Cooling the Planet, Clearing the Air: Climate Policy, Carbon Pricing, and Co-Benefits

James K. Boyce and Manuel Pastor

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Economics for Equity and the Environment Network (E3) is a national network of economists developing new and better arguments for protecting people and the planet. Through applied research and public engagement, we seek to improve decision making and further understanding of the relationship between economy and ecology. E3 is a project of Ecotrust.

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Written by James K. Boyce and Manuel Pastor

ABSTRACT: Policies to reduce carbon dioxide emissions can yield substantial co-benefits via reduced emissions of co-pollutants such as particulate matter, nitrogen oxides, and air toxics. Valuation studies suggest that these benefits may be comparable in magnitude to the value of reduced carbon emissions. However, co-pollutant intensity (the ratio of co-benefits to carbon dioxide emissions) varies across pollution sources, and so efficient policy design would seek greater emissions reductions where co-benefits are higher. Moreover, because co-pollutant impacts are localized, the distribution of co-benefits raises important issues of equity, particularly with regard to the unintentional income, racial, and geographic disparities that might result from carbon-charge programs, whether they are trading or fee approaches. This paper presents evidence on intersectoral and spatial variations in co-pollutant intensity and discusses options for integrating co-benefits into climate policy to advance the goals of efficiency and equity.

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Communities of color have a tremendous stake in efforts to reverse climate change and mitigate its impacts. They are among the first to experience the effects of climate disruption, which can include "natural" disasters, rising levels of respiratory illness and infectious disease, and heat-related sicknesses and deaths. They face greater risk from ill-conceived solutions to climate disruption, and they stand to gain considerable health and economic benefits from policies that are carefully constructed to maximize and broaden the impacts of addressing climate change and pollution.

Indeed, these were principal reasons why, in 2008, the Joint Center established a special commission to promote wider engagement and participation by African Americans in the climate change debate – a panel that has more recently become the Commission to Engage African Americans on Energy, Climate Change and the Environment. Over the years, we have worked with our commissioners and a broad range of partners to bring new voices to the table and advance climate and environmental policy discussions toward effective and equitable solutions.

One of our key objectives has been to build an evidentiary record to support these efforts, and this report – "Cooling the Planet, Clearing the Air: Climate Policy, Carbon Pricing, and Co-Benefits" – is an important step in furthering our knowledge and understanding. By highlighting the need for and opportunities to develop policies that both reduce emissions of harmful greenhouse gases and improve overall air quality, this report provides a roadmap for improving lives in communities of color. In particular, the evidence presented in this report outlines ways that policies to reduce carbon dioxide emissions can yield substantial additional benefits as co-pollutants such as particulate matter, nitrogen oxides and air toxics. Progress on these co-pollutants would yield additional positive health impacts for African Americans and other people of color, who are more likely than others to live near their point sources, and greatly increase the value of climate change policies, particularly in the short-term.

As this study shows, enormous progress could be made on reducing emissions of both greenhouse gases and other air pollutants with only modest adjustments to climate change mitigation approaches currently under consideration. We look forward to bringing this report into the climate change debate, and helping raise the level of awareness – within communities of color and among the broader population – about what can be done in the climate change framework to ensure a clean and healthy environment for all our citizens.

Ralph B. Everett, Esq.
President, The Joint Center for Political and Economic Studies
September 20, 2012

Today's challenges demand new economic thinking. Economics for Equity and the Environment Network is dedicated to applied research and dissemination of new economic arguments for protecting human health and the environment.

For economists in E3 Network, environmental protection and social justice are inextricably linked. Yet there are many examples of environmental policies designed without full consideration of the implications for vulnerable populations. E3's latest report, Cooling the Planet, Clearing the Air: Climate Policy, Carbon Pricing, and Co-Benefits, produced in partnership with the Joint Center for Political and Economic Studies, the Political Economy Research Institute at the University of Massachusetts, and the Program for Environmental and Regional Equity at the University of Southern California, takes a fresh look at the relationship between social equity and economic efficiency in the design of climate policies.

Climate policy is very heavily focused on reducing carbon emissions. The same power plants and refineries that emit carbon, however, produce other pollutants that have immediate and direct impacts on the health of nearby residents. These point sources are often disproportionately located in low-income and minority communities. This report examines the inter-sectoral and spatial variations in the intensity of co-pollutants with important findings for how we approach carbon reduction. Failure to consider co-pollutants in carbon cap and pricing strategies can exacerbate existing disparities while leaving valuable health care dollars on the ground. We could lose substantial economic benefits by excluding co-pollutants from our carbon strategies, and those losses would fall disproportionately on the most vulnerable amongst us.

The good news is that we can account for the co-benefits of carbon reduction through modest adjustments in our approaches to carbon reduction. Doing so would greatly enhance the benefits of climate change policies, especially for communities of color and low-income communities. There is progress to be made cleaning the air and protecting the climate. This report provides the evidence and recommendations policy makers need to forge a more equitable and efficient approach to climate policy.

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September 20, 2012

EXECUTIVE SUMMARY

Consider two emitters of greenhouse gases (GHGs) in California. One is a natural gas–fired electricity-generation facility in a rural area with no other major industrial facilities in the immediate vicinity. The other is a petroleum refinery in a densely populated urban center, with so many other adjacent pollution sources that the surrounding community is a poster child for what public-health researchers call "cumulative exposure." Each of these facilities, it turns out, emits roughly the same amount of carbon dioxide (CO_2)—but the refinery emits seven times more particulate matter (PM, a pollutant that leads to premature death, asthma, and other respiratory illnesses) and has hundreds of thousands more people living nearby.

Carbon-pricing strategies—in which polluters either are charged a set fee for carbon emissions or must surrender emissions permits whose total number is set by a cap and whose price is determined by the market—essentially treat these two sources as equal: a reduction of GHGs at one is the same as the reduction of GHGs at the other. However, the potential health benefits of reducing emissions of the various "co-pollutants" at these sources—particulates and other hazardous chemicals also emitted in the burning of fossil fuels—are very unequal. Where the emissions reductions occur can have dramatic effects on the number of people who benefit (or fail to benefit) from the ways that GHG reductions are coupled with other pollution cutbacks.

The failure of carbon-pricing strategies to consider co-pollutant externalities is a striking contradiction, since the point of such pricing is to build in the externality of global warming via a carbon charge. It is a source of inefficiency: potential health-care savings are left lying on the ground (or drifting in the air). And because point sources often are disproportionately located in low-income and minority communities, carbon pricing that does not take account of co-pollutants runs the risk of exacerbating existing disparities and thus running afoul of the nation's commitment to environmental justice.

This study explores the issue of co-pollutants and co-benefits in carbon-pricing policies and draws conclusions that are both disturbing and hopeful. The disturbing news is that significant benefits could be lost by failing to address this issue in designing climate policies, and these losses would fall disproportionately on more vulnerable communities. But there is also some important good news: the problems are concentrated in certain sectors and emitters, suggesting that a relatively modest set of market-constraining actions could yield big positive results.

Why Co-Benefits Matter

A large number of studies on the magnitude of air-quality co-benefits associated with climate policy have concluded that they are likely to be large. In fact, one study of carbon emissions reductions in the European Union found that "the welfare effects of climate policy seem to be positive even when the long-term benefits of avoided climate impacts are not taken into account." Several studies in the United States have also found that there are potentially large health gains apart from those that arise from curbing climate change, particularly through reductions in coal-based electrical power. Indeed, international data from the World Bank on damages from emissions of particulate matter—an air pollutant that poses serious health risks—suggest that co-pollutant damages per unit of carbon

dioxide emissions in the United States, while lower than in newly industrializing countries, are notably higher than in a number of other high-income countries, including Germany, France, and Canada (see Appendix).

Perhaps as important as the scale of air-quality co-benefits is their immediacy. Although environmentalists may lament the failure of policy makers to think generations ahead, shifting the gains from climate policy forward in time can help to build political support to stay the course on tackling global warming. Indeed, in a recent California campaign to protect the state's landmark 2006 global-warming legislation against an initiative funded largely by oil refiners, advocates found that stressing the policy's immediate health benefits was highly persuasive, particularly among communities of color, who often feel the brunt of dirty air.

These communities also face what some have called a "climate gap"—a set of higher risks from climate change that run the gamut from a lack of shade cover (in "urban heat islands") to a sharper hit from rising energy costs to inadequate disaster preparedness (as evidenced during Hurricane Katrina and several recent heat waves).

One California study has shown that large GHG emitters are also disproportionately located in communities of color—even when controlling for differences in income. So there are good reasons to worry about what may occur when some facilities decide to clean up and others decide to buy out. Climate policy will bring about changes in the geographic location of co-pollutant burdens. There may, for example, be intrafacility technological changes that reduce (or capture and sequester) CO_2 emissions but increase emissions of co-pollutants. There are likely to be interfacility shifts, as in electricity generation when coal-fired plants decline in importance and natural-gas plants replace them. And there certainly could be intersectoral shifts, for example, between power plants and refineries, as in the stark example with which we began this executive summary.

One recent strand of literature suggests the differences between point-source facilities may not be all that important, because cancer risks from air toxics are driven primarily by mobile sources. Differences between point-source polluters—and which polluters choose to buy permits under cap-and-trade (or pay fees under a carbon tax) rather than cutting their emissions—will be a ripple in a larger ocean of air pollution. Of course, one person's ripple is another community's wave: in certain locations, stationary sources are quite important. But we also show in this study that the relative importance of point sources for neurological health effects and for particulate matter emissions is much higher than it is for the single measure of air-related cancer risk. Similarly, sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions are more strongly associated with stationary sources. There is, in short, reason to be concerned about both the size of the effects from interfacility differences and the geographic and social inequalities that might result.

Taking the Measure of Co-Pollutant Burdens

Developing measures to gauge whether concern about co-pollutants in climate policy is not just theoretically interesting, but also empirically important is no easy task. The U.S. Environmental Protection Agency (USEPA) has finally assembled an inventory of GHG emitters across the country

(under its Greenhouse Gas Reporting Program, or GHGRP), but the resulting data do not mesh readily with data on co-pollutants reported in the agency's National Emissions Inventory or with data on air toxics in its Risk-Screening Environmental Indicators (which take into account the inhalation toxicities of different chemicals and use a fate-and-transport model to analyze where such toxics end up and how many people they affect).

Going where most researchers have feared to tread—or, better put, sending out plucky graduate students as the initial scouts, and then enlisting them to grind through the mechanics of data assembly and Geographic Information System (GIS) mapping—we put together a unique data set that includes over 1,500 large facilities (which together account for two-thirds of the CO_2 emissions reported in the GHGRP) for which we have matched data on SO_2, NO_X, $PM_{2.5}$, and air toxics. For the first three co-pollutants we have the simple mass of emissions; for air toxics, we have not only the mass of emissions, but also the toxicity-weighted mass and a score that takes into account the size of the impacted population. We also report a proximity-based version of the population-impact measure for $PM_{2.5}$ (particulate matter with a diameter of 2.5 micrometers or less, also known as "fine particles," which are considered particularly hazardous, because they can penetrate deeply into the lungs).

Our first main finding is that co-pollutant intensity—the ratio of co-pollutant emissions, or damages, to carbon emissions—varies widely across pollutants, sectors, and firms. For example, power plants are responsible for nearly 80 percent of the CO_2 emissions in our sample, but for a lower share of $PM_{2.5}$ emissions and for a markedly smaller share of the toxicity-weighted air toxics emissions and their human health impacts. Petroleum refineries, in contrast, account for less than one-tenth as much carbon emissions as the power plants, yet they have roughly the same air-toxics health impact.

One can immediately see that any carbon-charge system in which refineries en masse buy their way out of cleanup and instead let all the emissions reductions come from power plants (or other sectors) would forego significant health benefits from reducing co-pollutants. This concern is heightened when we carry out an analysis of variations in co-pollutant intensity within industrial sectors. If facilities within a particular sector are all over the map, not just with regard to geography but also in their co-pollutant intensities, it could be best to go plant by plant in analyzing the health and equity impacts of climate policies such as cap-and-trade. As it turns out, refineries have the lowest variance, suggesting once again that this industry is of particular concern.

At the same time, it is important to look for outlier co-pollutant emissions producers. For example, in our sample, the top 1 percent of SO_2 polluters are responsible for nearly one-quarter of the SO_2 emissions. The top 1 percent of the population-weighted $PM_{2.5}$ producers are responsible for over one-third of the total. In general, we find high levels of disproportionality, in which some facilities are far more problematic than the "typical" facility. This is an important finding, because it suggests that specific policy attention to a small number of "bad actors"—bad in the sense of high co-pollutant impacts by virtue of the quantity and toxicity of their emissions and their proximity to vulnerable populations—could likewise yield disproportionately positive results.

Benefits and Burdens

In a carbon-pricing policy, such as the cap-and-trade system now being developed by the state of California, the cap offers widely shared benefits with regard to GHG emissions—no matter where you live, virtually everyone gains from climate protection. On the other hand, the effects are unequal with regard to co-pollutants—some places will see more reductions in, say, $PM_{2.5}$ emissions than other places. This is inherent in a policy that gives polluters the option of paying to pollute rather than reducing their emissions.

One key question is whether there are systematic patterns of inequity in the distribution of co-pollutant burdens by salient socioeconomic characteristics such as race, ethnicity, and income. To get at this, we looked at the share of $PM_{2.5}$ and air-toxics burdens borne by different demographic groups by industrial sector. If co-pollutant exposures were evenly distributed across all racial, ethnic, and economic groups, these shares would correspond to their respective shares in the national population.

In the case of air toxics, we find disproportionate exposures for African Americans in most sectors (the exceptions are nonmetallic mineral product manufacturing and paper mills), with particularly high shares of exposure in the petroleum-refining sector. Latinos are disproportionately burdened in four of the eight sectors, with chemical manufacturing and petroleum refining topping the list and power plants not far behind. Overall, petroleum refineries pose the most disparate air-toxics burden on people of color. They also pose the most disparate burden on the poor.

Refineries also top the list for disproportional impacts on minorities in the case of population-weighted $PM_{2.5}$ emissions and rank second in disparate impacts on the poor. In only two sectors (paper mills and food manufacturers) is the minority share of the co-pollution burden less than the minority share of the population—and there is no sector in which the share of the poor in the burden is less than their share in the population.

Comparing these rankings to the sectoral sources of carbon emissions, we find that the three industrial sectors that produce the most carbon emissions—power plants, refineries, and chemical manufacturing, which together account for more than 90 percent of industrial CO_2 emissions in our sample—also have the most environmentally inequitable impacts on minorities with regard to the air-toxics measure and rank in the top five in population-weighted $PM_{2.5}$. Any climate policy that reduces co-pollutants along with GHG emissions, therefore, is likely to reduce environmental disparities and thereby advance environmental justice objectives. By the same logic, any regulatory program that sacrifices air-quality co-benefits not only will forgo public health savings, but also is likely to violate the official federal directives to consider environmental equity in rule and decision making.

Many industrial facilities are clustered together. Such clustering of CO_2 emitters is not consequential with regard to carbon—again, wherever you reduce a certain amount of carbon emissions, whether from a single industrial facility or from a group of facilities, the effect on climate change is the same. On the co-pollutant side, however, clustering can matter a great deal: if a cluster of facilities reduces its pollution rather than, say, buying emission allowances or offset credits, then the neighborhood

would find its overall air quality substantially improved.

Where facilities cluster, the share of overall cancer and neurological risk from industrial point sources rises dramatically. This is particularly pronounced in three clusters we map in detail—in Houston, Los Angeles, and Pittsburgh—but our analysis of the data overall suggests that large GHG-emitting facilities are likely important contributors to the health risk of their residential neighbors. This spatial analysis provides further insight into the equity impacts of climate policy.

Looking Forward

In our view, there is a strong case for integrating co-pollutants into climate-policy design on both efficiency and equity grounds. From an efficiency standpoint, failure to account for variations in air-quality co-benefits across carbon emission sources is tantamount to leaving health-care dollars lying on the floor. From an equity standpoint, co-pollutant burdens lie at the critical interface between climate policy and environmental justice.

Our recommendations include suggestions for improving the informational basis for policy making and for how to incorporate co-pollutant impacts into climate-policy design. The recommendations are summarized in Tables 1 and 2, respectively.

Table 1: Recommendations to Improve Information for Policy Design

Policy	Summary
Co-pollutant monitoring	Climate policy implementation should be accompanied by monitoring of co-pollutant emissions. Remedial policies should be introduced if monitoring reveals the widening of disproportional co-pollutant impacts on low-income communities and minorities.
Synchronize facility identification codes	Databases of the U.S. Environmental Protection Agency and other government agencies should include a consistent set of IDs for industrial facilities to improve the ability of researchers to analyze co-pollutant emissions in relation to carbon emissions.
Develop aggregate measures of co-pollutant impacts	Measures of co-pollutant impacts should be developed on a more granular neighborhood level, using fate-and-transport modeling of population exposures for criteria air pollutants for areas where monitoring is sparse, and combining this information with fate-and-transport models for air toxics.
Environmental justice screening	Environmental justice screening tools for the identification of disadvantaged communities should be developed to incorporate information on vulnerability to climate change.
Extend data collection & analysis to non-industrial sources of pollution	Spatial variation in the co-pollutant burdens posed by mobile sources, such as motor vehicles and aircraft, and by small point sources, such as dry cleaners and gas stations, should be analyzed, too.

Table 2: Recommendations to Improve Policy Outcomes

Policy	Summary
Strengthen carbon emission reduction targets	Air quality co-benefits should be counted in setting policy objectives for carbon emission reduction.
Designate high-priority zones	Climate policy design should include identification of high-priority zones where air quality co-benefits are especially large. Policy should ensure that emission reductions in these zones equal or exceed the average reductions achieved by the policy as a whole.
Designate petroleum refineries and chemical manufacturers as high-priority sectors	These two industrial sectors not only account for substantial carbon emissions but also for disproportionate shares of overall co-pollutant burdens and impacts on minorities and low-income communities. Policy should ensure that emission reductions in these sectors equal or exceed the average reductions achieved by the policy as a whole.
Designate high-priority facilities	Industrial facilities that rank in the top 5% in co-pollutant emissions should be designated as high-priority facilities for carbon emission reductions. Policy should ensure that emission reductions at these facilities equal or exceed the average reductions achieved by the policy as a whole.
Allocate a share of carbon revenues to community benefit funds	Part of the carbon rent generated by price-based climate policy instruments that is devoted to public investments should be allocated to community benefit funds to support environmental and public health improvements in disadvantaged communities.

Some proponents of a cap-and-trade approach to GHG reduction have argued against the integration of co-pollutants into climate policy, contending that co-pollutants are already regulated and that bringing them into a climate regime would unnecessarily complicate the construction of a new market and generate too many targets from a single policy. Although the existing regulatory regime may affect the extent of co-benefits, this does not mean that co-benefits from climate policy are inconsequential or irrelevant to climate-policy design. Moreover, the fact that co-benefits may be concentrated in certain key sectors and facilities suggests that administrative efficiencies are possible.

Another false dilemma is that posed between market and nonmarket mechanisms for pollution control. The climate debate has often focused on price-based policies, such as marketed permits or a carbon tax, partly because this is a new and intellectually exciting policy arena and partly because some are eager to capture the efficiencies and innovation incentives that price-based policies could provide. It is important to recognize, however, that quantitative controls on CO_2 emissions will be important too and are complementary; indeed, the bulk of the emissions reductions from California's Global Warming Solutions Act of 2006 (AB 32) will come from policies like the renewable portfolio standard for electricity supply and low-carbon fuel standard for transportation fuels, with a smaller share coming from its cap-and-trade component. That said, some part of emissions reduction in California will come from carbon-pricing strategies, and in the future these could play an even larger role nationwide.

Measures that could enhance efficiency and equity as carbon-pricing policies are adopted include the following (with one drawn from our list of information improvements and the rest from our list of policy suggestions):

1. **Strengthen carbon emission reduction targets:** A large body of evidence has established that the impacts of co-pollutants on public health are substantial. Air-quality co-benefits therefore should be included in setting targets for carbon emissions reductions. The concept of the "social cost of carbon" should be expanded to include the social cost of co-pollutants. One result of incorporating this information into climate-policy design will be more ambitious carbon emissions reduction targets.

2. **Develop mechanisms for co-pollutant monitoring:** Climate-policy design should include provisions for monitoring policy impacts on emissions of co-pollutants, particularly at facilities and locations with high emissions. Annual reviews of monitoring results should be conducted with a view to introducing remedial measures if the climate policy is found to widen the extent of disproportionate impacts of co-pollutants on minorities and low-income communities. Findings of absolute increases in co-pollutant burdens associated with climate-policy implementation should trigger immediate policy actions to ensure co-pollutant abatement.

3. **Designate high-priority zones:** Climate-policy design should include identification of high-priority zones where the co-benefits from reduced carbon emissions have the potential to be particularly large. In these zones, the policy should ensure that emissions reductions will equal or exceed the average level of reductions achieved by the policy as a whole. Insofar as the climate policy relies on price-based instruments, this can be achieved by introducing specific caps for these zones that limit the number of permits to be auctioned or allocated to facilities in these zones and prevent the purchase of offsets or permits from elsewhere.

4. **Designate high-priority sectors and facilities:** Petroleum refineries and chemical manufacturers tend to have the biggest health impacts and the most disproportionate impacts on minorities and the poor. Also, there is a high degree of disproportionality in co-pollutant emissions—that is, a small number of facilities often account for a large share of emissions in a given sector. If this pattern is confirmed by more research, these sectors could be designated as high-priority; co-pollution reductions could be accelerated for them either by conventional regulatory instruments or by sector-specific emission caps that limit the number of permits allocated to these sectors and facilities and bar purchases of permits from other sectors and facilities.

5. **Allocate a share of carbon revenues to community benefit funds:** To ensure that disadvantaged communities that bear disproportionate air-pollution burdens obtain a fair share of the benefits from public investments in the clean energy transition, a fraction of the carbon rent generated by the use of price-based instruments in climate policy should be directed to community benefit funds to support environmental improvements and public health in these localities. Screening methods that incorporate social vulnerability to both pollution and climate

change can be used to identify high-priority zones for such funds.

Why have these relatively straightforward modifications to market-based climate policies not been fully considered? Policy makers and advocates may have felt overburdened by other issues: the debates over conventional regulations versus price-based instruments, the social cost of carbon, and even the scientific basis for climate change itself. But part of the answer may also lie in the marginalization of the constituencies that are most burdened by co-pollutants.

In the end, this imbalance in policy priorities can be redressed only by ensuring that those advocating for environmental justice have a secure place at the climate-policy table. The benefit of this inclusion will be not only a more robust policy discussion, but also a wider base of support for the climate strategies that will be necessary to cool a warming planet. Working together, we can ensure that climate policy helps to secure a better environment, greater efficiencies in implementation, and more equitable outcomes for all Americans.

To read the full report, please visit www.e3network.org

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