MEMORANDUM

To: EAAC members
From: James K. Boyce
Re: Co-Pollutants & Co-Benefits
Date: August 3, 2009

This memo discusses an issue that I understand will be considered by EAAC's subcommittees on economics, allocation, and revenue use: how to integrate co-pollutants and co-benefits from their reduction into economic analysis and policy recommendations for AB 32 implementation.

Marginal abatement benefits vary across carbon emission sources due to the presence of co-pollutants such as particulate matter, NOx, and air toxics released by the burning of fossil fuels.

Variations in marginal abatement costs across pollution sources are the static-efficiency rationale for using market-based incentives (such as cap-and-trade) as opposed relying exclusively on regulatory standards to achieve pollution-control objectives, with the aim of achieving pollution reductions at least total cost.

Variations in marginal abatement benefits complicate the picture. They provide a rationale for greater pollution reductions (with higher marginal abatement costs) for some emitters than for others. AB 32 mandates that benefits from co-pollutant reduction should be incorporated into policy design and implementation.

Co-pollutants and co-benefits are relevant to the *environmental* objective of the policy. But they also are relevant to the objectives of efficiency and equity.

- From the standpoint of *efficiency*, the policy should seek to maximize net social benefits. These benefits include co-pollutant reductions. Ignoring opportunities for greater co-pollutant reductions would be tantamount to leaving health-care dollars lying on the ground.

- From the standpoint of *equity*, the policy should seek to reduce disproportionate pollution in historically overburdened communities. For this reason the issue of co-pollutants has been emphasized by the Environmental Justice Advisory Committee (EJAC).

In short, co-pollutants matter for the environmental, efficiency, and equity objectives of AB 32.

<u>Incorporating co-benefits in economic analysis</u>

Co-benefits from co-pollution reduction can and should be included in economic analysis of the costs and benefits of AB 32 implementation.

In a forthcoming paper, Muller *et al.* (2009) estimate that on average, the co-benefits from co-pollutant reductions associated with a nationwide cap on carbon emissions will be on the same order of magnitude as the benefits from carbon emissions reduction itself.[1] Similar conclusions have been reached in the European Union.[2]

In addition to improvements in the quantity and quality of life, economic benefits from co-pollutant reductions include health-care cost savings, reductions in days lost from work due to illness or the need to care for ill children and other dependents, and gains in property values.

The co-benefits from co-pollutant reduction add to the benefits that society gains from reducing carbon-dioxide emissions. This justifies greater reductions (tighter caps, higher permit prices, and higher marginal abatement costs) than would be warranted if the policy target were based solely on the benefits of lower carbon-dioxide emissions.

Variations in co-pollutant intensity

If the ratio of co-pollutant damages to carbon-dioxide emissions were a fixed coefficient, there would be no efficiency case for modifying policy design (beyond adjusting the cap) to take co-pollutants into account. But there are strong *a priori* reasons to expect that this ratio, which can be termed "co-pollutant intensity" for short, will vary across regions, sectors and polluters. Empirical evidence supports this expectation.

The ratio of co-pollutant emissions to carbon-dioxide emissions varies depending on the fuel source (higher for coal, lower for natural gas, in-between for oil) and on pollution control technologies. Damages per unit of co-pollutant emissions vary depending, among other things, on stack heights, population densities, and total exposure (the marginal damage function is usually assumed to be convex, with marginal damage increasing in total exposure).

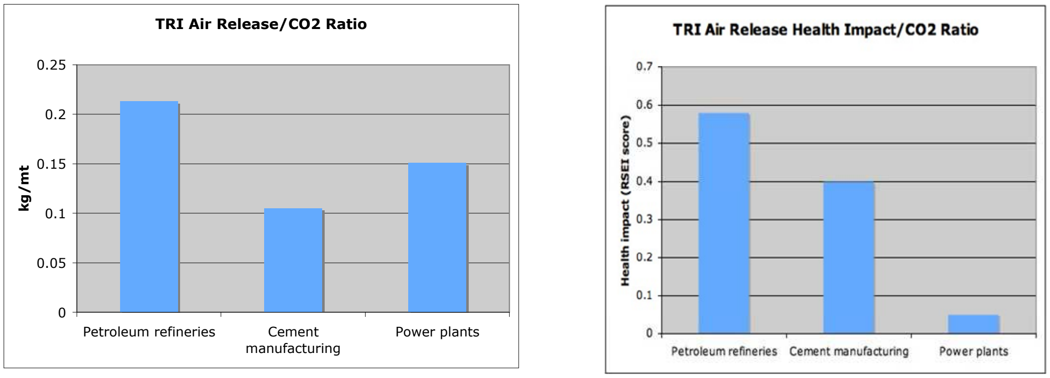
Such variations are illustrated in Figure 1, which shows co-pollutant intensity for air toxics releases reported in the USEPA's Toxics Release Inventory (TRI) from three industrial sectors: petroleum refineries, cement manufacturing, and power plants. Panel (a) shows total mass of releases (kilograms) of the roughly 600 chemicals in the TRI database per ton of carbon-dioxide emissions. By this measure, petroleum refineries have roughly twice the co-pollutant intensity of cement manufacturing facilities, with power plants lying between the two. Panel (b) shows the relative human health impacts of these same releases, taking into account stack heights, toxicities, the fate-and-transport of chemicals in the environment, and population densities. Petroleum refineries again score highest by this measure, but power plants score below cement manufacturing.

[1] Nicholas Z. Muller, Britt Groosman and Erin O'Neill-Toy, "The ancillary benefits of greenhouse gas abatement in the United States." Forthcoming, 2009.

[2] M.M. Berk *et al*, "Sustainable energy: Trade-offs and synergies between energy security, competitiveness, and environment." Bilthoven: Netherlands Environmental Assessment Agency (MNP), 2006.

Figure 1: Intersectoral variations in co-pollutant intensity
(air toxics/ton CO_2)

a. Mass (kg) of air toxics/tCO_2 b. Health impact/tCO_2



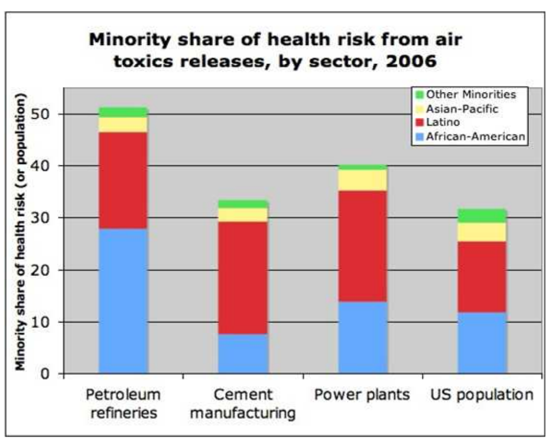
Source: Carnegie Mellon University Green Design Institute. (2009) Economic Input-Output Life Cycle Assessment (EIO-LCA) US Dept of Commerce 1997 Industry Benchmark (491) model [Internet], Available from: <http://www.eiolca.net/> [Accessed 22 Jun, 2009]

Note: Health impact calculated from USEPA's Risk-Screening Environmental Indicators (RSEI), 2006.

Variations in co-pollutant distribution

If co-pollutants were uniformly or randomly distributed across the landscape, there would be no equity reason to design policy to take them into account. But again, both *a priori* reasoning and empirical evidence tell us that they are not uniformly distributed, and that some communities – often lower-income communities – are overburdened by co-pollutants. Figure 2 illustrates this point, showing health risks from air toxics for the same three industrial sectors, relative to the shares of demographic subgroups in the national population. Petroleum refineries have the most disproportionate impact.

Figure 2: Shares of health risk from air toxics co-pollutants



Source: Minority shares of health impact calculated from RSEI-GM data; for methodology, see Ash *et al., Justice in the Air: Tracking Toxic Pollution from America's Industries and Companies to our States, Cities and Neighborhoods,* PERI and PERE, April 2009.

The California Air Resources Board recently resolved "to develop a methodology using available information to assess the potential cumulative air pollution impacts of proposed regulations to implement the Scoping Plan" and "to identify communities already adversely impacted by air pollution as specified in Health and Safety Code section 38750(b)(1) before the adoption of a cap-and-trade program."[3] The information that results from this effort is expected to influence policy design.

Incorporating co-benefits in policy design (1): Zonal trading systems

One way to include co-benefits from co-pollutant reductions in cap-and-trade policy design is to establish "zones" so as to guarantee some minimum level of emissions reductions in high-priority locations where co-benefits are greatest. Such areas may be identified using the methodology currently being developed by CARB.

In zonal trading systems, the availability of permits is defined on a zone-by-zone basis, i.e., permits are allocated across zones within the overall cap. Zone-based "sub-caps" can be established regardless of whether permits are distributed via auction, free allowances, or some combination of the two. The zones create semi-permeable boundaries for permit trading: polluters in lower-priority zones can buy permits from polluters in higher-priority zones, but permit trades against this gradient are not allowed.

Similarly, the purchase of offsets is constrained or proscribed altogether in high-priority zones. In the presence of co-pollutants, the purchase of offsets from out-of-state has the effect of exporting the co-benefits from air quality improvements.[4] In an analogous manner, offsets would result in the loss of co-benefits from co-pollutant reduction in high-priority zones.

One precedent for a zonal trading system is California's Regional Clean Air Incentives Market (RECLAIM), launched in 1994 to reduce point-source emissions of nitrogen oxides and sulfur oxides in the Los Angeles basin. The South Coast Air Quality Management District established two zones under RECLAIM: zone 1, the coastal zone, where pollution is more severe and the benefits from pollution reduction are considered to be greater; and zone 2, the inland zone, where pollution is less severe. Facilities in zone 1 can buy permits only from other facilities in the same zone; facilities in zone 2 can buy permits from either zone. One impact of the RECLAIM zonal trading system is that average permit prices have been roughly eight times higher in zone 1 than in zone 2.[5]

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[3] CARB, "Climate Change Scoping Plan, Resolution 08-47," December 11, 2009, p. 8. See also Manuel Pastor, Rachel Morello-Frosch and Jim Sadd, "Environmental Justice Screening Method: Integrating Indicators of Cumulative Impact and Community Vulnerability into Regulatory Decision-making," presented at CARB Informational Board Workshop on Policy Tools for the AB 32 Scoping Plan, May 28, 2008, online at http://www.arb.ca.gov/cc/scopingplan/meetings/5_28notice/presentations/pastor_5_28.pdf.

[4] David Roland-Holst, "Carbon Emission Offsets and Criteria Pollutants: A California Assessment," University of California Berkeley, Center for Energy, Resources, and Economic Sustainability, Research Paper No. 0903091, March 2009.

[5] Lata Gangadharan, "Analysis of prices in tradable emission markets: An empirical study of the Regional Clean Air Incentives Market in Los Angeles," *Applied Economics* 36: 1569-1582, 2004.

In the absence of regionally variable co-pollutant intensity, these permit price differentials across zones would be a symptom of inefficiency. If marginal abatement benefits were equal across pollution sources, the efficiency criterion would call for equalization of marginal abatement costs as well. But co-pollutants give rise to variations in marginal abatement benefits, and for this reason, permit price differentials can be an efficiency-improving result.

A zonal trading system – whether comprising two zones as in RECLAIM, or several zones – cannot, of course, perfectly match marginal abatement costs to all variations across pollution sources in marginal abatement benefits. Within any zone, some variations will persist. But the question is not whether a zonal trading system yields textbook efficiency; it is whether it yields a better outcome in terms of environmental, efficiency, and equity criteria than a system without zones. When externalities are spatially differentiated – that is, when emission location matters – zonal trading systems can be a "second-best" solution that yields a better outcome than the no-zone alternative.[6]

Incorporating co-benefits in policy design (2): Community benefits fund

An alternative way to tackle co-pollutant issues in AB 32 implementation would be to allocate part of the revenue from permit auctions to overburdened communities, with the money to be used for compensating environmental improvements.

Compensation is widely invoked to justify allocations of allowance value (whether free permits or revenue from permit auctions). Allocations to trade-exposed firms are proposed as a way to compensate them for the impacts of carbon policy on their competitiveness. Allocations to the electric utility industry are proposed as a way to compensate them for the costs of investment in clean energy infrastructure. Allocations to consumers often are rationalized as a way to counteract the effect of higher fossil fuel prices on their real incomes (in the case of cap-and-dividend, an additional rationale is sometimes advanced, namely that the new property rights created by carbon permits rightly belong in common and in equal measure to all).

Similarly, the allocation of auction revenue to overburdened communities can be viewed as a way to compensate for excess co-pollutant burdens that are not completely rectified by a zonal trading system or by other policy instruments.

Issues in developing and implementing a community benefits fund (CBF) policy include:

- how much revenue (or more precisely, the percentage of allowance value) to allocate to CBF;
- which communities are eligible to receive funds;
- what sorts of environmental projects are eligible; and
- what mechanisms should be established to allocate funds across and within communities.

[6] Tom Tietenberg, "Tradeable permits for pollution control when emission location matters: What have we learned?" *Environmental and Resource Economics* 5: 95-113, 1995.

For example, California Assembly Bill 1405, currently being considered in the state legislature, contains specific proposals on these issues. The bill would require that a minimum of 30% of the revenues generated under AB 32 be deposited into the CBF. The bill defines "the most impacted and disadvantaged communities as those areas within each air basin with the highest 10 percent of air pollution impacts, taking into account air pollution exposures and socioeconomic indicators." Within these communities, the CBF would provide competitive grants for projects for purposes such as reducing emissions of greenhouse gases and co-pollutants, minimizing health impacts caused by global warming, and emergency preparedness for extreme weather events caused by global warming.[7]

The language in AB 1405 provides a reasonable basis for EAAC and CARB to envision how a CBF component might work. In thinking through this second prong of a strategy to incorporate co-benefits in policy design, the main issue for EAAC is the appropriate percentage of allowance value to be allocated to this use.

Concluding remarks

Policies to reduce carbon-dioxide emissions from burning fossil fuels generate co-benefits – above and beyond the climate-change benefits – by also reducing emissions of co-pollutants that harm human health. Valuation studies suggest that these co-benefits are comparable in magnitude to the benefits of carbon-dioxide emission reductions alone.

Damages from co-pollutants per unit carbon-dioxide emissions vary across locations and pollution sources. Hence the social benefits from a cap-and-trade policy can be increased by a policy design that takes co-benefits into account.

This memorandum has sketched two policy options to this end: a zonal trading system and the allocation of a fraction of permit auction revenue to community benefit funds. The two are not mutually exclusive. Rather they can be seen as complementary instruments in service of the same goal: incorporating the co-benefits from reduced emissions of co-pollutants into the policy design.

[7] As of this writing, versions of AB 1405 have been passed by the Assembly and two Senate committees. The text is available at http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_1401-1450/ab_1405_bill_20090723_amended_sen_v94.pdf.