Health Benefits of Electrifying Chicago's Municipal Vehicle Fleet

Anastasia Montgomery, Jordan L Schnell, Amy Rogin, Daniel E Horton

Abstract

Background Approximately 100 000 American citizens die prematurely each year from air pollution exposure. To lower ambient pollution and co-emitted greenhouse gases, some cities have enacted vehicle electrification policies. In this study, we aimed to simulate changes in atmospheric composition due to the electrification of Chicago's municipal vehicle fleet and quantify the corresponding health and climate benefits of this policy.

Methods We simulated air quality at the neighbourhood scale (1·3×1·3 km) over the Chicago metropolitan area using the coupled Weather Research Forecast and Community Multiscale Air Quality Modelling System chemistry-climate model. We modified the 2014–16 National Emissions Inventory to create input emissions for baseline and electric vehicle adoption scenarios in Summer (August 2018) and Winter (January 2019) months. In the electric vehicle adoption scenario, we removed combustion products of the municipal vehicle fleet (school buses, transit buses, and refuse trucks) from the emissions data. To quantify the health effects of electric vehicle adoption, we calculated the difference in health response between the baseline and electrification scenarios by use of a suite of health response functions.

Findings We found that fleet electrification reduced CO_2 emissions (–1·4%) and NO_2 concentrations (–1·0%) while modestly increasing O_3 concentrations (+0·3%). Monthly average NO_2 reductions were found in high-density areas and along interstate highways, whereas O_3 increases were more prominent in the Chicagoland suburbs. Particulate matter changes were modest and spatially heterogenous. The pollutant changes resulted in both positive and negative health outcomes that were largely off setting.

Interpretation The inverse relationship between O_3 and NO_2 is known as the "weekend effect", in which the removal of NO_2 results in an increase in O_3 due to titration in volatile organic compound-limited environments. This relationship is particularly evident over the highways, where excess NO_2 reduces O_3 concentrations. The decision to electrify vehicles should consider air quality changes in addition to CO_2 due to complicating chemical interactions within urban environments.

Funding Ubben Program for Carbon and Climate Science at Northwestern University, US National Science Foundation.

Published **Online** April 25, 2021

Department of Earth and Planetary Sciences, Northwestern University, Evanston, IL, USA (A Montgomery MS, Prof D E Horton PhD, J L Schnell PhD); **Program in Environmental Sciences, Northwestern University, Evanston, IL, USA** (A Rogin BS); **Cooperative Institute for Research in Environmental Sciences, Boulder, CO, USA** (J L Schnell PhD)

Correspondence to: Anastasia Montgomery, Northwestern University, Chicago, IL 60657, USA **anastasiamontgomery2023@u.northwestern.edu**

Contributors

AM modelled, verified and analysed the data, and wrote the abstract. JS set up the model. AR conceived the study idea and provided initial analysis. DH oversaw all aspects of the study.

Declaration of interests

We declare no competing interests.