Q&A: Could automation, electrification of long-haul trucking reduce environmental impacts?

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A new University of Michigan study finds that automation and electrification of long-haul trucking can reduce urban health impacts and environmental damages.

For long-haul routes below 300 miles, electrification can reduce air pollution and greenhouse gas damages by 13%, or $587 million annually, according to the study. For long-haul routes above 300 miles, electrification of just the urban segments facilitated by hub-based automation of highway driving can reduce damages by 35%, or $220 million annually.

"It's the first study we know of that simultaneously studies a realistic model of automation and a realistic model of electrification—things that are feasible in the near term—and assesses their environmental benefits," said lead author Parth Vaishnav, assistant professor at the U-M School for Environment and Sustainability.

Vaishnav explains more about the study, which was published in the journal *Transportation Research Part D.*

Why did you want to focus on how automation and electrification might reduce health and environmental impacts from trucking?

Both automation and electrification of trucking are occurring in parts of the country, but separately. Electrification is difficult for very long routes. Diesel trucks can go 900 miles on a single tank. With today's technology, it is impractical to build an electric truck that can do that, because the battery would be so heavy that the truck would have no capacity to carry any payload.

But it's possible to build an electric truck that can go up to 300 miles.

Automation is easy on interstates—our past work shows that even truck drivers think that portion of their job can be automated—but very difficult in cities. So, we decided to see what would happen if you combined the best of both worlds: Electrify all routes shorter than 300 miles long, and for longer routes, electrify the portion of the route that occurs in cities, but keep human drivers. The benefit of doing this is that you cut tailpipe pollution in places where it can do the most harm, in urban areas where lots of people can breathe it.

What are the study's key takeaways/findings?

There is great environmental and health benefit from electrifying routes shorter than 300 miles: About half a billion dollars' worth of health and environmental harm would be avoided each year. Routes longer than 300 miles are responsible for a smaller share of freight ton miles than are shorter routes. Nonetheless, electrifying even the urban portions on these routes would cut health and environmental harms by over a third, or $200 million per year. That's true with today's grid, which still relies quite heavily on fossil fuels. As we clean up the grid, the benefits will grow.

Did anything surprise you about your findings? If so, what and why?

One of the challenges with using battery electric trucks on short routes is that you face a tradeoff between flexibility and efficiency. You want the smallest possible battery that will serve all the routes you want to serve because batteries are heavy, and you don't want to waste energy hauling around extra battery weight.

On the other hand, you want the truck to be able to be flexible in what it does; for example, to serve routes of all kinds of different lengths over

its lifetime. This means that you want to have a battery that is large enough to serve any route that the truck might be called upon to serve. To our surprise, this efficiency penalty was rather low—about 3%. This is good news, because you can have trucks with a few standard battery sizes without paying a massive efficiency penalty.

What would you like policymakers to take away from your paper in light of the Biden administration's new rules on heavy trucks?

That the electrification of trucking produces outsize benefits, even if it is done with today's technology in niche applications where it makes the most sense. However, these benefits are contingent on deploying a charging infrastructure that works for trucking. This means building out both chargers and strengthening the electricity grid.

The broader lesson is that there is a lot of room for both regulatory and operational creativity. For example, we assume that long-haul routes can be split into interstate and urban legs, and that before a truck enters or leaves the interstate, it stops to switch the trailer from an electric to diesel prime mover. These locations can be brownfield sites—for example, the sites of old retail malls—that are revived with a new purpose.

The study's co-authors include Yizhou Tian of the University of Michigan College of Engineering and Cecelia Isaac and Aniruddh Mohan of Princeton University's Andlinger Center for Energy and Environment.

More information: Parth Vaishnav et al, Automation and

electrification in long-haul trucking cuts urban health and environmental damages, *Transportation Research Part D: Transport and Environment* (2024). DOI: 10.1016/j.trd.2024.104187