RESEARCH BRIEF

OCTOBER 2020

Stanford WOODS INSTITUTE for the ENVIRONMENT

Mitigating Climate and Air Pollution in the Transportation Sector: A Regional Approach

Location is important when evaluating the climate change and air quality benefits of alternative vehicle and fuel choices across the United States.

Background

The transportation sector is currently the most significant contributor to carbon dioxide (CO_2) emissions in the United States. It is also a major contributor to the emissions of six of the most common air pollutants – or criteria air pollutants — as identified by U.S. EPA. In the case of two of those pollutants, carbon monoxide (CO) and nitrogen oxides (NOx), transportation accounts for half of total emissions. Adverse consequences and associated economic costs result from CO_2, a driver of climate change, and criteria air pollutants. Poor air quality, direct or indirect damage to built infrastructure, and elevated risks of mortality and morbidity are a few of the effects. In 2010, a U.S. National Academies report estimated that air emissions from on-road vehicles resulted in approximately $110 billion in damages.

POINTS FOR POLICY MAKERS

In examining the best fuel-vehicle technology for each U.S. county, three environmental goals were considered: climate change only; air quality only; or both climate and air quality benefits. Researchers found that:

- **A clean electricity grid with near-zero emissions is increasingly crucial for a sustainable transportation future.**
- **Battery-electric vehicles powered by a coal-phased-out electricity grid would deliver substantial health and climate benefits across the U.S.**
- **Battery-electric buses deliver the greatest benefits in all U.S. counties for addressing climate change of all the fuel and technology options considered.**
- **Battery-electric passenger cars could lead to co-benefits (mitigating both climate change and air pollution damages) for the West Coast, Rocky Mountain, and New England regions.** Similarly, gasoline/diesel hybrid-electric cars and SUVs would provide co-benefits in the Midwest.
- **Within the contiguous U.S., use of gasoline hybrid-electric vehicles results in the lowest climate and air pollution damages from passenger cars and SUVs, while battery-electric buses achieve the lowest damages from transit vehicles.**
- **Hybrid-electric vehicles have lower damages than conventional gasoline and diesel vehicles across all U.S. counties.** Hybrid-electric vehicles operate more energy-efficiently, consuming fewer fuels and leading to lower energy use and emissions from the upstream activities.

Alternative fuels and advanced vehicle technologies have been widely regarded as a potential solution for sustainable transportation. However, quantitative analysis of the climate change or air pollution benefits from alternative fuels and advanced vehicle technologies have not been widely available. Variations in regional conditions or timescales of goals have also been underexplored. A better understanding of the potential for alternative fuels and advanced vehicle technologies to deliver health benefits as well as climate mitigation compared to the existing, largely fossil fuel-based system, will be important for informing future transportation policy decisions.

To provide insights into the possible benefits of alternate fuels and vehicle technologies, research co-led by Stanford faculty estimated the life cycle monetized damages from greenhouse gas emissions and criteria air pollutant emissions for passenger cars, SUVs and transit buses in counties across the United States. The study examined vehicles powered by four different fuel types — gasoline, diesel, compressed natural gas, and grid electricity — coupled with three vehicle technologies: internal combustion engine vehicles (ICEVs), hybrid electric vehicles (HEVs) and battery electric vehicles (BEVs).

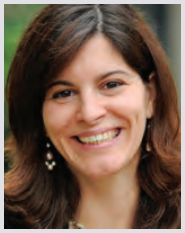
Conclusion

The study's results are largely driven by the electricity mix that is used to charge the vehicles. As the grid becomes cleaner, electrification of vehicles becomes more attractive in terms of reducing emissions.

It should be noted that policy actions towards sustainable transportation should account for the global (climate change) versus local (air pollution) impacts. Any initiatives should also consider stakeholders' value judgments of the relative importance between clean air and decarbonization goals as well as sensitivities to economic assumptions such as the social cost of carbon and the value of statistical life.

Stanford WOODS INSTITUTE for the ENVIRONMENT

ABOUT THE AUTHORS



Inês Azevedo

Inês Azevedo is an Associate Professor in Energy Resources Engineering and a Senior Fellow at the Stanford Woods Institute for the Environment at Stanford University.

This brief is based on the paper "**What are the best combinations of fuel-vehicle technologies to mitigate climate change and air pollution effects across the United States?"** published in the journal *Environmental Research Letters.*

FOR MORE INFORMATION

Office of Policy & Engagement
Stanford Woods Institute for the Environment
woods-extaffairs@stanford.edu
woods.stanford.edu