Integrating GHGs in the Bay Area 2010 Clean Air Plan

Extended Abstract #50

David B. Burch, Principal Environmental Planner
Bay Area Air Quality Management District
939 Ellis Street, San Francisco, CA 94109

INTRODUCTION

Air quality planning in the United States has traditionally been performed on a single pollutant basis, with a focus on reducing ambient concentrations of one "criteria pollutant," such as ground-level ozone, in order to attain or maintain national ambient air quality standards (NAAQS). The single-pollutant approach has been successful in reducing ambient concentrations of criteria pollutants in the San Francisco Bay Area and elsewhere. However, the traditional single-pollutant approach typically does not directly consider:

- Co-benefits or trade-offs for control measures that affect multiple pollutants
- The relative risk that different air pollutants pose in terms of public health, or
- The impact that control measures to reduce criteria pollutants may have on emissions of carbon dioxide and other greenhouse gases (GHGs) that contribute to climate change

Planning on a multi-pollutant basis, by contrast, recognizes that air pollutants often share common precursors and emissions sources and may interact in the atmosphere. Multi-pollutant planning offers a means to develop emission control strategies to maximize reductions of multiple pollutants, avoid or mitigate potential trade-offs among pollutants, and focus limited resources so as to provide the greatest benefit or payback. In addition, it is becoming increasingly difficult to find new control measures that are cost-effective when evaluated based on their ability to reduce a single pollutant. Potential control measures may prove to be more viable if evaluated on a multi-pollutant basis.

The National Research Council (NRC) laid the conceptual foundation for a transition to multi-pollutant air quality planning in a 2004 report which recommended that air quality planning employ a risk-based, multi-pollutant approach to address the key goals of the federal Clean Air Act, including 1) reducing concentrations of the six federal "criteria" pollutants; 2) reducing exposure to air toxics; and 3) addressing ecosystem impacts, such as acid deposition and stratospheric ozone depletion. [1] And while federal air quality planning requirements are still based on the single-pollutant paradigm, US EPA has been working with several states and metro areas to develop pilot air quality plans based on the multi-pollutant approach. [2]

In recent years, there has also been growing recognition of the need to integrate GHGs in air quality planning. [3] Criteria pollutants, GHGs and climate interact in various ways. For example, ground-level ozone acts as a (short-lived) GHG. Different components of particulate matter (PM) may either inhibit (aerosols) or exacerbate (black carbon) global warming. Conversely, GHGs and climate change may impact air quality. For example, methane emissions may be contributing to higher background levels of ozone. And higher temperatures related to climate change may lead to increased ozone formation in response to:

- Longer and more frequent heat waves
- More frequent and more severe temperature spikes

- Increased length of the ozone season
- More VOC emissions from trees and other biogenic sources of VOCs
- Increased evaporative emissions of VOCs from storage tanks, solvents, and motor vehicles
- Changes in meteorology, such as increased atmospheric water vapor, higher humidity; and reduction in wind and vertical mixing that disperse pollutants

Although the conceptual rationale for multi-pollutant planning is solid, it is inherently more complex than the single-pollutant approach. This is largely due to important differences among criteria pollutants, air toxics, and GHGs in terms of:

- Chemical composition and formation
- Season of year when highest concentrations typically occur
- Geographic scale (local, regional, global)
- Range and severity of their health effects
- Impacts on ecosystems and climate

Integrating GHGs with criteria pollutants is especially challenging. Complicating factors include (1) the huge range of potential impacts related to climate change; (2) impacts of today's GHG emissions (especially CO2) may not be fully felt until many decades in the future; and (3) local emissions of GHGs may have impacts at both the local and the global scale.

THE BAY AREA 2010 CLEAN AIR PLAN

In September 2010 the Bay Area Air Quality Management District (BAAQMD) adopted the Bay Area 2010 Clean Air Plan (2010 Plan) as an update to the Bay Area ozone plan. [4] (Note: The 2010 Plan responds to ozone planning requirements of the California Health & Safety Code; it is not a federal SIP document.) In addition, as a voluntary initiative, the BAAQMD elected to use the 2010 Plan as an opportunity to develop its first multi-pollutant air quality plan. Innovative aspects of 2010 Plan are described below.

Multi-Pollutant Scope: The 2010 Plan addresses the air pollutants that pose the greatest concern and risk to Bay Area residents. The plan provides both technical information (emissions inventory, monitoring data, modeling results, etc.) and an integrated control strategy to reduce four types of pollutants:

- Ozone and its precursors (VOCs and NOx)
- PM2.5 (both direct and secondary PM)
- Key air toxics (diesel PM, benzene, 1-3 butadiene, acetaldehyde, and formaldehyde)
- Key greenhouse gases: i.e. the "Kyoto Six" (carbon dioxide, methane, nitrous oxides, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride)

Focus on key outcomes: Although the 2010 Plan aims to attain and maintain all air quality standards, the plan focuses on achieving key outcomes, namely ***protecting public health*** and ***protecting the climate***. The control strategy in the 2010 Plan was crafted with the explicit objective of reducing population exposure to the most hazardous pollutants both at the regional scale and in the most impacted communities within the Bay Area. The plan also seeks to maximize GHG reductions, as discussed below.

Analyzing benefits of control measures: In developing a control strategy, it makes sense to consider both the ***cost*** and the ***benefit*** of potential control measures. Methodologies are well-developed to estimate the cost and cost-effectiveness of proposed control measures. However, estimating benefits is more complex, and less emphasis has been placed on quantifying benefits. For the 2010 Plan, BAAQMD staff estimated the potential benefits of control measures in terms of protecting public health and protecting the climate, using the multi-pollutant evaluation method described below.

Multi-Pollutant Evaluation Method (MPEM): BAAQMD staff developed the MPEM to help evaluate potential control measures on a multi-pollutant basis. [5] Estimated benefits of control measures were based upon their potential to protect public health and protect the climate. Public health benefits were based on estimated cost savings related to avoided illness and premature mortality. Climate protection benefits were based on potential long-range cost savings due to avoided climate change impacts, if current GHG emissions are reduced. The MPEM was also used to help evaluate potential trade-offs (e.g., a situation where a control measure might reduce one pollutant at the expense of increasing another), and to determine which pollutants pose the greatest risk to public health.

The MPEM is based on existing studies and tools, such as EPA's BenMAP program. [6] The key MPEM steps are shown in Figure 1. Staff used the results of in-house air quality modeling to determine the sensitivities between emissions and concentrations (Step 1 to Step 2) for ozone, PM, and air toxics; that is, how ambient concentrations are affected by a change in emissions of a given pollutant or its precursors. To assign a value to the benefit of reducing GHG emissions, staff performed a literature review and selected a value of $28 per metric ton of GHG reduced (expressed in CO2-equivalent). [7]

Figure 1: Key Steps of MPEM Analysis

Ozone: VOCs, NOx **PM2.5**: direct PM, NOx, ammonia, SOx **Air Toxics**: direct emissions	**Greenhouse Gases**
Step 1) Δ Emissions ↓ Step 2) Ambient Concentration ↓ Step 3) Δ Population Exposure ↓ Step 4) Δ Health Effects ↓ Step 5) Δ $$ Benefits	Δ Emissions ↓ ↓ ↓ ↓ Δ $$ Benefits ($28 per metric ton

Health burden analysis: BAAQMD used the MPEM, in combination with air quality monitoring data, to (1) analyze the health burden associated with both past and current levels of air pollution, (2) quantify the reduction in health impacts, and associated cost savings, due to improvement in air quality in recent decades, and (3) determine the contribution of each pollutant to the overall health burden. The following health impacts were considered in the analysis: premature mortality, cancer onset, respiratory hospital admissions, cardiovascular hospital admissions, chronic bronchitis; non-fatal heart attacks, and asthma emergency room visits.

Addressing GHGs and climate: The 2010 Plan incorporates greenhouse gases and climate protection by:

- Explaining the rationale for including GHGs and climate protection in air quality plans
- Making climate protection one of the two key goals of the plan
- Incorporating GHG reduction targets based on California's AB32 goals [8]
- Providing estimates of GHG emission reductions for proposed control measures
- Including the value of reducing GHG emissions, to avoid future climate change impacts, in estimating the monetary benefit of control measures

Control measures to reduce GHGs and protect the climate: The control strategy in the 2010 Plan includes a total of 55 control measures. The Plan attempts to maximize reductions of GHG emissions from traditional types of control measures, including the 18 stationary source measures, the 10 mobile source measures, and the 17 transportation control measures. Stationary source measures (SSMs) that were included specifically to reduce GHG emissions include:

- SSM 3 to reduce methane from livestock waste
- SSM 4 to reduce methane from natural gas processing and distribution, and
- SSM 15 to promote energy efficiency through the BAAQMD permitting program

In addition, the 2010 Plan control strategy includes a new set of four *Energy & Climate Measures* that address energy efficiency (ECM 1), renewable energy (ECM 2), urban heat island mitigation (ECM 3), and shade-tree planting (ECM 4). Finally, the Plan includes six *Land Use and Local Impacts Measures* designed to ensure that efforts to promote focused growth in infill areas are implemented in a way that protects people from exposure to air pollution from existing stationary and mobile sources.

Constraints and Limitations: In developing the 2010 Plan as a multi-pollutant plan, BAAQMD staff was constrained by various limitations, including:

- The plan did not include the impacts of PM, such as black carbon, in evaluating impacts related to climate change. This was because (1) the impacts of PM on climate are still the subject of intensive research, and (2) global warming potential factors were not available to express the climate forcing effects of black carbon or other PM on a CO2-equivalent basis.
- Emissions factors and emission inventory data were not available for certain pollutants or precursors, or certain types of emission sources.
- The MPEM and the health burden analysis did not include all health effects.
- Although a wide range of social costs were included in the valuation of GHG emissions, the MPEM did not include the full range of potential impacts from air pollution, such as property damage, ecosystem impacts, water pollution, etc.
- Although the plan includes control measures to reduce GHG emissions and protect the climate, such as the Energy and Climate Measures mentioned above, methodologies are not yet well developed to estimate potential emission reductions and cost-effectiveness of measures such as promoting renewable energy, energy conservation, urban heat island mitigation, and shade-tree planting.

Key Findings: Monitoring data for years 2006-2010 indicates that the Bay Area currently does not violate the annual average or the 24-hour PM2.5 NAAQS. Nonetheless, the health burden analysis in the 2010 Plan found that exposure to PM2.5 poses by far the greatest health risk to Bay Area residents, accounting for more than 90% of premature mortality related to air pollution in the region. In response to this funding, the control strategy in the plan was designed to maximize reductions in PM2.5 and prioritize early implementation of measures to reduce PM2.5.

SUMMARY

The Bay Area 2010 Clean Air Plan represents the BAAQMD's initial effort to develop a multi-pollutant plan. Innovative aspects of 2010 Plan include:

- A broad multi-pollutant scope, including an integrated control strategy to reduce ozone, PM2.5, key air toxics, and the "Kyoto Six" greenhouse gases
- An emphasis on ultimate outcomes – i.e., protecting public health and protecting the climate – rather than simply attaining ambient air quality standards
- Development of the multi-pollutant evaluation method (MPEM) to estimate the health and climate protection benefits of control measures, and express those benefits in monetary terms

A broad range of stakeholders expressed support for the BAAQMD's decision to develop a multi-pollutant plan, and to focus on protecting public health and protecting the climate. Developing a multi-pollutant plan was a learning experience, and forced BAAQMD staff to grapple with a variety of technical and policy issues. Although the 2010 Plan attempted to break new ground, it was never intended to serve as the final word in multi-pollutant planning. Rather, the 2010 Plan was intended to inform future multi-pollutant planning efforts in the Bay Area, as well as to provide an example that air quality agencies in other regions can build and improve upon.

ACKNOWLEDGEMENTS

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REFERENCES

1. *Air Quality Management in the United States*, National Research Council, January 2004.

2. *The Multi-Pollutant Report: Technical Concepts & Examples*, U.S. EPA, July 2008.
Also see EPA web page re: pilot multi-pollutant plans: www.epa.gov/air/aqmp/pilot.html

3. *Recommendations to the Clean Air Act Advisory Committee*, Air Quality Management Subcommittee, Phase II Draft Report, June 2007.

4. *Bay Area 2010 Clean Air Plan*, BAAQMD.
www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans.aspx

5. *Multi-Pollutant Evaluation Method Technical Document*, BAAQMD, June 2009.
www.baaqmd.gov/Divisions/Planning-and-Research/Plans/Clean-Air-Plans.aspx

6. US EPA BenMAP: www.epa.gov/air/benmap/

7. Tol, R.S.J. *The Social Cost of Carbon: Trends, Outliers and Catastrophes* August 2008. www.economics-ejournal.org/economics/journalarticles/2008-25

8. For an overview of AB 32, see www.arb.ca.gov/cc/ab32/ab32.htm