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Connected Eco-Driving Technology Can Help Improve Traffic Flow While Reducing Truck Emissions

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Issue

California has experienced faster growth in freight volume than freight-related infrastructure, leading to travel delays as well as traffic congestion and air pollution. One strategy to improve the efficiency of freight movement while also reducing environmental impacts is to encourage "connected eco-driving." This could be accomplished by utilizing innovative connected vehicle technology to provide truck drivers real time traffic signal phase and timing information that could be used to determine the best driving speed for passing smoothly through multiple intersections without stopping. The technology has been in research and development for over a decade. While initially developed for passenger cars,[1,2] the connected eco-driving technology has also been applied to other types of vehicles, including Class 8 diesel trucks.[3]

To better understand the feasibility, costs, and benefits of implementing a connected eco-driving strategy for trucks, researchers at the University of California, Riverside worked with local partners to deploy and evaluate a connected eco-driving system in the real world along three urban freight corridors near the Ports of Los Angeles and Long Beach. The connected eco-driving system was also tested in a traffic simulation environment for a robust evaluation of the system benefits. As part of this effort, the research team evaluated costs associated with enabling the technology, including capital investment in infrastructure upgrades (e.g., upgrading traffic controllers to export real-time traffic signal phase and timing data and installing communication links or devices to send the data to a server) and operating costs (e.g., wireless data plans and server maintenance). In addition, the team assessed changes in energy consumption and emissions of freight trucks traveling on the corridors as a result of using the technology.

Key Research Findings

The cost to upgrade and operate signalized intersections to support connected eco-driving is relatively low. Over a period of 20 years, the total cost for one intersection is estimated to be $18,200 (see Table 1 for detailed costs per intersection). However, a large-scale implementation could result in cost savings. For example, implementing the technology at 100 intersections could reduce the total cost per intersection to $12,460. It should be noted that there are also costs associated with enabling the technology on vehicles for the drivers to use. Those costs are expected to be borne by the private sector, who would invest in hardware and software to develop and market the connected eco-driving technology to drivers.

Item	Estimated Cost Per Section
Traffic signal controller upgrade	$3500 total
Communication modem	$1500 total
Wireless data plan	$30 per month
Server for computing	$25 per month
Server for data storage	$0.80 per month

Table 1. Costs associated with upgrading and operating a signalized intersection to support eco-driving.

Truck drivers and companies can expect significant fuel savings from using connected eco-driving technology. The technology can reduce truck fuel consumption by 20% under cold start conditions during the first few minutes of operation after overnight parking or a long stop at a warehouse when the engine temperature drops below a certain threshold. The technology can also reduce fuel use by 10% under hot running conditions after a few minutes of vehicle operation. Fuel is usually the second highest cost of operating a truck behind labor.

Connected eco-driving technology also delivers climate and public health benefits by reducing emissions from trucks. The emissions testing conducted in this study shows that connected eco-driving technology can reduce carbon dioxide (CO2) emissions from trucks traveling on signalized freight corridors with connected intersections by 22% under cold start conditions and by 10% under hot running conditions. In addition, under cold start conditions, the technology can reduce overall truck emissions of nitrogen oxides (NOx) by 20% and particulate matter (PM) by 15%. While the technology would not affect NOx emissions under hot running conditions, it can reduce overall PM emissions by 41%. These emission reductions would be especially significant for communities that are heavily impacted by truck traffic on city streets.

The technology also has potential to provide other co-benefits. In addition to fuel savings and emissions reduction benefits, the technology also has potential to provide other co-benefits, such as improving traffic safety, reducing brake and tire wear emissions, and mitigating noise pollution due to smoother vehicle operation. Further research on these potential co-benefits is needed.

More Information

This policy brief is drawn from the report "Evaluation of Benefits and Costs of Truck Connected Eco-Driving Program on Urban Freight Corridors" prepared by Kanok Boriboonsomsin, Peng Hao, George Scora, and Matthew Barth with the University of California, Riverside. The report can be found here: www.ucits.org/research-project/2020-16. For more information about the findings presented in this brief, please contact Kanok Boriboonsomsin at kanok@cert.ucr.edu.

[1]Xia, H., Boriboonsomsin, K., and Barth, M. (2013). Dynamic ECO-driving for signalized arterial corridors and its indirect network-wide energy/emissions benefits. Journal of Intelligent Transportation Systems, 17(1), 31-41.

[2]Hao, P., Wu, G., Boriboonsomsin, K., and Barth, M. (2019). Eco-approach and departure application for actuated signals in real-world traffic. IEEE Transactions on Intelligent Transportation Systems, 20(1), 30-40.

[3]Hao, P., Boriboonsomsin, K., Wang, C., Wu, G., and Barth, M. (2021). Connected eco-approach and departure (EAD) system for diesel trucks. SAE International Journal of Commercial Vehicles, 2(14).

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