NERA
ECONOMIC CONSULTING

Potential Air Quality Benefits of a 90%/75% Reduction in NO_x Emissions from New Heavy-Duty On-Highway Vehicles

– *Conceptual Summary of Methods and Key Results*

Prepared for the Truck and Engine Manufacturers Association

August 2021

Project Team

Anne E. Smith, Ph.D., Managing Director
Bharat Ramkrishnan, Consultant
Andrew Hahm, Analyst

About NERA

NERA Economic Consulting (www.nera.com) is a global firm of experts dedicated to applying economic, finance, and quantitative principles to complex business and legal challenges. For over half a century, NERA's economists have been creating strategies, studies, reports, expert testimony, and policy recommendations for government authorities and the world's leading law firms and corporations. We bring academic rigor, objectivity, and real-world industry experience to bear on issues arising from competition, regulation, public policy, strategy, finance, and litigation.

This report reflects the research, opinions, and conclusions of its authors, and does not necessarily reflect those of NERA Economic Consulting, its affiliated companies, or any other organization.

There is no way to select a single "best" cut-off point for limiting extrapolation uncertainties. In its 2013 $PM_{2.5}$ NAAQS decision, the Administrator discussed how insufficient confidence in the continued existence of health risk associations would arise somewhere between the 10th to 25th percentiles of a study's range of observations. She chose to set the standard near the lowest of the 25th percentiles of available studies. Based on that precedent, one could consider choosing to limit the benefit-per-truck estimates to those occurring in locations with exposures at or above the 25th percentile. In that case, our analysis indicates that the national average total benefits per truck *might be between $900 and $1,270* if using a 3% discount rate.[14] It would be somewhat lower if using a 7% discount rate. If one were instead to use the 10th percentile as the confidence cut-off, our analysis indicates that the national average total benefits per truck *might be between $3,110 and $4,310* if using a 3% discount rate, and somewhat lower still if using a 7% discount rate.[15]

The main conclusion is that a national average estimate of the combined $PM_{2.5}$ and ozone benefits per truck that includes adjustments for extrapolation-related uncertainties consistent with prior Administrator judgments would not likely exceed $4,500 per truck.

The above statement is based on a national average estimate of benefits, which is the typical way that EPA conducts its BCAs. Note, however, that Figure 2 shows significant differences in the projected $PM_{2.5}$ concentration distributions that are projected to exist between California and Rest of U.S. This suggests that there could be significantly different patterns in the confidence that this method would assign to the benefit-per-truck estimates for those two regions. It also suggests that even the raw (unadjusted) benefit per truck might be significantly higher for trucks operating in California than for those outside of California.

To understand this better, we have recomputed our benefits-per-truck for California and for the Rest of the U.S. separately. The results, including respective effects of confidence-adjustments, are provided in Table 4 (for $PM_{2.5}$) and Table 5 (for ozone). Those tables highlight the wide disparity in the benefit-per-truck estimates that exist for the two regions, *with total per-truck benefits possibly as high as $14,650 in California* even with a moderate confidence adjustment (*i.e.*, using the 10th percentile cut-off and a 3% discount rate), *while the equivalent per-truck benefits for the Rest of U.S. would likely not exceed $3,290.*[16]

[14] This range includes both ozone and $PM_{2.5}$ benefits and is the sum of the values in the last column of Tables 2 and 3.

[15] This is computed by summing the values in the penultimate columns of Table 2 and Table 3.

[16] These estimates sum the respective values in the penultimate columns of Table 4 and Table 5.

V. Conclusion

If a BCA is to be used to assess the level of cost that might be warranted to implement a tighter HDOH NO_x standard, it is reasonable, as an initial scoping exercise, to attempt to assess the maximum lifecycle cost per truck that might be justifiable before a specific HDOH standard is proposed and a more complex, resource-intensive full BCA is prepared. Having such *ex ante* scoping insights can help guide regulators towards regulatory proposals that will readily pass the more rigorous BCA test. To that end, NERA has developed rough estimates of the potential per-truck lifecycle benefits that one might expect to result from such a complete BCA and has addressed issues of confidence that might be associated with such estimates. Our analysis has limitations but has been based on data and studies that are currently available and has taken into consideration the current status of Agency discussions regarding the health risks driving $PM_{2.5}$ and ozone NAAQS decisions. In this report, we have explained our approach at a conceptual rather than technical level. The many assumptions that we have used, and the studies and data that we applied to set those assumptions, are documented in a separate technical report.

The goal of our analysis has been to develop approximate estimates of the per-truck lifecycle benefits associated with a 90% reduction in the FTP NO_x standard for HDOH trucks, and a corresponding 75% reduction in in-use NO_x emissions. We emphasize that the estimates we report here reflect an effort to anticipate what the Agency itself would estimate if it applied its own usual assumptions and analysis methodologies in a formal RIA, expected to be released later in 2021. We also note that our estimates have been based on data and modeling that the Agency has released in the past. Those will probably be replaced by updated information developed as part of the upcoming HDOH RIA. As there is no publicly available information on the nature of such updates, our present estimates are imprecise and subject to revision as such updated information becomes available. As noted above, were we to undertake this type of benefits analysis without regard to what we anticipate EPA is likely to do, it is likely that we would utilize different methods and assumptions.

We find that, *prior to any confidence weighting*, the Agency might determine that a 90% reduction in the FTP NO_x standard for HDOH (with a corresponding 75% reduction in-use NO_x emissions) would result in national average benefits per truck for 2027 model year trucks in the range of (roughly) $5,200 to $7,200 (for $PM_{2.5}$ and ozone combined). When confidence-adjusted for the multiple uncertainties associated with statistical extrapolations from the underlying epidemiological evidence of health risks, the Agency might project national average total per-truck benefits of about $4,300 at the 10^{th} percentile exposure cut-off. This suggests that a NO_x-control technology to achieve the estimated HDOH NO_x reductions would need to cost less than about $4,500 per truck to pass a robust benefit-cost test.

Extensive changes are now expected to occur in the mix of HDOH trucks that will be sold in the future, with a potentially significant transition away from ignition-based power trains to electric or fuel-cell trucks. Our analysis of the *per-truck* benefits before any confidence-weighting will not be affected by such a change, but this transition might lower the baseline future $PM_{2.5}$ and ozone concentrations and thus increase the degree of extrapolation, resulting in some lowering of confidence-weighted estimates. More importantly, however, such a transition might have more effect on the per-truck *cost* to which our benefits estimates ought to be compared. That is, the total investment costs of developing, designing, and retooling to meet a tighter HDOH diesel NO_x standard need to be spread over all of the affected fleet; if the projected size of the future fleet of diesel trucks is much reduced, the estimate of the cost *per truck* for use in a scoping analysis should be adjusted upwards accordingly.

In conducting this scoping analysis, we also noted that ozone benefits per ton were much higher for California than the rest of the U.S. We have thus also provided per-truck benefits estimates for California and separately for the Rest of the U.S.[17] In this disaggregated analysis, we estimate that EPA's future analyses might estimate per-truck benefits for trucks operating in California as high as $17,180 at the least-confident level, and as high as about $14,650 for a relatively moderate degree of increased confidence (*i.e.,* at the 10th percentile exposure cut-off). At the same time, of course, the equivalent benefit-per-truck estimates for Rest of U.S. would be reduced to about $6,200 (least confidence) and to about $3,290 (greater confidence). Although this finding could be used to justify a tighter standard for California trucks than for the rest of the U.S., it would be inappropriate to use the higher California-specific benefits estimates in a benefit-cost analysis of a standard that would be applied to other states.

In all the numerical summaries in the paragraphs above, we rely on the 3% discount rate and the higher end of our $PM_{2.5}$ benefits ranges, which are the combination of assumptions that produces the highest benefits estimates. Use of a 7% discount rate generally reduces the per-truck benefits by about 25%. We also note that our analysis has assumed, based on input from EMA, that a 90% reduction in the FTP standard would reduce *in-use* HDOH NO_x emissions by75%. NERA offers no opinion on what the correct in-use reduction percentage should be, but it would be straightforward to make adjustments to accommodate alternative assumptions. For example, if one expects *in-use* emissions to be reduced by the full 90% of the FTP standard's reduction, the benefit-per-truck estimates could increase by about 20%.

Finally, it should be noted that the benefits estimates we report are conservative or, stated differently, weighted to the high side. That conservative approach stems from the fact that in conducting our analyses we have assumed that: there is no exposure threshold to $PM_{2.5}$ or ozone below which mortality effects are no longer evident; it is still appropriate to include benefits associated with ozone-related mortality impacts; the slope of the C-R function for mortality is linear; it is appropriate to account for and credit potential health effects benefits at exposure levels below the NAAQS for $PM_{2.5}$ and ozone; the statistical associations observed in the relevant epidemiological studies between exposure to air pollution and mortality effects are sufficient to infer causality, notwithstanding unresolved issues relating to manipulative or interventional causation; and it is appropriate to assess quantified benefits values at the 10th percentile of the exposure levels at issue in the underlying epidemiological studies, as opposed to utilizing a cut-point at the 25th percentile of exposures. Applying different assumptions regarding any of the foregoing points would lead to a reduction in the calculated benefits estimates.

[17] The latter estimate is for the average over the 47 other conterminous U.S. states.