NEW REPORT!

ATRI American Transportation Research Institute

Understanding the CO_2 Impacts of Zero-Emission Trucks

New research from the American Transportation Research Institute (ATRI) analyzed the environmental impacts of Class 8 zero-emission trucks (ZETs). The research utilized federal and industry-sourced data to identify and compare full life-cycle CO_2 emissions for a range of truck types:

- Internal combustion engine (ICE) trucks powered by diesel
- Battery electric vehicle (BEV) trucks powered by electricity
- Fuel cell electric vehicle (FCEV) trucks powered by hydrogen

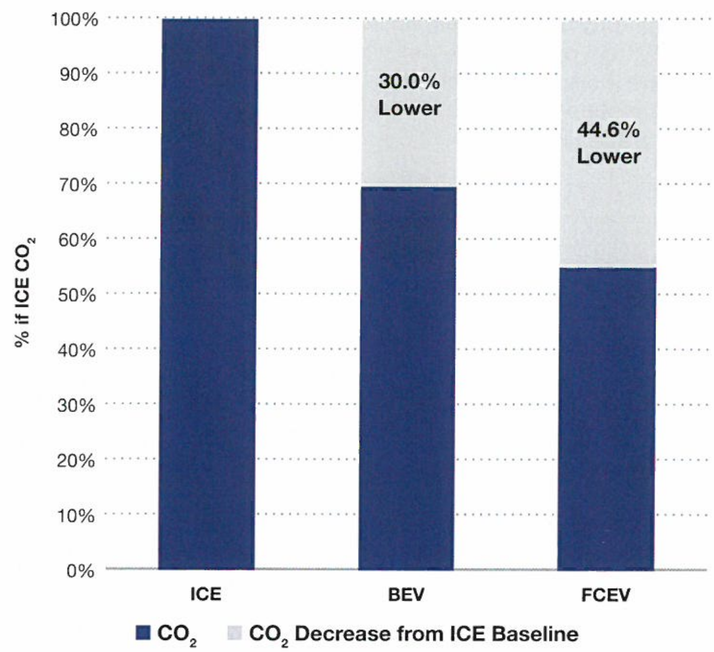
ATRI's analysis compared CO_2 emissions across the full vehicle life-cycle:

- Vehicle production
- Energy production and consumption
- Vehicle disposal/recycling

The study found that full life-cycle CO_2 emissions for the battery electric truck would only generate 30 percent fewer emissions than the standard diesel truck.

The marginal environmental benefits of electric trucks are due, in large part, to lithium-ion battery production – which generates more than six times the carbon of diesel truck production. ATRI's research concludes that hydrogen fuel cell trucks (FCEV) are ultimately the most environmentally friendly truck type, although the technology is not presently feasible for long-haul operations.

Lifetime CO_2 Emissions for Class 8 Diesel Truck (ICE) vs BEV & FCEV



Realities of Zero-Emission Trucks

VEHICLE COST

ZET vehicle costs will be a strong barrier to entry. While a new Class 8 diesel truck tractor may cost roughly $135,000 to $150,000, the purchase price of a new Class 8 BEV can be as much as $450,000. The same issue will likely impact the FCEV. Estimates for fuel cell truck costs range from $200,000 to $600,000 with 60 percent of the overall cost solely credited to the fuel cell propulsion system.

SOURCING OF MATERIALS AND SUPPLY CHAIN ISSUES

There are several key raw materials needed for lithium-ion batteries; depending on the battery chemistry, these might include lithium, graphite, cobalt, manganese and nickel. While these materials are critical for batteries and for the production of a large BEV national fleet, the U.S. is almost entirely dependent on other countries for these materials. Over the past decade, the U.S. has imported nearly 100 percent of the critical minerals needed for battery production from countries including China, Australia, Chile and the Democratic Republic of Congo.

REFUELING INFRASTRUCTURE

There currently is no U.S. network where over-the-road trucks can stop for rest breaks and recharging at the same time. In a forthcoming report, ATRI is documenting the infrastructure requirements of a nationwide truck charging network and the electricity sector's ability to power the U.S. truck fleet.

BATTERY LIFE

It is well understood that lithium-ion batteries begin to slowly degrade once the charging and discharging process commences, and battery degradation is greatly influenced by the number of charge cycles. Separate from the number of charging cycles, there is evidence that the *rate* at which a BEV is charged could impact battery life. Because of operational constraints – such as driver hours-of-service – and the large energy capacity of a truck battery, faster charging may be necessary.

Realities of Zero-Emission Trucks

Continued

BATTERY PERFORMANCE

Ambient temperatures can affect the battery performance of electric vehicles. Cold weather slows the chemical and physical reactions that make batteries work, leading to longer charging times and a temporary reduction in range. Conversely, higher temperatures generally lead to faster chemical and physical reactions.

In addition, low or elevated temperatures can initiate the use of electric air conditioning or heating systems, which can draw significant amounts of battery power – with an accompanying reduction in driving range.

Topography also has a strong influence on energy consumption and battery operation as well. On an uphill grade, all vehicles expend more energy than when traveling on level ground. Energy consumption for electric vehicles tends to steadily increase as road grade increases.

BATTERY WEIGHT AND CARGO CAPACITY

Battery weight may substantially limit the long-haul capabilities of a BEV, leading to a need for more BEV vehicles to carry the same amount of cargo. Those carriers operating closer to the maximum allowable weight will likely have to modify their operations if they wish to use long-haul battery electric vehicles.

Vehicle, Trailer and Cargo Weight

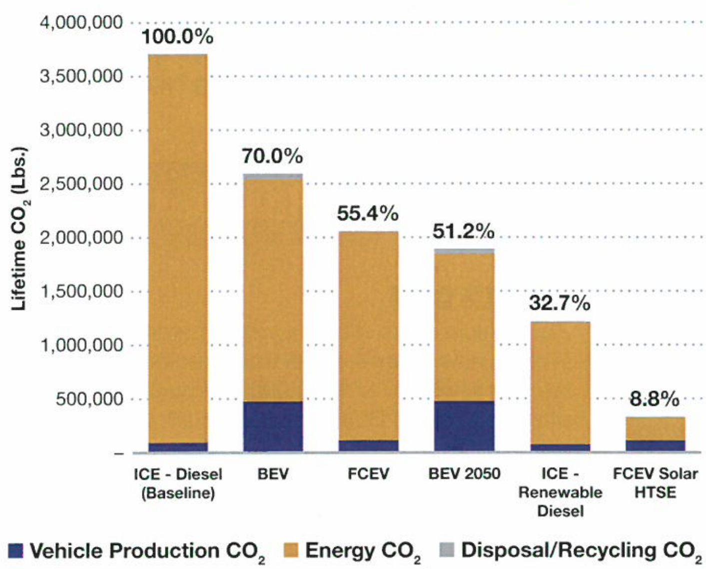
WEIGHT TYPE (lbs.)	ICE	BEV	FCEV
Tractor Weight	18,216	32,016	21,337
Trailer Weight	11,264	11,264	11,264
Average Cargo Weight	32,811	32,811	32,811
Total Weight	**62,291**	**76,091**	**65,412**
Remaining Available Cargo Weight	17,709	3,909	14,588

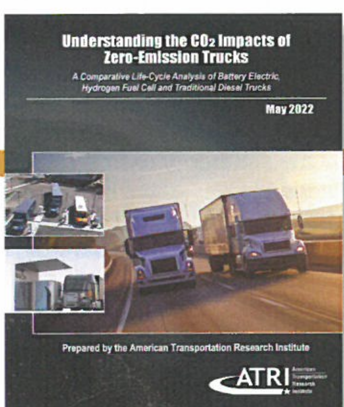
Reducing CO_2 Truck Emissions

ATRI's analysis concludes by identifying additional strategies that can reduce CO_2 truck emissions for all three energy sources – diesel, electricity and hydrogen. For example, renewable diesel could decrease CO_2 emissions to only 32.7 percent of a standard diesel engine without requiring new infrastructure or truck equipment. Hydrogen sourced from solar-power electricity could enable hydrogen fuel cell trucks to emit only 8.8 percent of the baseline diesel CO_2.

Overall, the three truck types studied in this report have a pathway for lowering CO_2 emissions in the coming decades. Research is needed to improve upon CO_2 reduction efforts, and specifically to lower energy source CO_2. While public policy is currently focused on moving the industry toward BEV, this research shows that even greater truck CO_2 emission reductions can be achieved through other approaches.

Potential CO_2 Emissions Reduction Options





For a copy of the full report, please visit ATRI's website at TruckingResearch.org

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