Environmental and Energy Study Institute

U.S. Environmental Protection Agency
Air and Radiation Docket and Information Center
Docket ID No. EPA-HQ-OAR-2015-0827

Department of Transportation
National Highway Traffic Safety Administration
Docket ID: NHTSA-2016-0068

Dear Administrator Pruitt and Secretary Chao:

The Environmental and Energy Study Institute respectfully submits the following comments regarding the U.S. Environmental Protection Agency and the Department of Transportation's Reconsideration of Final Determination of Mid-term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022 – 2025 Light Duty Vehicles; Model Year 2021 Greenhouse Gas Emissions Standards in *Federal Register* Vol. 82, No. 54 dated March 22, 2017. Specifically, EESI is providing EPA-requested comments on "The impact of the standards on advanced fuels technology, including but not limited to the potential for high-octane blends." **EESI is particularly eager to discuss the utility of a high-octane, low carbon biofuel blend – as it is the lowest cost option for CAFE compliance between 2022 and 2025.**

The Environmental and Energy Study Institute (EESI) is an independent, non-profit organization, dedicated to promoting an environmentally and economically sustainable society. EESI seeks to advance a transition to a low-carbon economy through greatly improved energy efficiency and renewable energy, including sustainable biomass energy. Founded by a bipartisan Congressional caucus in 1984, EESI is governed by a diverse Board of Directors comprised of environmental, business, academic, and former political leaders, serving as a trusted source of credible, non-partisan information on energy and environmental solutions for policy makers.

Transporting people and goods accounts for 27 percent, or 1.8 trillion tons, of U.S. greenhouse gas (GHG) emissions and approximately 70 percent of all U.S. oil use (about 13.1 million barrels of oil per day). Currently, the burning of gasoline and diesel account for 59 percent and 24 percent of the transportation sector's emissions, respectively. Significantly reducing the use of these fuels in autos and trucks is essential to reducing emissions and furthering climate change mitigation efforts.[1]

While the automotive industry has made tremendous progress under CAFE, the TAR reports that for model years 2022 through 2025, the light duty vehicle fleet is projected to meet a lower target of 50 to 52.6 miles per gallon (mpg), instead of the originally calculated target of 54.5 mpg. The original estimate has lowered because Americans are buying and trading for gas-guzzling trucks and SUVs at record levels.

Moreover, in 2016, 75 percent of those trading in an electric or hybrid car opted for traditional gasoline cars.[2] Currently, electric vehicles (EVs) make up less than 3 percent of all new vehicle purchases in the United States. Somewhat worryingly, only 3 percent of 2015 MY vehicles meet the 2025 standards. Of these cars, all employ hybridization or full electrification. Therefore, it seems unlikely, without vast investment into PHEVs and BEVs in the short-term, the U.S. passenger fleet will fall well short of mid-term CAFE goals.

A variety of strategies will be needed to meet mid-term CAFE standards and protect human health, lower consumer costs at the pump and mitigate climate-warming greenhouse gases. Luckily, there is a low-cost, immediate pathway available to achieving stringent CAFE standards, while still allowing the marketplace to continue to grow for needed EVs and plug-in hybrid electric vehicles (PHEVs) – namely a rapid uptake of a high-octane, low carbon biofuel.

While EESI believes EPA and NHTSA continue to have an unnecessarily pessimistic projection for the contribution of both EVs and PHEVs in meeting 2022 – 2025 CAFE goals, EESI's comments herein narrowly focus on two areas: **the utility of a high-octane, low carbon (HOLC) fuel in meeting CAFE in a cost-effective manner** as well as **the utility of preserving a viable pathway for Flex-Fuel Vehicles (FFVs)** as an effort that will enable a faster transition to HOLC fuels**.** As EPA and NHITSA seek to implement flexible, achievable and economical CAFE standards, a number of short-term and long-term options will be needed by the automotive industry to meet the necessarily stringent near-term 54.5 mpg target as well as future targets.

Therefore, EESI would like to express thanks to EPA and NHTSA for listening to the many stakeholders that asked the administration to take comments on the potential for high-octane blends, as this near-term strategy was unfortunately omitted in the Technical Assessment Report. Increasing vehicle fuel efficiency, through a variety of engine and fuels strategies, is a cost-effective way to significantly lower the transportation sector's emissions and reduce vehicle lifecycle cost without requiring major infrastructure adaptations.

In addition, fuel composition standards can have beneficial health effects, as bio-based fuels lower other harmful emissions like air toxics and ultrafine particulates.[1] The internal combustion engine will be the dominant engine for the next few decades, **making both fuel and engine efficiency critical pieces in reducing the GHG intensity of the transportation sector.**

Widespread adoption of a high-octane, low carbon biofuel blend in the next decade addresses a number of pressing issues facing the U.S. light-duty transportation sector, including:

- Liquid fuels will be utilized by the light-duty fleet for several decades to come
- The slow consumer uptake of advanced technologies, such as EVs, and the continued need for light trucks/larger SUVs in certain applications (farming, small businesses)
- Automotive manufacturers want higher octane fuels to achieve the fuel economy and performance needs of their engines
- Biofuels are by far the lowest GHG-emitting, cleanest, and cheapest octane provider available

Below, we provide rationale for examining fuels, especially biofuels, as a near-term strategy under CAFE. Without considering *fuels and engines as a system*, it will be impossible to achieve deep cuts to transportation emissions, both in the near term 2022 to 2025 period and beyond. Utilizing a high-octane, low-carbon biofuel blend achieves multiple goals including: meeting CAFE; preserving consumer choice when purchasing cars and lowering fuel costs; enabling the automotive industry to cost-effectively comply with stringent CAFE standards.

Liquid Fuels Will Be Utilized by the Light-Duty Fleet for Several Decades to Come

According to both the Energy Information Administration (EIA) and Department of Energy (DOE), internal combustion engines (ICEs) that burn petroleum will still be utilized for several decades, either as primary sources of mobility or as range-extenders for electric vehicles.

Recognizing the efficiency limitations of the current transportation fleet, DOE is investigating future fuel and engine design through Co-Optima, a collaborative effort between industry and DOE. Co-Optima's goal is to reduce per-vehicle petroleum consumption 30 percent by 2030, using a combination of improved vehicle technologies and increased use of low-carbon biofuel blends. If achieved, this would reduce petroleum consumption by 4.5 billion barrels and save consumers up to $50 billion.

Automotive manufacturers are using a combination of vehicle technologies to increase fuel efficiency, including downsized engines and turbocharging. However, these newer, smaller engines require higher amounts of octane for optimized performance. Co-Optima recognizes that ethanol is an excellent source of octane for today's newer, more efficient engines. With an octane rating of over 100—compared with 87 for regular gasoline and 91-93 for premium—ethanol is a cost-effective octane provider and is already blended into the gasoline supply at low levels, so infrastructure and experience already exists for blending. In the near term, ethanol is the best bio-based octane booster available. A high octane, low carbon biofuel blend can make immediate efficiency gains and reduce GHG emissions in current flex-fuel vehicles (FFVs) and future, more efficient ICEs.[3]

Automotive Manufacturers Want Higher Octane Fuels to Achieve the Fuel Economy and Performance Needs of their Engines

Manufacturers are already producing and selling greater quantities of vehicles that require higher octane levels.[4] This is because the smaller, turbocharged engines that increase vehicle efficiency also increase the tendency of the engine to exhibit engine knock. Knock, which can be damaging to engines, can be reduced by adding octane to fuel. These turbocharged engines therefore need higher volumes of octane for optimized performance.

Currently, the only widely available high octane fuel is premium gasoline, which has an octane rating of between 91 and 93. On April 6, 2015, the Energy Information Administration (EIA) reported that

premium gasoline sales have risen from a low of 7.8 percent of fuel sales in 2008 to a recent high of 11.8 percent in September, 2015. Historically, premium gasoline has been required only by luxury vehicles, and therefore has made up a small percentage of the overall gasoline market. According to EIA, increasing sales of newer, more efficient vehicles that require or recommend high octane fuel is driving the increased demand for premium gasoline.

EIA also reports the share of the light duty fleet that requires or recommends the use of high octane fuel is increasing. In 2010, the percentage of new vehicles optimized for high octane fuels was 12.5 percent. In 2013 that number had increased to 14.2 percent of new vehicles on the road. EIA estimates that the share of turbocharged vehicles will dominate the passenger fleet by 2025, making up a projected 83.3 percent of the light duty fleet.[5] Indeed – EIA has even warned of a looming 'octane shortage' at U.S. petroleum refineries, if this manufacturing trend of smaller, more efficient engines continues.

According to recent comments from both General Motors and Honda executives, higher octane gasoline will be required if efficiency of the ICE fleet is to continue growing. Dan Nicholson, VP of Global Propulsion Systems at GM commented at a recent automotive industry conference,

> *"Higher octane fuels are the cheapest CO2 reduction on a well-to-wheels analysis … Fuels and engines must be designed as a total system. It makes absolutely no sense to have fuel out of the mix."*[5]

EPA must include octane fuels as a viable pathway in the finalized MTR. Not addressing fuel quality until after 2025 has implications for consumers in two main ways: increased use of premium gasoline means increased exposure to aromatics and increased costs, as premium gasoline can run up to 50 cents higher per gallon than regular gasoline. Waiting to address fuel composition until well after 2025 has serious consequences in terms of both GHGs, public health and compliance costs for meeting CAFE. In addition, it prevents the automotive industry from standardizing engines across markets—already, Europe is using a high octane 102-RON fuel, which could be achieved by using a mid-level ethanol blend in the United States. Therefore, without opening up a viable high-octane pathway for U.S. automotive manufacturers, the administration is putting them at a competitive disadvantage compared to other manufacturers.

EESI sees no reason to postpone consideration of these fuels, especially when current fuels are causing harm to the environment, the public and increasing compliance costs for automotive manufacturers and increasing pump prices for consumers.

Biofuels Are the Lowest GHG Emitting, Cleanest, and Cheapest Octane Provider Available

Lifecycle Emissions from High Octane, Low Carbon Fuels

Various components of lifecycle greenhouse gas emissions are calculated by EPA for the Renewable Fuel Standard using several models, including the "Greenhouse gases, Regulated Emissions, and Energy use in Transportation Model" (known as GREET), developed by scientists at Argonne National Laboratory (ANL). GREET is a comprehensive modelling tool of lifecycle emissions. To estimate GHG emissions from changing land use, GREET combines land use change modelling results from Purdue's Global Trade

Analysis Project (GTAP) model with soil organic carbon data and carbon emissions from land use. GREET also incorporates updated production improvements at bio-refineries, including increased number of co-products, reduced energy and water use, and increased yields—both at bio-refineries and in fields.[6]

Researchers from ANL have calculated that corn ethanol may reduce lifecycle GHG emissions relative to gasoline by 19 to 48 percent, and cellulosic ethanol sourced from corn stover may reduce lifecycle GHG emissions relative to gasoline by 90 to 103 percent.[6] More recently, scientists from ANL have estimated the GHG emissions reductions possible when using a variety of high octane ethanol blends. Comparing E10, E25 and E40, they found well-to-wheels GHG emissions reductions in the range of 4 to 8 percent for E10 sourced from corn ethanol. They found an additional 4 to 9 percent reduction in GHG emissions from E25 and E40 blends, respectively. When using cellulosic ethanol (corn stover), GHG emissions reductions reached nearly 35 percent compared to E10 gasoline.

Clean Octane: Biofuels versus Aromatics

Currently, there are two ways of increasing the octane content of gasoline: increasing the volume of gasoline aromatics (the BTEX complex) or increasing the volume of ethanol. The BTEX complex is a petroleum refining product comprised of a mixture of benzene, toluene, ethyl-benzene and xylene. Commonly referred to as gasoline aromatics, these compounds are refined from low-octane petroleum products into a high-octane gasoline additive. While some volume of BTEX is native to gasoline, it is also added to finished gasoline to boost its octane rating. The total volume of BTEX in finished gasoline depends on the desired octane value and other desired fuel properties.

Knock used to be addressed by adding lead to fuel. As a result of its substitution for lead, BTEX volume rose from 22 percent to roughly a third of the gasoline pool by 1990. In premium gasoline grades, the BTEX volume content reached levels as high as 50 percent.

There were early concerns regarding the increased use of the BTEX complex. In 1987, Senator Tom Daschle expressed concern over gasoline aromatics, writing, “A revolutionary change is occurring in the gasoline industry which poses a serious threat to the environment and public health – namely the increased concentration of benzene and other aromatics.” In mandating cleaner fuels, through reformulated gasoline and other programs, EPA has reduced the volume of aromatics to between 25 to 28 percent of the conventional gasoline pool, though some health professionals question the safety of even these levels.

Today, research suggests that even very low-level exposure to the BTEX complex, from gasoline additives and other petroleum products, may contribute to negative developmental, reproductive and immunological responses, as well as cardio-pulmonary effects.[7] Considerable attention has been given to benzene in fuel, as it is highly toxic. At the same time, the partial replacement of benzene with other aromatic compounds (xylene, ethyl-benzene, and toluene) may not be sufficient in reducing exposure to BTEX's toxic effects. Additionally, upon incomplete combustion of the BTEX complex, ultra-fine particulates (UFPs) and polycyclic aromatic hydrocarbons (PAHs) are formed, both of which carry their own adverse health impacts at low levels. UFPs and PAHs are carcinogenic and mutagenic. Both UFPs

and PAHs have also been linked to developmental and neurodegenerative disorders, cancers, and cardio-pulmonary effects.

The toxicity of ethanol is low compared to the toxicity of BTEX and its combustion products, such as UFPs and PAHs. Research has shown a modest increase of ethanol content in fuel from 10 to 15 percent would result in an estimated 6.6 percent reduction in cancer risk from tailpipe emissions. Additionally, **engineers at MathPro, Ford, GM, and Chrysler found that shifting from a blend of E10 to E30 would reduce aromatics use by a staggering 60 percent at refineries, while still producing a high octane blend at 98 RON.**[8]

While there has been concern that increasing ethanol content in gasoline increases emissions of nitrous oxide (NOX), an ozone precursor, the effect of ethanol on NOX and carbon monoxide (CO) emissions is minor in newer engine emission control systems. A study of 2012 make and model year vehicles found no increase in NOX emissions between E10, E15 and E20 blends, suggesting that both engine design and engine age play a role in NOX emissions.[9]

Cost to Consumers and the Automotive Industry of Fuel Choices

Currently, ethanol is the least expensive octane provider available to refiners. The rack price for ethanol is cheaper than that of aromatics, translating to overall lower retail prices for ethanol-blended fuels. Aromatics are the most expensive component of gasoline, with aromatics costing 140 to 170 percent more than Conventional Gasoline Blending Components (CBOB). In the past year, the price difference between ethanol and aromatics have ranged from $0.35 to $1.[10] E15 is typically 2 to 10 cents cheaper per gallon than E10.

On the retail end, consumers benefit from increased ethanol content in fuels. The average E0 fuel is $2.93 per gallon, whereas the average gallon of E10 is $2.48, according to the fuel price tracker E85prices.com. Premium gasoline is, on average, $0.50 more per gallon, according to data from the Automobile Association of America. When increasing ethanol content beyond E10, there are even more consumer savings, as ethanol replaces costly aromatics – indeed, the average E15 price is $2.36 a gallon.

Conversely, without considering fuel strategies in setting and meeting CAFE, compliance costs for the industry will only continue to rise. According to the TAR, **the compliance cost to the automotive industry will be $311 billion between 2015 and 2028**.[11] These costs translate to $400 per vehicle for MY2025, according to research from the Defour Group LLC and the Air Improvement Resource INC.[11] Already, the cost of compliance between 2012 and 2016 has increased $120 per vehicle.[11] Compliance costs will significantly increase through 2025 because "manufacturers have fully utilized many of the low cost technologies and will depend increasingly on new, higher cost and more complex technologies such as hybrid electric vehicles."[11]

This is not a reason to abandon a stringent mid-term CAFE, but to rather expand the suite of technologies and compliance strategies to automotive manufacturers. Opening the marketplace to a high-octane, low carbon fuel, such as E25 with a Research Octane Number (RON) of 98 would be a

disruptive technology; allowing manufacturers to cheaply increase the efficiency of their engines – knowing that the appropriate fuel is available to consumers.

This fuel would be similar in price to today's regular grade gasoline, enabling higher compression ratio engines. A high-octane, low carbon E25 with RON of 98 is the lowest cost compliance option, at $100 per vehicle. Modelling from the Defour Group and Air Resources, Inc. found that with an E25 98 RON fuel, not only are per vehicle compliance costs cancelled out by fuel savings, if projected out to 2025 compliance costs were on average reduced $404. Utilizing an E25 98 RON fuel would lower compliance costs in larger cars, such as popular cross-over SUVs, as much as $873 per vehicle.[11]

Solutions:

Increasing the use of high octane, low carbon biofuels is the cleanest, cheapest, most immediate source of both efficiency gains and GHG emissions reductions for the light duty fleet. However, there are several steps that will ensure that a high octane, low carbon biofuel blend is an attractive option for fuel retailers, automotive manufacturers and consumers. These steps include:

- Restoring a reasonable FlexFuel Vehicle (FFV) credit
- Working with stakeholders to open the marketplace for high octane, low carbon biofuels
- Resolving issues surrounding certification fuels
- Extending the one pound Reid Vapor Pressure (RVP) waiver
- Fixing the Flawed MOVES 2014 Model
- Using Section 202 of the Clean Air Act to Regulate Toxic Gasoline Aromatics

Below, we provide rationale for examining fuels, especially biofuels, as a near-term strategy under CAFE. Without considering *fuels and engines as a system*, it will be impossible to achieve the deep cuts to transportation emissions, both in the near term 2022 to 2025 period and beyond.

Restoring a Reasonable FlexFuel Vehicle (FFV) Credit

General Motors estimates there are now 20 million FFVs in the United States, the majority of which have been produced by General Motors, Ford, and Chrysler. These cars can use blends of up to 85 percent ethanol. However, an average FFV only uses an estimated 13.4 gallons of E85 per year, likely due to a combination of factors, including lack of ethanol fuel availability at retail gas stations, pricing, and insufficient consumer knowledge. According to the National Labs, mid-level ethanol blends (E20 to E40) can be used in the existing FFV fleet.

Despite this, EPA decided to roll back this program that is one key component of exceeding the "blend wall." In EPA's new CAFE standards, the credit for FFVs are removed. While it is true that the average FFV owner only uses 13.4 gallons of E85 a year, this is not a vehicle manufacturing issue. Rather, it

speaks to a lack of E85 infrastructure at retail gasoline stations, a market that does not pass biofuel cost savings through to consumers, and a lack of consumer knowledge.

Instead of closing the FFV emissions gap by addressing fuel efficiency in FFVs, EPA chose to close off credits to a huge potential pool of vehicles that can utilize biofuels blends up to E85. EPA has the tools to verify the number of gallons of biofuels going to FFV vehicles, and going forward, the FFV credits are necessary to maintain the manufacturing of higher blend capable vehicles. Indeed, FFVs and associated fueling infrastructure will be necessary to help transition between current fuels and a standardized high-octane low carbon fuel, as FFVs can immediately utilize anywhere from 10 to 85 percent ethanol blends. The fueling infrastructure for FFVs can serve as needed hubs in the transition to a standardized high-octane, mid-level blend.

Additionally, given the number of trucks, SUVs and other larger vehicles on the road today and likely for years to come, it is nonsensical to remove the FFV credit as a potential pathway for increased efficiency and reduced petroleum consumption in these larger passenger vehicles.

Working with Stakeholders to Open the Marketplace for High Octane, Low Carbon Biofuels

Automakers have already asked EPA to approve and incentivize high-octane fuels, noting that they would make it significantly easier for the manufacturers to comply with more stringent miles per gallon standards. Mid-level ethanol blends would provide "ridiculous power and good fuel economy", according to William Woebkenberg, senior engineer for fuels policy at Mercedes-Benz.[12] **The auto industry is eager for high octane fuels and recognizes the value of biofuels. In a 2012 presentation, a Chrysler representative stated, "ethanol offers low carbon content and less GHG emissions....and offers the most expedient and least expensive means to lessen CO2 for liquid fuels." This sentiment is echoed by other American automakers.**

As far as moving past E10 in the near term, the Department of Energy (DOE) has carefully examined the effects of E15 on legacy vehicles and found that it is safe to use in these vehicles.[13] **As the EPA has approved the use of E15 in 2001 model year vehicles and beyond, ninety percent of vehicles on the road today are able to use E15 fuels.** Additionally, most new vehicles sold in the United States expressly allow for the use of an E15 blend as per their manufacturer's warranties; E25 has been expressly approved in both one BMW and the Mini Cooper.

Infrastructure challenges have also been overstated. Research from the National Renewable Energy Laboratory has shown that the infrastructure costs for transitioning to an E25 blend are modest, given that a significant amount of retail gas station infrastructure is already compatible with blends up to E25. Just last summer, Wayne Fueling Systems announced that all of its new pumps would be E25 compatible. Wayne is a global provider of fuel dispensing, payment and other systems for both retail and commercial fueling stations. Currently, nearly a thousand retail gasoline stations offer E15, and these pumps can offer higher blends as well.[14] Recent research from Oak Ridge National Laboratory found that a high-octane E25 gasoline blend:

- Reduced tailpipe emissions in all cases,
- Improved fuel economy associated with a 99 RON E25 erased the energy penalty associated with ethanol, and,
- Enabled increasing compression ratios, which increased engine efficiency and reduced energy consumption.[15]

Working with automakers and gas retailers to incentivize higher ethanol blends would provide significant environmental, health, and cost benefits.

Resolving Issues Surrounding Certification Fuels

EPA currently requires auto manufacturers to use "commercially available" test fuels for new vehicles. The net result is that manufacturers cannot sell vehicles that are co-optimized for mid-level ethanol blends, despite the technology being readily available. In fact, in a recent court case in the U.S. Court of Appeals for the D.C. Circuit, the Court ascertained, that if EPA allowed the use of E30 as a test fuel, there would be "substantial reason to think that at least some vehicle manufacturers would use it." In addition, the Court cited a comment from Ford Motor Company that a mid-level ethanol blend such as E30 would "enable the first steps to the development of a new generation of highly efficient internal combustion engine vehicles." Other auto manufacturers, namely Mercedes and General Motors, have also commented on the potential co-optimization of highly efficient engines with a mid-level ethanol blend.

There is great interest from the automotive industry to move to a higher octane-rated fuel, as much of the rest of the developed world already enjoys. If the agency approves the use of a mid-level blend as a test fuel, these fuels will be able to reach commercial availability. It is quite incredible in this global car manufacturing industry that U.S. manufacturers selling vehicles in other countries are able to access these higher octane fuels, but cannot here. In the United States, the lowest cost octane provider available is ethanol, and by resolving the test fuel issue, volumes of ethanol consumed will be able to increase.[16]

Extending the One Pound Reid Vapor Pressure (RVP) Waiver

To reduce the formation of ozone, the EPA regulates the volatility of gasoline in the summer months. To cut smog levels, EPA requires that summer blends have an RVP cap of no more than 9 pounds per square inch (psi). Adding 10 percent ethanol to gasoline raises gasoline's RVP rating by one psi, to approximately 10 psi, according to the National Renewable Energy Lab. Because of this phenomenon, the EPA granted E10 a one psi waiver in 1992. Currently, higher blends of ethanol, such as E15, do not have a waiver.

While neat ethanol actually has a very low RVP rating (2 psi), the chemical interaction between small volumes of ethanol and gasoline causes RVP to increase. As the volume of ethanol in the fuel is

increased beyond 10 percent, this effect is erased, and the RVP of the gasoline begins to drop. At higher blends, such as E30, RVP is below 9 psi. Because the RVP of gasoline drops as ethanol content increases, blends higher than E50 have a lower RVP than that of the base gasoline, and no RVP waiver is required.

There is no technical reason for regulating E15 and E20 differently than E10, as their RVP ratings during summer months are similar. While E10 can be sold year round, E15 is not permissible for use as a summer blend, as it does not currently have a one pound waiver from the EPA. According to numerous ethanol trade groups, gas station owners who would like to sell E15 are between a rock and a hard place. While they can freely sell E15 during the winter months, come summer, they must label the fuels as "FlexFuel Vehicle Only," due to the one pound waiver applying only to blends up to E10. This requires sign change outs and other administrative changes and, therefore, is viewed as an impediment to selling E15 and higher blends by many retailers.[17] Extending the one pound waiver would remove another barrier to increasing efficiency by improving the octane rating of the current gasoline pool.

Fixing the Flawed MOVES 2014 Model

EPA requires state regulators to use the MOVES model to craft state implementation plans (SIPs) for ozone. However, there is significant evidence that the underlying studies used to build the recently updated model seriously mischaracterize the emissions from ethanol-blended fuels. According to auto engineers from Ford and GM, when ethanol is "splash-blended" with gasoline, as it is at the refinery, it lowers the overall toxicity of emissions.[18] **EPA's studies were conducted using a method called "match blending," which artificially controls certain fuel parameters and is not reflective of what actually happens at refineries**. The result of this disparity is that ethanol is labeled as worse for ozone and other emissions than gasoline. Therefore, widespread use of this model would lead needlessly to an increase in the most toxic portion of gasoline—gasoline aromatics—instead of relying on clean forms of octane**.**

Researchers at the Urban Air Initiative used the Honda Predictive Model Index (PMI) to calculate particulate emissions for E0, E10, E15, and E20. Their results showed that splash blending ethanol from E0 to E20 resulted in an overall reduction in fine particulates.[19] Additionally, if refiners were required to perform splash blending, they would not be allowed to add heavy, low-value refinery fractions to gasoline prior to ethanol blending—another way in which splash blending results in improved fuel quality. **The use of match blending versus splash blending is a major factor in emissions testing and needs to be accounted for in any predictive model**.

Using Section 202 of the Clean Air Act to Regulate Toxic Gasoline Aromatics

Corn ethanol, as well as advanced and cellulosic biofuels, provide clean alternatives to toxic aromatic compounds that are used to boost octane in gasoline. When BTEX was chosen as a lead replacement for its octane-boosting qualities, its dangers were already well established.[20] There was early concern about aromatic additives in gasoline—when the removal of lead from gasoline was being considered in

Congress, the *Congressional Record* was filled with warnings about the parallels between BTEX and lead. In 1987, Senator Tom Daschle wrote to Vice President Bush to express his and many other's concerns about the negative health effects of aromatics and BTEX, writing:

> "given the mounting scientific evidence linking rising gasoline aromatic levels and the increased risk of human exposure to highly carcinogenic benzene, I believe the federal government should initiate a coordinated effort to reduce the dangers from gasoline spills and auto emissions, and that this effort should include the promotion of the use of environmentally safe ethanol as an alternative means of octane enhancement."[21]

Senator Daschle, along with Senators Dole and Harkin, introduced the "Clean Octane" amendment S. 1630, to the 1990 CAAA, which passed along with the other 1990 CAA amendments. The Clean Octane amendment calls for the use of "benign additives to replace the toxic aromatics that are now used to boost octane in gasoline." **Over 20 years later, this intent has not been fulfilled.** While we have succeeded in removing some of the benzene added to gasoline, it still contains at least 20 percent by volume of other aromatics, such as toluene, ethylbenzene and xylene, which are converted to benzene upon combustion. Research has also indicated a positive relationship between gasoline aromatic content and the formation of Secondary Organic Aerosols (SOA), an ultrafine particulate matter. Researchers at the Harvard School of Public Health demonstrated that the aromatics blended into gasoline are particularly efficient at forming SOA.[22] These ultrafine particulates (commonly referred to as $PM_{2.5}$) arise from the incomplete combustion of gasoline aromatics (BTEX) and contain a mixture of soot, ash, and unburned fuel and lubricant, leading to negative health effects.

Biofuels provide a clean alternative to toxic, petroleum-based fuel oxygenates that are currently in our gasoline. **The EPA has the authority, and the obligation, to enforce Section 202 of the 1990 Clean Air Act Amendments, to reduce "mobile source air toxics" to "the greatest degree … achievable,"** and in particular to reduce the toxins emitted by gasoline aromatic compounds (BTEX). A co-benefit of enforcing section 202 would be that use of renewable low-carbon fuels would increase in the transportation fuels marketplace.

Conclusions

As these comments illustrate, engines and fuels must be considered as a system in order to achieve the greatest efficiency. Using high-octane, low-carbon fuels as a tool to enable smaller, turbocharged engines to perform at their optimum will allow auto manufacturers to increasingly adopt these highly-efficient engines and meet ambitious efficiency standards. Biofuels provide a high octane fuel that is better for the environment, reduces aromatics emissions and their harmful health impacts, and saves consumers money. The solutions listed above will make biofuels an attractive option for retailers, automakers, and consumers.

Including high-octane, low-carbon fuels as a strategy for meeting CAFE standards would prove cost-effective for automakers as well as consumers. A 2016 study from Air Improvement Resources, Inc. shows that if EPA included high compression engines that use high octane fuels as a strategy, the cost of

compliance with 2025 model year standards would be significantly reduced, from $23.4 billion to $16.8 billion. Additionally, this strategy is implementable in the timeframe considered in the MTR of CAFE.

The private sector already understands the importance of pursuing these fuels. Wayne Fueling Systems, which provides a substantial number of the nation's fuel dispensers, announced in 2016 that it would be making all new dispensers E25 compatible. The auto industry has made its wish for high-octane fuel clear, and many have pointed to biofuels as the best choice. It is time for EPA to recognize the potential of high-octane, low-carbon fuels and include them as part of the CAFE standards.

DOE's Co-Optima program is currently analyzing the role that these fuels can play in a more energy-efficient U.S. fleet. EESI believes that the Co-Optima program's results and recommendations can play an important role in shaping more effective CAFE standards. Therefore, we urge EPA to work with DOE and Co-Optima and incorporate this important research into the final MTR.

EPA must consider high-octane fuels as a viable strategy in the MTR. Achieving market penetration of a high-octane, low carbon option, like a mid-level ethanol blend, may take several years, due to the need for increased biofuels infrastructure. **Therefore, EESI believes that EPA should begin to implement inclusion of these fuels now**, so that they can be fully operational nationwide by 2025. The climate crisis is an urgent problem, and we cannot afford to wait—the United States should be aggressively pursuing this cost-effective and environmentally sustainable strategy.

Sincerely,

Carol Werner

Executive Director

Environmental and Energy Study Institute

---

[1] Haven, P., and O. Gutin, Fact Sheet: Vehicle Efficiency and Emissions Standards, EESI, Aug. 2015.
[2] Richtel, M., American Drivers Regain Appetite for Gas Guzzlers, New York Times, Jun. 2016.
[3] Stolark, J. Designing Tomorrow's Fuels for Tomorrow's Engines: DOE's Co-Optima, Jun. 2016.
[4] GM, Honda Execs Agree: Higher Octane Gas Needed to Optimize ICE Efficiency, SAE International, Aug. 2016.
[5] Stolark, J. EIA Reports Sales of High Octane Gas Increasing, EESI, Apr. 2016
[6] Stolark, J. Fact Sheet: High Octane Fuels: Challenges and Opportunities, EESI, June 2015.
[7] Bolden, A.L., Kwiatowski, C.F., Colburn, T., New Look at BTEX: Are Ambient Levels a Problem?, Environmental Science & Technology, May, 2015
[8] D. Hirshfeld, et al., Refining Economics of U.S. Gasoline: Octane Ratings and Ethanol Content. Environmental Science & Technology, vol. 48, no. 19, Aug. 2014.
[9] Stolark, J. A Brief History of Octane in Gasoline: From Lead to Ethanol, EESI, Mar. 2016.
[10] Irwin, S. and D. Good, The Competitive Position of Ethanol as an Octane Enhancer, Feb. 2016

[11] Comments on the Draft Technical Assessment Report for Model Years 2022 – 2025 Greenhouse Gas Emission and Fuel Economy Standards, Minnesota Corn Growers Association, Sept. 2016.
[12] Wald, M. Squeezing More from Ethanol. New York Times, May 3, 2013.
[13] Knoll, K., et al., Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines, Report 1 – Updated, U.S. DOE, 2009.
[14] Stolark., J. Fact Sheet: The Consumer and Fuel Retailer Choice Act, EESI, Sept. 2017.
[15] West., B, et al., An Engine and Modeling Study on Potential Fuel Efficiency Benefits of a High-Octane E25 Gasoline Blend, ORNL, August 2017.
[16] Sapp, M. DC Court Throws out E30 suit against EPA but says ethanol proponents in the right, July 2015, Biofuels Digest.
[17] Stolark., J. Summer Gas Blends, EESI, May 2016.
[18] J. Andersen et. al, Issues with T50 and T90 as Match Criteria for Ethanol-Gasoline Blends. SAE International Journal of Fuels and Lubricants, vol. 7, no. 3. Nov. 2014.
[19] Vander Griend, S. Understanding the Emissions Benefits of Higher Ethanol Blends: EPA Modeling Fails to Tell the Whole Story, Ethanol Across America, 2013.
[20] Clean Fuels Development Coalition, Oxygenates: Fact Book.
[21] Daschle, T. Letter to Vice President George Bush, March, 1987.
[22] Fann, N. et al., Estimating the National Public Health Burden Associated With Exposure to Ambient $PM_{2.5}$ and Ozone, Risk Analysis, 2012.