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**To**: Marijke Bekken

California Air Resources Board

1001 “I” Street

Sacramento, CA, 95812

**From:** Dawn Fenton

Director, Sustainability & Public Affairs

**Subject**: **Volvo Group Comments on CARB Draft Technology Assessment: Medium- and Heavy-Duty Battery Electric Trucks & Buses**

**Introduction**

Volvo Group appreciates the opportunity to comment on the technology assessment “Draft Heavy-Duty Technology Assessment: Medium- and Heavy-Duty Battery Electric Trucks and Buses, October 2015,” by the California Air Resources Board. We welcome a methodical approach to assess the technical readiness, feasibility, suitability and impacts of various technologies as a matter of responsible policy development and rulemaking process.

Volvo Group is one of the world’s leading manufacturers of trucks, buses, construction equipment and marine and industrial engines. The Group also provides complete solutions for financing and service. Volvo Group, which employs some 100,000 people worldwide, has production facilities in 18 countries and sells products in more than 190 markets. In the United States, Volvo Group employs 12,000 people and has six manufacturing plants in five states.

Volvo recognizes that this is a challenging and complex task, and we are happy to provide additional detail if requested. We reference the sections and page numbers of the document in our comments.

For this report, Volvo will focus its comments on its areas of most relevant experience – heavy-duty trucks and buses.

**Discussion**

The staff report looks at the challenges of deploying battery electric technology in the medium- and heavy-duty sectors during the next five to 10 years. It notes that different sectors (such as the bus sector) appear to be further along in the technology development cycle than others (i.e. the Class 8 heavy-duty sector), but states on page ES-1, that battery electric technology is “beginning to penetrate the medium- and heavy-duty vehicles market.” While this is true, the emphasis should be on “beginning” since the number of vehicles operating in California is still extremely small.

For this reason, we believe it’s premature to characterize the report as a “technology assessment” if by technology assessment CARB means the evaluation of a technology in use. The CARB report presents an overview of electric vehicle technology and a few examples of its initial experimental use in medium- and heavy-duty vehicles, but provides little information about how these technologies perform in real-world applications.

The report states (p. VIII-1), “These medium- and heavy-duty demonstration projects will help to better understand the economics surrounding BEV operations.” While it is true that these projects help to better assess the suitability of BEV technology in different applications, a true economic assessment will require consideration of commercial factors from a fleet perspective, many of which have not yet been addressed.

Because of this limited deployment, it’s difficult to evaluate how the technologies perform against their incumbent competition. While some cost and environmental comparisons are offered, the core evaluation of a technology in the heavy-duty truck and bus sectors is based on its ability to cost-effectively perform a given task. On page II-7 the report states, “the vocation of the battery electric vehicle must be considered.” We firmly agree, and therefore don’t believe accurate assumptions can be made and expectations set for a technology’s penetration in the marketplace without broader experience with the challenges BEV heavy-duty vehicles must address. Vague projections of future reduced component costs and an appeal that the “economies of scale” will level the playing field are not solid analyses.

In moving forward, there are several issues which a future report must appropriately and technically consider before drawing conclusions:

**Battery Development**

The executive summary states that “Class 8 heavy-duty trucks remain a significant challenge,” and later in the report it is suggested that improved battery costs will help overcome the challenge (page VIII-1). We would suggest that there are several issues that need to be addressed in addition to battery costs, including concerns related to range and recharging time, which severely limit the potential use of BEVs in most applications.

**Duty Cycle Consideration**

When discussing battery chemistry, the report states that “the vocation of the BEV must be considered.” We would argue that this approach should be taken across the spectrum for the application of battery technology to heavy-duty sectors. Specific applications where battery technology delivers more for the customer than competing technologies need to be sought in order to effectively introduce this technology to the marketplace.

Further, the report discusses the “optimal duty cycle” for battery electric vehicles, such as “defined routes, lots of starts/stops, high idle time, lower average speed.” These applications should be the starting point of investigating the applicability of battery technology and the focus of demonstration projects, rather than any attempt at a broad introduction.

**Commercial Viability**

In our extensive experience, customers may be willing to embrace new technology, but only if it offers an equivalent or lower total cost of ownership. While cost is a major limiting factor for heavy-duty BEV applications, fundamental operational considerations such as range, payload capacity, maximum front and rear axle loading, wheelbase, maneuverability and packaging have an even greater impact on market acceptance.

One of the biggest challenges for BEVs is found on page ES-10 which states that “increased battery pack size has negative impacts on weight and payload capacity.” The report also acknowledges that “reliability for medium- and heavy-duty BEVs is even more critical than for light-duty vehicles, since business depends on the reliability of these vehicles (page IV-1).” This is a critical issue that strikes at the heart of customer issues with new technology.

Compromises to performance or functionality (such as weight/load) undermine customer productivity and cannot be overcome through the availability of purchase incentives. If BEV technology is to be seen as viable, it must be able to stand on its own without subsidies. Otherwise it is likely to remain a minor player, similar to what natural gas engines have become in heavy-duty trucks (as opposed to transit buses or refuse trucks, where regulations and appropriate technology for the duty cycle have created substantial markets).

In addition, factors external to BEV component costs, such as diesel and natural gas prices, will remain a major factor in marketplace competition and the potential commercialization of BEV technology

**Technology Development Process**

On page ES-4 it is noted that AQIP-funded pilot projects will support larger scale commercial deployments “designed to help increase vehicle production levels to the point where significant economies of scale can be realized.” In reality, these demonstration projects will still use technologies at a middle technology readiness level. This is before even a limited commercial product offering would be envisioned and far before any economies of scale could even begin to be realized.

Numbers of demonstration vehicles, such as those referenced on p. ES-5, do not equate to a product being close to commercialization. In Volvo’s development process, demonstration projects support technology development and system integration, but provide little contribution to the direct commercialization of a product.

On page ES-11it states, “Demonstrations allow manufacturers to fine-tune their products and showcase products that are in an early commercial readiness stage.” **This statement is emphatically false.** Demonstration projects serve to fine-tune and integrate technologies rather than products, and account for less than 20% of the time and cost to be expended by a company to achieve commercial readiness.

As a result, the claim that the ARB allocation solicitation for zero-emission drayage truck demonstrations “will greatly expand the number of zero-emission BEV drayage trucks” is misleading.

**Infrastructure**

Infrastructure costs and challenges are presented in the report as presenting “obstacles (that) may be significant.” Volvo Group would like to underscore this as a cost and customer issue that has repercussions for the OEM. If a customer is concerned about costs of the vehicle and infrastructure, it undercuts the benefits that the technology might bring. This uncertainty makes the new technology that much harder of a sell in the market.

This concern about infrastructure cost is accentuated by the fact that there is “no standard charging system or strategy.” The potential for stranded investment raises red flags to both OEMs and customers.

The issue of standardization for electromobility is mentioned several times throughout the assessment, noting that no standard charging system or strategy currently exists and that coordinated efforts between SAE and the industry is needed to meet the needs of cities. Volvo Group agrees that a coordinated effort is essential, and supports the discussion of this topic within standards organizations such as the SAE. Currently an SAE committee is working to establish common standards for high power (J3105) and low power (J3068) charging for transit buses.

**Relationship Between Light- and Heavy-Duty Vehicles**

Numerous references are made in the report about technologies being adapted from light-duty vehicle applications, particularly in battery technology, but we believe the use of light-duty examples for predicting applicability and success in the heavy-duty sector are deceiving because of higher voltage and current capacities, as well as more arduous operational requirements.

It should not be assumed that these technologies will be capable of surviving in the heavy-duty work environment. The regulated useful life is much longer in the heavy-duty sector as well, with many Class 8 trucks running 100,000 miles/year for five to 10 years. In the same way the light-duty sector found that scaling consumer batteries for automotive use was not a simple “sizing” task, moving batteries to the heavy-duty sector will require technology development and new battery management systems.

This analogy between the light- and heavy-duty sectors is found again on page ES-10 where it states, “Battery technology, the learning curve, and economies of scale found in the light-duty sector will readily transfer to the medium- and heavy-duty vehicle segment.” In light of the difference in market volumes and duty cycles of light- and heavy-duty vehicle markets, it is perplexing to understand how such claims can be credibly believed, especially with evidence to the contrary.

Based on Volvo’s experience in the heavy-duty sector, expected savings from reduced maintenance costs may apply only in certain sectors, such as transit buses and refuse trucks. Drayage trucks may not encounter the same level of savings.

Costs of battery technology are mentioned throughout the report, which is appropriate given its role as a key challenge for heavy-duty applications; yet we believe the presumption of cost reductions during the 10-year period the report covers is highly speculative. It is true that battery costs for a hybrid, like the Toyota Prius, have been reduced during its 15 years on the market, but the cost of the vehicle itself has actually increased over that time. While we would expect some reduction of the price differential between conventional trucks and electrics over time, we expect battery trucks to retain a significant price premium barring a breakthrough in battery technology and cost.

**Technology Costs**

In “Next Steps” (p. VIII-1), the report notes that “ARB has allocated $25 million toward zero-emission drayage trucks and has another $20 million for the zero-emission truck and bus pilot project” in addition to other funds. These incentives are critical because the customer may not derive direct operational benefit from ZEV technologies while incurring substantial upfront costs.

Manufacturers will require significant, long-term incentive commitments to have the confidence to foresee an active market for ZEV products before launching the investments necessary to industrialize them. In addition, market certainty should consider the life of a vehicle after the first owner. If a product has limited or uncertain resale value it will not survive in the market. Incentives or regulations will not change that.

It is important to remember that cost implications should not be studied only on the basis of incremental component costs. Development and integration costs, as well as infrastructure costs (which are mentioned in the report), should all be included in any cost estimation. The charger costs can be both off-board and on-board, depending on the configuration of the vehicle.

Warranty costs for an electric vehicle are unknown in the segment and must also be considered. As is mentioned in the report, the heavy-duty sector is a much harsher environment than the light-duty sector, so costs of maintenance and repair are likely to be higher.

Volume impacts should also be considered, but we don’t know the full regulatory landscape for the U.S. If California is the only locale requiring zero-emission vehicles, the incremental costs will be even higher than those built on the assumption of nationwide sales volumes. This increases the likelihood of OEMs shunning the market as too costly to compete for such small volumes, particularly in the truck market.

Finally, in the cost projections for BEV trucks included on page ES-9, baseline trucks costs are shown to increase while glider costs do not. Even if those cost increases take into consideration inflation alone, and much less regulatory equipment that might need to be added, the glider costs should also show an increase over the years.

**Purchase Inducements**

On page ES12 it states, “ARB currently has several incentive programs … that encourage the development and adoption of new BEV technologies.” While it is true that purchase incentives contribute to new technology adoption by fleets, the influence on technology development decisions are minor in comparison.

The report goes on to assert that “ARB can employ policies that increase stringency of vehicle and emission performance standards, which in turn will help accelerate development and deployment of zero-emission technologies (page ES-12).” The fallacy of this premise is that the “chosen” technology, battery electric vehicles, is somehow applicable to the needs of the entire heavy-duty sector. That remains to be seen. As has happened with other ARB technology initiatives, the results may be different than those envisioned by ARB staff as the industry strives to produce a product that not only meets the regulation but the requirements of customers.

**Compete Vehicle Approach**

The Volvo Group agrees that battery technology presents a great potential for local reductions of criteria emissions and GHG reductions depending on the charging infrastructure. The Volvo Group approaches technology evaluation to include integration of the powertrain and the complete vehicle from the basis of customer needs.

Volvo fully supports ARB’s call for an “integrated approach” to developing and deploying advanced technologies as stated in the Technology Assessment Overview released in April. Such an approach will lead to greater consideration of whole-vehicle emissions and performance.

We also would strongly suggest that ARB look beyond engine regulations as the sole method of measuring progress on many environmental issues. Integration should refer not only to the intersection between the fueling infrastructure and the vehicle, but also to the integration of emission reductions gained from improvements to the complete vehicle – not just the powertrain.

Finally, we would like to emphasize that giving manufacturers the flexibility to implement *vehicle* efficiency technologies according to customer needs, rather than imposing strict engine or technology standards, facilitates and expedites the availability and acceptance of new technologies that build on other inherent NOx reductions that come from reduced engine workload and vehicle improvements.

**Transit Specific Comments**

Page ES-2: CARB states that “There is currently no standard charging system of strategy.” It should be noted that standardization for electromobility is a current discussion topic, with an SAE committee working to establish common standards for high power (J3105) and low power (J3068) charging for transit buses. Nova Bus thinks coordination through an organization such as SAE is the best way to improve technologies and meet cities’ needs.

On page ES-9: When looking at BEV vehicles in the transit market, Nova Bus would suggest that CARB clarify the term “improve range,” in a way so that it considers the capacity of the battery over its total lifetime instead of its capacity when initially brought to market. This calculation should also account for the full use of auxiliary systems such as HVACs, heaters, etc.

Page IV-2: The report states, “Currently in the US, there are three manufacturers that offer battery all-electric transit buses for sale: Proterra; BYD; and New Flyer. Nova Bus’ LFSe commercial model is now ready to be demonstrated in Montreal, Canada. Nova bus is a division of the Volvo Group, which is engaged in a joint bus project with nine cities around the world using electric or electric-hybrid technologies. Montréal is the first North American city to participate in the project and will install two quick-recharging stations along the route taken by the STM’s 36 – Monk bus line in order to put three fully electric Nova LFSe buses into passenger service.

Page IV-4: The report shows a Nova Bus, noting that it is not yet available for purchase. This photo is not the actual Nova Bus LFSe, and we would like to see it replaced with the picture provided along with these comments. We would also like to note that the Nova Bus LFSe will begin testing at ALTOONA in the fall of 2016.

Pg.IV-5: The technology assessment states, “Note that the payback calculations do not include infrastructure costs, as these are highly variable and site-specific. Including these costs will increase the payback period; however, these costs are spread out over the fleet of electric buses, and are not on a per bus basis.”  Nova Bus would like to underline that a demonstration project with less than 10 buses doesn’t reflect the peak demand of a normal or large fleet of buses. As a result, it is important to remember that demonstration projects with less than 10 buses as a reference for evaluating potential costs and policy decisions relative to opportunity charging could be misleading.

Page IV-6. We request that the Nova Bus LFSe specs be included in the chart presented in the report.

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| **Make** | Nova Bus LFSe |
| Model | 40 foot |
| Price | Not available |
| Battery size (kWh) | 76 |
| Motor (kW) | 230 |
| Charge Time | < 6 minutes |
| Range on Single Charge | 15 miles\* for end of life batteries |

**Closing Comments**

The heavy-duty sector is coming off a decade of dramatic improvements in traditional diesel engine technology. While advances have been significant, there also has been a learning curve associated with the integration of these new technologies. In fact, these technologies are still striving to attain full acceptance in the market. CARB’s concerns expressed in various venues about durability and warranty issues are testament to the fact that this “learning curve” is ongoing.

Volvo fully agrees with CARB’s view expressed in other technology assessments that “heavy-duty diesel internal combustion engines will continue to play a major role in the passenger and freight transportation industry of the nation.” Manufacturers will be heavily taxed to develop the high efficiency and low NOx technologies of the future.

Development and deployment of battery electric vehicles adds an additional layer of engineering expense and complexity. Missteps can lead to premature technology offerings of marginal interest to fleets and owner-operators, which will only serve to delay the implementation of the cleanest, most efficient technologies.

Volvo continues to encourage CARB to implement available policy options that can bring significant reductions to NOx emissions without cost-prohibitive, time-consuming technology development, such as accelerating the pace of replacement of older, higher emitting vehicles.

Finally, other policies and programs such as EPA’s GHG Phase II program and the U.S. Department of Energy’s SuperTruck program are leading to continued advances in current technology to improve vehicle efficiencies and environmental performance

Those aforementioned “other policies and programs” create a substantial workload at most OEMs which inhibits their ability to develop specific technologies that may not be seen as a priority to achieving those goals.