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Electrifying Trucking

The Case for Ambitious Federal Emissions Standards and Policies

Shifting the market for medium-and heavy-duty vehicles (MHDVs) to electric vehicles is key to meeting climate goals. Though MHDVs, which range from delivery vans to school buses to tractor trailers, make up only 5% of U.S vehicles on the road, they account for about 24% of vehicle greenhouse gas (GHG) emissions. Globally, emissions from heavy-duty vehicles are expected to surpass those of passenger vehicles by 2025. There simply is no way to address the significant climate risks of the U.S. transportation system without electrifying these vehicles, which are critical to our economy.

Climate isn't the only reason trucking must go electric. MHDVs are also the largest source of nitrogen oxide pollution, which is linked to lung cancer, heart disease, and premature death, disproportionately affecting disadvantaged communities that are located near truck routes, ports, and distribution centers. For this reason, large-scale truck electrification — and, in the interim, stronger NOx standards — is also critical to addressing longstanding equity and public health concerns.

The good news is that the shift to electric vehicles increasingly makes economic sense for manufacturers and suppliers. However, strong policy support is necessary to accelerate this transition at the rate necessary to meet the goals of the Paris Agreement of limiting global warming to 1.5C and solve our climate and air quality challenges. Bloomberg's 2021 EV Outlook projects that, while 95% of MHDV sales will need to be EVs by 2040 in order to meet a net zero scenario, just 30% of new MHDV sales in 2040 will be electric without new policies in place.

Ceres' analysis finds that several classes of trucks, especially larger medium- and heavy-duty trucks, are well positioned for the move to electrification. One key reason: the total cost of ownership for these electric vehicles is increasingly favorable compared to traditional internal combustion engine vehicles because of the long-term savings they provide on fuel and maintenance. Practically, many of these classes of trucks also operate consistent routes of less than 200 miles per day, permitting overnight charging when they are not in use.

To electrify the sector rapidly enough to meet Paris goals, the following policies will be necessary:

1. Federal zero-emission manufacturing and fleet purchase requirements, similar to California's Advanced Clean Truck (ACT) and Advanced Clean Fleet (ACF) standards.

2. Public financial support for charging infrastructure costs, as opposed to individual charging stations.

3. Public financial support for targeted purchase incentives, which are most appropriate for smaller fleets or smaller vehicles, such as some medium-duty pickups and vans.

Our analysis concludes that, with the help of these measures, sector electrification would bring economic benefits and competitive advantages to both manufacturers and suppliers that position themselves to take advantage of the transition. As the costs of battery electric vehicles drop due to increased production and technology improvements in other sectors, truck manufacturers will benefit from cost savings and higher profit margins. For example, the cost of owning and operating an electric vehicle is so much lower in some sectors that truck manufacturers may be able to increase their profit margins for electric trucks. This is particularly true for buses, Class 6/7 box trucks, and Class 8 tractors.

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Key Findings from the Analysis

- Large fleet owners would realize the greatest benefits and lower lifetime costs from battery electric vehicle ownership within several classes of trucks in a variety of different use cases under various cost assumptions.
- A federal zero-emissions vehicle mandate (requiring truck manufacturers to produce a portion of their new vehicle fleet as zero-emissions vehicles), coupled with financial support for infrastructure, would help ensure battery electric vehicle uptake by a wide range of users, including smaller fleet owners who might otherwise not have the capital to absorb higher purchase costs for battery electric vehicle-powered trucks.
- A zero-emissions vehicle mandate would lead to lower production costs by increasing sales and production volumes, which would further justify increased investment in infrastructure and incentivize the production of battery electric trucks in other classes.
- Manufacturers stand to benefit as increased production and technology improvements provide cost savings and higher profit margins.
- Forward-thinking suppliers also stand to benefit from the transition to electric trucks. Major suppliers, such as Detroit (formerly Detroit Diesel), Magna, Dana, and Meritor, are working with leading truck makers to provide critical components that enable electrification, providing these suppliers with new opportunities as their traditional business declines. These suppliers' investment and product development will enable truck makers to expand their electric vehicle product line, while reducing the time, product development, and capital required to make the transition to zero-emissions products. Employment at these suppliers collectively exceeds that of the truck makers, leading to significant economic benefits to both the public and private sector.
- Both a zero-emissions vehicle mandate for trucks and government support for charging infrastructure will be necessary to accelerate the deployment of electric vehicles at the rate and scale necessary to meet climate goals. A fleet mandate would also play an important role in building demand, and targeted purchase incentives — most appropriate for smaller fleets and vehicles — would also play an important role.

Based on this analysis, we recommend that the U.S. Environmental Protection Agency include a zero-emissions vehicle mandate in its rulemaking for federal truck standards that is currently under development. In March 2022, the EPA published a proposed rule to reduce emissions for heavy-duty trucks beginning in Model Year 2027. The proposed rule builds upon an existing Phase 2 Greenhouse Gas (GHG) Rule for Model Years 2019-2027 for medium- and heavy-duty vehicles. In 2023, the EPA is planning to propose emission standards for light- and some medium-duty vehicles for Model Years 2027 and beyond. EPA also plans to set GHG standards for heavy-duty vehicles for Model Year 2030 and beyond.

Including a zero-emissions vehicle mandate in the proposals currently under development would not only accelerate the electrification of the medium and heavy-duty sector, driving significant progress on national climate and air quality goals. It would ensure that manufacturers and suppliers are positioned to reap economic benefits and gain a competitive advantage as leaders during the global market shift to electric vehicles.

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Economic Analysis Supporting the Need for Federal Action

The conclusions of a report Ceres commissioned in 2021, **Electrifying U.S. Trucking: Promise and Challenges**, support this recommendation for a federal zero-emissions vehicle mandate. The report forecasted the composition (by propulsion type) of the medium- and heavy-duty truck market in 2025 and 2030, including over-the-road "tractors" and some "straight" trucks in Classes 7 and 8, which are covered by this rule. The report found that a zero-emissions vehicle mandate would be critical to increasing the availability and volume of zero-emissions trucks, as well as uptake by fleet owners. This support would accelerate the efforts of major fleet buyers and the truck makers to make these products available to the market in what might otherwise be a more protracted process.

This analysis, which is premised upon calculations of total cost of operation (TCO) for a variety of medium- and heavy-duty trucks in various classes powered by either a diesel engine, batteries, or fuel cells (which include batteries for energy storage), indicates that, given the lower operating costs (which increases with the number of miles driven) of a battery electric vehicle, large fleet owners in particular will have lower costs compared to trucks powered by diesel engines or fuel cells in a number of different use cases and cost assumptions. For large fleets, the additional up-front cost of a battery-powered heavy-duty truck is generally not a large concern, since these fleets are generally able to obtain financing at attractive rates or have the resources to purchase these vehicles. While truck makers are developing new battery-powered products and making numerous deals with large fleets, a zero-emissions vehicle mandate and governmental support for public charging infrastructure will accelerate truck manufacturers' efforts to broaden their product line. The public infrastructure investment will spur corporate spending on private charging facilities that often serve as the base of operations for major fleets. This will drive a virtuous cycle that will lead to higher product volumes for additional applications, making products more readily available to buyers beyond the larger fleets that are the early movers. Increased volume will facilitate cost reductions and justify both public and private investment in charging stations.

Additional Details

The Ceres **Electrifying U.S. Trucking: Promise and Challenge** report uses three scenarios to determine the distribution by propulsion type of medium- and heavy-duty trucks through 2030. Figure One illustrates the assumptions used to generate three alternative scenarios.

Figure One. Diesel Fuel Prices, Battery Pack, and Electricity Costs per kWh in Three Scenarios

	2025 (in 2020$)			**2030 (in 2020$)**		
Scenario	Diesel Price per Gallon	Cost per Battery Pack kWh	Cost per Battery Pack kWh	Diesel Price per Gallon	Cost per Battery Pack kWh	Electricity Cost per kWh
Baseline	$2.99	$ 130	$ 0.16	$3.29	$ 115	$ 0.18
Midrange	$3.49	$ 115	$ 0.16	$3.79	$ 100	$ 0.18
Aggressive	$3.99	$ 100	$ 0.16	$4.29	$ 85	$ 0.16

Note: BNEF reports that 2019's average battery pack cost per kWh to automakers was $156, or $158 in 2020$.[1]

1. The report includes battery prices for light-duty vehicles in this analysis because many large manufacturers (such as Tesla, Ford, VW, etc.) will benefit from large volumes of production and have lower battery prices. The prevailing question is what prices mainstream (high-volume) truck makers will be able to secure. Their volumes are below light-duty, but they have market power and supply chain experience that startups do not have.

In June 2020, the California Air Resources Board (CARB) adopted the Advanced Clean Truck (ACT) Program, a zero-emissions vehicle mandate which has also been adopted by Oregon, Washington, New York, New Jersey, and Massachusetts (six more states have begun the adoption process). The ACT's requirements are consistent with the Aggressive Scenario set forth in Figure Two.

The 2030 forecast in the analysis shows growth in truck electrification. However, the addition of a federal zero-emissions vehicle mandate that is at least consistent with California's ACT Program would be needed to incentivize truck makers, fleet buyers, and companies involved in infrastructure development focused on medium- and heavy-duty trucks and adequately increase the volume of electric trucks.

Government incentives for publicly available charging stations are critical for the development of the electrified truck market and should be pursued in concert with stringent EPA standards.[2] In the absence of such incentives, our forecast for national electric truck share in 2030 would be well below the ACT requirements and would likely fall short of the Aggressive Scenario for that year, even if the other assumptions contained in that scenario were met.

Figure Two. BEV Truck and Bus Volume and Market Share in 2025 and 2030, by Scenario

2025 Sales			
Scenario	Baseline	Midrange	Aggressive = CA ARB ACT
Class 4-8 Straight	21,756 (6.1%)	31,759 (9.0%)	41,045 (11.6%)
Class 8 Tractor	15,166 (7.0%)	15,166 (7.0%)	15,166 (7.0%)

2030 Sales				
Scenario	Baseline	Midrange	Aggressive	CA ARB ACT[3]
Class 4-8 Straight	51,430 (14.5%)	68,996 (19.5%)	88,470 (25.0%)	178,770 (50%)
Class 8 Tractor	37,709 (17.4%)	41,747 (19.2%)	45,995 (21.2%)	65,100 (30%)

Various assumptions were made to estimate the total cost of ownership:

- Vehicle cost
- Residual value
- Years of vehicle in service
- Battery charging infrastructure cost
- Maintenance
- Electricity cost per kWh
- Diesel fuel costs
- Battery cost per kWh
- Annual mileage related to various vocational uses
- Daily mileage for various duty cycles
- Registration and other governmental fees
- Insurance
- Purchase incentives from government and other sources

2. The report's analysis included government incentives for public infrastructure that were tied to the sale of electrified trucks with varying levels of support based upon the class and vocation of the truck.

3. This takes the shares from California's Advanced Clean Truck regulation and applies them to U.S. total sales.

The analysis showed that for a wide range of use cases and assumptions, the total cost of ownership for battery-powered vehicles was more favorable than diesel-powered vehicles and those powered by fuel cells. Based on these results, as well as the volume of vehicles in the various use cases, and the extent and nature of fleet ownership in these categories (larger fleets are more likely to purchase battery electrics as they have better access to capital to handle the higher purchase costs and infrastructure costs of electric vehicles), volume forecasts by propulsion category were made.

Note that even the Aggressive Scenario does not meet the CARB ACT volumes. California's zero-emissions vehicle requirement will force truck makers to ensure that California and other state sales are ahead of the national average in electrification. However, a federal zero-emissions vehicle mandate would drive increased zero-emissions truck availability and volume, necessary GHG emissions reductions, and increased investment in infrastructure.

A purchase incentive would be particularly helpful for smaller fleets and retail buyers of larger pickup trucks that may find the additional up-front cost difficult to afford. The analysis also assesses incentives for buyers, particularly with respect to upfront infrastructure costs. These costs are recouped in operation over time, but the upfront purchase costs may be difficult for buyers who do not operate large fleets (larger fleets are generally able to acquire financing more easily and/or spread the cost over multiple trucks). While the infrastructure bill signed into law in late 2021 set money aside for charging infrastructure, it is not sufficient to provide adequate charging infrastructure for medium- and heavy-duty trucks.

In sum, a federal zero-emissions vehicle mandate, additional public funding for infrastructure, fleet mandates, and targeted purchase incentives will be necessary to accelerate the transition to electrification in the sector, which would provide economic benefits to fleets, vehicle manufacturers, and suppliers.

This analysis is based on a report commissioned by Ceres and produced by independent industry analysts Alan Baum and Dan Luria. Baum is Principal of Baum & Associates, an automotive consultancy in suburban Detroit with a focus on fuel economy and electric vehicles. Luria works with Baum on a quarterly newsletter for auto suppliers, having retired from a career at the UAW and at a manufacturing think tank.

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