

Diesel or electric? Study offers advice for owners of urban delivery truck fleets

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Georgia Tech researchers (l-r) Valerie Thomas, Dong-Yeon Lee and Marilyn Brown pose at an electric vehicle charging station located on the Georgia Tech campus. Their study compared energy use, greenhouse gas emissions and total cost of ownership of electric and diesel medium-duty trucks. Credit: Rob Felt

(Phys.org) —For owners of delivery truck fleets who may be trying to decide between electric or diesel vehicles, researchers at the Georgia Institute of Technology are offering some advice: comparisons of the energy consumption, greenhouse gas emissions and total cost of ownership for the medium-duty vehicles.

The advantages of electric versus diesel depend largely on how the trucks will be used – the frequency of stops and average speeds – and the source of electricity for charging batteries. In city driving with frequent stops, the electric trucks clearly outperform diesel vehicles.

"On average in the United States, electric urban [delivery trucks](#) use about 30 percent less total energy and emit about 40 percent less [greenhouse gases](#) than diesel trucks, for about the same total cost, taking into account both the purchase price and the operating costs," said Dong-Yeon Lee, a Ph.D. student in the Georgia Tech School of Civil and Environmental Engineering. "However, costs and emissions depend on how and where the truck will be used."

In urban delivery routes with lots of stop-and-start driving, electric trucks are roughly 50 percent more efficient to operate than diesel trucks overall. That makes them at least 20 percent less expensive than diesel-fueled trucks, and reduces [greenhouse gas emissions](#) by roughly 50 percent. Where they are frequently stopped and started, the higher efficiency of the electric motor at low speeds and the regenerative braking systems in electrical vehicles help provide better efficiency.

However, electric delivery trucks lose their advantage in suburban routes that involve fewer stops and higher average speed. Electric vehicles have a limited daily range and top speed, and without a lot of stops, lose their regenerative braking advantage. Electric vehicles can cost more than their diesel counterparts under certain conditions, particularly if high-cost [charging systems](#) are used, if the battery must be replaced early, or if they are used mainly for highway driving.

The relative benefits of the [electric vehicles](#), the researchers found, depend on vehicle efficiency associated with drive cycle, diesel fuel price, travel demand, electric drive battery replacement and price, electricity generation and transmission efficiency, electric truck

recharging infrastructure and purchase price. The study findings were reported July 16, 2013, in the journal Environmental Science and Technology.

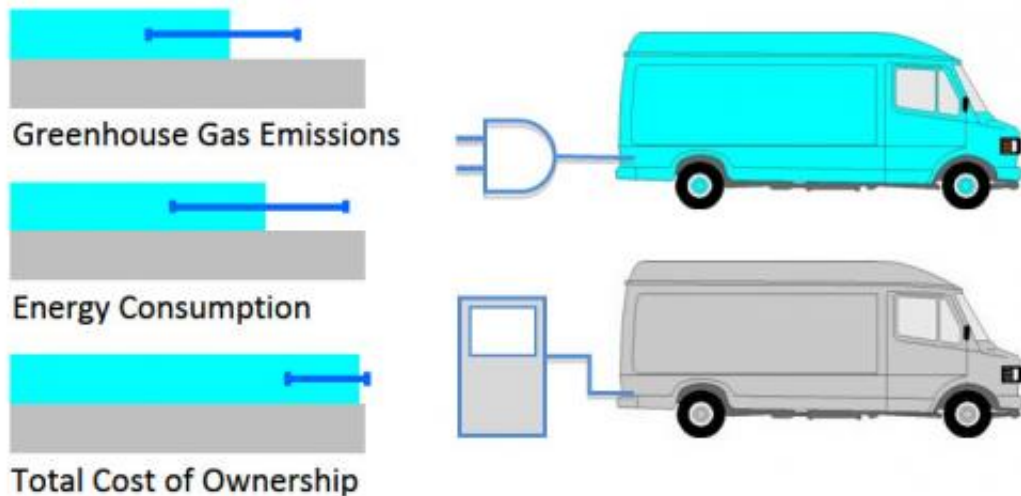


Chart compares electric and diesel urban delivery trucks in terms of lifecycle greenhouse gas emissions, energy consumption and cost. Credit: Environmental Science & Technology, copyright 2013 American Chemical Society

The research team took into account the sources of electricity used to charge the electric vehicles in evaluating [greenhouse gas](#) emissions. Electricity produced from hydroelectric sources – more common in the northwest United States – dramatically reduced total greenhouse gas emissions for electric vehicles operated there. Vehicles operated in states heavily dependent on coal for producing electricity showed higher emissions.

In every state in the U.S., electric trucks provided some reduction in

greenhouse gas emissions, with urban routes providing the most advantage. In about half of the states, the electric trucks cut greenhouse gas emissions by a third or more compared to diesel vehicles.

Wild cards in the study included the future costs of both diesel fuel and electricity, and the potential cost of replacing an electric truck's battery pack if it has a shorter-than-expected lifetime. Lithium-ion battery packs are expected to last the lifetime of the trucks, as much as 150,000 miles for the drive cycles tested.

"Technology advances make predicting the long-term price of electric trucks difficult," said Valerie Thomas, one of the study's co-authors and a professor in Georgia Tech's Stewart School of Industrial and Systems Engineering and School of Public Policy. "Battery price reductions down the road could have a large effect on the cost-competitiveness of electric trucks, while only diesel fuel prices could have a similarly large effect on the future cost-competitiveness of [diesel trucks](#)."

The researchers decided to study electric trucks in urban delivery applications because vehicles in these applications tend to travel the same routes each day, spend significant amounts of time in stop-and-start operation, and return at the end of each day to a central location where they can be charged.

The comparison involved a 2011 Smith Newton electric truck powered by a 120 kW electric motor, and a 2006 Freightliner truck powered by a Cummins diesel engine. The two trucks had approximately the same gross vehicle weight, curb weight and payload. The comparison controlled for improvements in diesel efficiency between 2006 and 2011.

The researchers were surprised to find that the electric truck had cost advantages over the diesel vehicle under some conditions. They had

expected that costs would always be higher for the electric vehicle, especially since the purchase price of the electric truck studied was higher than the diesel truck – and other models of electric trucks would have larger cost differentials.

"Over the life of the truck, there are many situations in which the total cost of operating an electric vehicle is less than operating a diesel vehicle," noted Marilyn Brown, another co-author and a professor in Georgia Tech's School of Public Policy. "Our expectation was that the electric vehicle would provide environmental benefits, but at a cost. We found that particularly in urban settings and in locations with relatively low greenhouse gas emissions from electricity, electric delivery trucks both save money and have environmental benefits."

Depending on what happens with vehicle and fuel costs, the advantages could swing even farther in the direction of electric vehicles.

"The relative benefit of electric trucks over [diesel](#) counterparts could be much more significant than one might expect," said Lee. "If the electric truck is deployed in the right drive or duty cycle application, fleet operators could enjoy higher returns on investment, while saving energy and reducing greenhouse [gas emissions](#)."

More information: Lee, D., Thomas, V. and Brown, M. Electric Urban Delivery Trucks: Energy Use, Greenhouse Gas Emissions, and Cost Effectiveness, *Environmental Science and Technology*, 47 (14): 8022-8030, 2013). [dx.doi.org/10.1021/es400179w](https://doi.org/10.1021/es400179w)

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