The air quality co-benefits of US clean energy and climate change policies

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1. Clean energy and clean air

Sustainable policy for clean energy and clean air in a changing climate

In his State of the Union address, President Obama called for policies to mitigate climate change, reduce pollution, transition to clean energy, and drive strong economic growth. Climate change, air pollution, and clean energy are grand sustainability challenges and are intimately linked. This work is part of a growing literature to understand those links.

Can air quality co-benefits "pay for" a clean energy or climate policy?

We examine the impacts of energy and climate policy on air pollution. We ask if air quality co-benefits alone can offset the costs of these policies. Many claim they can, but few have studied the effect of co-benefits on real economic resources and their distribution.[1,2,3] Can clean energy and climate policies "pay for" themselves with air quality co-benefits? If so, who pays?

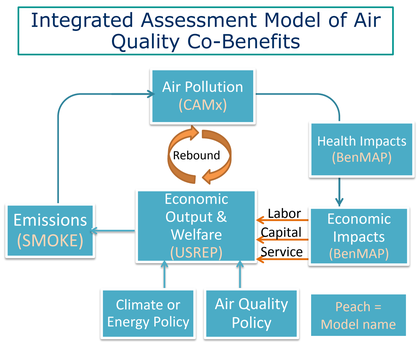
2. Can co-benefits "pay for" policy?

- **Co-benefits vs. costs:** Can a Cap-and-Trade or a Clean Energy Standard "pay for itself" in terms of market-based effects by reducing fine particulate matter pollution, thereby reducing risks to human health?
- **Distribution of costs and air quality co-benefits:**
  - Which US regions win and lose for each policy in terms of net air quality co-benefits?
  - Do net air quality co-benefits accrue to rich or poor households?
  - Which policy is more even in its distribution of costs and co-benefits (by region and income)?

3. Modeling energy & climate policy

- We compare the air quality impacts of **two national policies**:
  - **Clean Energy Standard (CES)** modeled from the Clean Energy Standard Act of 2012, doubling clean energy from 42% in 2012 to 80% by 2035.[4]
  - **Cap-and-Trade (CAT)** program requiring the same CO_2 reductions (economy-wide reductions of 10% or 500 million tons by 2030).

- We track the **economy-wide costs and air quality co-benefits of each policy** through a novel integrated assessment framework.[4]



Economic Model:
We use the US Regional Energy Policy Model (USREP), a Computable General Equilibrium (CGE) economic model, to estimate the complex effects of policies on emissions, and of air quality on the economy. With simplified production and human behavior, this model can track the economy-wide distribution of costs and benefits. It has a detailed energy sector, and is grounded in economic and energy data.[5]

Air Quality Model:
We use the Comprehensive Air Quality Model with extensions (CAMx), a 3D high-resolution chemical transport model, to estimate outdoor pollution levels due to emissions. This model has been validated extensively.[6]

Health Impacts Model:
We use the Benefits Mapping and Analysis Program (BenMAP), a regulatory health impact model which relates air pollution to health impacts and costs through peer-reviewed epidemiologic and economic studies.[7]

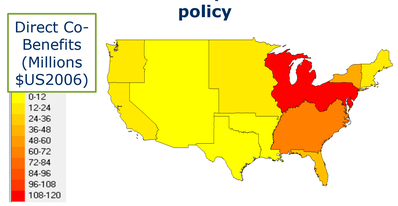
- Here, we improve this framework to estimate economy-wide policy costs and co-benefits using consistent economic assumptions and economic impacts by estimating costs and co-benefits using the USREP model. We track shocks to labor and capital, and demand for health services.[8,9,10,11]

4. Distribution of costs and co-benefits

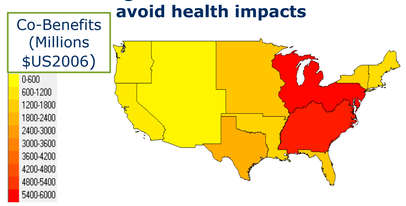
Indirect effects of policy on real economic resources mean that more people gain from better air quality than those who avoid getting sick

Traditional air quality co-benefits assessments only consider the gains to people who avoid illness and death from fine particulate matter as a result of each policy. Our method includes the indirect economic effects that arise through the interconnection of markets.

Direct air quality co-benefits of the Clean Energy Standard are gains for those who avoid illness from air pollution under this policy



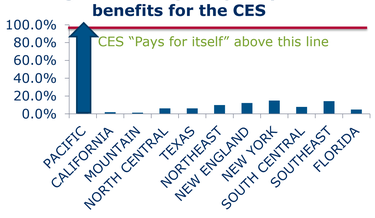
Total air quality co-benefits of the CES, including indirect effects, show that those who gain are more than those who avoid health impacts



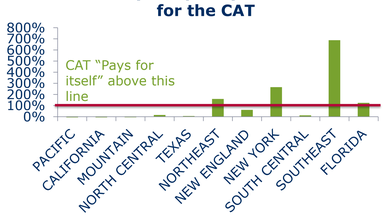
Air quality co-benefits offset 10% of the CES cost, and 90% of the CAT cost

The CES has both higher policy costs (because abatement is restricted to the energy sector), and higher air quality co-benefits (due to greater fine particulate matter reductions) than the CAT. The CAT is a more cost-effective means of achieving the same CO_2 reductions. The air quality co-benefits of the CAT nearly offset its policy costs (90% are offset). Both policies favor the eastern US regions. The CES offsets costs more evenly by region than the CAT.

Fraction of welfare loss per region offset by air quality co-benefits for the CES



Fraction of welfare loss per region offset by air quality co-benefits for the CAT

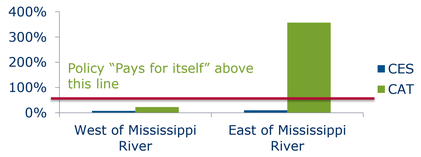


Cap-and-Trade "pays for itself" with air quality co-benefits east of the Mississippi

The CAT more than "pays for itself" with air quality co-benefits east of the Mississippi River.

CES air quality co-benefits offset about ~10% of policy costs in each region. It is more "fair" in its net effects in the east and west.

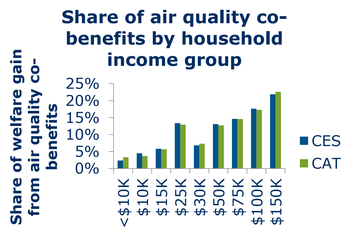
Fraction of welfare loss per region (West/East of Mississippi river) offset by air quality co-benefits



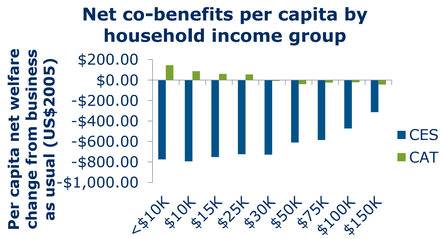
CES net co-benefits appear regressive with income, and CAT appears progressive

- Both policies appear to share air quality co-benefits similarly across income groups; greater air quality co-benefits accrue to rich households on a per capita basis.
- Considering net co-benefits (co-benefits minus costs), the CES appears regressive (i.e., poor households lose the most welfare), while the CAT appears progressive. The progressive nature of the CAT is a function of how revenues are treated in the policy design.[5] In this policy design, they are returned lump-sum to households.[4]

Share of air quality co-benefits by household income group



Net co-benefits per capita by household income group



5. Contributions

Tracking policy impacts on real economic resources throughout the economy

We offer a new view on the net air quality co-benefits of CES and CAT policies by tracking market-based effects (e.g., to labor, capital, health services). While traditional benefits estimates yield higher benefits by estimating the full willingness-to-pay to avoid health risks, our approach is resource-constrained, and captures economy-wide effects, including gains to those not directly affected by pollution.

Identifying distribution of gains and losses of net air quality co-benefits

Our model offers the resolution to assess winners and losers by region and income group.

6. Conclusions

The CAT nearly pays for itself (90% of costs offset) with air quality impacts to real economic resources

The air quality co-benefits of the CES offset about 10% of its economy-wide policy costs.

The net benefits of the CAT accrue to the Eastern US

The Eastern US is the only net winner for both policies considered. The CES has a more even spread in its net air quality co-benefits across US regions.

The net co-benefits of the CES fall hardest on the poor, while the CAT favors the poor

In this analysis, the CAT appears more progressive with income than the CES, though this depends on the specific policy design of the CAT.[5]

More work is needed to understand the key drivers and uncertainties of air quality co-benefits. We continue to study this question, including the effect model resolution. [5,14]

7. References

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Images from http://forumonenergy.com/2012/05/18/experts-project-significant-role-for-nuclear-under-the-clean-energy-standard-act and http://www.epa.gov/captrade/

7. Acknowledgments

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