Energy Technologies Area

Energy Analysis and Environmental Impacts Division

December 4, 2019

Mary Nichols, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Clean trucks standards consistent with California's carbon neutrality goals are economically and environmentally compelling

Dear Chair Nichols and Members of the Board,

In light of our recent work suggesting rapidly declining electric truck costs, LBNL has conducted a high-level modeling effort to understand the cost and environmental impacts of the ACT standard currently proposed by CARB, and to contrast it with alternative potential ACT standards. In particular, we contrast the proposed standard with an alternative proposal (hypothesized for modeling purposes) that would be in line with Gov. Jerry Brown's 2045 carbon-neutrality goal for California established in Executive Order B-55-18 (herein referred to as the "climate-consistent" scenario). We find that the difference between the two proposals is significant: the climate-consistent ACT standard is found to save $62 billion more than CARB's proposed standard by 2045. With this substantial difference in mind, we urge CARB to conduct further study on the impacts of more stringent, climate-consistent ACT standards.

This analysis was motivated by our recent work assessing costs of truck electrification in light of dramatically declining battery costs (see attachments). Our work suggests that electrifying trucking can have substantial economic benefits over diesel trucking, particularly when electricity tariffs are structured to facilitate off-peak charging. Given these recent findings, and understanding California's policy target of achieving deep decarbonization, we conducted this preliminary analysis to investigate the impact of a climate-consistent ACT standard.

We find the differences between the more stringent ACT standard and the current proposal to be notable across many elements of analysis:

Cost: While both electrification scenarios save money compared to business-as-usual diesel scenarios, the net present cost of the proposed ACT standard is $62 billion more by 2045 than that of the climate-consistent proposal. This figure includes carbon pollution costs reflecting the social cost of carbon as well as air pollution damages; however, even when omitting pollution costs, the proposed ACT standard still costs $25 billion more than the alternative. These figures assume a low-cost electricity scenario—however, even in the

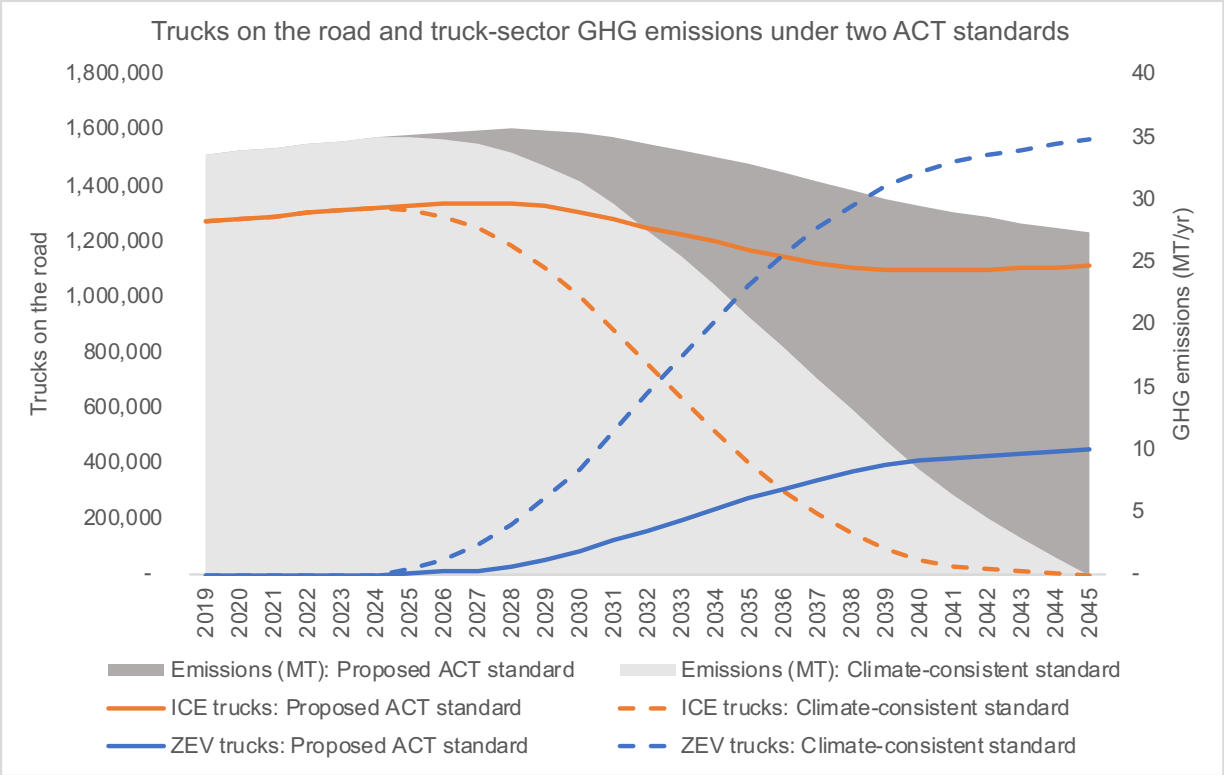

Figure 1. ICE and ZEV trucks on the road through 2045, and GHG emissions through 2045, under the proposed CARB ACT standard and the carbon-neutral ACT standard.

high-cost electricity scenario, the climate-consistent standard is still $51 billion cheaper than CARB's proposal when including pollution costs, and $14 billion cheaper when not doing so.

ICE trucks on the road: The proposed ACT standard will leave a significant portion of today's internal combustion engine (ICE; gas- and diesel-powered) trucks on the road through 2045. For class 4-8 (non-tractor) trucks, which face 50% ZEV sales by 2030, the number of ICE trucks on the road in 2045 is 62% of the number on the road today. For class 2B-3 and 7-8 tractor trucks, which face 15% ZEV sales by 2030, ICE trucks on the road in 2045 will number 105% of those on the road today—a net gain in the number of diesel- and gas-powered trucks given the proposed ACT standard and expected growth in vehicle population. In contrast, the climate-consistent proposal, which necessitates 100% ZEV sales by 2030 across all truck classes, leaves no ICE trucks on the road in 2045 as compared to today. (Because of the long lifetime of Class 8 trucks, to get all diesel trucks off the road by 2045 in our model, a 100% ACT standard is needed by 2030. Moving the 100% standard to 2035, however, only leaves 10% of the original Class 8 truck population number on the road in 2045.)

Carbon emissions: The net present cost of carbon emissions in the climate-consistent proposal is $28 billion through 2045, 33% less than the cost of $41 billion under the current ACT proposal, and 42% less than the $48 billion carbon cost of business-as-usual. These figures assume a price on carbon consistent with the EPA's social cost of carbon. (The carbon cost of even the climate-consistent proposal is significant both because stock turnover from ICE vehicles to zero-emission vehicles takes time, and because future carbon savings are discounted.) Under the current ACT proposal, trucks would still be emitting 27 million tonnes per year of carbon in 2045, or about 82% of what our model shows they are producing today.

Air pollution: Under the climate-consistent proposal, air pollution costs are $49 billion through 2045, 33% less than the cost of $72 billion under the current ACT proposal, and 41% less than the $83 billion cost of BAU. (The cost of air pollution from ICE trucks is higher than the modeled cost of their carbon emissions.) Trucks that have the lowest ACT targets under the current proposal—Class 2B-3 trucks and Class 8 tractors—are responsible for most air pollution costs today: Class 2B-3 trucks are estimated to contribute 24% of air pollution damages from trucks, and Class 8 trucks are estimated to contribute 55% (roughly half from tractors, half from non-tractors).

This model is intended to create a timely, first-order estimate of the high-level impacts of selecting a certain ACT standard. We have not considered here the practical aspects of implementing this proposal, although it is technically feasible; as such, we hope other efforts will expand on this work.

Our analysis combines a stock model, to estimate truck population each year, and a cost-benefit analysis model. The principal simplifying assumptions we made in this model are as follows: first, we treat California as a closed system, and assumes that all trucks present in California are sold and driven in California. We do not attempt to analyze emissions from out-of-state ICE trucks being driven in California, but this additional source of pollution would only seem to heighten the importance of having a strong in-state clean vehicle standard. We assume all classes of vehicles reach 100% ZEV sales in the same year, making no distinction between tractors and non-tractors or pickup trucks. Next, we only analyze battery electrification as a ZEV option, omitting other technologies, such as fuel cells. Our estimates of charging infrastructure needs are based on total energy required, rather than on a spatially oriented model such as a truck flow model. Finally, we hold diesel and electricity prices constant in real terms over the course of the analysis to reflect the uncertainty associated with projecting either into the future, given such trends as electrification and renewable buildout.

We drew on a few principal data sources for this analysis. To estimate the number of trucks in each class in California and their characteristics, we combined data from the Bureau of Transportation Statistics, the Census, the Federal Highway Administration, and the Transportation Energy Data Book, as well as car sales data to perform a segmentation of pickup trucks. To estimate costs associated with charging stations, electricity provision, and electric trucks, we drew principally on work we performed for two other papers—"Reforming electricity rates to enable economically competitive electric trucking" (published in *Environmental Research Letters*[1]) and "Long-haul battery electric trucks are technically feasible and economically compelling" (available as an LBNL working paper)[2]. To estimate the cost of grid infrastructure, we used transmission costs from the CPUC's RPS calculator. To estimate air pollution costs, we combined data from Goodkind et al.'s *PNAS* paper[3] with CARB and EPA data on truck-class-specific emissions. Further details and citations are available in the attached writeup.

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[1] Phadke, A., McCall, M., & Rajagopal, D. (2019). Reforming electricity rates to enable economically competitive electric trucking. *Environ. Res. Lett.* https://doi.org/10.1088/1748-9326/ab560d

[2] Phadke et al. (2019) Lawrence Berkeley National Laboratory. Working Paper 005: Long-haul battery electric trucks are technically feasible and economically compelling. https://eta.lbl.gov/publications/working-paper-005-long-haul-battery

[3] Goodkind et al. (2019). Fine-scale damage estimates of particulate matter air pollution reveal opportunities for location-specific mitigation of emissions. *Proceedings of the National Academy of Sciences, 116*(18), 8775–8780. https://doi.org/10.1073/pnas.1816102116

In light of these preliminary results, **we urge CARB to rigorously evaluate and consider adopting a more stringent, climate-consistent ACT standard.**

Sincerely,
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