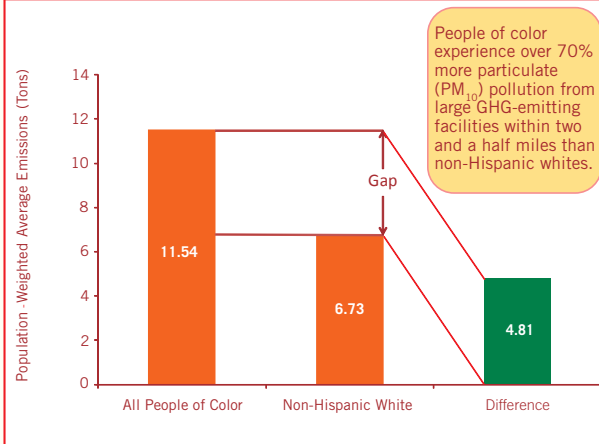
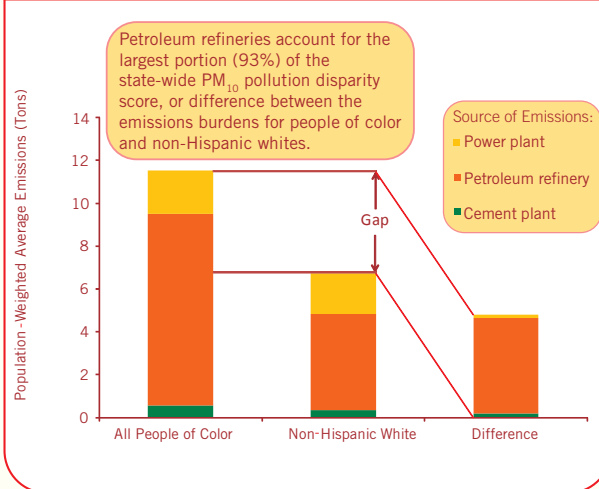


Figure 8: Population-Weighted Average Annual Particulate (PM₁₀) Emissions Burden (Tons) by Facility Category and Race/Ethnicity for Facilities within 2.5 Miles



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 9: Distribution of the Pollution Disparity Index for PM₁₀ at 2.5 Miles Across All Major GHG-Emitting Facilities

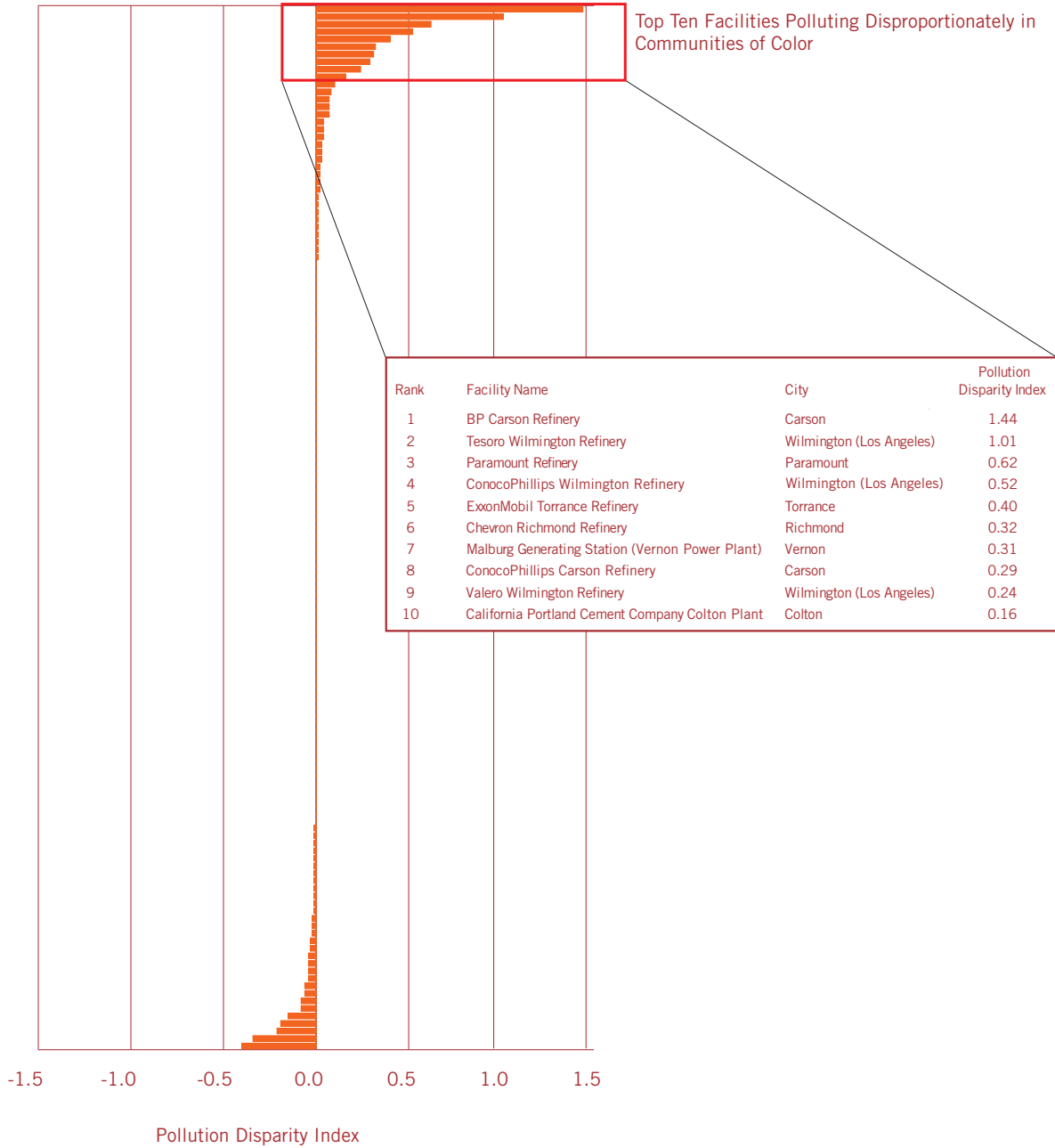
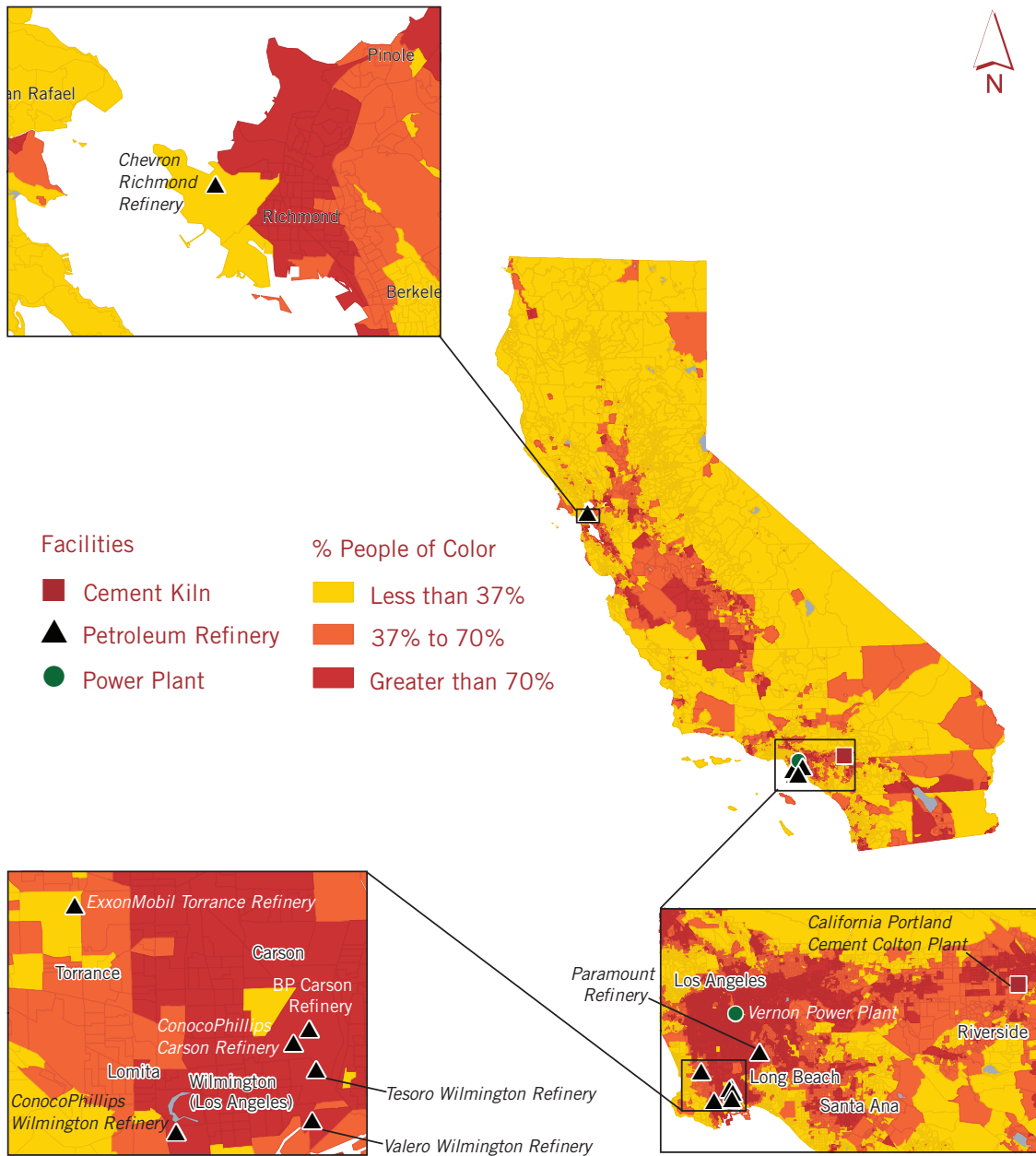


Figure 10: Map of Top Ten Facilities in Pollution Disparity



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?

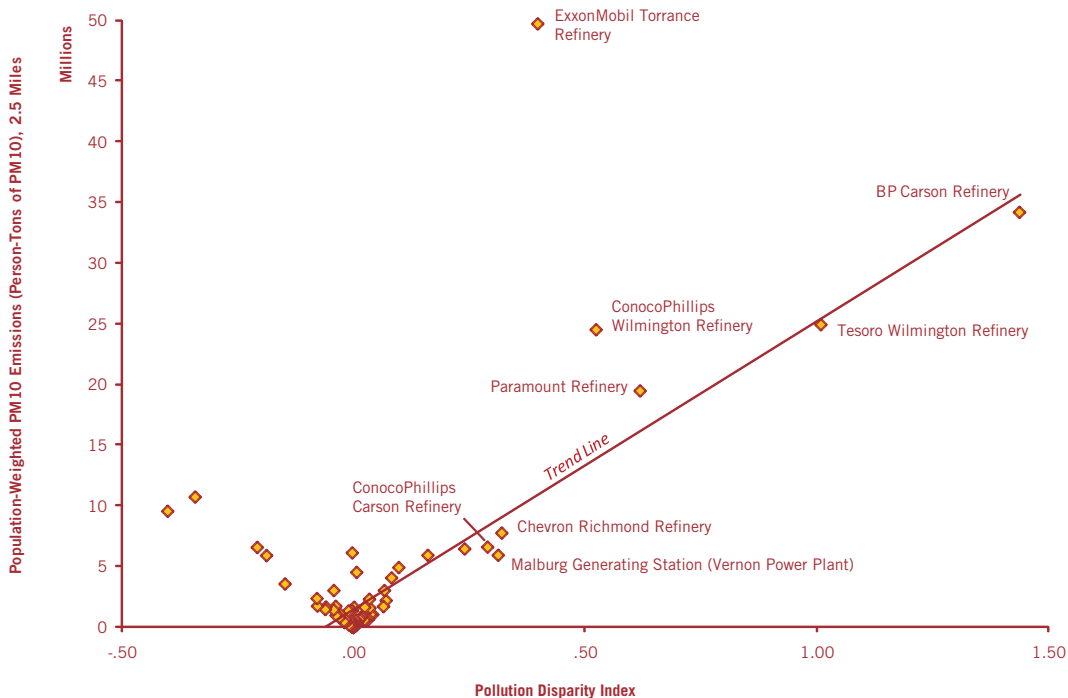
The first point made by this analysis is that some trades or allowance allocations *could* widen the climate gap by worsening disparities in emissions burdens by race/ethnicity. The second point is that while there are legitimate concerns about outcomes resulting from trades or the distribution of allowances *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: PM₁₀ 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 NO_x 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/emsmv/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:

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

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 PM₁₀ 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 PM₁₀ emissions burden associated with the facilities included in our analysis can be calculated as the population-weighted sum of PM₁₀ emissions across all facilities i within a certain distance d (i.e. total person-tons of PM₁₀). Average local PM₁₀ emissions burden at distance d, calculated separately for each group, is measured essentially as a simple population-weighted average of PM₁₀ 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 PM₁₀ emissions to zero for all people beyond distance d of any facility, and is

$$\begin{aligned}
 & \text{CA difference in average PM10 burden (POC - NHW)}_d \\
 &= [\text{average POC PM10 burden}_d] - [\text{average NHW PM10 burden}_d] \\
 &= \left[\frac{\sum_{i=1}^n \text{POC}_i \times \text{PM10}_{i,d}}{\text{POC}_{CA}} \right] - \left[\frac{\sum_{i=1}^n \text{NHW}_i \times \text{PM10}_{i,d}}{\text{NHW}_{CA}} \right] \\
 &= \sum_{i=1}^n \left[\frac{\text{POC}_i \times \text{PM10}_{i,d}}{\text{POC}_{CA}} \right] - \sum_{i=1}^n \left[\frac{\text{NHW}_i \times \text{PM10}_{i,d}}{\text{NHW}_{CA}} \right] \\
 &= \left[\frac{\text{POC}_{1,d} \times \text{PM10}_{1,d}}{\text{POC}_{CA}} + \frac{\text{POC}_{2,d} \times \text{PM10}_{2,d}}{\text{POC}_{CA}} + \dots + \frac{\text{POC}_{n,d} \times \text{PM10}_{n,d}}{\text{POC}_{CA}} \right] - \left[\frac{\text{NHW}_{1,d} \times \text{PM10}_{1,d}}{\text{NHW}_{CA}} + \frac{\text{NHW}_{2,d} \times \text{PM10}_{2,d}}{\text{NHW}_{CA}} + \dots + \frac{\text{NHW}_{n,d} \times \text{PM10}_{n,d}}{\text{NHW}_{CA}} \right] \\
 &= \left[\frac{\text{POC}_{1,d} \times \text{PM10}_{1,d}}{\text{POC}_{CA}} - \frac{\text{NHW}_{1,d} \times \text{PM10}_{1,d}}{\text{NHW}_{CA}} \right] + \left[\frac{\text{POC}_{2,d} \times \text{PM10}_{2,d}}{\text{POC}_{CA}} - \frac{\text{NHW}_{2,d} \times \text{PM10}_{2,d}}{\text{NHW}_{CA}} \right] + \dots + \left[\frac{\text{POC}_{n,d} \times \text{PM10}_{n,d}}{\text{POC}_{CA}} - \frac{\text{NHW}_{n,d} \times \text{PM10}_{n,d}}{\text{NHW}_{CA}} \right]
 \end{aligned}$$

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

DR. RACHEL MORELLO-FROSCH is Associate Professor in the Department of Environmental Science, Policy and Management and the School of Public Health at the University of California, Berkeley. Dr. Morello-Frosch's research examines race and class determinants of environmental health among diverse communities in the United States. A focus of her work is the relationship between segregation and environmental health inequalities associated with air pollution, children's environmental health, and the intersection between economic restructuring and community environmental health. Currently, Dr. Morello-Frosch collaborates with colleagues and environmental justice organizations to research and address climate justice issues, including the social equity implications of proposed greenhouse gas reduction strategies in California associated with the AB 32 Scoping Plan; and disparities in community capacity to adapt to environmental impacts of climate change. Her work is funded by the National Institutes of Health, the National Science Foundation, the California Environmental Protection Agency, the California Wellness Foundation, and the California Endowment, among others. Dr. Morello-Frosch currently serves on the Health Impacts Assessment Advisory Committee for the implementation of the AB 32 Scoping Plan.

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Minding the Climate Gap Report