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Harvard T.H. Chan School of Public Health
Center for Climate, Health, and the
Global Environment

February 18, 2021

To: Chairman Bobby Rush, Ranking Member Fred Upton and members of the Energy Subcommittee of the Energy and Commerce Committee of the U.S. House of Representatives

Re: Subcommittee Hearing on A Smarter Investment: Pathways to a Clean Energy Future

President Joseph Biden has set a goal of achieving a carbon-free electricity sector by 2035 and net-zero greenhouse gas emissions economy-wide by 2050 and the CLEAN Future Act includes a clean energy standard and a goal of net-zero carbon emissions from the power sector by 2050.

Our Clean Energy Futures (CEF) project shows that several clean energy policies, including clean energy standards, carbon prices, and a national cap and trade policy can achieve low or zero carbon emissions in the electricity sector by 2040 to 2050 and provide major health gains at modest costs.

We summarize the key research findings of the CEF project here and append supplemental information for your reference. We are available to provide a briefing to the committee on the results from this extensive research.

About Clean Energy Futures (CEF)

The CEF project quantifies the carbon emissions, costs, air quality, and health outcomes of different policies to reduce carbon dioxide (CO_2) emissions from the U.S. electricity.

The CEF team is analyzing 12 leading policy options including (1) clean electricity standards, (2) national cap and trade policies, (3) carbon prices in the electricity sector, and (4) rules under section 111(d) of the Clean Air Act.

Each electricity sector policy is compared to a no-policy reference case (business as usual, BAU) to estimate changes in: (1) carbon dioxide emissions; (2) electricity system generation sources and system costs; (3) co-pollutant emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury; (4) air quality, including fine particulate matter ($PM_{2.5}$) and ozone; and (5) air quality-related human and ecosystem health outcomes.

Key Findings

Reaching Zero Emissions in the Electricity Sector is Achievable at Modest Costs

Several clean energy policies, including clean energy standards, carbon prices, and a national cap and trade policy can achieve low or zero carbon emissions in the electricity sector by 2040 to 2050 with existing technology at a cost of about 15% above baseline. Moreover, the strongest policies deliver 20% more benefits than the moderate policies at only 6% higher costs.

Clean Energy Delivers Climate and Health Benefits That Far Outweigh Policy Costs

All of the policies that we examined deliver climate benefits that exceed policy costs. In addition, all policies considered, except the Affordable Clean Energy rule, decrease sulfur dioxide and nitrogen oxide emissions resulting in substantial additional health benefits associated with improvements in air quality. Virtually the entire coterminous U.S. is projected to experience better air quality. Improvements are most striking in the eastern U.S., particularly in areas experiencing chronically impaired air quality. For the most ambitous policies, such as a 100% Clean Energy Standard by 2040, our projections suggest that over 11,000 premature deaths could be avoided annually from decreases in air pollution by 2030.

Policy Design Determines Timing, Cost, and Benefits of Clean Energy

- For Clean Energy Standards, the timeline for achieving 100% clean energy exerts a larger impact on future energy generation and emissions trajectories than which carbon intensity benchmark is used and whether partial crediting is allowed, when banking is limited.
- Policies that drive down coal generation can achieve large reductions in sulfur dioxide, nitrogen oxide and mercury emissions, decreasing atmospheric concentrations of fine particulate matter ($PM_{2.5}$) and ozone, and providing considerable health benefits.
- Policies with stringent targets and timelines without banking reach the zero- or near-zero emissions the earliest.
- Emissions banking can lower costs and, together with a stringent policy target, achieve early emissions reductions and larger cumulative benefits for carbon dioxide and co-pollutants. It can also extend the use of fossil fuels further into the future.
- If small generating units (<25W) are not covered and run unconstrained, they can drive up emissions of nitrogen oxides when a stringent standard is applied to larger covered sources.

Next Steps

The Clean Energy Futures project is expanding on our current work to produce maps of future carbon emissions reductions, air quality, and health benefits. We also plan to conduct a distributional analysis of the health benefits by race/ethnicity and income and to analyze electricity sector effects under a scenario of high electrification of the transportation sector.

We are available to answer questions or brief the committee on our findings.

Yours truly,

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University Professor of Environmental
Systems Engineering

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Senior Advisor
Harvard Chan C-CHANGE

Clean Energy Futures Collaborators

The CEF project is a multi-institutional research initiative with experts from Syracuse University; Center for Climate, Health and the Global Environment at the Harvard TH Chan School of Public Health; Resources for the Futures; and Georgia Institute of Technology.

- Charles Driscoll, Jr. – University Professor of Environmental Systems and Distinguished Professor of Civil & Environmental Engineering, Syracuse University
- Kathy Fallon Lambert – Senior Advisor, Center for Climate, Health, and the Global Environment at the Harvard T.H. Chan School of Public Health
- Jonathan Buonocore – Research Scientist, Center for Climate, Health, and the Global Environment at the Harvard T.H. Chan School of Public Health
- Dallas Burtraw – Darius Gaskins Senior Fellow, Resources for the Future
- Maya Domeshek – Research Associate, Resources for the Future
- Amelia Keyes – Research Associate, Resources for the Future, JD candidate Harvard Law School
- Qasim Mehdi – PhD candidate, Syracuse University
- Armistead (Ted) Russell – Regents Professor, Georgia Institute of Technology
- Huizhong Shen – Postdoctoral Fellow, Georgia Institute of Technology
- Peter Wilcoxen – Professor, Director of the Center of Environmental Policy and Administration, Maxwell School, Syracuse University
- Petros Vasilakos - Postdoctoral Fellow, Georgia Institute of Technology

Supplemental Information from the Clean Energy Futures Research Project

Table 1. The Clean Energy Futures project compares the 12 electricity sector policies shown below to a no-policy reference scenario. The colors in the table denote low, moderate, and high ambition policies.

Policy Type	Code	Description
Reference case	BAU	Business as usual, no policy
Section 111 rules	ACE	Affordable Clean Energy – assumed 4.5% HRI for affected units
	CPP20	Updated Clean Power Plan - achieves 65% CO2 reduction from 2005 levels by 2035
Clean Energy Standard	CES40	100% clean in 2040, 0.82 metric tons/MWh, partial crediting, total generation, no banking
	CES40-B	100% clean in 2040, 0.82 metric tons/MWh, partial crediting, total generation, banking allowed
	CES50-H	100% clean in 2050, high carbon intensity benchmark (0.82 metric tons/MWh), total generation, banking allowed until 2040
	CES50-L	100% clean in 2050, low carbon intensity benchmark (0.46 metric tons/MWh), total generation, banking allowed until 2040
Cap and Trade	CAP	Net 0 emissions in 2040, offsets allowed but no banking
	CAP-B	Net 0 emissions in 2040, banking allowed
Carbon Price	CP-25	Carbon price $25/ton rising at 5% per year
	CP-25u	Like CP-25 but units below 25 MW “unconstrained” (not held to BAU capacity factors)
	CP-50	Carbon price $50/ton rising at 5% per year
	CP-50u	Like CP-50 but units below 25 MW “unconstrained” (not held to BAU capacity factors)

Figure 1. Projected total carbon dioxide emissions from the U.S. power sector under a set of policy cases from 2020 to 2050.

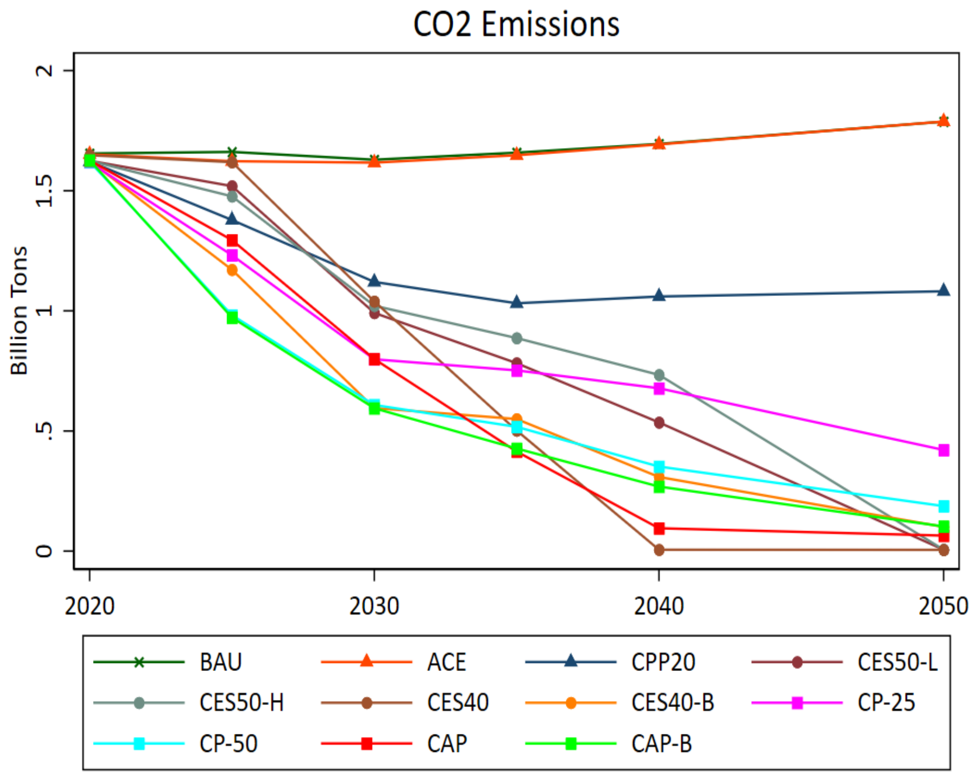


Figure 2. Comparison of estimated net present value system costs (green bars), climate benefits calculated using the social cost of carbon (orange bars), and health benefits associated from improved air quality due to lower sulfur dioxide and nitrogen oxide emissions (blue and red bars).

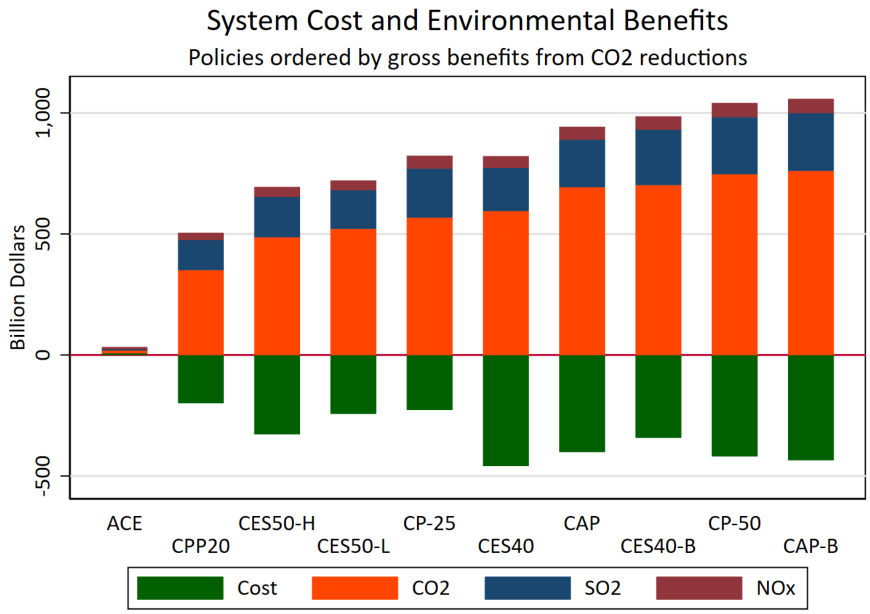
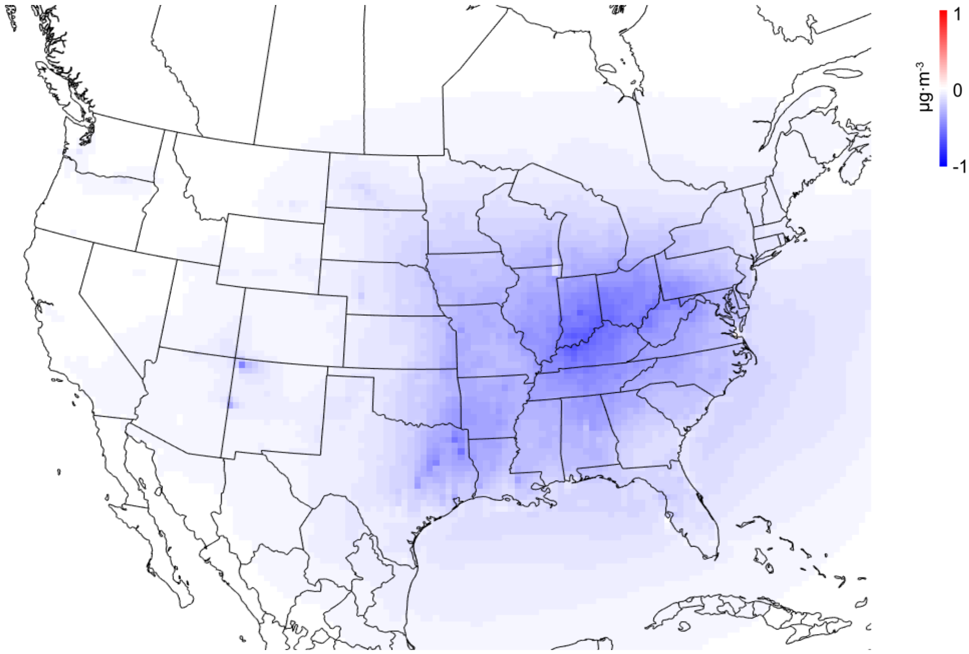
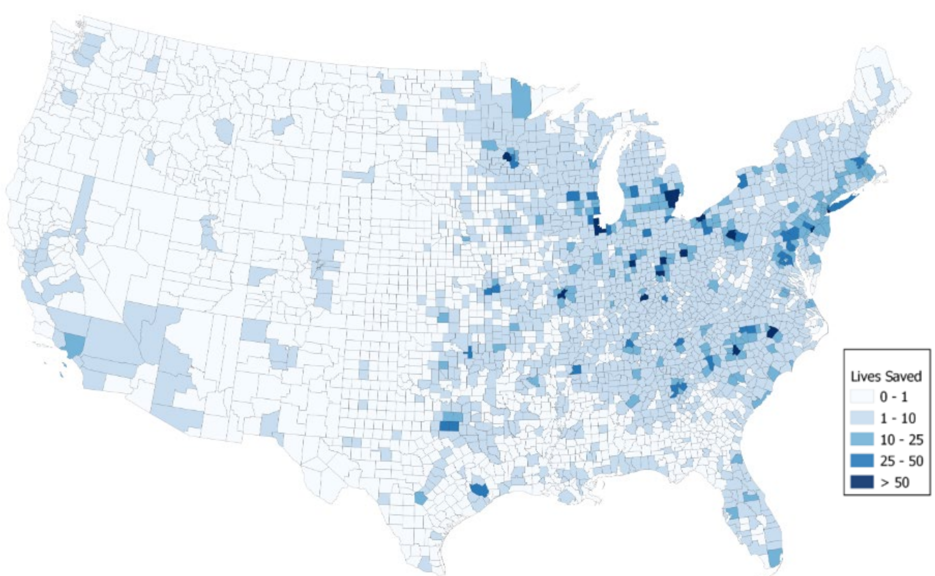


Figure 3. Projected change in air quality (a) and premature deaths (b) avoided under a Clean Energy Standard with banking (CES40-B). Similar results are also available for the other policy scenarios.

3a. Estimated change in fine particulate matter ($PM_{2.5}$) concentrations for the CES40-B policy in 2030 (annual average of 24-h averages)



3b. Estimated premature deaths avoided from reductions in fine particulate matter ($PM_{2.5}$) and ozone concentrations for the CES40-B policy in 2030. Annual total lives saved = 11,200.



Modeling References

Byun DW, and Ching JKS. 1999. Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) modeling system. United States Environ Protection Agency.

Heo, J., P.J. Adams, and H. Gao. (2016) "Reduced-form modeling of public health impacts of inorganic PM2.5 and precursor emissions", *Atmospheric Environment*, 137, 80—89. doi:10.1016/j.atmosenv.2016.04.026.

ICF International. Integrated Planning Model. 2013. http://www.icfi.com/insights/products-and-tools/ipm. IPM simulations were conducted by ICF. The CEF project is solely responsible for the scenario specifications and all assumptions used in the IPM analysis.

U.S. Environmental Protection Agency. BenMAP [Internet]. 2015. Available: http://www2.epa.gov/benmap/benmap-downloads.