Three Alternatives for Implementing Multi-Dimensional Cost-Effectiveness Analysis

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Problem: Regulatory Gaps when Multiple Pollutants Are Reduced

- **The regulatory calendar causes control strategies for different pollutants to be designed sequentially – first NO_X, then PM, CO_2 someday**
- **Control measures that affect NO_X, PM and CO_2 are considered separately in each individual proceeding without reference to their benefits for other pollutants**
- **Some technologies can reduce NO_X, PM and CO_2 emissions, but do not receive credit for reducing other pollutants**
- **Technologies that could be cost-effective in a comprehensive multi-pollutant strategy appear to be excessively costly when their incremental cost is divided by reductions in emissions of a single pollutant**

Question: Can Costs Be Allocated Across Different Pollutants?

- **A comprehensive emission trading system for all pollutants would remove this problem**
- **Current law combines sequential consideration of different pollutants with a combination of technology and performance standards in implementing emission reductions**
- **The solution is to allocate costs so that not all the costs are borne by an individual species in cost-effectiveness calculations**
- **Simply adding together all emission reductions probably is not satisfactory**
- **A method to weight different species of emission reductions is required**

Basic Underlying Principles

- **Mimic results of an optimal choice of control measures applied simultaneously to multiple pollutants, *i.e.* a comprehensive trading system**
- **Be sufficiently flexible to adapt to local or regional regulatory requirements for all relevant pollutants**
- **Be expandable to include additional pollutants if they are regulated**
- **Be consistent with expected approaches to pollutants that come later on the regulatory calendar**
- **Use reasonably available and non-controversial data and/or models**

Three Approaches

- Alternatives
  - Subtract avoided costs
  - Subtract co-benefits estimated directly
  - Subtract co-benefits based on “environmental adders”
- How to do it
  - Theory
  - Data
- Hazards
  - Cost
  - Quality and controversy

Alternative 1: Subtract marginal cost of control of other pollutants from cost

- **The avoided cost of compliance with future regulations of other pollutants provides a basis for adjusting the cost of control on one pollutant**
  - **If a technology is adopted in a State's NOx SIP, for example, its effects on PM or other emissions will be included in the baseline for PM and other pollutants considered later**
  - **Having achieved these reductions through use of the new technology, it will be possible to forego the most costly controls that would otherwise be required on PM or other pollutants in the future**
- **To estimate cost-effectiveness of the first technology, subtract the marginal cost of controlling the other pollutants, multiplied by the reduction in those emissions attributable to the first technology**

Example of the cost adjustment

Under consideration as a NOX control measure			
	NOx	**PM**	**CO2**
Emission reductions in typical application (tons/year)	1	0.5	10
Incremental cost of a typical application	$ 15,000		
Cost per ton of most costly control technology required without Technology A		$ 10,000	$ 10
Avoided cost due to a typical application of Technology A		$ 5,000	$ 100
	No Cost Adjustment	**PM Avoided Cost Subtracted**	**PM and CO2 Avoided Costs Subtracted**
Cost/ton of NOX emission reduction	$ 15,000	$ 10,000	$ 9,900

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Rationale

- The correct value to use for avoided cost is the most expensive control that would otherwise be required in the future SIP, because this is the control that can be foregone
- The simplest estimate would use a nationwide, established estimate of marginal cost of compliance with future limits on each pollutant affected
- State SIPs are likely to diverge widely from national marginal costs due to differences in severity of problem and available controls

How calculations would be done

- Use EPA's cap on costs
  - In some cases, SIPs follow the assumption made in EPA cost estimates that there will be a cap (for example, $10,000 per ton) on the cost per ton of required measures
  - For regions where such a cap is expected to be binding, that cost per ton would be the appropriate measure of avoided cost
- Estimate marginal cost based on required reductions and control technology guidelines
  - If a state is not expected to be up against a cost constraint, more study would be needed to estimate the cost of the most expensive option likely to be used
  - EPA data on control technology costs can be matched with required reductions from baseline to estimate marginal cost

Data sources

- **Calculating avoided cost when States are not clearly up against cost-per-ton caps is the difficult step**
  - **The emission inventory, the required emission reduction, and EPA control technology guidelines provide a basis for identifying emission controls applicable to a local area**
  - **EPA data on costs of control provide rough cost ranges for types of emission controls**
- **Ranking the control technologies and multiplying percent reductions by baseline emissions can provide a marginal cost curve for each region**
- **The required emission reduction identifies the relevant marginal cost**

Issues, advantages and disadvantages

- In principle, this allocation should produce the same result as a comprehensive emission trading system, because the cost of the most expensive control measure will set the cost of permits
- Identifying the margin should not be difficult unless the technologies at issue have large effects compared to required emission reductions
- Lack of pre-existing studies of marginal control costs may necessitate significant analytical effort
- EPA control cost estimates fall in very broad categories, so that the marginal cost curve will not be precise

Alternative 2: Subtract estimated co-benefits for other pollutants from cost

- **A comprehensive program would compare the incremental cost of a control technology to the benefits of associated reductions in every type of emission**
- **This calculation can be approximated for a program that regulates pollutants one at at time**
- **To estimate incremental cost for the pollutant regulated first, estimate its benefits for every other pollutant and subtract those co-benefits from its cost**

Example of the cost-effectiveness calculation

Under consideration as a NOX control measure			
	NOx	**PM**	**CO2**
Emission reductions in typical application (tons/year)	1	0.5	10
Incremental cost of a typical application	$ 15,000		
Health and other damages per ton of emissions		$ 20,000	
Avoided damages from a typical application		$ 10,000	$ -
	No Cobenefits	**PM Cobenefits included**	**PM and CO2 Cobenefits included**
Cost/ton of NOX emission reduction	$ 15,000	$ 5,000	$ 5,000

Rationale

- Regulating multiple pollutants requires simultaneous comparison of costs and benefits of controlling all pollutants
- A comprehensive program would compare the incremental cost of a control technology to the benefits of associated reductions in every type of emission

How calculations would be done

- Estimating co-benefits is the difficult part
- Health and other damages from other pollutants reduced by the technology must be estimated
- This requires a calculation including
  - Change in emissions of each type
  - Emission-concentration relationship
  - Dose-response relationship
  - Valuation of morbidity and mortality
- It may appropriate in this context to use low-end values for each key variable to reduce probability of overestimating co-benefits
- It may be necessary to consider interactive effects between pollutants

Data sources

- Established methods for evaluating health and other benefits exist for each species of pollutant
- Estimates at the national level already exist in the literature, so that a literature review followed by choosing values from the low end of the range could be sufficient
- For pollutants with a local footprint, the calculation should take into account local and regional conditions, as in benefits transfer methods

Issues, advantages and disadvantages

- It may also be necessary to introduce various toxics that may be affected by the technology at issue
- The calculation of co-benefits is always contentious
- Co-benefits are non-linear, and become smaller as baseline concentrations fall, so that the baseline must be chosen correctly
- Using low estimates of co-benefits will reduce the cost-effectiveness of the first pollutant analyzed, so that this approach is not neutral to which goes first
- The result may fail to be cost-effective, since co-benefits are not likely to equal avoided costs

Alternative 3: Subtract environmental adder value for other pollutants from cost

- **As an alternative to developing independent estimates of avoided health and other damages, environmental adders already adopted by State agencies could be used**
- **Some states have developed estimates of “residual damages” of various pollutants in proceedings with “environmental adders” for electricity generation**
- **In States where such adders exist, they are a simple and established alternative that in principle provides the information required by Alternative 2**

Description

- Environmental adders were developed in order to change the choice between coal, natural gas and other fuels in new powerplants
- It was also proposed these adders be used in addition to fuel and operating cost in economic dispatch
- A substantial literature grew up around the subject of environmental adders
- The adders are intended to reflect the damages done by emissions of pollutants from burning fossil fuels after all required emission controls are implemented (therefore “residual damages”)
- Therefore, the adders contain the same information required to estimate avoided cost of new techologies

How calculations would be done

- Calculations of reductions in each type of emission from use of the new technology are still required
- Environmental adders are calculated by multiplying emissions per Btu of fuel burned by health and other damages per ton of emissions
- Working back to the health damage estimates used in the environmental adders provides the information required to allocate costs of the new technology

Data sources

- Only a limited number of states have adopted environmental adders
- Those that have provide documentation of varying quality
- There is also a substantial academic literature debating what the correct values should be

Issues, advantages and disadvantages

- Simplicity and prior political acceptance are the main advantages of using these adders
- The values assigned to environmental adders have been quite variable and did not always reflect the best science in regard to health effects
- The "revealed political preference" approach to environmental adders, which takes the highest cost required to meet a standard in the jurisdiction, has been discredited in the academic literature
- Not all relevant jurisdictions have established adders appropriate for use

What other regulatory failures are relevant

- Use of standards with no credit for exceeding standard
- Separate jurisdictions and division of responsibility among agencies
- Incomplete and inconsistent regulatory coverage of options for reducing emissions
- Lack of comprehensive optimization of net benefits in setting standards

Comparing the Alternatives

- Quality of resulting estimates
  - Uncertainty
  - Bias
- Practicality and cost
  - Analytical effort required
  - Likelihood of political consensus
- How closely results approximate an ideal system
  - Equalize marginal costs of control within each class of pollutant
  - Equalize marginal benefits of control across all pollutants
  - Equalize marginal benefits and marginal costs

How the Alternatives Compare

	Quality of Estimate	Analytical Effort	Controversy	Optimality Properties
Subtract Costs	Good	Significant but defined	Limited	Cost-effective
Subtract Benefits	Fair but biased low	Depends on depth	Significant	Unclear
Subtract Adders	Poor	Low	Settled but contentious	Unclear