Air Quality Impacts of a Clean Energy Standard on Major U.S. Cities

Tammy M. Thompson
Noelle E. Selin, Sebastian Rausch, Rebecca Saari
Massachusetts Institute of Technology
Joint Program on the Science and Policy of Global Change
Corresponding Author Email: TammyT@mit.edu

Introduction:

Environmental policy and economics are closely linked and decisions made in one realm can have profound impacts on the other. Therefore, it is important to consider both when designing policy options. We have created a modeling system that takes a policy option and first models economic impacts, then links that output to emissions inventory processing and regional air quality modeling and finally pollution and human health impacts and the effect on the economy

Results:

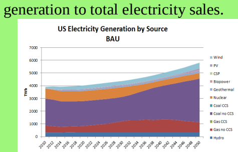
Clean Energy Standards reduce electricity generation from coal and gas, but increase industrial use of fossil fuels leading to large reductions in Sulfur and Nitrogen Dioxide Emissions. Regional air quality modeling results show an average 2% decrease in 8-hr ozone during summer months and an average 5% decrease in 24-hr averaged particulates in 42 major cities in the U.S.

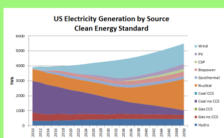
Model the Impact of Clean Energy Standard on the U.S Economy

U.S.REP Economic Model

Model the change in output (in $) of 17 sectors of the U.S. economy due to a specific policy option[1]

- The Clean Energy Standard scenario is constrained to achieve a specific clean electricity fraction target in each modeled year : Targets increase linearly from 42% in 2012 to 80% by 2035. Then targets increase linearly from 2035 to 2050, achieving a final value of 95% in 2050.
- Clean Electricity Fraction is the ratio of total clean energy electricity generation to total electricity sales.





USREP: Output by Regions and Sectors

- **Electricity Generation**
- **Energy Intensive Industry**
- **Other Industry**

- **Coal**
- **Oil**
- **Gas**

- **Light Duty Transportation**
- **Other Transportation**
- **Agriculture**
- **Services**
- **Crude Oil**
- **Petroleum**
- **Coal**
- **Gas**

Standard Classification Codes (SCC) Used as Industry Identifiers in Emissions Inventories

Alter Emissions Inventories to Reflect Economic Changes due to CES Scenario

SMOKE Emissions Preprocessing

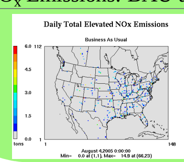
Speciate, Control, and Spatially and Temporally Allocate Emissions Inventories

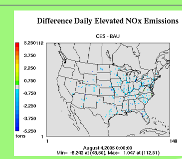
- Emissions inventory is based on 2005 National Emissions Inventory and Continuous Emissions Monitors and was developed by the U.S. EPA.[2] This was run as the Business As Usual air quality modeling case.
- Ratios of Clean Energy Standard (CES) Year 2050 output to Business as Usual (BAU) Year 2050 output, by sector and U.S. region, are applied to all species within the emissions inventories to adjust base case (BAU) emissions to reflect predicted changes in the economy. This is the CES policy case.

SMOKE: Control Factors by Regions and Sectors

Region	Electric	Coal	Electricity from Coal	Industrial Coal Use	Gas	Electricity from Gas	Industrial Gas Use
Alaska	0.00	1.00	0.00	1.00	0.99	0.00	0.99
California	0.94	1.00	0.01	0.00	1.00	0.41	1.07
Florida	0.98	1.00	0.03	0.00	0.50	0.39	1.06
New York	0.97	1.00	0.05	0.00	0.93	0.40	1.01
Texas	0.93	0.65	0.21	1.68	0.95	0.35	1.08
New England	0.96	1.00	0.38	0.00	1.00	0.23	0.00
South East	0.91	0.90	0.12	1.88	0.80	0.24	1.10
North East	0.91	0.90	0.12	1.45	0.97	0.94	1.03
South Central	0.92	0.03	0.13	1.17	0.91	1.02	1.09
North Central	0.89	0.54	0.04	1.57	0.91	2.61	1.06
Mountain	0.92	0.62	0.15	1.65	0.96	0.43	1.07
Pacific	0.94	0.04	1.10	1.38	0.59	0.13	1.21

NO_x Emissions: BAU and Difference due to CES





Evaluate the Resulting Changes in Regional Air Quality (Criteria Pollutants)

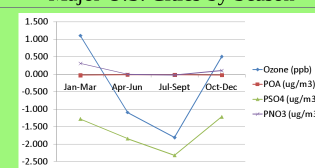
CAMx Regional Air Quality Model

3-D Photochemical Model simulates processes associated with emissions, transport, chemistry, and deposition[3]

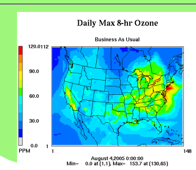
Year long episode developed by the U.S. EPA for use in support of the Cross State Air Pollution Rule with meteorological inputs representing conditions as they occurred in 2005 developed by MM5[2]

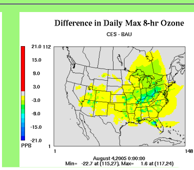
- Two cases: Basecase model run with emissions representing BAU, and Scenario case model run with emissions representing CES applied to 2005 emissions
- Results show modeled changes in Daily Max 8-hr Averaged Ozone and 24-hr averaged $PM_{2.5}$ (Nitrates, Sulfates and Organic Carbon) due to CES

Average Changes in Pollution Across 42 Major U.S. Cities by Season



Ozone Concentration: BAU and Difference due to CES





The resulting changes in pollution and potential human health impacts will be fed back into USREP to close the loop

Continuing Work:

We are working with the NorthEast States for Coordinated Air Use Management (NESCAUM) to identify air quality linked policy questions that are important to New England regulators right now. For example, a likely next run will investigate the potential air quality impacts of electric vehicles in New England.

Acknowledgments: The research described has been supported by the U.S. Environmental Protection Agency's STAR program through grant R834279 and by the MIT Joint Program on the Science and Policy of Global Change. It has not been subjected to any EPA review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

1. S. Rausch, G. E. Metcalf, J. M. Reilly, and S. Paltsev (2010). Distributional Implications of Alternative U.S. Greenhouse Gas Control Measures, The B.E. Journal of Economic Analysis & Policy, 10(2).
2. http://www.epa.gov/airtransport/techinfo.html
3. www.camx.com