An Integrated Approach to Air Quality Attainment

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ABSTRACT

Many states face the challenge of developing state implementation plans (SIPs) for multiple non-attainment regions for both fine particulate matter ($PM_{2.5}$) and ozone. However, this challenge also represents an opportunity to adopt integrated approaches that consider the interconnections of air quality with economic growth, regional planning, and public health. This poster presents a framework for incorporating considerations of emission control costs and health benefits into the SIP development process. It highlights emerging technologies and resources for three key components of what is envisioned as an integrated and multi-faceted approach to SIP development: (1) resources for identifying potential control measures and quantifying associated costs, (2) atmospheric sensitivity analysis techniques for predicting the impacts of control measures on air quality, and (3) software for linking air quality improvements with likely benefits to human health, vegetation, and visibility.

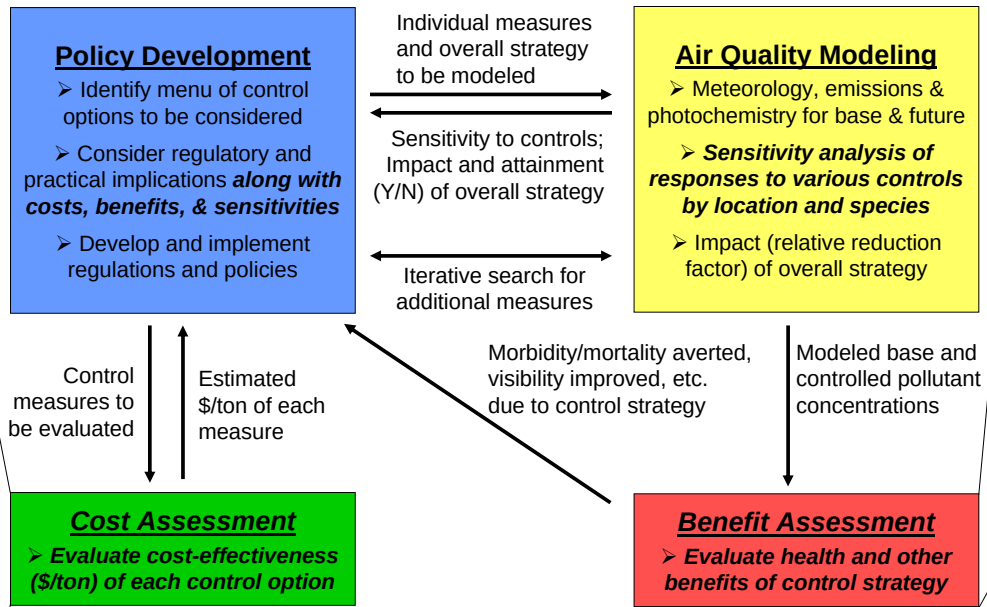
INTEGRATED FRAMEWORK FOR SIP DEVELOPMENT

In the framework below, policy and modeling are envisioned as intertwined efforts as costs, benefits, and atmospheric sensitivity jointly inform the development of sensible SIP strategies. Bold-italic text in each box indicates elements that have often been neglected historically, but that can enhance the information available for decision-making.

Rather than applying air quality models only as a final check of an overall strategy, in the integrated framework modelers and policy developers would collaborate early in the SIP process on sensitivity analysis efforts to estimate the responsiveness of ambient pollutant concentrations to various emission reductions. By assessing atmospheric responsiveness to various emission compounds, categories, and locations, sensitivity analysis can guide the identification and prioritization of control measures. Sensitivities can also facilitate an iterative search for additional measures if an initial strategy is found to be insufficient.

A growing array of resources for cost and benefit assessment (see sidebars) fosters the incorporation of these factors into the SIP process. The linkage of cost ($/ton) and sensitivity (ppb/ton or μg/m^3/ton) estimates allows for the evaluation of measures on a common metric even for pollutants which arise from multiple precursors. While cost-based rankings may be illuminating, social and political factors and ancillary impacts should be considered as well.

For single pollutant SIP development, benefit assessment is not needed for the ranking of control measures but can be highly informative in quantifying the impact of an overall strategy. While SIPs are mandated to achieve ambient air quality standards rather than a particular threshold of benefits, benefits analysis can enlighten decision-makers and the public about the overall value of pollution control.



CONTROL COST ASSESSMENT

The Clean Air Act mandates that EPA develop standards for criteria pollutants (ozone, particulate matter, lead, NO_2, SO_2, and CO) sufficiently stringent to protect public health "with an adequate margin of safety" for sensitive populations. While economic consequences are not to be considered in *setting* the standards under the Act, states have an obvious interest in *attaining* the standards in a cost-efficient manner given the potential costs to businesses, consumers, and taxpayers. Some measures may impose little or no net cost on society (e.g., revenue-neutral economic incentives, or efficiency measures whose long-term savings compensate for up-front costs), whereas other measures may have costs ranging upwards of $100,000 per ton. Prudent decision-making should therefore consider costs, along with social and political factors and the ancillary impacts of measures, in the development of air quality plans.

Among the available resources for cost assessment:

➢ **AirControlNET** (Pechan, 2003): This software links a detailed U.S. emissions inventory with a spreadsheet of the costs and efficacies of various measures to provide cost-ranked strategies for any region and criteria pollutant. It focuses on emissions control options for area sources and individual point source facilities, with non-road and on-road mobile options currently (v. 3.2) limited to measures such as vehicle standards, which could be implemented on a national basis.

➢ **Clean Air and Climate Protection Software** (STAPPA/ALAPCO, 2003): Unlike AirControlNET, this software focuses on measures at the state or local level, including options for energy conservation and solid waste disposal. Greenhouse gases (CO_2, N_2O, methane) are considered along with criteria pollutants.

➢ **Congestion Mitigation and Air Quality Improvement Program Assessment** (Transportation Research Board, 2002): Appendices of this report compile and tabulate empirical estimates of the cost-effectiveness of past emission abatement efforts, both for mobile source controls funded by the CMAQ program and for other mobile and stationary measures.

BENEFIT ASSESSMENT

Quantifying the benefits of pollution abatement can be invaluable in the development and prioritization of air pollution control strategies and in communicating the importance of those measures to the public. Most analyses (e.g., U.S. EPA, 1999) have found that improvements in human health represent the most valuable benefits of ozone and PM abatement. Impacts on ecosystems, agriculture, and visibility can be important as well.

Resources that may help states quantify the benefits arising from air pollution abatement policies include:

➢ **Health impacts**:
- **BenMAP** (Abt Associates Inc., 2003): This environmental benefits mapping and analysis software, developed for the U.S. EPA, links monitored or modeled air pollution data with population maps and concentration-response functions to translate reductions in ambient concentrations into expected benefits in health outcomes and associated monetary valuations.
- **MAQERI**: The Model of Air Quality and Exposure Related Impacts, a component of the Princeton/Yale Assessment Platform currently under development, links air quality simulations to exposure assessments, health impacts, and associated economic valuations (D. Q. Tong, personal communication).

➢ **Crop, forestry, and ecosystem impacts**: Numerous ecosystem models simulate the impacts of pollutant stresses on crop yield, net primary productivity, and/or tree growth rates. The Register of Ecological Models (eco.wiz.uni-kassel.de) contains information about many of these models.

➢ **Visibility**: Many photochemical models output visibility conditions based on pollutant concentrations. Techniques such as hedonic price analysis can translate visibility improvements into economic valuations (Delucchi *et al*., 2002).

BEYOND THE SIP FRAMEWORK

The above framework primarily envisions the task faced by states in developing state implementation plans (SIPs) for attainment of the U.S. National Ambient Air Quality Standards, and how sensitivity analysis, economic and health considerations can be effectively integrated into that process. Currently, states develop separate SIPs for each criteria pollutant violated by each non-attainment region.

A recent examination of air quality management practices in the United States suggested that the current SIP process should be transformed into a "multipollutant air quality management plan process" (National Research Council, 2004). While the development of multi-pollutant plans would require a broader analysis than that outlined here, the framework suggested in this poster would provide a starting point for the multi-faceted approach that would be needed to develop such a plan. In fact, shifting to a multi-pollutant approach would only enhance the need for thorough consideration of economic, health, and other factors as a means of prioritizing various abatement options and evaluating progress toward multiple objectives.

The multi-pollutant approach outlined by NRC could also streamline the modeling and sensitivity analysis needs of air quality management. The fact that states face separate attainment deadlines and separate non-attainment region boundaries for each criteria pollutant has often made impractical the use of a unified set of model simulations that could potentially be applied under a multi-pollutant approach.

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