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Environmental costs of shipping

A new life-cycle analysis of freight transportation suggests that policy makers should examine all of the emissions associated with shipping goods.

Truck, train, or airplane—which one has the smallest environmental footprint when it comes to shipping? A new assessment published in *ES&T* (DOI: 10.1021/es070989q) examines the emissions released over the life cycles of several forms of freight transportation for long-distance deliveries in the U.S. Although rail transportation has the lowest emissions overall, each form has phases in which emissions of a pollutant are much worse than in others. The researchers conclude that policy actions designed to reduce emissions from one phase of the life cycle can have unintended negative consequences, and they recommend policies that consider each phase carefully.

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Trains may be cleaner than planes and trucks for shipping goods when it comes to tailpipe emissions of $C0_2$, particulate matter, and other pollutants, but other life-cycle stages need to be considered for a full picture.

Cristiano Facanha of ICF International, a consulting firm that advises government agencies and others on transportation issues, and Arpad Horvath of the University of California Berkeley focused their life-cycle assessment (LCA) on greenhouse gases, particulate matter (PM), and other emissions from the U.S. freight transportation system. The researchers included data on emissions from building roads, tarmac, and rails, evaluated according to miles traveled by the ton.

They also looked at the emissions generated by the machinery used to load a plane or to lift a container onto a railcar as well as emissions from producing the fuel to keep the trains, trucks, and planes in motion. The assessment did not include the "short run" miles that are toted up by smaller trucks that might deliver goods to an airplane or rail yard for shipping. The researchers also excluded ship emissions, because those are limited mostly to freight on certain stretches of the Mississippi River or Great Lakes in the continental U.S.

Facanha and Horvath included tailpipe emissions generally considered for such studies: nitrogen oxides (NO_x), SO_2, PM less than 10 micrometers in diameter (PM_{10}), carbon monoxide, and CO_2. They combined two LCA methods to overcome the limits of each: process-based analysis, which translates inputs and outputs to a

representative unit, and economic input–output analysis, which combines economic data with environmental impact. The authors found that CO_2 and NO_x emissions tend to be underestimated, by up to 38% for airplanes but less so for trains and trucks. Facanha notes that "most of the time, rail is better than trucking—but you definitely have to qualify it."

Horvath says he was surprised to find mile-to-mile comparisons inadequate for comparing emissions for the same delivery by different methods. "It turns out that it's not as the crow flies. The roads between points A and B can be a certain length, and rails may be 20–30% more or less of those miles traveled." Air transportation may be even less direct, including fuel-use-intensive stops at different hubs, depending on the carrier.

Although it may be easier to reduce emissions from trucks than from rail, for example, Facanha and Horvath also conclude that current policy proposals to reduce tailpipe emissions overlook many other sources. Their policy models show that although NO_x and SO_2 may decline after restrictive regulations are in effect, PM_{10} might not. "We're trying to raise the awareness of the decision makers" in both government and business, Horvath says, that "it's not enough to focus on your fleet for delivering goods; it's important to focus on other parts of the economy that service your goods or delivery mechanisms."

What Facanha and Horvath found may not be all that surprising, says Sonia Yeh of the Institute of Transportation Studies at the University of California Davis. For SO_2 and PM_{10}, she says that the scenarios underscore "the possibility that if you reduce tailpipe emissions, you might increase overall life-cycle emissions" of pollutants. And although the authors "used very stylish policy scenarios to point out the strengths in their argument," she continues, these model cases are not detailed enough and "beg more questions regarding the feasibility, costs, and the adequateness of current policies to regulate upstream emissions."

Other critics of the paper note that LCAs are not complete unless they take a global view of impacts. Multiregional assessments that indicate emissions can be up to 20% greater than current assessments, notes James Corbett of the University of Delaware (DOI: 10.1021/es060752e), (DOI: 10.1021/eS0629110). Future assessments also should include new standards promoting low-carbon fuels. Although many studies look at light-duty vehicles, Yeh says, few "look at the LCA of freight, especially long-range rail and air, and compare them systematically." She says the new LCA "points out the right direction" for future research.
—NAOMI LUBICK

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