EPRI

P201 Back Pocket Insights

KEY INSIGHTS

- Commonly used short-run **marginal emissions approaches can underestimate CO_2 reductions from electrification** by 32% to 91%.

- The emissions bias from simplified marginal emissions factor methods is **larger under scenarios where structural change is expected in the electric sector**, especially with decarbonization policies.

- End-use **electrification can be environmentally beneficial today**, and CO_2 and criteria pollutant emissions benefits can increase over the lifetime of the device as emissions intensities of regional grids improve.

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)

Approaches to Assess the Emissions Impacts of Electrification

by John Bistline

New research compares approaches to evaluate the emissions impacts of end-use electrification.

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. This analysis finds that **electrification decreases CO_2 and other air pollutant emissions** even in the absence of a national climate policy, and these declines are amplified by decarbonization drivers.

These findings contrast with earlier studies suggesting more limited emissions effects of electrification, especially those that use short-run marginal emissions estimates, which characterize emissions from fixed electricity systems and do not account for structural change over time (e.g., deployment of renewables and coal retirements) as energy systems models do.

This analysis assesses emissions changes from electrification under two policy conditions:

- A reference scenario with current policies
- An economy-wide CO_2 policy scenario with an escalating CO_2 price

Across all scenarios, **the carbon intensity of electricity generation declines over time**. Even in the absence of CO_2 policies, load growth is largely met with expanded renewables and natural gas generation, which have lower emissions profiles than the current generation mix in many regions.

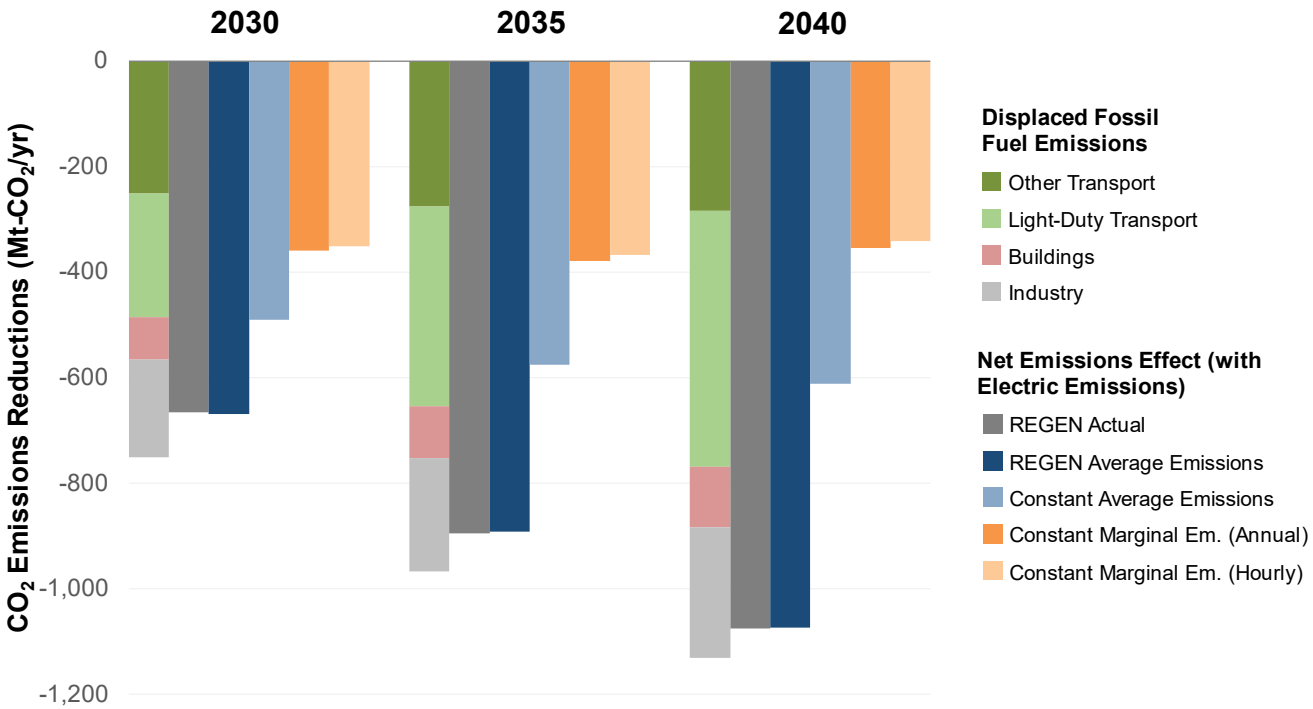

Figure 1. CO_2 reductions from electrification over time by emissions accounting approach. Stacked bars show displaced fossil fuel emissions by sector, and other bars show net CO_2 after accounting for electricity production under five approaches. Values are shown for a scenario with an economy-wide CO_2 policy. Constant average and marginal rates are based on 2019 estimates.

Marginal and average emissions approaches systematically underestimate reductions from electrification (Figure 1): These emissions factors only capture 52% to 91% of anticipated CO_2 reductions under a reference scenario and 32% to 74% of reductions under a carbon pricing scenario. Marginal emissions estimates implicitly assume that coal and gas generation serve an additional unit of demand for a large fraction of hours and do not capture changes over time.

The **emissions bias from simplified emissions factor methods is larger under scenarios where structural change is expected** in the electric sector, especially with CO_2 policies. Constant average emissions perform better than short-run marginal emissions but worse than observed reductions for a carbon tax, since the electricity generation fleet decarbonizes over time. There are several considerations to balance in emissions accounting for indirect "Scope 2" greenhouse gas emissions for corporate inventories.

Overall, this study indicates that **emissions declines from electrification are larger than simplified short-run marginal and average emissions methods suggest**. Emissions decline with today's grid mix but are lower with future market trends (e.g., coal retirements, renewables) and existing state policies. End-use electrification can be environmentally beneficial today, and benefits can increase over the lifetime of the device.

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*.

CONTACT

John Bistline (corresponding author)
jbistline@epri.com