Introduction

The Motor & Equipment Manufacturers Association (MEMA)\(^1\) submits these comments to the U.S. Environmental Protection Agency (EPA), the U.S. Department of Transportation’s National Highway Traffic Safety Administration (NHTSA), and California’s Air Resources Board (CARB) on the Draft Technical Assessment Report (TAR) on the Midterm Evaluation (MTE) of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy (CAFE) for Model Years (MYs) 2022-2025.

MEMA represents more than 1,000 companies that supply systems and components for use in the light- and heavy-duty vehicle original equipment and aftermarket industries. The motor vehicle components manufacturing industry is the nation’s largest direct employer of manufacturing jobs – over 734,000 workers are employed by suppliers in all 50 states – and contributes nearly $355 billion in GDP. Our members innovate and develop a multitude of technologies and manufacture a wide-range of products, components and systems. We anticipate several members will submit individual comments specific to their company’s product mix and technology expertise. Accordingly, the MEMA comments address aspects of the draft TAR that are important to many of our members.

Motor vehicle suppliers have a significant role in the research, development and engineering of innovative technologies that improve vehicle performance, fuel efficiency and emissions. Suppliers work collaboratively with original equipment manufacturers (OEMs) and offer solutions to help them develop and deploy fuel-saving technologies.

MEMA supports the uniform, footprint-based National Program because it permits vehicle manufacturers to focus their resources on investing in the best technologies available for their fleet to achieve the levels prescribed by the program. This, in turn,

---
\(^1\) MEMA represents its members through four divisions: Automotive Aftermarket Suppliers Association (AASA); Heavy Duty Manufacturers Association (HDMA); Motor & Equipment Remanufacturers Association (MERA); and, Original Equipment Suppliers Association (OESA).
enables suppliers to continually innovate, to advance development and to turn research technologies into commercially viable products.

In order for the National Program’s targets to be realized for the outlying years of the standards, the draft TAR analysis indicates that steep efficiency gains will be needed. It is important to have a variety of technology strategies from which OEMs can choose. Ultimately, the OEMs must make the difficult choices about which technologies they end up deploying in their fleet. As such, suppliers must invest heavily to offer multiple technology solutions intended to support a variety of vehicle manufacturers’ strategies and meet different platforms’ goals. Long term certainty is an essential factor in the industry’s investment equation. For these reasons, motor vehicle suppliers are interested in promoting an improved off-cycle credit process and providing more opportunities for the OEMs to fully utilize the technologies available in the most efficient way possible.

Our comments to the draft TAR will address the following:

- **Ensure Harmonization of the National Program**
  - Harmonization of regulatory frameworks is critical and must be a cornerstone of the MTE analysis.
  - A true National Program is crucial to ensure long-term compliance planning and corresponding technology investments.

- **Improve Utilization of Off-Cycle Technologies**
  - Off-cycle technologies offer real-world benefits in reducing GHG emissions and improving efficiencies.
  - The draft TAR analysis needs to fully evaluate the off-cycle credits program for adequate consideration in the MTE.
  - There are opportunities to improve the current program pathways to spur technology innovation and incentivize adoption.

- **Validate Technology Deployment Projections**
  - The marked differences in the agencies’ assessment of technology deployment projections between the Federal Rulemaking (FRM) and the draft TAR as well as the agency predictions of technology pathways needed to meet the 2025 targets must be further evaluated in the MTE.
  - MEMA highlights that some technologies in the draft TAR evaluation, like turbocharging, downsizing and diesel, require review in the MTE.

- **Consider Supplier Observations on Other Technologies and Credits**
  - The agencies should re-evaluate their assessments and/or consider evaluating various technology strategies in the MTE. MEMA addresses technologies such as: 48-volt systems, micro-hybrids 12-volt dual energy storage systems and high efficiency alternators.
  - MEMA also asks the agencies to consider our comments related to air conditioning efficiency credits and mild hybrid truck credit.

Even with the denial of the industry’s coalition request for an extension of the comment period, motor vehicle suppliers are committed to providing the agencies...
important feedback. To that end, these comments were a diligent and collaborative effort by motor vehicle suppliers to provide as helpful an assessment as possible on the draft TAR within the timeframe allotted. However, in the event we come across additional information or analysis, we certainly appreciate the commitment in your August 22, 2016 letter3 that the Administration will make every effort to consider public comments submitted after the close of the comment period.

All stakeholders would benefit from a better understanding of the agencies’ anticipated scheduling leading up to the MTE, particularly in relation to any response to or follow up on the draft TAR. The final rulemaking (FRM) only addresses the MTE timeline in a general manner. As such, it is important for stakeholders and the MTE process that agencies provide a more detailed, transparent process. In the interim between the close of the comment period and the de novo rulemaking/proposed decision, the agencies need to outline their next steps. This includes indicating whether the agencies either intend to issue a revised or final TAR or whether they intend to release a response to comments on the draft TAR.

**Importance of Harmonization**

MEMA supports harmonization of the GHG emissions and CAFE standards programs to a true National Program. Harmonization of these programs provides regulatory clarity and the certainty needed for OEMs and suppliers to make the necessary technology investment decisions. Program harmonization also creates economies of scale and improves market availability for the needed technologies. Since motor vehicle suppliers are responsible for a significant proportion of research and development of the technologies needed to meet and exceed the standards, any initiative to further align regulatory requirements is equally important to suppliers.

On the heels of the first joint rulemaking for the EPA GHG emissions and NHTSA CAFE standards for light-duty vehicles MYs 2012-2016, President Obama issued a presidential memorandum directing NHTSA and EPA to start work on the next set of standards for MYs 2017-2025. He directed the agencies to continue the National Program to allow automakers to comply with both programs through a single, light-duty national fleet.

Unfortunately, discrepancies between the two programs have prevented the level of harmonization stakeholders anticipated. The draft TAR discusses these discrepancies in detail in sections 11.2 through 11.4. As the National Program stands now, it is possible for OEMs to be in compliance with the more stringent GHG standards while not being able to meet the corresponding CAFE standards. There are several examples of current misalignment between the NHTSA and EPA programs, but of particular concern to MEMA, is the accounting for off-cycle technology credits. Generally, EPA recognizes off-cycle credits starting in MY2014 while NHTSA recognizes off-cycle credits starting in MY2017.

---

Further, each agency allows different credit lifespans and have different transfer caps.\textsuperscript{4} MEMA urges the agencies to consider the impacts of these discrepancies in its MTE.

MEMA generally supports the intent behind the Petition for Direct Final Rule submitted to EPA and NHTSA by the Alliance of Automobile Manufacturers and the Association of Global Automakers on June 20, 2016, which requested regulatory changes to harmonize the GHG and CAFE regulations. Further harmonization between the two programs is pertinent to the MTE evaluation and the draft TAR because of the inconsistencies in the way the agencies recognize, transfer and account technology credits. As such, harmonization of the two programs to a true National Program, is crucial to enhance the industry’s ability to make technology investment decisions and plan for compliance.

**Importance of the Off-Cycle Technology Credits**

Off-cycle technologies will continue to be critical for the automotive industry to lower GHG emissions and improve fuel efficiency, particularly in the latter half of the program for MYs 2017-2025. Off-cycle credits help spur innovation and continuous improvements of the technologies as well as incentivize OEMs to incorporate these technologies where they make the most sense in their various product lines. In MEMA’s February 2012 comments on the Notice of Proposed Rulemaking (NPRM) for MYs 2017 and beyond, MEMA supported the agencies proposal to provide off-cycle credits for any technologies that demonstrate significant, incremental off-cycle CO\textsubscript{2} reductions and corresponding fuel consumption improvement values.\textsuperscript{5} MEMA also supported the option to make eligible for credit those technologies that may only register small reductions on the 2-cycle test, but have more significant off-cycle gains. The 2012 FRM for the MYs 2017-2025 standards laid out a regulatory framework to manage and account for off-cycle technology credits. As a result, many OEMs have earned credits using various off-cycle technologies, but there are challenges with the existing framework that should be more closely examined in the context of the MTE.

The draft TAR does mention off-cycle credit flexibilities and their role in the National Program because they “allow manufacturers to maintain consumer choice, spur technology development, and minimize compliance costs, while achieving significant GHG and oil reductions.”\textsuperscript{6} However, the draft TAR does not include any significant analysis of how the off-cycle credits and processes could be amended to offer more opportunities for OEMs to expand utilization of off-cycle technologies. These are technologies with real-world benefits that improve emissions and efficiencies. The improvements needed to meet the standards will require the utilization of a variety of technologies, many of which are off-cycle improvements. MEMA agrees that this process will promote significant technology research and development. The agencies must consider how off-cycle credits and flexibilities can be optimized under the current regulatory framework.

\textsuperscript{4} Draft TAR pgs. 11-3 – 11-6.
\textsuperscript{5} 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards (Docket Numbers EPA-OAR-201-0799; FRL-9495-2; NHTSA-2010-0131)
\textsuperscript{6} Draft TAR page 11-1.
Ultimately, the OEMs decide the technology mix they will use to meet the targets. Beyond 2020, suppliers anticipate a plateau in the further progress of some currently available internal combustion engine (ICE) technologies. This is driven by two reasons: 1) technologies with the highest cost/benefit ratio will have already been employed, and 2) both OEMs and suppliers must shift financial resources and investments to growing electrification and automated driving efforts. Although further advances in traditional ICE efficiency are possible (e.g. cooled exhaust gas recirculation, water injection, high compression, etc.), these will likely not be realized in high volume without support of off-cycle credits.

**Current Off-Cycle Credit Structure and Process Needs Change**

MEMA urges the agencies to examine improving and streamlining of the off-cycle credit structure and process. While much of the draft TAR’s analysis of the off-cycle credit utilization is promising, it is clear that the off-cycle credit program has room for improvement if it is to continue to encourage the use of these technologies in MYs 2022-2025. Based on new and evolving technology, there could be more opportunities for off-cycle technologies to be recognized and applied. Therefore, as part of the agencies’ continuing analysis, the credits and technologies under this element of the program must be thoroughly evaluated. Particularly the first and third pathways, which are the pre-defined list and the application for approval to use an alternative methodology for determining off-cycle credits.

As explained in chapter 5 of the TAR, the vast majority of off-cycle credits utilized in MY2014 were from the pre-defined list (colloquially called “the menu”). These off-cycle on-menu credits averaged an equivalent of 2 grams per mile (g/mi) in MY2014 per OEM. Industry’s early use of off-cycle credits points to the growing resources dedicated toward lowering emissions using off-cycle technologies.

**Remove Credit Caps**

The pre-defined list off-cycle technologies has a credit cap of 10 g/mi. The FRM acknowledged that the cap will “be a topic for further consideration ... and to be one of the issues the agencies examine during the mid-term review.” Based on the data provided in the draft TAR chapter 5 on the utilization of the off-cycle credits, the use of off-cycle technologies in the coming years should be expected to grow. The regulatory program should continue to account for and encourage these emissions-reducing technologies and continue to evaluate how these credits can be expanded and developed. OEM adoption of off-cycle technologies will soon be stymied by the arbitrary credit caps established in the regulation.

MEMA strongly recommends that the agencies eliminate the cap on the use of off-cycle credits. This cap will eventually become counterproductive since, once the cap is met, there is no compliance benefit for OEMs to continue to invest in the technologies. Further,

---

7 Draft TAR pg. 5-223.
8 77 Fed. Reg. at pg. 62835.
9 Draft TAR pgs. 5-222 – 5-223.
OEMs may be compelled to invest in other technologies with less associated benefits but which provide a higher testing value. Far from “off-ramps,” these technologies incentivize the development and adoption of additional innovative fuel-saving technologies that cannot be quantified using on-cycle testing. These technologies result in real-world reductions of GHG emissions and meet customer demands.

Unfortunately, the TAR does not address or evaluate the impact of removing the cap. As agencies go forward in their MTE, the agencies must evaluate and consider removing the cap on off-cycle credits.

**Opportunities with the Off-Cycle Credit Technologies Program**

There are currently three pathways a manufacturer can accrue off-cycle technology credits. The first pathway is the predetermined list or “menu” of technologies and corresponding credit values. The second pathway is known as the 5-cycle testing methodology that captures emission benefits over elements of real-world driving not captured in the regular 2-cycle test. The third pathway allows OEMs to seek EPA approval through a public process for an alternative methodology for determining the off-cycle technology credits. The draft TAR explains in chapter 5 that the off-cycle credits granted under the second and third pathways have not been utilized as much and only a handful of applications have been approved.\(^\text{10}\)

We anticipate that the second and third pathways of accruing off-cycle credits will continue to be underutilized because the information, data and testing requirements for these can be arduous. Further, limited agency resources have delayed the processing of petitions for off-cycle credits, and these delays impede the ability of suppliers and OEMs to make technology investment decisions and effectively plan for compliance. The agencies and the industry would both greatly benefit if the process for petitioning for off-cycle credit technologies is better defined, standardized and streamlined. The current process of off-cycle credit petition has a significant amount of risk and is unpredictable, which is a barrier to innovating and deploying these technologies that have real world benefit and further the goals of the standards. Having a better process for the application procedure will allow OEMs to more effectively use off-cycle credits to meet the goals of the programs.

As outlined above, suppliers have a major role in providing the innovative technologies allowing OEMs to meet their targets. Therefore, suppliers have a vested interest in making sure these technologies are easily deployed and utilized by OEMs. Currently, any OEM wanting to implement an off-cycle technology is required to submit an application with data and test validation, even if a petition has already been made by another OEM for the same off-cycle technology. When an OEM applies for a not-on-the-menu, off-cycle technology, that same technology and test validation should then be available to all OEMs that want to implement the same off-cycle technology. If that same technology and test validation is available to the other OEMs, the OEM will then only need to validate what level of credit they are applying for based on how the technology is applied.

---

\(^{10}\) Draft TAR pgs. 5-222 - 5-223.
in their fleet. This process will decrease the workload of the agencies and vehicle manufacturers.

The agencies should further evaluate each off-the-menu, off-cycle credit petition from OEMs for their applicability across the industry. If the agencies find that the technology is applicable industry-wide, the off-cycle technology should be added to the menu for all manufacturers to benefit. If the appropriate off-cycle technologies are gradually added to the off-cycle technology menu, this would be a significant workload reduction effort for agencies and OEMs. It would also greatly increase the adoption of suppliers’ off-cycle technologies.

The current off-cycle technology credit process allows only OEMs to submit petitions for off-cycle credits and only the applying OEM can receive the approved credits. Suppliers should be allowed to directly petition for an off-cycle credit for a specific technology they offer. This would further incentivize development of innovative technologies. Often suppliers are developing technologies that will be implemented by multiple OEMs. Allowing suppliers to submit petitions for off-cycle credits could greatly expedite industry adoption of certain technologies. Suppliers, as developers and implementers of these innovative technologies, are the most knowledgeable about how these technologies work and how they can be utilized in a motor vehicle. Suppliers are also in the best position to provide data and information on these technologies to the agencies. This process would provide assurance that supplier investments in these innovative technologies will be rewarded. Having a supplier petition process would allow these technologies to enter the market faster and gain penetration more efficiently than if each OEM applied separately for the same credit.

**Pre-Defined List of Off-Cycle Credits**

One way to help lessen the need and demand for the second and third pathway is to expand the current pre-defined menu. The technologies on the current menu includes many categories and, as the agencies noted in the draft TAR, have been utilized by manufacturers. The off-cycle credit program is an important aspect of the standards’ regulatory framework. As is demonstrated by the TAR’s Table 5.31, many manufacturers have utilized the program. In fact, the menu could be supplemented with even more technology categories and corresponding, reasonable credit values. This is due to technology advances since the current menu was established.

 Appropriately expanding the technologies available on the menu (meaning it reflects a more current list of available, in-production technologies that have tangible, real-world benefits) would encourage broader implementation of these technologies by OEMs into the fleet. Updating and expanding the pre-determined list of technology categories and establishing reasonable credit values:

- opens up the opportunities for automakers to apply technologies in a prescriptive manner for various platforms where the technology(ies) may have the most measurable impact on efficiencies;
- provides certainty for long-term tooling investments, product development planning and system integration strategies for both OEMs and their suppliers;
• incentivizes further improvements to those products where there is opportunity for an OEM to seek higher value credits through the third pathway (if they choose); and,
• curtails the need to heavily rely on the third pathway (application process) for any technology not measured in the 2- or 5-cycle tests.

There are several categories that should be considered for the pre-determined list. MEMA offers some examples of possible additions to the menu in our Appendix A. The suggestions are not intended to be all-inclusive. However, these categories do represent a host of viable technology areas that could be considered for addition in the pre-defined list. Also, as agencies go forward in their MTE, MEMA suggests adding the off-cycle technologies that are recognized by the European Union to the menu.11

Validate Technology Deployment Analysis

As demonstrated in the draft TAR Table ES-3 below, there are significant discrepancies in the agencies’ technology projection estimates to meet MY2025 standards. The draft TAR does not explain why each agencies’ forecasts are so far apart. For instance, as displayed in the TAR Table 12.45, the agencies estimated penetration rate for the mild hybrid in the 2012 FRM is 26 percent, yet the estimated penetration rate in the current draft TAR decreased to 18 percent without any explanation. The agencies should give a thorough explanation as to why their projections regarding the same technologies are so different, what data these projections are based on and how these discrepancies will be handled when making decisions for the MTE. Understanding these critical differences is an important aspect of the MTE.

Technologies Needed to Meet MY2025 Standards

There are fundamental differences with suppliers’ estimates and technology projections contained in the EPA and NHTSA TAR technology market adoption estimates as illustrated in Table ES-3. For example, consider the mild hybrid (48V) needed adoption rates. In order to meet MY2025 standards, the EPA estimates mild hybrid adoption rate needs to be at 18 percent and NHTSA at 14 percent. Supplier industry’s projections for adoption are much lower. Therefore, agencies need to assess the potential of incentives in order to encourage wider adoption, including off-cycle credits. In addition, suppliers estimate that the required take rates for SHEV and PHEV would need to be in excess of 10 percent of the total fleet to meet the 2025 target. The draft TAR, however, shows that high voltage electrification needed is much lower (less than 3 and 2 percent, respectively).

11 Please see http://ec.europa.eu/clima/policies/transport/vehicles/cars/documentation_en.htm
12 Draft TAR Executive Summary, Table ES-3, pg. ES-10.
13 Draft TAR Chapter 12, Table 12.45, pg. 12-35.
Table ES- 3 Selected Technology Penetrations to Meet MY2025 Standards

<table>
<thead>
<tr>
<th>Technology</th>
<th>GHG</th>
<th>CAFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharged and downsized gasoline engines</td>
<td>33%</td>
<td>54%</td>
</tr>
<tr>
<td>Higher compression ratio, naturally aspirated gasoline engines</td>
<td>44%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>8 speed and other advanced transmissions(^2)</td>
<td>90%</td>
<td>70%</td>
</tr>
<tr>
<td>Mass reduction</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Stop-start</td>
<td>20%</td>
<td>38%</td>
</tr>
<tr>
<td>Mild Hybrid</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>Full Hybrid</td>
<td>&lt;3%</td>
<td>14%</td>
</tr>
<tr>
<td>Plug-in hybrid electric vehicle(^3)</td>
<td>&lt;2%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Electric vehicle(^3)</td>
<td>&lt;3%</td>
<td>&lt;2%</td>
</tr>
</tbody>
</table>

Notes:
1 Percentages shown are absolute rather than incremental. These values reflect both EPA and NHTSA’s primary analyses; both agencies present additional sensitivity analyses in Chapter 12 (GHG) and Chapter 13 (CAFE). For EPA this includes a pathway where higher compression ratio naturally aspirated gasoline engines are held at a 10% penetration, and the major changes are turbocharged and downsized gasoline engines increase to 47% and mild hybrids increase to 38% (See Chapter 12.1.2)

Differences Between FRM and Draft TAR Comparisons

The draft TAR did not fully address the differences between the FRM technology deployment predictions with the current state of technology. In the context of informing the MTE, it is important for stakeholders to understand how the agencies can explain the miscalculations and how they will adjust for new projections for the latter half of the standards. Certainly, prognosticating technology trends is never perfect. However, such large gaps between the FRM predications and the draft TAR warrant a fuller analysis on accounting and accommodating for uncertainty. The agencies need to account and explain these differences.

Table 12.45 Final Technology Penetration Comparison – 2012 FRM vs Draft TAR

<table>
<thead>
<tr>
<th>Technology</th>
<th>2012 FRM</th>
<th>Draft TAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline direct injection engine</td>
<td>94%</td>
<td>79%</td>
</tr>
<tr>
<td>8+ speeds &amp; improved CVTs</td>
<td>91%</td>
<td>90%</td>
</tr>
<tr>
<td>Turbocharged and downsized gasoline engine</td>
<td>93%</td>
<td>33%</td>
</tr>
<tr>
<td>Higher compression ratio/naturally aspirated gasoline engine (Atkinson-2)</td>
<td>n/a</td>
<td>44%</td>
</tr>
<tr>
<td>Stop-start</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>Mild HEV</td>
<td>26%</td>
<td>18%</td>
</tr>
<tr>
<td>Strong HEV</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>EV+PHEV</td>
<td>2%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Note: 2012 FRM values taken from EPA’s final RIA Table 3.5-25; Atkinson-2 was not considered in the 2012 FRM; V battery in the 2012 FRM but uses a 48V battery in this Draft TAR.
**Turbocharging, Downsized Engines and Turbocharge Improvements**

Downsized turbocharged engines continue to be a cost-effective solution for meeting future standards as well as the required performance attributes that consumers demand. The penetration rate of these engines in the draft TAR Table 12.45 of 33 percent (a significant reduction from the 93 percent indicated in the 2012 FRM) is below the 57 percent indicated by IHS Automotive data. There are a few factors contributing to the continued growth of downsized boosted engines in the U.S. market. Turbocharging will also play a greater role in electric hybrid vehicles of the future and the agencies should consider this in their evaluation.

First, turbocharger suppliers are constantly working on improving the efficiency of the turbo machine and their inertia to reduce turbo lag. Usage of low weight materials for turbine or compressor wheel, or bearing systems with lower friction, like ball bearings, can also decrease the lag in turbo response. New high temperature materials, water cooling jackets to minimize the need for high temperature materials, new manufacturing processes for the wheels opening their design space, extensive computational fluid dynamics to optimize the efficiency where it matters and introduction of mixed flow turbine wheels are all ongoing efforts to improve turbocharger performance.

A second factor is the use of available 48-volt (48V) systems for thermodynamic hybridization through the use of e-boosting systems or electric supercharging. These systems comprise a higher voltage electrical system used to provide power for compressor stage mounted on small electric motors for an electric booster or for an e-motor directly within a turbocharger. These either directly boost the engine and reduce the boost lag, or spin up the turbocharger to greatly reduce turbo lag, increasing the ability to downsize and downspeed the engine as well as reducing backpressure. E-boost also allows the use of larger turbines with lower backpressure, for a direct reduction in brake specific fuel consumption (BSFC) in addition to the benefits from engine downspeeding/downsizing. 48V mild hybrids and plug-in hybrids using turbocharged engines continue to grow in the market as OEMs continue to decrease the number of engine platforms for improved economies of scale. These technologies have proven their benefits in many demonstration vehicles and are now beginning to appear in the market. Significant effort is underway to minimize the packaging variation between non-hybrid and hybrid powertrains for common mounting and application.

Third, as the draft TAR indicated, is the emergence of Miller cycle engines which, by definition, use a turbocharger to mitigate airflow loss incurred by early or late intake valve closing. While Miller cycle engines are just entering the market in significant volume, their balance of fuel efficiency – over a broad operating range and synergy with other emerging technologies such as 3-step discrete variable valve lift and variable compression ratio – will result in a larger market share of this technology in 2025 than predicted by the draft TAR. Additionally, as a way to further improve the fuel efficiency and power density of a Miller cycle engine, a VNT™ or a.k.a. VGT, could be used. This type of turbo, which is a

---

14 Draft TAR, 5.2.2.10, pg. 5-33.
well-proven, cost-effective technology, is an enabler for balancing the performance requirements of diesel and, more recently, gasoline engines.

Of all the developments made so far towards the achievement of GHG reductions, the application of GDI and turbocharging with downsizing has clearly been one of the most significant. These efforts combined with higher speed transmission (either CVT or AT) have already made a major contribution towards the targets. Through 2020, we see further realization of these technologies as they are applied in second and third generations of development. These powertrains will provide further progress towards the targets of reduced GHG as well make major strides towards the goals of the standards.

*TAR Analysis for Light Duty Diesel*

The draft TAR acknowledges diesel engines have evolved considerably over the past several years. The TAR also illustrated the penetration share of various light vehicle technologies. Modern diesel engines can provide equal or better performance than equivalent gasoline engines while improving fuel economy due to their inherent lean-burn operating regime. As such, light-duty diesel vehicles will remain an important strategy for compliance and for customers.

The data used by EPA and NHTSA relied on the 2015 National Research Council (NRC) report. The NRC report estimated EPA Tier 3 compliance costs for diesel vehicles are unclear and not sourced with specific technology cost breakdowns. The agencies must review and amend the cost/benefit analysis for light duty diesel cars and trucks as published in the TAR.

In response to the draft TAR, The Martec Group (MARTEC), an automotive industry consulting firm used by the regulating agencies in previous rulemakings, published a white paper related to diesel compliance costs. MARTEC published its own analysis after conducting interviews with leading suppliers in early 2016. They concluded that the 4- and 6-cylinder diesel engines now have a lower total variable cost than 2007 EPA estimates due to overall cost reductions and technology improvements. In fact, MARTEC determined costs to be 40 percent lower than the NRC estimates. This is largely due to a significant drop in Precious Metals Group (PGM) cost reductions since the previous rulemaking estimates. These cost reductions were not mentioned in the 2015 NRC report. Due to these cost reductions and technology improvements, MARTEC determined that the cost of light duty diesel compliance with Tier 3 will be insignificant by 2025. MARTEC provided detailed breakdowns of the technology packages and costs needed to meet Tier 3. The NAS 2015 report provides no breakdown of the technologies used or cost sourcing to reach its cost conclusions. As this NRC report is referenced in the draft TAR, MEMA recommends the agencies closely review the MARTEC report and revisit the NRC diesel analysis.

---

15 Draft TAR, pg. 5-36.
16 Draft TAR, Chapter 3, Figure 3.10, pg. 3-12.
Observations on Other Technologies & Credits in the Draft TAR Analysis

48-Volt Systems

In addition to direct powertrain performance and fuel economy enhancements, 48V systems can provide power to high energy systems which further increases performance and efficiency. Such systems include, HVAC compressors, chassis stabilization and safety systems, electric steering, etc.

Electrically heated catalysts (EHCs) can be more efficiently powered by 48V systems to electrically light off the after treatment catalyst faster than possible when heated solely by exhaust gases. This not only lowers tailpipe emissions it also enables start-stop operation sooner.

48V has been demonstrated to fill the gap in efficiency between Simple and Enhanced Start Stop systems and Full Hybrids at a fraction of the cost of full hybrids. It has been demonstrated that a 48V system can be very flexible and with a motor mounted in P0, P1, P2 or P4 position the amount of efficiency gained can be a significant fraction of the gain from a full hybrid in a mid-sized passenger car.

MEMA recommends the agencies more closely evaluate the potential for 48V systems in its analysis as an enabling technology that can leverage efficiencies in other vehicle systems or can provide other flexibilities.

Start-Stop Microhybrids; 12V Dual Energy Storage Systems (DESS)

With a 12V system, there is additional CO₂/fuel economy that automotive manufacturers are pursuing by increasing the energy storage capability of the vehicle and converting the alternator to a motor/generator. Input from our members’ modeling, development vehicle testing and analysis shows that correctly pairing two battery types together with a motor/generator can provide an additional 3 percent effectiveness beyond idle start-stop.

In the draft TAR, benchmark test results of a Mazda vehicle with the i-ELOOP system are presented. The configuration of energy storage for this vehicle is a lead-acid battery paired with a bank of ultracapacitors. The alternator operates at variable voltage to be able to charge the ultracapacitors during brake regeneration and power the traditional 12V network as well as charge the 12V lead-acid battery. The system also includes a DC/DC converter. While agencies acknowledge the benchmark results of the i-ELOOP system in the draft TAR, the true benefits of pairing together two technologies were not provided.

Alternative solutions exist which are much more cost effective. By using a motor/generator (modest power boost) paired with an optimized lead-acid and lithium ion dual energy storage system, brake regeneration can be performed at 12V and modest power boost of the engine can be performed without the need for a variable voltage alternator or a DC/DC converter as required in the Mazda i-ELOOP system. This configuration provides an additional 3 percent effectiveness over idle start-stop. Energy into and out of each battery is managed through the characteristics of the chemistries chosen. MEMA recommends the agencies consider this in their analysis.
**High Efficiency Alternators**

The efficiency of alternators can play an important role with regard to GHG emissions and the fuel economy of a vehicle. In a vehicle, the alternator is being driven from the engine via a belt to generate a certain amount of electrical energy. The higher the efficiency of an alternator, the less fuel is needed to generate that certain amount of electrical energy. An alternator that has a significantly higher efficiency can therefore reduce the GHG emissions or fuel consumption of a vehicle.

There are generally two widely proven technical options available to increase the efficiency of alternators – low loss diodes or MOSFETs (instead of diodes). Both options work by reducing the conversion losses within the alternator to convert the generated alternate current into direct current that is needed to supply the electrical energy to the vehicle.

It should be noted that once invested in MOSFET rectification, the alternator can be treated as both generator and a motor. The motoring capability can accomplish warm internal combustion engine starts and minor torque-smoothing as well as regenerative energy capture (a.k.a. BAS / micro-hybrid).

Reduced conversion losses can result in GHG reductions somewhere in the range of up to 1 g/mi per use of the low loss diodes or up to 2 g/mi per use of MOSFETs in real world driving. Improved rotating machine efficiency has the potential to further improve emissions. The impact is much less in the CAFE certification due to the usage of much less electrical consumption/load than in real world driving. We note that this technology is already incentivized through the European and Brazilian programs. Therefore, MEMA recommends the application of off-cycle credits support the proliferation of this readily available technology.

**Aerodynamic Drag Reduction**

Aerodynamic drag reduction encompasses a wide range of passive and active technologies to reduce vehicle drag. Passive systems employ aerodynamic design principles to reduce the drag co-efficient and surface area of a vehicle to lower the wind drag during motion. Active system examples include moveable wings, active engine inlet dampers, vehicle lowering and active skirts – in effect anything that is actively controlled based on vehicle speed and other factors to reduce drag. The drag coefficient needed for the model input is highly dependent on significant wind tunnel validation. Acquiring adequate wind tunnel time to conduct these tests is time-consuming and usually a lot of trial and error. MEMA asks these factors to be accounted for in the agencies’ analysis.

**Mass Reduction**

The agencies have long recognized that mass reduction (light weighting) has a strategic role in reducing fuel consumption and vehicle emissions. Lighter weight materials – plastics, polymer composites, aluminum, high strength steel, carbon fiber and magnesium – just to name a few – have been and continue to be contributors to the feasibility of ongoing mass reduction efforts. Whether as a stand-alone material or as part of a multi-material solution, these lighter weight materials are increasingly being incorporated into vehicle components.
The draft TAR appropriately recognizes some of the likely ways that these types of materials will be used in the upcoming light-duty fleet. However, MEMA notes that closed loop recycling programs have the ability to drive down manufacturing costs, thus making it more attractive for OEMs to deploy mass reduction as a strategy to meet the standards. MEMA recommends that the agencies consider the impact of closed loop materials recycling programs within stamping and assembly plants in their analysis.

New materials and composites can also improve and optimize component design and even reduce the overall number of components/subcomponents, which may have a corresponding weight savings. For example, plastics and polymer composites, in many cases, offer the ability for injection molding to help shape the vehicle environment. Through collaborative efforts with OEMs, the plastics/composites industry has developed lightweight alternatives for bumper beams, thin-wall instrument panels, door modules, and floor rockers. These light weighting solutions continue to develop. Within the next three to five years, the plastics and polymer composites industry anticipates providing lightweight alternatives for cross car beams and B-pillars, as well as lightweight windows and tailgates. These solutions contribute to the goals of reduced emissions and fuel consumption in a cost-effective manner. Many plastics and polymer composites solutions require fewer parts to assemble, and are made possible by technology such as injection molding, injection compression molding and insert over-molding. Other solutions, such as reversible bonded joints, allow for more rapid part assembly or repair. Assembly efficiency and the ability to merge different parts together make plastics and polymer composites cost effective in various applications.

**Other Credits**

**A/C Efficiency Credits and SNAP Refrigerants Rule**

The pre-defined and pre-approved air conditioning (A/C) efficiency credits, or the Motor Air Conditioning (MAC) indirect credit menu, are playing a significant role in incentivizing air conditioner efficiency technologies. A/C efficiency credits were used by 17 auto manufacturers as part of their compliance demonstration in MY2014. This data confirms earlier agency conclusions that these technologies will be widely adopted and will continue to play a role in overall vehicle GHG reductions and regulatory compliance. As the draft TAR states, suppliers will continue to develop and deploy additional technologies improving A/C efficiency. While these new technologies will not be added to the MAC indirect credit menu they will continue to be eligible for credit under the off-cycle program.

According to the draft TAR, A/C credits earned through the off-cycle credit petition process count towards the A/C efficiency credit cap of 5.7 g/mi. Credits earned for A/C

---

20 "Efficient Assembly and Joining: Reversible Bonded Joints Using Nano-Ferromagnetic Particles", Mahmoodul Haq, September 2015, 15th Annual Society of Plastic Engineers (SPE) and Automotive Composites Conference and Exhibition (ACCE), at Novi, MI, Volume: Abstracts of 15th Annual Society of Plastic Engineers (SPE) and Automotive Composites Conference & Exhibition (ACCE).
21 Draft TAR pg. 5-210.
22 Draft TAR pg. 5-208.
23 Draft TAR pg. 5-210.
technologies through the off-cycle credit petition process should not count towards the overall A/C efficiency credit cap since this cap is set on credits gained through the MAC indirect credit menu. Credits earned through the MAC indirect credit menu may be based on different testing procedures then those credits earned through the off-cycle petition process. Further, no credit cap is applied to off-cycle credits earned through the petition process. As agencies go forward in their MTE, MEMA strongly recommends the agencies consider discontinuing counting A/C efficiency credits, which are earned through the off-cycle petition process, toward the cap on A/C technologies credits. This cap could significantly stifle further development of these technologies and remove incentives for OEMs to continue to invest in these technologies.

Furthermore, MEMA supports the confirmation in the draft TAR that credits will continue to be available for using low-global warming potential refrigerants in new motor vehicles. Also, that the July 2015 SNAP final rule will have "no effect on how manufacturers may choose to generate and use air conditioning leakage credits under the light-duty GHG standards."25

**Mild-Hybrid Truck Credit**

At the time of the FRM, the agencies offered an incentive to large pickup trucks that incorporated hybrid technology or significantly outperformed the emissions target for that year. This incentive was offered to encourage the adoption of “game changing” technology in the large pickup truck market.

The pickup truck credits were based on the level of hybridization or degree to which the vehicle outperformed the standard. In addition, those technologies were required to achieve a certain level of market penetration within the vehicle manufacturer's large truck market. For example, the required market penetration for mild-hybridization is 20 percent in 2017 growing to 80 percent in 2021.

The FRM phases out the mild-hybrid truck credit after 2021. With mild-hybridization just now emerging as a technology solution in the marketplace, the elimination of these credits will inhibit the proliferation of this much needed innovative solution on trucks. In addition, the market penetration requirement in 2021 may discourage OEMs from implementing this technology due to concerns that the required sales volumes may not be met. Therefore, to better encourage the adoption of the technology MEMA asks the agencies to evaluate the extension of these credits beyond 2021 and reconsider the required market penetration necessary to receive these credits during the MTE.

**Conclusion**

Suppliers play a key role in the innovation and development of a wide variety of technologies that improve fuel economy and reduce GHG emissions. These technologies will be critical to help OEMs meet the MYs 2017-2025 standards. Thus, OEMs must have a
variety of options and flexibilities available to them to apply in their fleet and meet the goals of the standards.

MEMA urges the agencies to assess opportunities for further alignment and harmonization between the standards under the National Program. The agencies must consider how off-cycle credits and flexibilities can be optimized under the current regulations. Further, the agencies should reexamine other technology areas and their potential impact on efficiencies. Likewise, the agencies need to evaluate the different technology deployment analyses and explain discrepancies.

As the agencies continue the MTE, these recommendations must be thoroughly evaluated before the proposals are issued.

Thank you for consideration of these comments. Please do not hesitate to contact Leigh Merino, senior director of regulatory affairs or Laurie Holmes, senior director of environmental policy, with any questions.

# # #
Following from Page 8 in our comments, MEMA notes that there are several categories that should be considered for the pre-determined list. MEMA offers some examples of possible additions to the pre-determined menu. Again, this is not intended to be all-inclusive. However, these categories do represent a host of viable technology areas that could be considered for addition in the pre-defined list. Also, MEMA further suggests the agencies consider the off-cycle technologies that are recognized by the European Union in their MTE analysis.

**Start/Stop Technology**

Based on advancements in systems and additional data and benchmark testing since 2012, an increase of the off-cycle stop-start credit should be considered. In the draft TAR, the agencies updated the estimated effectiveness of Start-Stop technology, which shows a 67 percent increase in effectiveness.²⁶

The existing off-cycle credit is based on data from the EPA MOVES model that indicates that idle time in the real world exceeds that which is represented in certification testing. Daimler petitioned for additional off-cycle credits based on this rationale of real world driving having more idle time than what is represented in certification testing. In addition, in response to a request by Daimler for stop-start off-cycle credits, the EPA analyzed data provided by Progressive Insurance of 1.2 million vehicles showing an increased idle time of 22.7 percent compared to an idle time of 13.8 percent when the credits were established.²⁷

The combination of increased effectiveness and idle time warrants consideration of an increased off-cycle credit for stop-start systems. Using the 67 percent effectiveness improvement provided in the draft TAR, MEMA suggests the off-cycle credits for Start-Stop technology be adjusted as follows:

<table>
<thead>
<tr>
<th>Technology</th>
<th>2012 FRM</th>
<th>Proposed off-cycle credits (67% uplift)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cars (g/mi)</td>
<td>Trucks (g/mi)</td>
</tr>
<tr>
<td>Engine Idle Start-Stop with heater circulation system</td>
<td>2.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Engine Idle Start-Stop without heater circulation system</td>
<td>1.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>

²⁶ Draft TAR Table 5.83.
The existing off-cycle credit table allows for engine idle start-stop with and without heater circulation system, which is based on the ability to keep the engine switched off for a period of one minute. The time before an engine re-start is commonly limited by the requirement for cabin comfort as requested by the occupants, in this case a need for heat in a cold ambient, with the source of cabin heat coming from the engine cooling system waste heat.

Emissions benefits can also be obtained in hot ambient conditions through engine start-stop operation. In these hot ambient conditions, the start-stop time limitation is also commonly controlled by the occupant cabin comfort requirement, although this time, it is driven by the need for cabin cooling or humidity control. The condition may be eligible for the engine idle start-stop without heater circulation system off-cycle credit, since it is not directly connected to the heater circulation system. However, the engine and air conditioning compressor, which is a significant additional parasitic load on the engine, may be kept off during this operation, allowing a higher emissions offset than the cold ambient heating condition.

Therefore, MEMA recommends that a similar off-cycle credit of higher value for start-stop capability based on cabin cooling conditions also be added to the off-cycle credit table.

Start-Stop with Coasting Technology

Start-Stop with Coasting (also called Rolling Start-Stop) adds an additional dimension that will bring increased CO₂ or fuel economy benefits that will not be captured on the 2-cycle test. During coasting the engine is shut off and the driveline is decoupled from the engine. By decoupling the drivetrain the vehicle is able to eliminate engine drag, reducing parasitic loss, in addition to the fuel savings form engine shut down. However, since the 2-cycle test is comprised of many different acceleration and deceleration modes with different rates, there are very few opportunities for coasting to be activated during the 2-cycle test. Even if a manufacturer designed a vehicle that maximized the coasting opportunity on the test, variances driven by trims levels and powertrains could have a dramatic effect on the benefit seen in the 2-cycle test, even though real-world CO₂ or fuel economy may not be affected. This is due to differences in aerodynamic drag, driveline friction, tire rolling resistance, unsprung mass and total mass.

MEMA recommends the addition of an off-cycle menu benefit for Start-Stop with Coasting. Since this technology is nascent, it is recommended that the off-cycle benefit be determined through modeling. The 2012 rule granted off-cycle credits for start-stop technology based on the assessed difference between idle time in the 2-cycle test and the documented idle time in the EPA MOVES model. Since then, applications by Daimler and Ford noted that idle time of their customers versus the industry average is the primary technical driver for their applications for additional off-cycle credits. Similar analysis through the EPA MOVES database could provide sufficient evidence of the percentage of time drivers have both feet off any pedals during real world driving.
Influence of Glazing on Stop/Start

The current menu does account for different aspects of glazing and recognizes the influence it has on vehicle efficiencies. There is potential for even more recognition of the influence of glazing and the menu could be correspondingly amended. For example, solar glazing, which is recognized in the predefined list, could have an added benefit related to Stop-Start technology because the engine would not have to turn on for longer stops in order to maintain cabin temperature comfort.

Expand Active Warm-up Category

The current pre-determined list allows for categories for active engine and transmission warm-up technologies. Some technologies can be categorized under the active warm-up category, but have merit to be added as additional or separate listed credits, since they can show significant improvements in emissions reduction over and above the listed active warm-up credit values. MEMA recommends that the agencies consider further evaluation of these technologies for inclusion on the pre-determined list in recognition of their potential off-cycle impacts.

One such example, would be thermal energy storage technologies. Thermal energy storage technologies collect wasted energy from the exhaust or cooling system during normal operation and re-apply this energy to either; pre-condition the powertrain during a cold start condition, or enable a significant increase in the warm up rate of the powertrain. This offers the benefit of rapid or instant heat availability for cabin heating negating the use of inefficient fuel burning technologies such as fuel fired heaters or traditional remote start systems which rely on starting and operating the engine. Since these traditional solutions for cabin heating increase emissions levels, the offset should be applied to an energy storage system that negates the use of traditional methods in addition to the warm up benefit.

System integration and operation of thermal management technologies can be used to provide passive or active warm up depending on a multitude of factors. Generic technologies that could be used to support active or passive warm up of engine or transmission could include, but are not limited to: electrified or intelligent coolant pumps, coolant flow control devices such as electrically heated thermostats or electrical coolant control valves, transmission oil heat exchanger flow control devices, exhaust heat recovery systems (exhaust to coolant heat exchangers), transmission oil heat exchangers, engine oil heat exchangers, electrical fluid heating devices, active grill shutters, etc.

Exhaust Waste Heat Recovery

With the desire for improved efficiency, waste heat recovery is an area of significant research in the auto industry to develop solutions that recover the fuel energy lost to exhaust or cooling system. Technologies such as Thermoelectric generators, Organic Rankine Cycle, turbo compounding, etc. have the potential to provide significant emissions benefits in the longer term, although require further development to address cost/benefit
concerns to support production introduction. The existing off-cycle credit table includes a credit for waste heat recovery, scalable at 0.7 g/mi per 100W, however, with the cap of 10 g/mi for all technologies listed in the table, the potential application of these waste heat recovery technologies is hindered due to the relative cost of these technologies when compared to the other technologies in the table. With development these waste heat recovery technologies could exceed the credit limited alone, and offer emissions reductions in addition to the other technologies listed in the table. MEMA would recommend the removal of the 10 g/mile limit which could provide the impetus for application of these waste heat recovery technologies.

Opportunities for Emerging Technologies and Off-Cycle Credits

There are special cases where even off-cycle technologies are difficult to evaluate using traditional test methods. In the 2012 FRM, the agencies indicated their concerns about including technologies that involve driver interaction saying, they “face the highest demonstration hurdle” and that it is “highly unlikely that off-cycle credits could be justified for these non-safety technologies.”

Understanding the agencies’ concerns that there are challenges with quantifying the potential benefit, MEMA continues to encourage the agencies to review and consider a baseline credit for technologies that influence the driver to drive more efficiently. For example, technology for real-time traffic and rerouting options have improved significantly since the 2012 FRM. This information can help the driver to avoid significant congestion and change their route to avoid long idle times and very low speeds (impacting efficiencies and increasing emissions/fuel consumption). In addition to real-time traffic technologies, the agencies should be open to consider other technologies intended to influence driver habits, such as haptic pedal feedback.

Also, in the draft TAR, the agencies acknowledge that autonomous vehicles and connected vehicles “could lead to dramatically reduced GHG emissions through more efficient driving ...” These technologies are becoming increasingly available. The draft TAR did not address whether these technologies should earn off-cycle credits citing that the future of these technologies as too uncertain. As the agencies go forward in their MTE, MEMA proposes that there be considerations to evaluate these types of technologies impact on GHG emissions and fuel consumption.

# # #

---

28 77 Fed. Reg. at pg 62734.
29 Draft TAR at 3-22.
30 Ibid.