

# Effects of Carbon Mitigation on Co-pollutants at Industrial Facilities in Europe

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The combustion of fossil fuels simultaneously releases carbon dioxide (CO<sub>2</sub>) and air pollutants such as sulfur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>), and particulate matter (PM). More stringent climate policies therefore may generate air quality co-benefits, increasing the overall benefits from carbon mitigation. So far, however, little is known about the relationship between CO<sub>2</sub> and co-pollutant emissions at the point-source level.

Using European data on large industrial point sources from the European Pollutant Release and Transfer Register (E-PRTR), we estimate how changes in carbon dioxide emissions affect emissions of the three co-pollutants SO<sub>x</sub>, NO<sub>x</sub>, and PM<sub>10</sub>. Our sample includes between 630 and 2,400 facilities for the years 2007 to 2015. We find substantial and statistically significant co-pollutant elasticities of about 1.0 for SO<sub>x</sub>, 0.9 for NO<sub>x</sub>, and 0.7 for PM<sub>10</sub>. The energy sector is characterized by relatively high co-pollutant elasticities of 1.6 for SO<sub>x</sub>, and 1.0 for NO<sub>x</sub> and PM<sub>10</sub>.

Identifying climate policy-induced changes in CO<sub>2</sub> emissions based on changes in regulatory stringency, we estimate co-pollutant elasticities in the electricity sector of 1.2 to 1.8 for SO<sub>x</sub>, 1.1 to 1.5 for NO<sub>x</sub>, and 0.8 for PM<sub>10</sub>. Combining these results with co-pollutant damage costs obtained from the European Environmental Agency, we calculate the value of air quality co-benefits arising from one ton of CO<sub>2</sub> reduction in the energy sector. The monetized co-benefits (in 2005 EUR) range from 33 to 98 EUR/tCO<sub>2</sub> for SO<sub>x</sub>, 9 to 24 EUR/tCO<sub>2</sub> for NO<sub>x</sub>, and 4 to 10 EUR/tCO<sub>2</sub> for PM<sub>10</sub>, with a joint magnitude of 46 to 132 EUR/tCO<sub>2</sub> for the three co-pollutants together. These air quality co-benefits are significantly higher than the European Environmental Agency's estimated climate damage costs of 10 to 38 EUR/tCO<sub>2</sub>. These findings would justify substantially higher carbon prices based on co-benefits alone, independent of their climate benefits.

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