Multi-Pollutant Strategies & Integrated Assessment

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Overview

• Making the Linkages:
  – Where have we been?
  – What are we doing now (at least at USEPA)?
  – What’s possible?
• Multi-Attribute v. Multi-Objective Frameworks
• Some Issues and Implications
Beginnings of Acid Rain
Sources
- Electricity
- Industry
- Transport
- Residential
- Commercial
- Agriculture
- Biogenics
- Geogenics

Pollutants
- Hg
- POPs
- SO₂
- Soot Smoke
- NOₓ
- Dust
- NH₃
- VOCs
- CH₄
- CO
- Other GHG
- CO₂

Receptors
- Surface Waters
- Terrestrial Ecosystems
- Marine Ecosystems
- Visibility Aesthetics
- Crops Forests
- Human Health
- Materials

Grennfelt, Hov, & Derwent (1994)
Ambio, 23:425-433
Currently adding PM to the mix
Need to Extend to Climate and Global Air Quality
Still other linkages to be made
Examples of “Integrated Assessments”

- Multi-Attribute
  - Multi-Pollutant Strategies for the Electricity Sector
Multi-Pollutant Utility Legislation

Levels proposed in the 106th and 107th Congress

Graphic does not include a bill introduced by Sen. Allen in the 107th Congress
## Proposed Requirements for Electric Generating Units

<table>
<thead>
<tr>
<th></th>
<th>Actual Emissions in 2000</th>
<th>Clear Skies Initiative Emissions Caps</th>
<th>Total Reduction at Full Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First Phase of Reductions</td>
<td>Second Phase of Reductions</td>
</tr>
<tr>
<td>SO₂</td>
<td>11.2 million tons</td>
<td>4.5 million tons in 2010*</td>
<td>3 million tons in 2018*</td>
</tr>
<tr>
<td>NOₓ**</td>
<td>5.1 million tons</td>
<td>2.1 million tons in 2008*</td>
<td>1.7 million tons in 2018*</td>
</tr>
<tr>
<td>Mercury</td>
<td>48 tons</td>
<td>26 tons in 2010</td>
<td>15 tons in 2018*</td>
</tr>
</tbody>
</table>

*Because sources can reduce emissions early, earn allowances for those actions, and use those allowances later, actual emission levels will be higher than the cap in the first years of these phases.  
**The NOₓ cap is divided between two zones with separate trading programs under each zone.
Detailed Modeling of Electricity Sector
ICF’s Integrated Planning Model

Individual Plant Characteristics

Fuel Supply

Marginal Cost of Hg Reductions
(SO2 at 4.5 million tons, NOx at 1.9 million tons)

Note: Based on spreadsheet estimates for the year 2010; IPM results would differ.

Generation in 2010

- Controlled coal
- Uncontrolled coal
- Comb. cycle gas
- Turbine
- Repowered CC
- Nuclear

Basecase  Example case #1
Detailed Cost/Benefit Analysis

- $O_3$, $PM_{10}$, $PM_{2.5}$
- NAAQS Attainment
- Hg Deposition
- Eutrophication
- Visibility
- Change in ANC

- Monetized Health Benefits
  - Premature deaths
  - Chronic bronchitis
  - Hospital visits
  - Respiratory symptom days

Control Technology Costs
Impacts on Jobs
Consumer Prices
Focus on Opportunities, Look Holistically

- Transport Sector
  - Decoupling efficiency and emissions?
- Open Biomass Burning
  - Differentiation between types of sources
  - Management opportunities
- Residential Coal & Biofuels
- Renewables & Energy Efficiency

- Integration Beyond AQ and Climate
Examples of “Integrated Assessments”

- Multi-Attribute
  - Multi-Pollutant Strategies for the Electricity Sector
  - Integrated Environmental Strategies (IES) for Developing Countries
Began as the International Co-Controls Analysis Program (ICAP) with an emphasis on GHG reductions.

Now working on the design and implementation of integrated or harmonized GHG/AQ strategies in: Argentina, Chile, China, S. Korea, Brazil, Mexico, India, and S. Africa

http://www.nrel.gov/icap
IES Objectives

- Support and promote the analysis of environmental, public health, economic development and AQ/GHG mitigation benefits of integrated strategies.

- Build permanent institutional & human capacity for that analysis.

- Incorporate results into local policy initiatives (such as Air Pollution Reduction Plans).

- Engage *policy makers* in discussions that link research to policy and build support for integrated approaches.

- Promote *implementation plans* for mitigation policies/programs.
IES Program Accomplishments

• Published AQ management plans with GHG benefits (Buenos Aires, Santiago, Shanghai, Seoul)

• Created lasting in-country capacity through training

• Collaborating with external donor groups (WHO, World Bank, UNEP)
IES Program Accomplishments

• Launched experts process on public health and AQ at ISEE and AWMA meetings
• Enabled south-south exchanges (ex: Chile and China)
• Increased visibility of IES efforts:
  – Special sessions at COPs
  – Publications in refereed journals
  – Media coverage
IES Contacts:

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Examples of “Integrated Assessments”

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  - Air Quality - Climate Linkages
Intercontinental transport & Climatic effects of Air Pollutants (ICAP)
Carey Jang & Dennis Doll, EPA/OAR/OAQPS

- Host a workshop and establish an expert advisory panel (December 2001)
- “Global Modeling of Air Pollution & Climate” (Harvard Univ., Jacob)
- “Global Radiative Forcing of Aerosols” (Stanford Univ., Jacobson)
- “Emission Inventories for Climate-Forcing Pollutants” (DOE/Argonne Lab, Streets)
- Project coordination and modeling protocol and reports drafting (MCNC-EMC, Hanna)
Phase 1 Progress

Workshop Summary & Panel Recommendations

PRIORITY QUESTIONS AND STRATEGIES FOR PHASE 2

1. Intercontinental Transport - impact to US & other regions
   - Need improved global/regional emission inventories for O₃ and PM precursors partitioned by source sector
   - Need nested global and regional model
   - Need policy-relevant future emission projections

2. Climatic Effects of Air Pollutants - direct and indirect effects
   - Need global climate/chemistry model to estimate climate response for selected policy-relevant emission projections,
   - Develop approaches for quantifying direct and indirect climate responses on the perturbation of climate-forcing pollutants

3. How do U.S. & other regions emissions affect the ability of other countries to meet their air quality objectives?

http://www.emc.mcnc.org/projects/GRO
Intercontinental Transport Workshops

Seattle, July 2000, Trans-Pacific
Palisades NY, June 2001, Trans-Atlantic
Bad Breisig, Germany, October 7-9, 2002
Transport Between Asia, Europe & NAmerica
Ozone, Aerosols, Mercury
US/German Photochemistry Workshop, Oct 9-11

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Air Quality & Global Change

EPA’s National Center for Environmental Research Science to Achieve Results (STAR) Program
Request for Applications:
Assessing the Consequences of Global Change for Air Quality: Global chemistry and sensitivity analysis

Figure 1. Components of an Integrated Air Quality Assessment Framework

http://es.epa.gov/ncer/
Examples of “Integrated Assessments”

• **Multi-Attribute**
  – Multi-Pollutant Strategies for the Electricity Sector
  – Integrated Environmental Strategies (IES) for Developing Countries
  – Air Quality - Climate Linkages

• **Multi-Objective**
  – RAINS Europe & Asia
Constrained Optimization in RAINS

Source-Receptor Relationship
(Country Emissions to Concentration in Grid Cell)

Control Cost Curve
(Cost per Emission by Country and Sector)

Pollutant Critical Load
(Deosition or Concentration Threshold by Grid Cell)

Aspiration Level
(Achievement or Gap Closure to Critical Load)
Constrained Optimization in RAINS

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- Aspiration Level
  (Achievement or Gap Closure to Critical Load)

- Least Cost Strategy
  (Emissions by Country)
Issues & Implications

• Bound the Effects, Feedbacks & Uncertainties
  – Will be used to make risk/risk tradeoffs.
  – Reduced Form Models: Where can we simplify?
Issues & Implications

• Bound the Effects, Feedbacks & Uncertainties

• Differentiation of Particles
  – Mass is going to be a leading metric for some time
  – Identify implications for mass, number, species & size
  – Take advantage of emerging data
  – No Regrets?
Issues & Implications

• Bound the Effects, Feedbacks & Uncertainties
• Differentiation of Particles
• Make Global Effects “Real”
  – Understand Regionality, Impacts on Local AQ, Cost of Achieving Goals
  – Need to Change Understanding of National Self Interests
    • Industrialized Countries: Local Impacts of Global Action
    • Developing Countries: Global Benefits of Local Action