**Subcommittee on Environment and Climate Change**
**Hearing on**
**"Building a 100 Percent Clean Economy: Solutions for Planes, Trains and Everything Beyond Automobiles"**
**October 23, 2019**

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**The Honorable Greg Walden (R-OR)**

1. Would you please speak to innovation in the internal combustion engine; you see a strong future of clean and efficient diesel trucks, is that correct?

   **RESPONSE:** Diesel engines are the predominant powerplant for medium- and heavy-duty trucks, and most likely will continue to dominate the commercial vehicle marketplace for the foreseeable future. Powered by ultra-low sulfur diesel fuel, modern heavy-duty on-highway engines emit near zero levels of pollutant emissions and are highly fuel-efficient with low greenhouse gas emissions. The high energy density of diesel fuel plus the high thermal efficiency of diesel engines make them the most financially efficient option for most commercial truck operators. Additionally, diesel engines are highly reliable, provide long service life, may be rebuilt to extend that life, and provide the buyer predictable and strong residual values. All those factors make diesel engines a favorable economic choice for trucking businesses.

   a. The performance of diesel power for hauling loads is important for agricultural and ranching areas in my district—and the districts of other members on this Committee. What do you tell farmers and ranchers about the future of medium and heavy diesel engines?

      **RESPONSE:** Diesel engines produce a great deal of torque at low speed, making them the preferred source of power for doing work. Looking to the future, manufacturers are continuously developing new technologies to improve diesel engine performance, fuel efficiency and reliability. Advances include, to name a few, optimizing fuel combustion, improving turbocharging and air handling systems, reducing friction and other parasitic loses, and increasing exhaust aftertreatment efficiency.

2. You indicate engine makers are investing billions of dollars to develop zero-emissions trucks. What type of trucks is this most likely to work most cost-effectively?

   **RESPONSE:** Truck and engine manufacturers are developing and bringing to market zero-emission products that will meet their customers' needs in specialized applications. Battery-electric zero-emission trucks will perform best in applications with lighter loads (so less battery power is needed to move the vehicle); with little or no auxiliary loads such as

refrigeration, pumps, and lift gates (that require power to operate); that operate shorter distances (so less battery capacity is needed); and are in operations where they dwell at a central location each day (to enable recharging). Additionally, batteries perform better in warm weather, so temperate climates are optimal, and stop-and-go operation enhances the regenerative charging performance of a battery-electric truck. Commercial vehicle applications that have all those characteristics are most suitable for battery-electric technology.

a. What are the challenges to overcome for zero-emissions trucks to become an economical, and performance reality?

**RESPONSE:** Significant obstacles must be overcome before a fleet will consider converting its trucks to battery-electric technology. Since the purchase of a commercial vehicle is a capital investment that must return a profit, to be viable battery-electric trucks must be able to perform the work needed by the fleet with competitive life-cycle costs. A fundamental challenge with battery-electric trucks is that their initial purchase price is significantly higher than that of a diesel truck, and residual prices are much lower. Additionally, depending on battery life, the fleet may need to plan for replacing the batteries during a truck's life. (Battery replacement may be especially unfavorable when compared to a diesel engine that, when nearing the end of its useful life, may be rebuilt to its original specifications to extend the utilization of the asset.)

To deploy battery-electric technology in trucking operations, fleets will need to adjust their routes so the batteries are never depleted and be sure to never use the truck for special uses that may involve longer routes or heavier loads. Additionally, fleets will need to train drivers and maintenance technicians on the new technology, establish unique maintenance facilities, and stock additional new replacement parts. Most challenging, fleets must install the expensive and complicated infrastructure needed to charge the vehicles, plan for expanding the infrastructure for additional battery-electric trucks, and plan for obsolescence of the charging electronics. Of course, fleets also must make long-term financial plans for powering their trucks with electricity, the cost of which may fluctuate by the time of day and the number of trucks being charged. (The charging infrastructure and electricity costs may present the greatest challenges to a fleet that historically has purchased diesel fuel – as most fleets currently do -- at relatively stable prices and without the need to invest in any infrastructure.)

Fleets also must consider the possibility that battery-electric trucks, and the charging infrastructure, could become a stranded technology with the potential advent of hydrogen fuel cell technology. Such a potential future evolution could significantly chill the industry's willingness to invest capital in battery-electric technology.

3. You make reference to the scale of the challenge for actually converting the commercial vehicle market-place to zero-emissions trucks. Is the technology available today to do this?

**RESPONSE:** Medium- and heavy-duty vehicles are highly customized to perform in a broad range of unique applications including, to name a few, parcel delivery vans, intracity pickup and delivery trucks, buses, utility trucks, dump trucks, concrete mixers, refuse trucks, fire trucks, regional freight tractors, heavy-haul tractors, and long-haul tractors. Battery-electric truck technology is being developed for the most suitable commercial vehicle market segments, such as applications that have the characteristics identified in the response to question 2. However, the technology (and the necessary infrastructure) is not available for applications such as dump trucks, concrete mixers, fire trucks, heavy-haul tractors, and long-haul tractors.

a. What would a major transformation look like in terms of performance of trucks, behavior change, routes, the cost of goods and services?

   **RESPONSE:** To deploy battery-electric trucks, fleets must analyze the weight and distance of the freight they haul and carefully specify their new trucks so that sufficient battery capacity will be available. Fleets must also ensure that the operation of their vehicles will always stay within that predicted range and loading, and that they schedule enough downtime each day to recharge the batteries. Fleets also will need to be able to pay for the higher purchase price of battery-electric vehicles and account for lower residual value at the end of their planned use of the vehicle. Fleets will need to invest in new maintenance facilities, parts inventory, and driver and maintenance technician training. Most importantly, fleets will need to make significant investments in the necessary charging infrastructure. Finally, fleets will need to account for electricity costs, including hour-by-hour variability and long-term cost trends.

b. Given the benefits of power and efficiency from existing diesel engines, would the tradeoffs from forcing electric prematurely be worth it for the public?

   **RESPONSE:** Before a fleet begins the process of converting its trucks to battery-electric – which may take over a decade to complete – it must carefully analyze all of the associated operational issues and costs. Compared to diesel, battery-electric trucks require higher up-front acquisition investments, changes that may decrease a fleet's operational efficiency, and will require significant investments in developing, maintaining, and expanding the necessary charging infrastructure. Sufficient and sustained government incentives are absolutely necessary to overcome the unfavorable life-cycle costs of battery-electric trucks – and make them financially viable for commercial truck operators. The life-cycle costs of hydrogen fuel cell technology are higher still, and would require even greater incentives.