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KEY INSIGHTS

- **Electrification lowers CO_2 and improves air quality**, which yields immediate and localized benefits. Decarbonization policy can amplify these trends.
- Electrification can **double or triple ozone improvements**, and benefits vary by location.
- Growing activity from non-energy-related particulate matter sources—such as fugitive dust—suggests that **additional measures beyond CO_2 policy may be needed to meet air quality goals**.
- Commonly used short-run **marginal emissions approaches underestimate reductions from electrification** by 32-91%.

This brief is based on the paper "Economy-Wide Evaluation of CO_2 and Air Quality Impacts of Electrification in the United States" in *Nature Communications* (2022)

Economy-Wide Air Quality and CO_2 Impacts of Electrification in the U.S.

by John Bistline, Geoff Blanford, John Grant, Eladio Knipping, David McCollum, Uarporn Nopmongcol, Tejas Shah, and Greg Yarwood

New research evaluates the CO_2 and air quality benefits of electrification by linking of a detailed energy systems model and full-form photochemical air quality model.

Adopting electric end-use technologies instead of fossil-fueled alternatives, known as electrification, is an important decarbonization strategy that also reduces criteria pollutants and improves air quality. To quantify the CO_2 and air quality impacts of electrification, we use a novel linking of a detailed energy systems model (US-REGEN) and full-form photochemical air quality model (CAMx) in the U.S. with scenarios that vary the extent of electrification and drivers of decarbonization.

Electrification increases electricity demand by 25% in 2035 and 39-52% in 2050 with CO_2 reductions of 33-78% from 2005, where the higher value is driven by CO_2 policy. **Transport electrification leads this growth and associated emissions reductions**.

Electrification lowers NO_x emissions by 46-58% by 2035 across the economy. Categories of emissions that are dominated by fuel combustion exhibit larger declines with electrification and decarbonization (e.g., CO_2, SO_2, NO_x) than emissions with substantial non-combustion sources (e.g., particulate matter, NH_3).

Deep NO_x emission reductions lead to striking ozone reductions across the U.S. Magnitudes vary

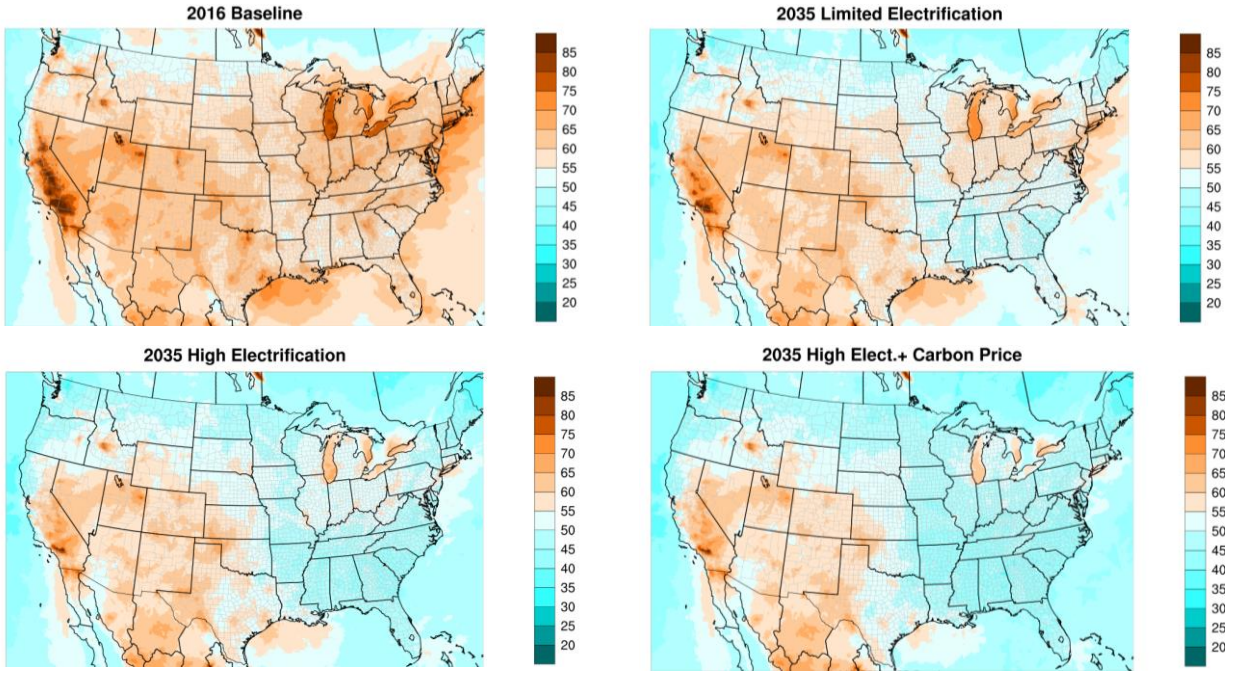

Figure 1. Estimated ozone design values (in parts per billion, ppb), the fourth highest maximum daily 8-hour average ozone concentrations. A 2016 baseline is compared with 2035 and 2050 scenarios with different levels of electrification and policy.

by location, but benefits are highest for the Northeast, Southeast, and Ohio Valley (Figure 1), which lead to attainment of 70 ppb NAAQS in eastern states with electrification reducing ozone by 3-13 ppb in 2035. **Increased electrification, as expected into 2050, can double or triple ozone improvements**.

Electrification also lowers fine particulate matter ($PM_{2.5}$) design values by 0.5 μg/m^3. Adding carbon pricing further lowers $PM_{2.5}$ by 0.5-1.0 μg/m^3. While combustion-related $PM_{2.5}$ emissions decrease, growing economic activity could increase emissions from categories such as road dust, industrial facilities, and agriculture. Although $PM_{2.5}$ impacts are small on a relative basis, even small changes in $PM_{2.5}$ can have large health benefits. **Air quality improvements yield immediate and localized benefits**, which occur rapidly following emissions reductions and near the mitigation source. In contrast, reducing climate damages may take decades to be felt and may occur in geographically distant locations.

The analysis compares results with simplified approaches using emissions factors that are common in the literature. We show how short-run **marginal emissions approaches underestimate reductions from electrification** by 32-91%. The emissions bias from simplified emissions factors is larger under scenarios where structural change is expected, especially with CO_2 policies.

FOR MORE INFORMATION

Read the full paper: Bistline, et al. (2022), "Economy-Wide Evaluation of CO_2 and Air Quality Impacts of Electrification in the United States." *Nature Communications*.

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