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MECA Comments on the U.S. Environmental Protection Agency Notice of Proposed Rulemaking: Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3

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MECA is pleased to provide comments regarding the U.S. EPA's notice of proposed rulemaking (NPRM) to update MY2027 Phase 2 and set Phase 3 greenhouse gas (GHG) emission standards for heavy-duty on-highway vehicles. MECA supports stringent GHG standards founded on technologically feasible and cost-effective solutions that allow the attainment of carbon reduction goals. We concur that the introduction, transition and widespread adoption of battery electric and fuel cell vehicles represents a vital advancement in the decarbonization of heavy-duty vehicles. Further, we believe an important opportunity exists to continue to reduce GHG emissions from heavy-duty vehicles due to the evolution of engine and vehicle efficiency technologies in the 7 years since the Phase 2 standards were last set. It is critically important for clean mobility suppliers that EPA finalizes this rule by the end of 2023 and implements it by 2027 to align with the truck criteria pollutant rule. This will allow for the simultaneous optimization of engine calibration and aftertreatment designs to minimize the emissions of NOx and GHGs.

MECA is a non-profit association of the world's leading manufacturers of technologies for clean mobility. Our members have over 50 years of experience and a proven track record in developing and manufacturing emission control, engine efficiency and electric propulsion technology for a wide variety of on-road and off-road vehicles and equipment in all world markets.

Our industry has played an important role in the emissions success story associated with light- and heavy-duty vehicles in the United States, and has continually supported efforts to develop innovative, technology advancing, emission reduction programs to deal with environmental problems.

MECA members represent over 70,000 of the nearly 300,000 North American jobs building the clean mobility technologies that improve the fuel economy, reduce emissions and transition on-road and non-road vehicles to zero tailpipe emissions. These jobs are in nearly every state in the United States – the top 10 states being Michigan, Texas, Illinois, Virginia, New York, Indiana, North Carolina, Ohio, Pennsylvania, and South Carolina. Finalization of the proposed Phase 3 regulatory provisions will provide certainty to technology suppliers and their OEM customers who continue to invest billions of dollars each year in developing the technologies that reduce mobile source carbon emissions.

MECA appreciates the time and effort that EPA staff have put into this regulatory effort under a compressed timeframe, and we thank EPA staff for their dedication in receiving and incorporating feedback from a broad range of stakeholders.

SUMMARY

- MECA strongly supports the need to reduce CO_2 emissions from heavy-duty vehicles by setting technology neutral, performance-based standards that will result in the greater penetration of advanced engine, powertrain and vehicle technologies including electric and hydrogen zero emissions vehicles into the U.S. fleet.
- The degree of electrification in EPA's proposal is ambitious and would benefit from EPA's review and inclusion of additional engine, powertrain & vehicle technologies.
- Advanced Technology Multipliers for PHEV (3.5) and BEVs (4.5) and FCEVs (5.5), and weight class modifier incentives are not needed.
- U.S. directed production should include all states due to the fluid nature of HD trucks.
- EPA should reduce the lifetime and/or value of Phase 2 credits carried over to Phase 3 and extend the treatment of credits as in Phase 2 to within averaging sets of vehicle categories.
- Existing off-cycle provisions that allow manufacturers to request approval for other "innovative" technologies not reflected in GEM should be retained.
- Longer useful life for zero emissions trucks should be phased-in to more closely match current ICE requirements.
- The inclusion of SOH monitors and usable energy measurement as per UN ECE GTR No. 22b as well as battery labeling and recycling are vital to support future program success.
- Charger standards are essential to ensure infrastructure deployment, quality and consumer acceptance.
- EPA should recognize the need to include life cycle analysis in future rulemaking by assigning realistic "non-zero" emission values to EVs and FCEVs thereby providing a regulatory incentive to continue to improve the electric efficiency of components and vehicle powertrain technologies that will further reduce vehicle related environmental impacts.

MECA Supports the Need to Reduce CO_2 Emissions from Heavy-Duty Vehicles

MECA supports the need to reduce CO_2 emissions from heavy-duty vehicles by setting technology neutral, performance standards that continue to improve the efficiency of today's vehicles while accelerating the introduction of battery and fuel cell electric powertrains across applications where they yield significantly lower GHG emissions as well as meet the needs of end users. We believe the rate of electrification estimated for compliance in EPA's proposed pathway to be ambitious and we deem that the final rule would be more robust with consideration of additional engine and vehicle technologies in those vehicle applications that may take longer to electrify. Several engine and powertrain technologies have evolved to be commercially viable since the Phase 2 standards were finalized and may be deployed by OEMs to meet the proposed CO_2 emission limits. Technologies such as cylinder deactivation, advanced driven turbochargers, hybrid powertrains, vehicle electrification and hydrogen internal combustion engines should be considered in EPA's analysis.

MECA members have been engaged in developing a large portfolio of technology options that can be installed on vehicles to optimize the lowest GHG emissions. Technology commercialization has a long development cycle, including design, testing, vehicle integration and real-world deployment across many truck applications in the field to make sure systems are reliable and durable. This long cycle time is why long-term regulatory certainty and stringent standards are a critical signal to industry to make investments and to foster the increased collaboration between vehicle manufacturers and technology suppliers that will be needed in the future.

The penetration of fuel-saving technologies into the heavy-duty fleet has been spurred by U.S. EPA's Heavy-Duty Greenhouse Gas Phase 1 and Phase 2 Standards. At the same time, research undertaken by multiple teams as part of the Department of Energy's SuperTruck programs has demonstrated how these technologies can be combined to achieve a 16% boost in fuel economy and improved freight efficiency. Participants in the SuperTruck II program have demonstrated even greater gains in fuel and freight efficiency, with engines achieving 55% brake thermal efficiency using technologies like waste heat recovery. Last year DOE awarded five OEMs funding to develop electric powertrains in SuperTruck III.

Last December, EPA finalized new heavy-duty criteria pollutant standards that go into effect in model year 2027. Engines and aftertreatment systems can be designed and optimized for simultaneous reductions in NOx and CO_2 emissions and we thank EPA staff for aligning the implementation dates of these two rules to allow manufacturers of components and vehicles to optimize their engine designs to address both pollutants simultaneously.

The portfolio of technology options available to reduce GHG emissions from heavy-duty trucks and engines is continually growing in response to federal GHG standards. A review of heavy-duty engine certifications from 2002 to 2023 shows that once emission control and efficiency improving technologies were required on engines in 2010-2011, the inverse relationship between CO_2 and NOx emissions at the tailpipe was overcome and both were reduced simultaneously (see Figure 1 below). Several engines certified since 2010 have shown the ability to achieve 0.1 g/bhp-hr or lower NOx emissions over the composite FTP certification cycle, which is 50% below the current standard. Of those engines, several have demonstrated the ability to meet future Phase 2 GHG regulation limits for vocational engines that go into effect in 2021, 2024 and 2027. Setting stringent emission targets for both CO_2 and NOx through realistic regulations has caused engine calibrators to expand their toolbox from the engine to the powertrain to enable simultaneous NOx reductions and engine efficiency improvements.

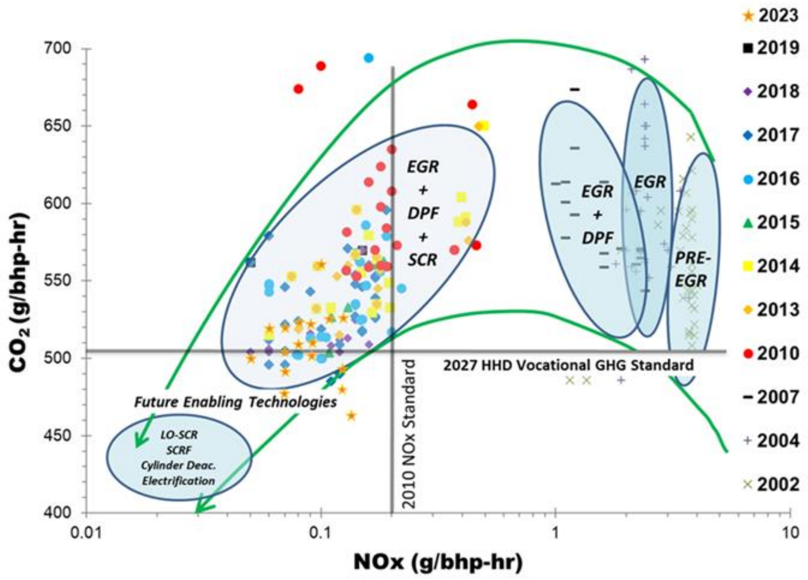

Figure 1. Model Year 2002-2019 Heavy-Duty Engine Certification Test Data for NOx and CO_2*.*

Component suppliers have continued to innovate, and many technologies that were not even considered as compliance options in the Phase 2 rule are now likely to be deployed on limited engine families in 2024 and more broadly in 2027. Furthermore, engine efficiency technologies – such as cylinder deactivation, advanced driven turbochargers, and hybridization – have also been demonstrated in combination with advanced aftertreatment technologies on heavy-duty diesel engines. Testing has shown the ability of these engine technologies to be optimized to reduce both GHG and criteria pollutant emissions including NOx.

Cylinder Deactivation

Cylinder deactivation (CDA) is an established technology on light-duty vehicles, with the primary objective of reducing fuel consumption and CO_2 emissions. This technology combines hardware and software computing power to, in effect, “shut down” some of an engine’s cylinders, based on the power demand, and keep the effective cylinder load in the more efficient portions of the engine map reducing fuel consumption. Based on decades of experience with CDA on passenger cars and trucks, CDA is now being adapted to heavy-duty diesel engines. On a diesel engine, CDA is programmed to operate differently than on gasoline engines, with the goal of the diesel engine running hotter in low load situations by having the pistons that are firing do more work. This programming is particularly important for vehicles that spend a lot of time in creep and idle operation modes. During low load operation, the use of CDA results in exhaust temperatures increasing by 50°C to 100°C to maintain effective conversion of NOx in the SCR [1]. In some demonstrations, CDA has been combined with a 48V mild hybrid motor with launch and sailing capability to extend the range of CDA operation over the engine, and this may deliver multiplicative CO2 reductions from these synergistic technologies [2,3]. In another study, CDA combined with an electric heater or fuel burner has been shown to reduce NOx as well as CO_2 to levels below the capabilities of each technology individually [4]. CDA has also been synergistically combined with high efficiency turbochargers, and an electrically driven EGR pump to yield an additional 1.7 to 3.6% reduction in CO_2 [5].

We support the provision in the proposed rule of a 1.5% GEM credit for engines that include full CDA during coasting where both exhaust and intake valves are closed. As presented above, CDA and other advanced engine and powertrain technologies are still developing and often in combination to synergistically yield higher values of CO_2 reduction. As a result, EPA should allow manufacturers to request variable GEM credit values for CDA and for other engine and powertrain technologies based upon the submission of performance data.

Advanced Turbochargers

Advances in turbochargers are providing a variety of available design options enabling lower CO_2 emissions by improving thermal management capability, such as: i) state of the art aerodynamics, ii) electrically actuated wastegates that allow exhaust gases to by-pass the turbocharger to increase the temperature in the aftertreatment, and iii) advanced ball bearings to improve transient boost response. More advanced turbochargers are designed with a variable nozzle that adjusts with exhaust flow to provide more control of intake pressure and optimization of the air-to-fuel ratio for improved performance (e.g., improved torque at lower speeds) and fuel economy. These variable geometry turbochargers (VGT), also known as variable nozzle turbines (VNT) and variable turbine geometry (VTG), also enable lower CO_2 emissions through improved thermal management capability to enhance aftertreatment light-off. Finally, modern turbochargers have enabled engine and vehicle manufacturers the ability to downsize engines, resulting in fuel savings without sacrificing power and/or performance.

The latest high-efficiency turbochargers are one of the more effective tools demonstrated in the DOE SuperTruck program [6]. In addition to affecting the power density of the engine, turbochargers play a significant role in NOx and CO_2 regulations compliance. Continuous improvement in turbocharger technology is making it possible to run very lean combustion (high air/fuel ratios), which reduces CO_2, particulate and engine-out NOx.

Turbo-compounding

Turbo-compounding is a variant of turbocharger technology that allows for the energy from the exhaust gas to be extracted and mechanically added to the engine crankshaft. Alternatively, waste exhaust energy can also be extracted by using an electric turbine to recover the waste exhaust energy electrically (see *Driven Turbochargers*) and used to increase primary turbocharger response and efficiency or to power other electric vehicle systems.

Mechanical turbo-compounding has been employed on some commercial diesel engines, and EPA estimated penetration to reach 10% in the U.S. by the time the Phase 2 GHG Regulation is fully implemented in 2027 [7]. An early 2014 version of a turbo-compound-equipped engine was used during the first stage of testing at SwRI under the CARB HD Low NOx Test Program, and the results from this engine with advanced aftertreatment have been summarized in several SAE technical papers [8, 9, 10]. While turbo-compounding has the potential to reduce fuel consumption, it can result in lower exhaust temperatures that can challenge aftertreatment performance. Therefore, it is important to consider turbo-compound designs that incorporate bypass systems during cold start and low load operation or electrically driven turbo-compounding systems where the unit can be placed after the aftertreatment system.

Driven turbochargers

Driven turbochargers can be used to control the speed of the turbomachinery independently of the engine's exhaust flow and vary the relative ratio between engine speed and turbo speed. Driven turbochargers may be utilized for several reasons, including performance, efficiency, and emissions. Considered an 'on-demand' air device, a driven turbocharger also receives transient power from its turbine. During transient operation, a driven turbocharger will behave like a supercharger and consume mechanical or electrical energy to accelerate the turbomachinery for improved engine response. At high-speed operation, the driven turbocharger will return mechanical or electrical power to the engine in the form of turbo-compounding, which recovers excess exhaust power to improve efficiency [11]. This cumulative effect lets a driven turbocharger perform all the functions of a supercharger, turbocharger, and turbo-compounder.

NOx emission control uniquely benefits from the application of driven turbochargers in several ways, including the ability to decouple EGR from boost pressure, reduce transient engine-out NOx, and improve aftertreatment temperatures during cold start and low load operation.

Bypassing a driven turbine can provide quick temperature rises for the aftertreatment while still delivering the necessary boost pressure to the engine through supercharging, which also increases the gross load on the engine to help increase exhaust temperature [11]. Testing has shown that routing engine exhaust to the aftertreatment by bypassing a turbocharger is one of the most effective methods to heat up the aftertreatment [2].

Electrification: Mild Hybridization

In the near future, 48-volt mild hybrid electrical systems and components are expected to make their way onto medium and heavy-duty vehicles. These 48-volt systems can be found on many light- duty vehicle models (primarily in Europe) from Mercedes, Audi, VW, Renault and PSA. In the U.S., FCA is offering a 48-volt system on the RAM 1500 pick-up and the Jeep Wrangler under the eTorque trademark. Because the safe voltage threshold is 60 volts, which is especially important when technicians perform maintenance on the electrical system, 48-volt systems are advantageous from an implementation standpoint. From a cost perspective, 48-volt systems include smaller starter and wire gauge requirements, offering cost savings from a high voltage architecture of a full hybrid. The U.S. Department of Energy's SuperTruck II program teams employed 48-volt technologies on their vehicles to demonstrate trucks with greater than 55% brake thermal efficiency. A recent study demonstrated through model-based simulations that a 48-volt technology package combined with advanced aftertreatment can achieve a composite FTP emission level of 0.015 g/bhp-hr [3].

Similar to the passenger car fleet, truck OEMs are considering replacing traditional mechanically driven components with equivalent or improved electric versions to gain efficiency. Converting electrical accessories from 12-volts to 48-volts reduces electrical losses and this is particularly advantageous for components that draw more power, such as pumps and fans. The types of components that may be electrified include electric turbos, electronic EGR pumps, AC compressors, electrically heated catalysts, electric cooling fans, oil pumps and coolant pumps, among others. Another technology that 48-volt systems could enable is electric power take-offs rather than using an engine powered auxiliary power unit or idling the main engine during hoteling while drivers rest. MECA members supplying commercial 48V components for commercial vehicles believe that the technology may be feasible to apply to a limited number of engine families by 2024, and it is likely to see greater penetration by 2027, especially on Class 8 line-haul where full hybridization is less practical.

Mild hybridization covers a range of configurations, but a promising one includes an electric motor/generator, regenerative braking, electric boost and advanced batteries. Stop/start deployment also provides a thermal management benefit to the aftertreatment by preventing cooling airflow through the aftertreatment during hot idle conditions. In this way, 48-volt mild hybridization is complementary technology to CDA and start-stop capability, allowing the combination of multiple technologies on a vehicle to yield synergistic benefits to reduce CO_2 by an additional 5-8% at the vehicle level by enabling engine-off while coasting (1.5% benefit), anti-idle and hoteling modes (up to 6% benefit for sleepers), and efficient electrical accessories (1.5% benefit), while recovering the energy for these systems from the vehicle dynamics (braking and coasting) [12, 13]. By shutting off the engine at idle or motoring using start/stop, micro hybrid technology can help to reduce CO_2 while maintaining aftertreatment temperature by avoiding the pumping of cold air through the exhaust. Capturing braking energy and storing it in a small battery for running auxiliary components when the engine is off offers another CO_2 reducing strategy for OEMs to deploy.

In lighter medium-duty applications, advanced start-stop systems have been developed that use an induction motor in a 48-volt belt-driven starter-generator (BSG). When the engine is running, the motor, acting as a generator, will charge a separate battery. When the engine needs to be started, the motor then applies its torque via the accessory belt and cranks the engine instead of using the starter motor. The separate battery can also be recharged via a regenerative braking system. In addition to the start-stop function, a BSG system can enhance fuel economy even during highway driving by cutting off the fuel supply when cruising or decelerating. Such systems can also be designed to deliver a short power boost to the drivetrain. This boost is typically 10 to 20 kW and is limited by the capacity of the 48V battery and accessory belt linking the motor to the crankshaft. New designs are linking the BSG directly to the crankshaft and allowing additional power boost of up to 30kW to be delivered, giving greater benefits to light and medium commercial vehicles [2].

Electrification: Full hybridization and electric vehicles

Full hybrid configurations are currently found on a growing number of models of light-duty passenger cars and light trucks in the U.S. and a limited number of medium-duty trucks and urban buses. These include models that can also be plugged-in (PHEVs) to enable electric operation for a determined “all- electric” range (AER). A full hybrid (HEV) can enable enhanced electrification of many of the components described above for mild hybrid vehicles as the higher voltages allow for more parts to be electrified and to a larger degree. Full hybrids also employ larger electric motors and batteries, which support greater acceleration capability and regenerative braking power. Full hybrid and plug-in hybrid vehicles have made the highest penetration into vocational applications such as parcel delivery, beverage delivery and food distribution vehicles because they can take advantage of regenerative braking in urban driving [14] and operate from a central location. Model predictions of HD HEV 600-800V technology recently verified at Oak Ridge National Laboratory [15] have shown that GHG emissions reductions of 9% on tractor certification cycles and 13%-19% on the vocational cycles, while enabling both anti-idle and hoteling function.

We expect to see the increasing application of strong / parallel and serial hybrids combined with a low NOx engine to reduce CO_2 emissions in several vocational applications. Integrated electric drivetrain systems, consisting of a fully qualified transmission, motor and power electronics controller, are now commercially available. With power levels of over 160kW and the ability to meet high torque requirements, these systems enable electrification of medium-duty commercial vehicles. There is also an increasing number of electric drivetrain solutions up to and over 300kW that are suitable for Class 8 vehicles that can be used with either hybrid [16], battery or fuel cell power sources [2].

MECA members are commercializing components for electric and hydrogen fuel cell vehicles. This includes battery materials for the manufacture of both cathode and anodes utilizing unique macrostructure and composite formulations to improve efficiency and energy density. Electric component manufacturers are using state of the art transistor materials in their motors and power electronics that operate at higher voltages and require simpler cooling strategies to again reduce switching losses and improve electric efficiency of the system architecture in electric powertrains. To facilitate integration, component suppliers are integrating the motor, inverter and transmission into electric drive units to simplify the thermal management of the electric components and ease design into vehicles.

To drive future U.S. technology leadership, EPA should recognize the need to include life cycle analysis in future rulemaking. This is particularly relevant to heavy-duty vehicles because of the magnitude of their power demand, battery size and charging time. Efficiency regulations have historically driven vehicle manufacturers and technology suppliers to continue to innovate and develop better materials, components, and vehicle systems to reduce energy demand, operating costs and related emissions of vehicles. By assigning realistic “non-zero” emission values to EVs and FCEVs, EPA will provide a regulatory incentive to further improve the electric efficiency of components and powertrain technologies that will further reduce vehicle related environmental impacts.

Hydrogen-Fueled Internal Combustion Engines

Another promising technology that is being commercialized to both reduce the NOx and carbon footprint of heavy-duty vehicles is the hydrogen internal combustion engine (H_2ICE). These engines, when coupled with advanced NOx aftertreatment, have the potential to meet the MY 2027 NOx limits while emitting zero tailpipe carbon emissions when operated on hydrogen fuel and zero lifecycle carbon emissions when operated on renewable green hydrogen. There is broad industry support for internal combustion engines fueled with clean hydrogen and most engine manufacturers and component suppliers are conducting significant development work and testing with ongoing on-road demonstrations in Europe and North America. H_2ICEs are attractive options for commercial trucking where challenges exist in applying current BEV or H_2FC technology.

One of the main benefits of H_2ICE is their lower upfront capital costs due to the leveraging of existing investments in manufacturing capacity in engines, emission controls and powertrain as well as vehicle servicing. H_2ICE vehicles share many components with today's diesel and natural gas-powered vehicle fleet, including the base engine, installation parts, powertrain components and aftertreatment system architectures. Furthermore, H_2ICE can borrow technology from currently available natural gas engines, such as cylinder heads, ignition systems, fuel injection, turbochargers, cooled exhaust gas recirculation (EGR), and engine control unit/software, among others. Nearly all on-road and off-road engine OEMs, along with their suppliers, are developing H_2ICE for commercial introduction in the MY 2026-2027 timeframe.

Suppliers of on-vehicle hydrogen storage tanks are looking at this H_2ICE transition technology to grow the manufacturing capacity for 350 bar and 700 bar high pressure hydrogen tanks and bring down their costs. This will accelerate the introduction of fuel cell trucks that will rely on the same high pressure fuel tanks and hydrogen infrastructure that they will share with H_2ICE trucks. Truck and engine manufacturers are targeting the introduction of H_2ICE trucks at least 10 years before fuel cell trucks will become cost competitive. The early introduction of H_2ICE trucks will help to accelerate the build-out of the hydrogen infrastructure and allow fleets to seamlessly transition from operating H_2ICE trucks to operating fuel cell trucks in their fleet.

These technologies represent only a few of the potential pathways available to OEMs to reduce CO_2 from commercial engines and vehicles. It is MECA's recommendation that EPA expand their analysis of potential compliance pathways, beyond only battery electric or fuel cell powertrains, to include improvements in engine and powertrain efficiency and incorporate them into a more robust final rule.

Averaging, Banking and Trading

U.S. Directed Production

EPA's analysis supporting this proposed rule is based on a 50-state approach which provides greater flexibility to address the complexities and fluid nature of heavy-duty vehicle purchases, licensing and operation. For these reasons, MECA believes that it is appropriate that U.S. directed production should include all 50 states.

Advanced Technology Multipliers and Weight Class Modifiers

Analyses by ICCT and researchers at Carnegie Mellon have shown that extended use of super credits in the light-duty sector has resulted in the unintended consequence of increased emissions from the non-ZEV fleet as it is allowed to emit more under a fleet average regulatory structure that includes averaging, banking and trading provisions [17, 18].

Given the considerable incentives created by the Inflation Reduction Act (IRA) and Bipartisan Infrastructure Law (BIL) and other federal and state programs supporting the production, sale and operation of heavy-duty zero tailpipe emitting vehicles, MECA agrees that Advanced Technology Multipliers for PHEVs, BEVs and FCEVs are no longer needed beyond MY 2027. Similar to the light-duty sector, an over-incentivized credit scheme for heavy-duty ZEVs is likely to result in market distortions that will reduce the broader deployment of electric and other advanced efficient powertrains and thus decrease the benefits anticipated by the standards.

MECA also supports the need for the inclusion of lifecycle analysis under the Phase 3 program to determine appropriate levels of crediting for zero emissions vehicles. To date, the assigning of zero CO_2 emissions results in an arbitrarily large number of credits which impedes the adoption of all advanced CO_2 reduction technologies. For this reason, MECA supports the accelerated retirement of advanced technology multiplier credits generated under the Phase 2 program by reducing their five-year lifetime. Furthermore, the Phase 2 regulation did not allow for the transfer of credits across averaging sets, and we believe this provision should be extended into the Phase 3 final rule. This is particularly important as the increasing number of electric trucks sold will afford EPA an opportunity to assess durability, FUL and LCA for different vehicle classes and averaging sets.

For similar reasons, MECA does not support the use of weight class modifiers which we believe can have the same effect of reducing or delaying the broader deployment of advanced GHG reducing technologies across all commercial vehicle sectors.

Off-Cycle Provisions for Innovative Technologies

MECA strongly supports the generation of credits through the off-cycle provisions for innovative technologies so manufacturers can deploy all possible technologies to address the CO_2 emission limits. The value of the credits must be verified by actual technology testing submitted to EPA. We believe that in the absence of advanced technology credit multipliers, a broader range of advanced technologies will see greater implementation by manufacturers to ensure their compliance. For this reason, MECA believes off-cycle provisions should be retained as an option under a performance-based regulatory framework.

Durability and Warranty Requirements

MECA believes that durability and warranty requirements instill confidence in the reliability of all technologies to fleet and truck owners. Therefore, based on their given weight class and application, diverse heavy-duty powertrains should be required to meet similar durability and warranty requirements. MECA recognizes that EPA's currently proposed warranty periods of 50,000 miles / 5 years for light-heavy-duty and 100,000 miles / 5 years for medium and heavy-heavy duty zero emissions vehicles reflect the low market penetration and lack of experience with this new technology. However, EPA should set a phase-in schedule to collect real-world data from electric trucks with the goal to align the durability, warranty and full useful life of the heavy-duty zero emission vehicles to more closely match the recently adopted durability and warranty requirements outlined under the EPA Heavy-Duty Engine and Vehicle Standards for MY 2027 and beyond which are shown in Table 1 below.

Table 1. Warranty periods for HD engines

	Current		MY2027+	
	Miles / Years	Hours	Miles / Years	Hours
Spark-ignition HDE	50,000 / 5	-	160,000 / 10	8,000
Light HDE	50,000 / 5	-	210,000 / 10	10,000
Medium HDE	100,000 / 5	-	280,000 / 10	14,000
Heavy HDE	100,000 / 5	-	450,000 / 10	22,000

MECA believes that equivalent warranty periods and durability for zero emissions vehicles are essential to ensure confidence in the technology for truck and fleet owners as well as ensure longer term emissions reductions.

Battery State of Health (SOH) Monitors as per UNECE GTR No. 22b & Labeling

MECA supports the inclusion of SOH monitors and usable battery energy (UBE) measurement requirements as per UN ECE GTR No. 22b that include vehicle miles traveled and power take-off (PTO) equivalent miles traveled. This information will serve to generate durability data to support future EPA programs, as well as industry and consumer needs. The UN-ECE is expected to finalize GTR No.22b in the next year and once completed EPA should assess and align with this global regulation. MECA believes that mandated battery labeling requirements will facilitate in-use vehicle service and end-of-life vehicle recycling. Towards this goal, EPA should align battery labeling requirements with those required under California's ACC II light-duty regulation.

Charger Infrastructure and Standards

The prioritization of building forward-looking vehicle charging infrastructure is critical to the penetration of electric commercial vehicles. Furthermore, analogous to vehicle electronic designs and material selection impacts electric vehicle efficiency, similar approaches can be used to improve charger efficiency in delivering the maximum power to the vehicle. For this reason, we believe that EPA should work with other agencies, like the Joint Office on Energy and Transportation, in setting minimum charger efficiency standards to ensure that infrastructure funds are spent on chargers with the best utilization of electric power.

While overnight charging at lower power may be appropriate for certain vehicle applications and fleets on a regimented schedule, we recommend the EPA prioritize the planning and building of direct current fast chargers (DCFC). The planning of public DCFCs is indispensable to allow in-service electric vehicles to address unforeseen day-to-day vehicle use variables (i.e., weather, traffic conditions, needed route changes, etc.). The availability of strategically placed, publicly accessible DCFCs prevents vehicles becoming inoperable due to these use variables, allowing vehicles to be rapidly charged and quickly placed back into service while minimizing interruptions to vehicle operations, traffic disruptions from vehicle strandings and maximizing the utilization of available space for heavy-duty vehicle recharging.

DCFC is also crucial to address long-term heavy-duty vehicle charging needs. Many commercial EVs will need to achieve fast charging times to encourage fleet owners to transition to e-mobility. This is particularly true for those vehicle operators who do not have access to charging at their own facilities. EV fleet adopters with slower rate overnight charging should also diversify their charging assets with DCFCs to have more flexibility as their fleets grow and unforeseen needs arise to charge vehicles and return them to service.

Additionally, DCFCs futureproof infrastructure investments by allowing fleet operators to immediately convert and deploy BEVs while also allowing them to remain up to date with advancements in battery technology. Vehicle batteries are quickly improving in size, chemistry, energy density, and efficiency resulting in increased vehicle range. This range improvement will, however, require faster charging capabilities. While HD BEV vehicles typically require large batteries with increasing power density, DCFCs enable quicker and more efficient charging of these vehicles. In addition, site and infrastructure owners maximize their investment because DCFCs enable site-readiness for future DCFC expansions while allowing the best utilization of available space and higher turnover of serviced vehicles.

DCFCs also allow for bidirectional charging which futureproofs infrastructure investment further by providing support for increasing electricity demand. Vehicle-to-Grid ("V2G") technology can help address energy use and manage peak demand times and costs, as well as serve as backup power during an outage. As EV adoption increases, this technology becomes more critical to enable sustainable grid management, grid resilience, utilization, and national security protection.

MECA also recommends the EPA consider national certification, such as UL Certification, for EV supply equipment to provide consistency, quality, safety, efficiency and compliance. A Certificate of Compliance will mean the product has passed a series of rigorous tests to demonstrate performance, safety, quality, and serviceability, while enhancing sustainability, strengthening security, and managing risk. National certification also supports local permitting efficiency, therefore, helps fast track deployment of charging stations.

For these reasons, MECA urges EPA to work with other government agencies, such as the Joint Office for Transportation and Energy, and industry to develop national standards for minimum charger efficiency which will ensure the efficient energy utilization and lowest operating cost for electric vehicles. With regards to technology, several suppliers of vehicle power electronics are applying similar electric efficiency technology innovation to the development of more efficient chargers to minimize switching losses and deliver maximum power to the battery. This is important to fleets as charging losses increase their operating cost and it is important to the environment because these loses represent electricity that is generated but never used. The difference in electric efficiency between the first generation of chargers, that are deployed in the field today, and the advanced second generation chargers can be as much as 10-20%. This becomes significant given the magnitude of battery energy in conventional vehicles.

Future BEV/FCEV Powertrain Efficiency Standards

Today, vehicle manufacturers are deploying the first generation of electric and fuel cell commercial vehicles. On the other hand, suppliers are already looking ahead and developing the next generation of advanced efficient powertrain components such as batteries, power electronics, transmissions, e-motors and integrated drive units. Technology innovation has strived for greater efficiency and power for the past 50 years of combustion engines and similarly, electric component suppliers continue to innovate electric technology. Some of these innovations will be revealed in the five funded projects under the DOE's SuperTruck III program.

As such, it is important that EPA begins to consider ways to incentivize and reward more efficient vehicles just as it has for combustion engine technology. In the light-duty sector, where EVs have been around for much longer, we are already seeing significant differences in the energy efficiency of similarly sized vehicles. This is a result of some manufacturers deploying more advanced technology and investing in efficient powertrain integration which reduces the impact on the environment across the vehicle life-cycle from manufacturing to recycling and disposal.

CONCLUSION

The stringent CO_2 standards being proposed by EPA will help to drive electric truck technology into the U.S. market. However, an accurate prediction of HD ZEV penetration remains difficult at this time despite the generous incentives that have been established. There are many factors that will impact EV technology uptake, including infrastructure readiness, grid resiliency and critical material availability for batteries and transformers. Despite the critical time deadlines that EPA is operating under to finalize this rule by the end of 2023, MECA strongly advises that EPA also examine and include additional engine, powertrain and vehicle GHG-reducing technologies in their evaluation as part of the final HD GHG Phase 3 rule.

MECA appreciates the hard work and dedication that EPA staff put into this important HD GHG Phase 3 rulemaking proposal on the heels of the truck criteria pollutant standards finalized last year. Our industry is prepared to do its part and deliver cost-effective and durable advanced emission, efficiency and electric technologies to the heavy-duty sector to meet the CO_2 reduction goals of this rule.

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