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Health and Climate Benefits of Different Energy-efficiency and Renewable Energy Choices

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Using diagrams of lungs to illustrate how tiny fine particulates in the air can lodge deep inside the lungs and from there migrate into the bloodstream, Jonathan Buonocore of Harvard's T.H. Chan School of Public Health explained the significant public health impacts of sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions from electricity generation plants, especially coal plants. Outdoor air pollution resulting from electricity generation is estimated to cause approximately 460,000 deaths a year worldwide from health impacts that include lung cancer, asthma, heart attacks, and strokes.

These particulate emissions often go hand in hand with greenhouse gas emissions, creating the possibility of "co-benefits" from technologies and policies that reduce these emissions—that is, technologies and policies that can reduce carbon emissions can also have benefits for health by improving air quality.

The potential for these kinds of benefits can be an argument in favor of technologies and policies that reduce pollution from the power sector. In his talk in Monday's Energy Policy Seminar, Dr Buonocore presented an overview of his research, aimed at modeling the different impacts of wind power, solar power, and energy efficiency in terms of the potential value of both their climate and their public health benefits.

Buonocore began by giving a sense of the complexity of the analysis. There is no one universal value for the public health benefits of any of the energy resources he looked at. In each case, the benefits depend on what marginal energy resources are being displaced, and on where in the country these resources are located—and how many people are downwind.

To capture this complexity, the analysis relied on the PROSYM tool for detailed modeling of electrical dispatch at hourly resolution, and taking into consideration factors such as transmission constraints, economics, and regulations. The impact of an additional wind plant, solar facility, or energy efficiency in a particular location was assessed by running a dispatch simulation with and without the resource. Then the health impacts of the resulting change of emissions were assessed, taking into account the emissions displaced, and the size of the downwind population likely to be affected.

Buonocore ran the simulation for four types of renewable energy or energy efficiency interventions in six locations in the northern Midwest and northeast, comparing the impacts of utility-scale solar PV, wind power, general energy efficiency, and demand side management aimed at reducing peak energy use. Overall, wind and baseload energy efficiency measures (ones that run constantly, as opposed to just during times of peak demand) showed the greatest combined health and climate benefits per MWh produced or not consumed—primarily because these interventions displaced power at times when coal plants were being used as marginal resources. Calculated in terms of dollars per MWh, the benefits of the six hypothetical wind power projects examined all exceeded estimates of the levelized cost of energy for the projects (the same was not true for solar PV).

Buonocore acknowledged that he would expect these results to vary, depending on levels of penetration of different resources. But he noted that he would expect some underlying relationships to be predictable; for example, displacing coal will be more beneficial than displacing natural gas, since coal generally has higher emissions than natural gas, and displacing emissions upwind of large population centers will be more beneficial than displacing emissions remote from population centers.

Buonocore spoke as part of the Kennedy School’s Energy Policy Seminar Series, which is jointly sponsored by the Energy Technology Innovation Policy research group of the Belfer Center and by the Consortium for Energy Policy Research of the Mossavar-Rahmani Center on Business and Government.