Characterization of Regional Marginal Abatement Cost Curves for NOx that Incorporate Control Measures, Renewable Energy, Energy Efficiency and Fuel Switching

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Abstract

Anthropogenic nitrogen oxides (NOx) are emitted when fossil fuels are combusted. In the atmosphere, NOx reacts with volatile organic compounds (VOCs) to produce tropospheric ozone, a component of photochemical smog. In most parts of the country, strategies for reducing ozone generally focus on placing NOx emission control devices on power plants, industrial sources and vehicles. In some metropolitan areas, however, these "end-of-pipe" control measures may not be sufficient to achieve the National Ambient Air Quality Standard (NAAQS) for ozone.

In this work, we use the MARKAL energy system model to examine additional options for reducing NOx emissions, including renewable energy, energy efficiency and fuel switching (RE/EE/FS). Our methodology involves applying a dollar-per-ton cost on energy system NOx emissions within the model. We execute MARKAL iteratively, incrementing this cost from a level of $250 per ton through $100,000 per ton. For each iteration, we track the quantity of NOx reduced by end-of-pipe controls and that reduced by RE/EE/FS. These results allow us to develop marginal abatement cost curves (MACCs) for NOx for each of the U.S. Census Divisions. We also track impacts on the emissions of other pollutants, short-lived climate forcers and greenhouse gases. Thus, we are able to examine the multi-pollutant benefits of RE/EE/FS.

Our results indicate that some RE/EE/FS can be cost-competitive with end-of-pipe controls. Furthermore, RE/EE/FS can reduce NOx emissions once cost-effective end-of-pipe controls have been exhausted. By ranking the efficacy of specific RE/EE/FS measures, we show that their relative cost-effectiveness differs from one region of the country to another. Ultimately, through this and follow up research, our goal is to provide information to air quality managers about the emission reduction potential of RE/EE/FS on NOx emissions, helping inform decisions about strategies to meet air quality improvement goals.