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October 26, 2016

Giulia Giannangeli
Legislative Clerk
Committee on Energy and Commerce
U.S. House of Congress
2125 Rayburn House Office Building
Washington, DC 20515

Re: Midterm Review and Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards for Motor Vehicles, Hearing September 22, 2016.

Dear Ms. Giannangeli,

In response to Chairman Upton's and Chairman Burgess' letter of October 12, 2016, attached you will find responses to the additional questions for the record associated with the referenced joint hearing of the Subcommittee on Commerce, Manufacturing, and Trade, and the Subcommittee on Energy and Power.

Sincerely,

Jennifer Thomas
Vice President, Federal Government Affairs
Alliance of Automobile Manufacturers

Attachment

The Honorable Michael C. Burgess M.D.

1. In your opinion, are advances in conventional internal combustion engine technology (i.e., non-hybrid) sufficient by themselves to achieve the current standards for model year 2025? If not, could you please provide your estimates for how much of each of the following technologies (as defined in the TAR) will be required to achieve the current standards for model year 2025: (a) mild hybrid, (b) full hybrid, (c) plug-in hybrid electric vehicle, and (d) electric vehicle.

A. Automakers, suppliers, and national laboratories agree that advances in conventional internal combustion engine technology are not expected to be sufficient by themselves to achieve the currently promulgated standards for model year 2025.

In the Alliance of Automobile Manufacturers (Alliance) opinion, the MY2025 standards cannot be met with the mix of technologies modeled by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) in their recent Draft Technology Assessment Report (Draft TAR)[1] and that greater electrification will be required. The Alliance and Association of Global Automakers (Global Automakers) both submitted comments to this effect in response to the Draft TAR.[2,3] Nearly every automaker in the United States is represented by these two trade associations. This position is also supported by automotive suppliers such as BorgWarner.[4] Increased electrification will result in increased costs to consumers and raises manufacturer concerns on customer acceptance of these advanced technologies.

In addition to automakers and suppliers, a recent study by Oak Ridge National Laboratory draws similar conclusions: "[t]he path to meeting 2025 standards will likely involve significantly larger numbers of hybrid electric powertrain vehicles and/or plug-in vehicles being sold, compared to the current U.S. sales of such

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[1] "Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." Office of Transportation and Air Quality, U.S. Environmental Protection Agency; National Highway Traffic and Safety Administration, U.S. Department of Transportation; California Air Resources Board. EPA-420-D-16-900, July 2016. (Hereinafter "Draft TAR".)

[2] Alliance of Automobile Manufacturers. *Comment submitted by Michael Hartrick, Director of Fuel Economy and Climate, Alliance of Automobile Manufacturers.* "Alliance of Automobile Manufacturers Comments on Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4089. ii.

[3] Association of Global Automakers, Inc. *Comment submitted by Julia M. Rege, Director, Environment and Energy, Association of Global Automakers, Inc.* "Comments of the Association of Global Automakers: Midterm Evaluation Draft Technical Assessment Report for Model Year 2022-2025 Light Duty Vehicle GHG Emissions and CAFE Standards." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4009.

[4] BorgWarner Inc. *Comment submitted by Erika Nielsen, Director, Global Government Affairs, BorgWarner Inc.* "Re: Docket: EPA-HQ-OAR-2015-0827 and NHTSA-2016-0068 Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles-Phase 2 Notice of Availability: Midterm Evaluation Draft Technical Assessment Report for Model Years 2022-2025 Light Duty Vehicle GHG Emissions and CAFE Standards." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4315.

vehicles," and "[i]t will be quite difficult for the most efficient gasoline vehicles to reach 29%-31% combined-cycle efficiency, but this is the level the gasoline fleet would need to average to comply with the 2025 regulations…"[5]

B. Actual vehicle data from EPA shows that only electrified light-duty vehicles meet their 2025 targets.

In its most recent fuel economy and greenhouse gas "trends" report, EPA shows that less than 5% of total U.S. light-duty vehicle production meets its MY2025 target greenhouse gas requirement. In addition, all such vehicles with any significant production are hybrid electric vehicles, plug-in hybrid electric vehicles, or battery electric vehicles.[6]

C. EPA and NHTSA analyses in the Draft TAR suggest much greater levels of electrification than those observed in the fleet today will be needed for compliance in 2025.

In the Draft TAR, EPA and NHTSA provide their estimates for potential mixes of technology necessary to meet the standards.[7] The agencies purport that the standards can be largely met with only "…modest amounts of hybridization, and very little full electrification..."[8] However, their data also suggests significant growth in electrified vehicle production over the levels observed in the present light-duty vehicle market will be required.

In the case of EPA, mild hybrid electric vehicles (MHEVs) are projected in over 18% of the fleet.[9] In 2015, almost no sales of this technology occurred (<0.1%).[10] Combined plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) sales will also need to grow to meet EPA's projections from 0.7% in 2015 to 4.3% in 2025, a six-fold increase over the next decade.[11,12]

NHTSA's analysis similarly predicts large increases in electrification. Strong (full) hybrid electric vehicles (HEVs) grow to 14% by 2025.[13] Such growth would be truly impressive given that the market for HEVs has remained stagnant, averaging less than 3% over the past seven years, and only exceeding 3% a single year (2013).[14]

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[5] Thomas, J., "Vehicle Efficiency and Tractive Work: Rate of Change for the Past Decade and Accelerated Progress Required for U.S. Fuel Economy and CO2 Regulations," SAE Int. J. Fuels Lubr. 9(1):2016, doi:10.4271/2016-01-0909.
[6] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2015." U.S. Environmental Protection Agency. EPA-420-R-15-016, December 2015. 119.
[7] Draft TAR at ES-10, Table ES-3.
[8] Draft TAR at ES-9.
[9] Draft TAR at 12-29, Table 12.33.
[10] "MY 2015 Baseline Study." Novation Analytics. September 19, 2016. 42. Available at Docket ID EPA-HQ-OAR-2015-0827 as "Attachment 10: Novation Analytics MY 2015 Baseline Study."
[11] Ward's Automotive. "U.S. Light Vehicle Sales, December 2015." January 5, 2016.
[12] Draft TAR at 12-29, Table 12.33.
[13] Id. at ES-10, Table ES-3.
[14] Ward's Automotive. "U.S. Light Vehicle Sales…" 2009-2015 data.

D. Further analysis will be required to project the degree of electrification required in the U.S. light-duty vehicle fleet to meet future standards.

Given automakers' concerns with the technical analysis provided by the agencies in the Draft TAR, we believe that it will be critical for the agencies to work cooperatively with all stakeholders to correct the issues identified[15] and to reassess the likely technologies required for compliance prior to proposing a determination of the appropriateness of the 2022-2025 standards.

The Alliance continues to work on an analysis of what kind of mix of advanced conventional, MHEV, HEV, PHEV, and BEV vehicles will be necessary to comply with the MY2022-2025 standards. We will be happy to share such results with the agencies and Congress when they become available.

2. According to Table ES-3 of the TAR, EPA's compliance pathway for meeting the MY2025 GHG standard envisions that 44% of vehicles would use higher compression ratio, naturally aspirated gasoline engines. If a manufacturer does not have that type of engine in any of its vehicles today, what steps would it have to take in order to integrate that type of engine in its product line, and how long would it take for it to reach a 44% penetration rate?

A. The high compression ratio (HCR) naturally aspirated engines referred to by EPA include additional technologies for high greenhouse gas and fuel consumption benefits.

The 44% "higher compression ratio, naturally aspirated gasoline engines" referred to by TAR Table ES-3 are generally considered to be "Atkinson cycle" engines in non-HEV applications. [16] Current examples of such technology are limited to a single automaker (Mazda) and represent less than 2% of the vehicles sold in the United States.[17]

Moreover, 90% of the 44% referred to in Table ES-3 are actually an agency-projected future engine which includes the present technology with an even higher compression ratio, cooled EGR, cylinder deactivation and direct injection technologies.[18] (Advanced Atkinson Cycle Engine Technology)

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[15] See Alliance of Automobile Manufacturers. "Alliance of Automobile Manufacturers Comments on Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4089.

[16] Draft TAR at 12-29, Table 12.33, "ATK2." The abbreviation "ATK2" means a non- hybrid electric vehicle Atkinson cycle engine (5-282).

[17] U.S. Environmental Protection Agency. *2014-2025 Production Summary and Data with Definitions.* "2014MY Baseline with Tech and Market Tabs for Docket.xlsx." Docket EPA-HQ-OAR-2015-0827-0402. https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-0402.

[18] U.S. Environmental Protection Agency. "Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA)." https://www3.epa.gov/otaq/climate/models.htm. (Follow "OMEGA pre-processor,

B. Manufacturers would need to upgrade an existing engine platform and/or design a new engine to integrate the Advanced Atkinson Cycle Engine Technology modeled by EPA.

The Advanced Atkinson Cycle Engine technology generally modeled by EPA requires changes to increase compression ratio, enablement of late intake valve closing, cylinder deactivation, cooled EGR and gasoline direct injection – the technical background below elaborates on these necessary technical modifications. Higher octane fuel (premium fuel) may also be required to maximize the fuel economy of these engines. Certain engines currently in production have one or more of the required features, but it is important to note that none exist with all of these technologies in combination. In most cases, either an engine redesign to add technology or a completely new engine design will be required to integrate Advanced Atkinson Cycle Engine Technology into an OEM's product line – adding significant cost and time to an already lengthy manufacturing process.

Technical Background on Advanced Atkinson Cycle Engine Technology:

Compression ratio increases require an increase in the ratio of total volume of the engine cylinder at the bottom of the piston stroke to the total volume of the engine cylinder at the top of the stroke. This can be achieved by several means but all are generally considered significant changes to a production engine including modifications to the engine block, head(s), crankshaft, connecting rods, and/or pistons. Additionally, depending on engine design, modifications may be necessary to the valve train to accommodate other changes.

Implementing a cylinder deactivation system involves hardware changes to valve actuation systems, control software development, and other potential changes to mitigate or prevent noise-vibration-harshness (NVH) caused by the deactivation of the cylinders.[19] Cylinder deactivation currently has an overall industry penetration of less than 25% in the United States.[20] A number of manufacturers and their supplier partners have developed variants of cylinder deactivation.[21]

The addition of cooled EGR technology requires control system software, control valve(s), plumbing to route exhaust gases from the exhaust manifold to the intake air, and a heat exchanger to cool the hot exhaust gases.[22] The hardware required may require changes to vehicle or engine designs to accommodate the space required. Additionally, the engine cooling system may need to be modified to

Technology cost development, and Input / Output files used in the Draft TAR analysis (ZIP) link located in the OMEGA 1.4.56 section.) (Last updated July 18, 2016.) Data extracted from the files located therein.

[19] Draft TAR at 5-17.

[20] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2015." U.S. Environmental Protection Agency. EPA-420-R-15-016, December 2015. 48.

[21] Id. at 48.

[22] Draft TAR at 5-28.

handle increased heat rejection requirements. Cooled EGR is a relatively recent development for spark-ignited gasoline engines.[23] The technology was installed on less than 3% of the fleet in MY2014.[24]

Gasoline direct injection involves changes to the cylinder head and fuel system. The cylinder head(s) must be modified to accommodate injection of fuel directly into the cylinder. The fuel system must be modified to use high pressure fuel injectors and a high pressure fuel pump.

Additionally, although not a specific modification to the engine, high octane (premium) fuel may be required to maximize the potential greenhouse gas and fuel economy benefits. In general, high octane gasoline enables greater fuel efficiency, albeit at increased fuel costs to customers.

C. Manufacturers will incur significant expenses to implement Advanced Atkinson Cycle Engine technology, particularly if such implementation occurs sooner than an originally planned engine redesign.

In its report "Cost Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles," the National Research Council (NRC) provides an estimate of $0.75 to $1.5 billion investment for a manufacturer to develop a new engine.[25] Because of the high capital requirements, manufacturers typically only redesign engines every 10-15 years,[26] allowing the investment to be spread over hundreds of thousands to millions of vehicles. If a manufacturer needed to redesign an engine more quickly to ensure regulatory compliance, previous investments become stranded capital, increasing financial pressure on the manufacturer and resulting in higher costs to consumers.

Such concerns are of particular importance to manufacturers which have already invested heavily in downsized turbocharged engines, a technology EPA had originally projected to achieve 87% penetration in the MY2025 fleet.[27]

D. EPA's flawed modeling overestimates the benefits of Advanced Atkinson Cycle Engine Technology; EPA was unable to validate their modeled benefits even in a laboratory setting.

EPA derived the greenhouse gas (GHG) and fuel consumption improvement benefits of an Advanced Atkinson cycle engine with a theoretical model.[28] EPA relied on benchmarking data from a present Mazda

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[23] Id. at 5-28.
[24] U.S. Environmental Protection Agency. *2014-2025 Production Summary and Data with Definitions.* "2014MY Baseline with Tech and Market Tabs for Docket.xlsx." Docket EPA-HQ-OAR-2015-0827-0402. https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-0402.
[25] National Research Council. "Cost, Effectiveness and Deployment of Fuel Economy Technologies for Light-Duty Vehicles." Washington, D.C.: The National Academies Press. 2015. 256.
[26] Id. at 256.
[27] "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards." U.S. Environmental Protection Agency and U.S. Department of Transportation, National Highway Traffic Safety Administration. 77 Fed. Reg. 62623, 62870 (October 15, 2012).
[28] Draft TAR at 5-280.

SkyActiv engine, and then applied theoretical improvements to create the modeled Advanced Atkinson Cycle Engine with higher compression ratio, cooled EGR, and cylinder deactivation.[29] In its comments on the TAR, the Alliance of Automobile Manufacturers noted multiple technical problems in the development of the baseline data and in the subsequent development of the theoretical models which likely led to over-optimistic results modeled by EPA.[30]

Furthermore, during the development of the Advanced Atkinson Cycle Engine models supporting the Draft TAR, EPA attempted to validate the modeled benefits of this combination of technologies in a laboratory setting. EPA's description of the results was that they could not be validated due to the inability to operate the test engine at the necessary speed and load conditions due to the onset of "knock" (a condition which can result in engine damage and failure).[31]

Therefore, if actual achieved benefits are lower than predicted by EPA, greater penetrations of this technology package will be necessary to achieve the same benefit, and/or other costly technologies will need to be adopted to ensure compliance.

E. The time to reach a 44% penetration rate will vary by manufacturer; the Alliance estimates it will take more than a decade (more than the eight years remaining before the 2025 model year).

The question of exactly how long it will take for Advanced Atkinson Cycle engine technology to reach a 44% penetration rate is difficult to answer. Some manufacturers may reach high penetration rates relatively quickly, particularly those which have already invested in more of the underlying technologies which are required. Other manufacturers may require significantly more time or may choose to continue the development and implementation of other alternatives such as turbocharging and downsizing for reasons such as those described above.

The NRC studied the time required to implement significant new engine technologies, e.g. engine downsizing and turbocharging, finding that new engine designs require 2-3 years for engine development alone and that an additional 1-2 years are required for vehicle integration, including emissions certification.[32] The Alliance maintains that the degree of modifications necessary to implement an Advanced Atkinson Cycle Engine would be similar to that required for a downsized and turbocharged engine as studied by the National Research Council. Therefore, should manufacturers choose to invest in

[29] Lee, S., Schenk, C., and McDonald, J., "Air Flow Optimization and Calibration in High-Compression-Ratio Naturally Aspirated SI Engines with Cooled-EGR," SAE Technical Paper 2016-01-0565, 2016, doi:10.4271/2016-01-0565.
[30] Alliance of Automobile Manufacturers. "Alliance of Automobile Manufacturers Comments on Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4089. 46-50.
[31] Lee, S., Schenk, C., and McDonald, J., "Air Flow Optimization and Calibration in High-Compression-Ratio Naturally Aspirated SI Engines with Cooled-EGR," SAE Technical Paper 2016-01-0565, 2016, doi:10.4271/2016-01-0565.
[32] National Research Council. "Cost, Effectiveness and Deployment of Fuel Economy Technologies for Light-Duty Vehicles." Washington, D.C.: The National Academies Press. 2015. 257.

the described technology, it would generally take about five years before the technology is available to begin installation in production vehicles, even at low fleet penetrations.

Beyond just availability, it also takes additional time to apply the technology in specific vehicles and to achieve penetration across the fleet. In some vehicles the implementation would likely be relatively straightforward. In others implementation may require waiting for a vehicle redesign (e.g. if the cooled EGR system space requirements could not be met in an existing vehicle.) The adoption rate would also likely be influenced by how many vehicle models a particular engine is designed to power for each particular manufacturer. Given the time required to develop the described technology and then to subsequently apply it across multiple vehicles, it is reasonable to assume a minimum of a decade or more to reach 44% penetration (under favorable circumstances and absent other constraints or decisions which could potentially slow the introduction of Advanced Atkinson Cycle Engines). Automakers are already building MY2017 vehicles and product investment decisions have likely already been made for the next couple of years, further increasing the lead-time needed to achieve the penetrations described by EPA. Most importantly, the Alliance questions the viability of the 44 percent penetration rate for Advanced Atkinson Cycle Engine technology because even with such engine technology (and the resulting costs to manufacturers), the expected engine efficiencies are not sufficient to comply with future Fuel Economy Standards (MY 2025) – which points to additional ICE technologies and/or electrification being necessary for future compliance.

F. Modeled penetrations of Advanced Atkinson Cycle Engines far exceed 44% for certain manufacturers.

Not only does EPA model high compression ratio, naturally aspirated engines at 44% of the overall U.S. fleet,[33] certain manufacturers are estimated to need much higher penetrations of Advanced Atkinson Cycle Engines. For example, Jaguar Land Rover is estimated by EPA to utilize 72% Advanced Atkinson Cycle Engines in its fleet by 2025, and four other manufacturers are projected to exceed 50% penetration.[34]

3. In the TAR, the EPA states that in its modeling, "the California Zero Emission Vehicles (ZEV) program is considered in the reference case fleet; therefore, 3.5% of the fleet is projected to be full EV or PHEV in the 2022-2025 timeframe due to the ZEV program and the adoption of that program by nine additional states." TAR at ES-10. Since a significant portion of the required GHG reductions will be met through manufacturing electric-drive vehicles for the ZEV mandate, shouldn't EPA have considered

[33] Draft TAR at ES-10, Table ES-3.

[34] U.S. Environmental Protection Agency. "Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA)." https://www3.epa.gov/otaq/climate/models.htm. (Follow "OMEGA pre-processor, Technology cost development, and Input / Output files used in the Draft TAR analysis (ZIP) link located in the OMEGA 1.4.56 section.) (Last updated July 18, 2016.) Data extracted from the files located therein.

those costs in its assessment of the costs of the regulation? If EPA had considered the costs of producing electric-drive vehicles, what impact would that have had on the cost estimates in the TAR?

Fundamentally, the California ZEV program constrains the technology choices manufacturers have for meeting the federal GHG regulations. Although the federal GHG regulations generally allow manufacturers to choose any combination of technologies which enable compliance with the standards, the presence of the California ZEV program removes some of this flexibility, requiring manufacturers to sell plug-in electric vehicles (PEV) and/or fuel cell vehicles.[35] EPA recognized this technology constraint in the Draft TAR by including an estimated volume of plug-in electric vehicles required for each manufacturer to comply with the California ZEV program.[36] In its analysis, EPA accounts for the GHG benefits of these vehicles, but at zero cost. In so doing, the Alliance believes that EPA has presented a misleading assessment of the costs to customers and manufacturers of meeting the GHG and closely related ZEV program regulations.

A. EPA should have considered the costs of the California ZEV program in its assessment of the costs of the greenhouse gas regulation.

In its comments on the Draft TAR, the Alliance sets forth two arguments on why the costs for the California ZEV program should be included in the assessment of the costs of the greenhouse gas regulation, which are summarized here. First, the integrity of cost-benefit analysis requires making equivalent assumptions on both the cost and benefit side of the analysis. By including the benefits, but not the costs of the California ZEV program, EPA violates this basic tenet. Second, EPA has explained in its guidance the position that it is generally appropriate to include existing regulations in the cost baseline because, presumably, those costs have been accounted for elsewhere and should not be counted twice.[37]

[35] See 13 California Code of Regulations §§ 1962.1 and 1962.2
[36] Draft TAR at ES-10.
[37] See National Center for Environmental Economics, Office of Policy, U.S. Environmental Protection Agency, "Guidelines for Preparing Economic Analyses" (December 17, 2010) at 5-9. Cited authority states "[i]f a proposed regulation is expected to increase compliance with a previous rule, the correct measure of the costs and benefits generally excludes impacts associated with the increased compliance. This is because the costs and benefits of the previous rule were presumably estimated in the economic analysis for that rule, and should not be counted again for the proposed rule."

However, EPA has not considered the cost of the ZEV program at any point in time.[38] Please refer to the Alliance's comments on the Draft TAR for additional detail. [39]

B. Inclusion of California ZEV program costs would have significantly increased the cost estimates in the Draft TAR.

PEV technology can be much more expensive than other potential technologies for reducing greenhouse gas emissions. A recent analysis by Honda, based on PEV technology costs from the draft TAR, estimated that if ZEV program costs were included in EPA's analysis, the average per vehicle cost would increase by $356 (and approximate 40% increase over the costs shown in the Draft TAR).[40,41] Average cost impacts would potentially be much higher for manufacturers with relatively higher sales in states which have adopted the California ZEV program.[42]

C. Direct costs of the California ZEV program are not the only issue – customer acceptance and infrastructure are also concerns which need to be addressed by the midterm evaluation.

Aside from the direct costs of PEV technology, manufacturers have additional concerns with customer acceptance and infrastructure.

4. Mr. German mentioned a study prepared by Novation Analytics at the behest of your trade associations and implied that it was backwards looking and didn't account for future technologies. Is this true, and if not, why not?

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[38] In evaluating whether to grant California the waiver necessary to implement the ZEV mandate, EPA did not fully evaluate the costs of the mandate at that time, either. Instead, EPA largely deferred to CARB estimates. See, e.g., U.S. Environmental Protection Agency, "Notice of Decision Granting a Waiver of Clean Air Act Preemption for California's Advanced Clean Car Program and a Within the Scope Confirmation for California's Zero Emission Vehicle Amendments for 2017 and Earlier Model Years," 78 Fed. Reg. 2111, 2115 (Jan. 9, 2013), noting that in the waiver context, EPA gives "very substantial deference to California's judgment" on the balancing of costs and benefits, and 78 Fed. Reg. 2118, noting that in decision whether to grant a waiver, EPA "provide[s] California with the broadest possible discretion in setting regulations that it finds protective of the public health and welfare while limiting EPA's review to a narrow role that provides substantial deference to the State."

[39] Alliance of Automobile Manufacturers. "Alliance of Automobile Manufacturers Comments on Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025." September 26, 2016. Docket EPA-HQ-OAR-2015-0827-4089. xi-xiii.

[40] Bienfeld, Robert. "Advanced Powertrains 2025 & Beyond – What's Driving Us?" Presentation at Center for Automotive Research Management Briefing Seminars. 2016. Slides 10 and 14.

[41] Draft TAR at ES-9.

[42] ZEV Program requirements are specific to each manufacturer and are based on a manufacturer's sales in a state administering the California ZEV program. As sales increase, PEV sales requirements increase. Manufacturers with relatively higher sales markets in the ZEV program states have greater costs to amortize over their production volume.

The Novation Analytics study referred to by Mr. German is "Technology Effectiveness – Phase 1: Fleet-Level Assessment" (Fleet Level Assessment).[43] The study draws the following conclusions:[44]

- The MY 2021 and 2025 fuel economy and greenhouse gas standards cannot be met with the suite of technologies assumed by the agencies.
- Higher deployment rates of electrification, alone or in combination with other advanced spark ignition powertrain technology, will be required than were projected by both EPA and NHTSA in the MYs 2017-2025 rulemaking.

Mr. German's implications are not accurate. The following specific rebuttals to Mr. German's statements and written testimony are provided in response to your question.

A. Novation Analytics accounted for future technologies in the Fleet Level Assessment Study.

In its fleet level assessment, Novation Analytics assumed the same technology sets as the agencies did in the 2012 final rulemaking.[45,46] These included the EPA and NHTSA assumptions for vehicle mass, aerodynamics, and tire improvements,[47] and accounted for regulatory credits.[48] Powertrain technologies included downsized turbocharged engines with efficiencies beyond any current non-hybrid spark-ignited internal combustion engine with the same types of advanced future transmissions described in the TAR.[49,50]

Mr. German is correct in his assertion in that the study did not include some of the technologies considered by the agencies in the TAR such as Advanced Atkinson Cycle Engines. However, this point is without merit. The technologies that were studied by Novation Analytics exceeded the efficiencies of current spark-ignited engines. In fact, EPA's own analysis of the benefits of the technologies modeled by Novation Analytics are comparable or better than the Advanced Atkinson Cycle Engines now relied upon by EPA in the TAR analysis.[51]

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[43] "Technology Effectiveness – Phase 1: Fleet-Level Assessment." Novation Analytics. October 19, 2015. Available at Docket ID EPA-HQ-OAR-2015-0827-4089 as "Attachment 1: Technology Effectiveness – Phase I: Fleet Level (version 1.1)."
[44] Id. at 8 et seq.
[45] "Technology Effectiveness – Phase 1: Fleet-Level Assessment." Novation Analytics. October 19, 2015. 10.
[46] "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards." U.S. Environmental Protection Agency and U.S. Department of Transportation, National Highway Traffic Safety Administration. 77 Fed. Reg. 62623 (October 15, 2012).
[47] "Technology Effectiveness – Phase 1: Fleet-Level Assessment." Novation Analytics. October 19, 2015. 10.
[48] Id. at 29.
[49] Id. at 57.
[50] Draft TAR at 5-42 et seq.
[51] U.S. Environmental Protection Agency. "Lumped Parameter Model (LPM) for Light-Duty Vehicles." https://www3.epa.gov/otaq/climate/lpm.htm. (Follow "Download the executable version of LPM_DTAR.exe.") (Last updated July 18, 2016.) Vehicle type standard car modeled with 24 bar Advanced gas stoichiometric gas direct injection provides 15.5% benefit; the same vehicle type modeled with Atkinson cycle with cooled EGR and

B. Novation Analytics accounted for increased future technology benefits on current technologies.

Future generations of technology generally incorporate learnings from previous generations, leading to increased efficiency and other positive developments. For example, Toyota has built four generations of the Prius HEV. Each generation has made incremental improvements to the hybrid electric vehicle powertrain, resulting in improved fuel economy.

Such learning was incorporated by Novation Analytics through statistical analyses of fuel economy technologies. When the same set of technologies is applied to similar vehicles, the resulting fuel economy benefit will be a range, not a single point. The majority will achieve benefits somewhere near the center of the range, while others will achieve either lower or higher benefits. However, through learning, the average across the fleet will gradually improve towards what was originally best-in-class. Novation Analytics accounted for such learning by assuming the average benefit of a technology in the future will improve towards the best-in-class current examples of such technology. Said mathematically, such learning is incorporated by assuming the average benefit of a technology moves toward higher percentiles (90th percentile in the case of the Fleet Level Assessment).

In Mr. German's witness statement, he attempts to discredit the Novation Analytics Fleet Level Assessment by pointing to its modeling of a 90th percentile naturally aspirated engine (with high-spread transmission, but without stop / start technology) at 22.8% energy conversion efficiency in comparison to a current engine at 25.1% efficiency.[52] Mr. German's analysis fails to recognize that he is comparing a single data point to an assumed future average. Of course there will be examples of technology better than average, just as there will be examples of the same technology that are below average – this is the heart of the mathematical concept of "average." His analysis also fails to recognize that the higher efficiency engine he refers to was included in the Novation Analytics statistics used to develop the 90th percentile upon which the future average was based.

It warrants noting that the very techniques criticized by Mr. German were similarly applied by Novation Analytics in its study of vehicle load reduction potential (i.e. reduced mass, aerodynamics, and tire rolling resistance loads) sponsored by the State of California's Air Resources Board (CARB)[53] that was later cited in the TAR.[54]

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intake cam phasing) provides 11.7% benefit. Note that the Alliance of Automobile Manufacturers believes that both of these values are over-stated. Data provided as an example only.

[52] German, John. Witness Statement to the House, Subcommittee on Commerce, Manufacturing, and Trade and Subcommittee on Energy and Power, Committee on Energy and Commerce. *Midterm Review and Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards For Motor Vehicles,* Hearing, September 22, 2016. Available at http://docs.house.gov/meetings/IF/IF17/20160922/105350/HHRG-114-IF17-Wstate-GermanJ-20160922.pdf. (Accessed 10/14/2016)

[53] "Technical Analysis of Vehicle Load Reduction Potential for Advanced Clean Cars (Contract 12-313)." ControlTec, LLC. April 29, 2015. The division of Control-Tec, LLC which prepared this report took the name Novation Analytics when it separated from Control-Tec, LLC.

[54] Draft TAR at Appendix A.

C. Current diesel powertrain efficiency is a logical proxy for future gasoline engine powertrains as assessed by Novation Analytics.

Mr. German asserts that Novation Analytics' use of current compression-ignition engines (typically diesel) as a proxy for future advanced gasoline engines is an "unfounded assumption. He goes on to state that "any competent analysis of upcoming powertrain technology (which includes transmissions and accessories, not just engines) finds that 2025 gasoline engine powertrains will exceed current diesel powertrain efficiency."[55]

At face value, this is merely Mr. German's opinion. He fails to present any evidence of studies showing future spark-ignited engines as exceeding diesel efficiency. His caveat including transmissions and accessories only conflates the issue, as such technologies were also considered in the Novation Analytics Fleet Level Assessment, as previously described.

In contrast, Novation Analytics has presented reasonable evidence for the use of the current diesel engine efficiency boundary as a logical proxy for future advanced gasoline engines. Novation Analytics reasons that the strategies which generally make current diesel engines more efficient are the same strategies which are being pursued for future advanced gasoline engines. These include higher compression ratios and reduced pumping losses. [56]

Furthermore, there is ample evidence that manufacturers and researchers are targeting "diesel-like" efficiency for future advanced gasoline engines. Delphi (an automotive supplier) recently described efforts to develop an advanced gasoline engine with program objectives including the "[achievement] of diesel-like fuel efficiency."[57] Similarly, in 2013, Southwest Research Institute launched a cooperative research program targeting diesel-like fuel consumption in an advanced gasoline engine.[58]

5. If the assumptions in the TAR prove wrong, what, if anything, can we do to mitigate the damage to consumers and industry?

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[55] German, John. Witness Statement to the House, Subcommittee on Commerce, Manufacturing, and Trade and Subcommittee on Energy and Power, Committee on Energy and Commerce. *Midterm Review and Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards For Motor Vehicles,* Hearing, September 22, 2016. Available at http://docs.house.gov/meetings/IF/IF17/20160922/105350/HHRG-114-IF17-Wstate-GermanJ-20160922.pdf. (Accessed 10/14/2016)

[56] "Technology Effectiveness – Phase II: Vehicle-Level Assessment." Novation Analytics. September 20, 2016. Available at Docket ID EPA-HQ-OAR-2015-0827-4089 as "Attachment 2: Technology Effectiveness - Phase II: Vehicle-Level Assessment (version 1.0)."

[57] Sellnau, M., Moore, W., Sinnamon, J., Hoyer, K. et al., "GDCI Multi-Cylinder Engine for High Fuel Efficiency and Low Emissions," SAE Int. J. Engines 8(2):2015, doi:10.4271/2015-01-0834.

[58] Southwest Research Institute. "SwRI launches third high-efficiency gasoline engine consortium." March 7, 2013. http://www.swri.org/9what/releases/2013/hedge-3.htm#.WADfpSQnVFd. (Accessed 10/14/2016)

The standards set forth under the One National Program (ONP) are ambitious and aggressive, especially in the later years of the program. The first phase of the One National Program (MY2012-2016) has yielded significant progress and automakers remain committed to continued efficiency improvements. However, it is imperative that policymakers, stakeholders, and the public utilize the Mid-term Evaluation process to examine those factors and assumptions that shaped the joint rulemaking, finalized in 2012, and to evaluate the technical merits underpinning the ONP. Much has changed in four years – most notably, fuel prices and changes in consumer purchasing habits. These trends are important to note since automakers are judged not by what they produce, but by what consumers buy.

Contrary to the agencies' findings in the Draft TAR, automakers maintain that meeting the aggressive MY 2022-2025 standards likely will require a greater degree of vehicle electrification. This stark contrast in the levels of electrification necessary to meet the aggressive standards versus actual sales of electric vehicles highlights the daunting challenge facing automakers. Consumer adoption of alternative powertrain vehicles has not lived up to expectations despite a 174 percent increase in such models being available to consumers since 2010. The Alliance expects this trend to continue in a low fuel price environment as projected by the Energy Information Administration (EIA).[59] A failure to take these marketplace realities into account could result in unintended financial consequences.

Additionally, policymakers must be mindful of the impact the aggressive standards have on consumer affordability. Over the past 23 years, average new car prices have increased by more than 60 percent, to an all-time high of $34,428.[60] The Draft TAR fails to fully examine consumers' ability to afford the increasingly expensive technologies needed to meet the standards. If consumers have difficulty affording the cost of new technologies for compliance, they may decide to hold onto their current vehicles, disrupting the "virtuous cycle" of fleet turnover that adds safer and more fuel-efficient new vehicles to the roadways.

Nationwide, eight million workers and their families depend on the auto industry.[61] Each year, the industry generates $500 billion in paychecks, while generating $70 billion in tax revenues across the country.[62] Last month, the Center for Automotive Research (CAR) released an economic analysis entitled "The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy."[63] In this study, CAR analyzed nine scenarios using varying fuel prices and technology costs and

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[59] "Annual Energy Outlook 2015 with projections to 2040." U.S. Energy Information Administration. Available at http://www.eia.gov/forecasts/archive/aeo15/ (Accessed 10/20/2016)

[60] http://mediaroom.kbb.com/record-new-car-transaction-prices-reported-december-2015

[61] "Contribution of the Automotive Industry to All Fifty States and the United States." Center for Automotive Research. January, 2015. Available at http://www.cargroup.org/?module=Publications&event=View&pubID=16.

[62] Id. at 1.

[63] "The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates on the U.S. Economy." Center for Automotive Research. September, 2016. Available at http://www.cargroup.org/?module=Publications&event=View&pubID=143. (Accessed 10/20/2016)

found that significant job loss would result in eight of the nine scenarios.[64] CAR concluded "if the value of fuel savings to the new vehicle buyer falls short of the cost of mandated fuel economy technologies, then U.S. automotive sales, production, manufacturing, and retail employment will fall, which will result in serious consequences for the entire U.S. economy."[65] It is imperative that we get the midterm evaluation process right, without unnecessary harm to the auto industry and the economy as a whole.

We appreciate the oversight of this Committee. We strongly encourage the Committee to continue to help ensure this mid-term evaluation process is open, robust and transparent. Additionally, we urge the Committee to explore avenues to better harmonize the EPA and NHTSA programs to ensure "One National Program" is truly One National Program for motor vehicle fuel economy standards – eliminating a piecemeal, fragmented automotive policy that is inefficient and costly to everyone. The goal of the One National Program is not materializing; harmonization gaps exist – primarily between the EPA GHG and NHTSA CAFE credit trading programs. However, harmonization is a near-term problem that should be addressed outside of the mid-term evaluation process. As automakers assess their current situation and attempt to forecast future product development and customer demands, many are anticipating problems in managing compliance with the two different programs. In some cases, the inconsistencies between the two agencies likely will create a situation where an automaker is in compliance with EPA's GHG program and simultaneously out of compliance and subject to civil penalties under the NHTSA CAFE program. The Alliance and Global Automakers, recently jointly petitioned the agencies to address some of these harmonization gaps; however, others cannot be addressed administratively and will require Congressional action.[66] We look forward to working with this Committee to ensure the goal of the One National Program is realized.

[64] Id. at 2.
[65] Id. at 2.
[66] *Petition for Direct Final Rule with Regard to Various Aspects of the Corporate Average Fuel Economy Program and the Greenhouse Gas Program,* submitted June 20, 2016 by Mitch Bainwol (Pres. & CEO, Alliance) & John Bozzella (Pres. & CEO, Global Automakers) to Mark Rosekind, PhD (Admin., NHTSA) and Gina McCarthy (Admin., EPA).