

**Comments to the U.S. Environmental Protection Agency Regarding the
“Multi-Pollutant Emission Standards for Model Years 2027 and Later
Light-Duty and Medium Duty Vehicles Rules”**

Docket ID No. EPA-HQ-OAR-2022-0829

June, 2023

The Clean Fuels Development Coalition (CFDC) is a not-for-profit educational organization supporting the production and use of clean and renewable transportation fuels in the interests of reducing emissions, promoting the rural economy, enhancing energy security for the United States, and meeting a range of public policy objectives. CFDC supporters include biofuel producers, agriculture organizations, automobile manufacturers, and a variety of public interest groups. Established in 1988, CFDC has participated in every major fuel related legislative and regulatory action of the past four decades.

On behalf of our members, including Doug Sombke, president of South Dakota Farmers Union whose correspondence with Christopher Grundler, former Director of EPA’s Office of Transportation and Air Quality (OTAQ) is cited in this correspondence, we respectfully request that in finalizing this rule, EPA/OTAQ officially recognize the existence and importance of secondary organic aerosols (SOA)-borne polycyclic aromatic hydrocarbons (PAH), the primary precursors of which are benzene-based gasoline aromatics hydrocarbons (BTEX).

The MY2027 and Later Multipollutant Emissions is an ambitious undertaking and Administrator Regan is to be commended as it appears to contain many worthwhile initiatives. However, unless significant changes are made to the NPRM before it is finalized—including those offered here—it will leave huge opportunities to improve climate and health unfulfilled.

In December 2021, EPA finalized the landmark MY2023 and Later LDV GHG Rule to which we registered strong opposition. Unfortunately, like this NPRM, EPA did not address the dramatic increases in SOA + PAH emissions that are already being caused by the rapid adoption of GDI engines in the absence of gasoline BTEX controls. Of even greater concern—as the U.S. LDV fleet rapidly adopts GDI engines, the most harmful UFP + PAH emissions will dramatically INCREASE.

We understand that the primary thrust of this rulemaking is to drive commercialization of electric vehicles. However, it is also widely understood that this process will take many years/decades, perhaps even generations. For many years, ICE-powered vehicles will require gasoline and other liquid fuels, and trillions of miles will be driven on them before EVs dominate the U.S. fleet. EPA staff [recently pledged](#) that the rule would reflect a “balanced approach” taking into account both electrification trends and a projection that 100 million conventional light- and medium-duty vehicles could be sold before any full transition to electric vehicles (EVs).

When Congress was banning leaded gasoline for its horrific health effects in the *1990 Clean Air Act Amendments*, it went to extraordinary lengths to ensure that EPA avoided making the same mistake with BTEX compounds which are in many respects worse

than lead. Congress knew that fuel quality and vehicle emissions control systems were part of an integrated system and that three-way catalysts were unable to capture BTEX combustion by-products. Consequently, Congress gave EPA the nondiscretionary duty to reduce BTEX emissions by the “greatest degree achievable”, (Sec 202(l)(2)) as explained in more detail below.

Many experts believe that the 20% BTEX fraction found in a typical gallon of U.S. gasoline poses the single greatest threat to public health and the environment. *“The effect of aromatics [BTEX] on pollution and human health is thus magnified twice over: Aromatics lead disproportionately to PAH formation, and PAHs lead disproportionately to SOA formation. Worse yet, PAHs hitch a ride on SOA for long distances and weaponize these particles as they travel through the human body...When SOA particles are formed in the presence of gas-phase PAHs, their formation and properties are significantly different from SOA particles formed without PAHs: They exhibit slower evaporation kinetics and have higher fractions of non-volatile components and higher viscosities, assuring their longer atmospheric lifetimes. This increased viscosity and decreased volatility act as a shield that protects PAHs from chemical degradation and evaporation, allowing for their long-range transport.”* [Detchon – Modlin MY2023 Final Rule comments, p. 17. [RDRMCommentsEPA-HQ-OAR.pdf \(cleanfuelsdc.org\)](#)]

Americans cannot escape the harmful emissions produced by tens of billions of gallons of BTEX contained in U.S. gasoline. That is why last fall we wrote Administrator Regan to commend him on his aggressive actions to control emissions of highly persistent, pervasive, and toxic PFAS. [ReganDuranteFinePMPFAs8-30-22 \(cleanfuelsdc.org\)](#) We urged the Administrator to apply those same exacting standards to regulating BTEX-produced MSATs under the Fine PM and MY2027 Multipollutant NPRMs, because “By any metric, gasoline PAH emissions are as bad or worse than PFAS for public health and the environment.” [p. 4] In fact, many experts believe that SOA-bound PAH are more pervasive, have a higher “deposition efficiency”, and are less susceptible to remediation than PFAS once they are emitted from the tailpipe and undergo atmospheric transformation.

PAHs are not only carcinogenic and highly carbon-intensive, they are also mutagenic and reprotoxic (CMR) and widely recognized by health experts as ubiquitous endocrine disruptor compounds (EDCs). [See discussion of 2018 EPA Riedel study on p. 9, [ResearchGate](#)https://www.researchgate.net/publication/315864231_Mutagenicity_and_Carcinogenicity]

The science is indisputable: unless EPA recognizes and honors its legal obligation to substantially reduce gasoline BTEX levels in the final MY2027 rule, it will among other undesirable consequences violate President Biden’s *Executive Order 13045*, “Protection of Children from Environmental Health Risks and Safety Risks”. Beginning at p. 598 of the NPRM, EPA states “that the environmental health risks or safety risks of the pollutants addressed by this action may have a disproportionate effect on children”. It goes on to describe how children are more susceptible than adults to air pollutants. In fact, the SOA-bound PAHs that are either deliberately or inadvertently omitted from the NPRM have been widely acknowledged by health experts as a predominant cause of some of the most adverse health end points for children, including pre-term births, IQ loss, asthma, cardiopulmonary conditions, and a wide range of cancers.

Criteria Pollutant Standards for ICE Vehicles. At p. 42, EPA proposes a particulate matter (PM) standard of 0.5 mg/mi and makes the remarkable (and untrue) assertion that “the standards will reduce tailpipe PM emissions from ICE vehicles by more than 95 percent”! It goes on to say that the proposal will also “reduce emissions of mobile source air toxics.” According to the Health Effects Institute: *“It is estimated that about 50% of the benzene produced in the exhaust is the result of decomposition of aromatic hydrocarbons in the fuel...two studies showed that lowering aromatics levels in gasoline significantly reduces toxic benzene emissions from vehicles exhausts.”* [Detchon – Modlin, p. 6, FH #23. [RDRMCommentsEPA-HQ-OAR.pdf \(cleanfuelsdc.org\)](https://www.cleanfuelsdc.org/RDRMCommentsEPA-HQ-OAR.pdf)]

Despite OTAQ assurances, continuation of “business as usual” will ensure dramatic increases in the most harmful ultrafine particulates and their associated PAH and other toxics. False assurances like these threaten public health and the environment by lulling the public, health experts, and policymakers into a false sense of complacency that all is well, when the reality is that things are bad and rapidly getting worse.

Despite the magnitude and immediacy of the health threat, EPA attempts to address its gasoline quality “Achilles’ heel” beginning at p. 572, “**Consideration of Potential Fuels Controls for a Future Rulemaking**”. EPA states “there is an opportunity to further address PM emissions from the existing vehicle fleet, the millions of vehicles produced during the phase-in period...through changes in market fuel composition...we expect that tens of millions of gasoline-powered sources will remain in use well into the 2030s.”

However, despite the nondiscretionary duty Congress imposed on it in the 1990 CAAA, EPA does what it has done for more than 30 years—defers “potential” action to a “future rulemaking” by requesting comment on possible changes to “gasoline fuel property standards”. EPA falsely states that it must act under CAA section 211c and that “such changes are beyond the scope of this rulemaking”. In fact, the NPRM rests its authority upon CAA section 202, and section 202(l) imposes a clear nondiscretionary requirement that EPA must ensure that fuel quality improvement—specifically BTEX reduction—is employed as a co-equal regulatory tool to reinforce vehicle technology advances.

No action could be more germane to this rule than reducing gasoline BTEX content to achieve substantial, and immediate, reductions in the most toxic and carbon intensive ICE tailpipe emissions. In fact, after more than 30 years of inaction, EPA’s failure to comply with CAA section 202(l) unquestionably qualifies as “action unreasonably withheld”. Accepting more years of inaction will unnecessarily harm yet another generation of American children.

In a letter to Doug Sombke, South Dakota Farmers Union president, Christopher Grundler, then-director of OTAQ, described his view of CAA section 202(l): *“With respect to CAA section 202(l), the EPA has acted twice under this specific authority, including the February 2007 rule that addresses the aromatics content of gasoline through required limits on benzene...Since Congress established section 202(l) in the CAAA of 1990, the net result of the EPA regulations and market shifts has been a reduction in gasoline benzene levels by roughly two thirds and aromatics levels by roughly one third...In combination, these fuel and vehicle standards have already*

dramatically reduced air toxics emissions. While the EPA continues to look for opportunities to further reduce air toxics, as required by CAA section 202(l), we must also consider technological feasibility and costs, among other factors. We take our regulatory authority very seriously and must ensure the appropriateness of taking further regulatory action before doing so.”¹

It should be noted that Mr. Grundler cites the non-benzene aromatics reductions which occurred not due to EPA’s actions, but thanks to Congressional ethanol requirements under Renewable Fuel Standards 1 and 2. Experts have estimated that the RFS program—which made E10 the nation’s in-use fuel—displaced nearly **10 billion gallons per year of aromatics as refiners adjusted their blendstocks to accommodate ethanol’s higher octane.**

The NPRM indirectly acknowledged the importance of ethanol’s rise in the nation’s gasoline pool at p. 579: “A common thread across the market shifts in T90 has been a decreasing gasoline-to-distillate ratio (GDR) in the product slates produced by refiners...**Perhaps the most important factor affecting GDR was the influx of ethanol into gasoline. The increasing ethanol volume displaced a portion of petroleum, which caused refiners to move more of the midrange gasoline cut into the distillate pool. Ethanol’s octane also allowed refiners to back out aromatic content.**” [Emphasis supplied.]

For many years, automakers have implored EPA to ensure the availability of higher-octane fuels (HOFs) because “octane is the single most important fuel property in designing an internal combustion engine”, according to Mercedes Benz. In the U.S., only two commercially available octane boosting compounds are legally permitted for use in gasoline—benzene-based aromatic compounds commonly known as BTEX (benzene, toluene, ethyl-benzene, xylene) and ethanol. A typical gallon of U.S. gasoline contains approximately 20% BTEX and 10% ethanol. Congress has directed EPA to reduce the carcinogenic mobile source air toxics (MSATs) produced by the incomplete combustion of BTEX “the greatest degree of emission reduction achievable through the application of technology which will be available”. [RDRMCommentsEPA-HQ-OAR.pdf \(cleanfuelsdc.org\)](#) [p. 2]

Section 202(l)’s mandatory directive is unique for its “legislative endangerment” language, as well as the legislative history’s clear Congressional expectation that EPA would employ “technology-forcing” regulatory strategies to improve gasoline quality by substantially reducing BTEX content. While it was banning the use of poisonous tetraethyl lead in leaded gasoline in the *1990 Clean Air Act Amendments*, Congress took extraordinary steps to ensure that EPA used its authority to require petroleum refiners to improve fuel quality and thus complement automakers’ efforts to improve vehicle technologies. In the ensuing years, OTAQ has ignored the “technology-forcing” requirements imposed by Congress by refusing to improve gasoline quality by requiring an orderly reduction in BTEX and replacement with ethanol’s superior, low-carbon, low-toxics octane. [See Detchon – Modlin MY2023 Final Rule comments discussion on “EPA’s response to a legislative mandate” pp. 21 – 31]

¹ Christopher Grundler, EPA Office of Transportation and Air Quality, letter to Doug Sombke, SDFU president, March 15, 2018.

The Clean Air Act makes it perfectly clear that EPA requires only one “metric” for guidance on how best to reduce BTEX content—and it is not some permutation of the GDR. It is the mandatory language in CAA section 202(l).

Technology-Forcing Legal Precedents Put the Burden on EPA to Encourage E30 HOLC Fuels. “Technology-forcing” language has been used by Congress throughout the Clean Air Act, not only in section 202(l) [see *NRDC v. EPA*, 655 F.2d 318, 328 (DC Circuit 1981): “Congress intended the agency to project future advances in pollution control technology. It was expected to press for development and application of improved technology rather than be limited by that which exists today.” *Ecology Law Quarterly*, FN# 126]. However, as the record makes clear, OTAQ has done the exact opposite. It has gone to extraordinary, even unlawful, lengths to OBSTRUCT the development of higher quality fuels which are required to complement advanced engine technologies.

EPA’s sub-sim interpretation that prohibits the use of HOLC fuels like E30 in existing vehicles is unlawful and contrary to Congressional intent. Since EPA established E10 as the nation’s certification fuel in January 2017, it cannot prohibit increased concentrations of ethanol for use in existing vehicles unless it complies with all of the steps that Congress set forth in CAA section 211c. The burden of proof is on EPA, including the legal precedents set by 42 U.S.C. 7545, which require EPA to prove that prohibiting increased ethanol use will NOT result in the use of another octane substitute—BTEX—that makes tailpipe emissions even worse. Especially now with the rapid adoption of GDI engines, EPA cannot make such a finding. Finally, section 202(l) and the 1990 CAAA also require EPA to apply Maximum Achievable Control Technology (MACT) standards to fuel quality improvements. The U.S. light-duty vehicle (LDV) fleet’s ICE vehicles require gasoline of sufficient—ideally much higher than today’s—octane or they will not operate properly. Fuel efficiency improvements and carbon reductions require the use of HOLC Fuels. EPA cannot comply with the statute’s “greatest emissions reduction achievable” requirement unless it encourages an orderly transition to nationwide use of E30 “clean octane” fuels. By blocking such use, EPA is imposing a “de facto” BTEX mandate on U.S. consumers because there are only two commercially available, cost effective, and (at least thus far) legally permissible octane enhancing compounds: BTEX and ethanol. Subsequent Congressional decisions in both RFS1 and RFS2 (2005 EPACT and 2007 EISA) make it clear that Congress intended for ethanol to replace BTEX—and that EPA’s duty is to promulgate the necessary regulations to optimize those results.

Unfortunately, EPA has spent the past thirty years doing the exact opposite. In fact, EPA’s fuel efficiency demands have driven automakers to accelerate the introduction of gasoline direct injection (GDI) engines which in the absence of BTEX controls dramatically **increase** emissions of the most harmful ultrafine particulates and their associated toxics, especially polycyclic aromatic hydrocarbons (PAHs).

EPA’s judgement is misdirected by OTAQ’s MOVES Model. As explained further in the “Supporting Documentation and End Notes” section, OTAQ’s now repudiated MOVES Model underwent a highly questionable “development process” facilitated by BP and Chevron refinery experts. OTAQ emails obtained via FOIA requests reveal a shocking degree of collaboration/collusion between OTAQ experts and Coordinating Research Council (CRC) scientists funded by the petroleum industry. Their “cooperation” went so far as OTAQ agreeing to delete fuel samples that produced

emissions results that “appeared too positive” when more ethanol was added. Rather than adhering to market practices in full display at the time—e.g., splash-blending additional ethanol on top of market gasoline, thus reducing BTEX content by dilution—OTAQ/CRC experts developed an incomprehensible “match-blending” scheme that resulted in more BTEX being added to fuel samples at the same time as more ethanol. Naturally, the resulting emissions were worse, but they were attributed to ethanol rather than the BTEX.

EPA’s testing methods (and relative outcomes) for ethanol-gasoline blends seemed to undergo a fundamental shift beginning with the Tier 3 NPRM. In 2012, during development of the Tier 3 Rule when EPA was initially requesting comment on encouraging E30 higher octane blends, OTAQ published test results that compared E10 to E0 fuel sample. In this [Tier 3 Fuels Impact Study](#), E10 had a 0.3% efficiency gain over E0 gasoline and the E10 fuel had 1.3% less carbon per unit of energy due to lower aromatic content. Thus, EPA’s own data shows a 1.6% CO₂ reduction mostly due to E10’s lower aromatic content (22 vol. % vs. 30 vol. % in the E0 test fuel). These results are consistent with the 2015 Ford/Leone E30 chart in the endnotes, see p. 13.

However, seven years later, in its 2019 E15 RVP Rule (ultimately rejected by the courts), EPA’s MOVES Model concluded that compared to E10, E15 blends increased NMOG by 2.2%, NO_x by 2.5%, and PM by 4.1%. Recently, buried deep in OTAQ/CRC footnotes, we found one clue: It turns out that CRC admitted in the fine print of one of their subsequently released studies that ethanol’s alleged propensity to increase PM and NO_x emissions was observed ONLY WHEN ETHANOL WAS MIXED IN A HIGH-AROMATIC FUEL BLEND. Of course, the burning question is why would EPA encourage the blending of ethanol into fuel samples that contain elevated levels of aromatics, especially when Congress has directed it to promote technologies that REDUCE aromatics to the “greatest degree achievable”?

CRC clarified (after prodding) that “the two-phase vaporization is NOT seen in fuel blend with lower aromatic content”. In other words, if EPA had complied with Congressional directives to REDUCE aromatics content to the greatest degree achievable there would not be a MOVES PM controversy.²

This connection between aromatics and higher PM emissions was indirectly validated by EPA in the NPRM at p. 590, “Estimated Emissions and Air Quality Impacts”, where EPA begins to acknowledge that changes in fuel composition (e.g., aromatics controls) “may also impact secondary pollutants formed in the atmosphere”. EPA goes on to note that “Mobile sources are an important contributor to secondary aerosols formed from...organic precursors [aromatics]”, and that “Changes in aromatic content may also affect NO_x emissions”. (P. 592)

Clearly, the CRC refinery experts knew about the linkage between aromatics and increased PM emissions very well, which explains why they insisted on adding more aromatics to fuel samples whenever they added more ethanol.

² For further explanation of CRC’s rationale, see Endnotes, p. 13.

Restricting BTEX Controls to “High-Boiling” Aromatics Will Not Solve the Problem.

At p. 572 of the NPRM, EPA introduced the concept of limiting “high-boiling compounds in gasoline” that have been linked to increased tailpipe PM emissions. The Agency noted that “the high-boiling tail of gasoline contains a high proportion of aromatics and that the heaviest few percent of this material has very high leverage on PM emissions”.

As interesting as this discussion is—and while it is a worthy goal to limit high-boiling compounds—we are concerned by EPA’s apparent interest in limiting BTEX control to a “few percent” of the average twenty percent fraction contained in a typical gallon of U.S. gasoline. Limiting BTEX control to the small high-boiling fraction would most certainly not be consistent with the spirit and letter of the Congressional mandate in CAA section 202(l) that requires EPA to reduce BTEX by the “*greatest degree of emission reduction achievable through the application of technology which will be available.*” In fact, OTAQ experts implicitly admitted that more is needed when they issued their 2016 report on the 2015 UFP Workshop when they said this:

OTAQ experts admitted that its MOVES Model was defective and in need of replacement more than seven years ago: “a new SOA paradigm has been developed”. [see Detchon/Modlin comments, p. 19, FN#109].

*“[SOA] particles play an important role in air quality but for many years available atmospheric models were not able to predict SOA formation. The main issue was the fact that all models relied on the assumptions that SOA particles were well-mixed low viscosity solutions and maintained equilibrium with the gas-phase by rapid mixing in the condensed phase with evaporation and condensation. Recent studies using the multidimensional characterization approach demonstrated that **these assumptions were wrong and that SOA particles must be viscous semi-solid. These studies showed also that there is a synergetic effect between PAHs and SOA since PAHs trapped inside the SOA particles slow down SOA evaporation and increase SOA yield and lifetime. This can explain the long-range transport of toxic compounds like PAHs and other persistent pollutants. In conclusion, a new SOA paradigm has been developed.**”³ (Emphasis supplied)*

For all these reasons, EPA cannot focus only on the few percent of the “high boiler” BTEX fraction of gasoline—it must reduce BTEX to the greatest degree achievable as required by Congress.

Despite its enormous deterrent effect on EPA’s regulation of mobile source air toxics, however, EPA has yet to correct MOVES. In fact, EPA continues to use the MOVES Model to support its most consequential rulemakings, including the MY2023 and Later LDV GHG Rule, see end notes, p. 20-22.

³ Richard W. Baldauf et al., “Ultrafine Particle Metric and Research Considerations: Review of the 2015 UFP Workshop,” *International Journal of Environmental Research and Public Health* (2016):13(11): p.13: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5129264/pdf/ierph-13-01054.pdf> (accessed Feb. 24, 2021).

SOA from Gasoline Aromatics. On p. 591, EPA noted that “Mobile sources are an important contributor to secondary aerosols formed from nitrate, sulfate and organic precursors. Studies have shown that secondary organic aerosol (SOA) formation from gasoline vehicle exhaust can exceed directly emitted (tailpipe) PM emissions, and that changes to gasoline formulation can have impacts on SOA that are larger than the associated shifts in direct PM emissions.”

This statement seems at odds with the Agency’s claim that the proposed rule would reduce PM emissions by “more than 95 percent”. In fact, EPA historically has vastly understated the substantial contributions mobile sources—especially gasoline BTEX—make to SOA + PAH formation.

Former OTAQ Director Grundler offered this explanation to SDFU President Sombke: *“With respect to your concern that the EPA’s models incorrectly predict the contribution of light-duty gasoline vehicles to PM (e.g., as compared to leaf blowers) it is important to note that the EPA estimates cited in the Wall Street Journal refer only to directly emitted PM. We agree that ambient levels of PM are a result of secondarily formed particles in addition to direct PM emissions, and that light-duty gasoline vehicles are important sources of precursors to PM formation.”*⁴ [Emphasis supplied]

It took several exchanges to elicit this admission five years ago. It is clear from EPA’s claim that the proposed rule would reduce PM emissions by “more than 95 percent” that the Agency continues to downplay the disproportionate role SOA plays in fine and ultrafine particulate emissions.

Leading experts are convinced that aromatics (“organics”) are the primary culprit. “An important recent study, co-authored by the Nobel Prize winner Mario Molina, concluded that reducing the smallest (ultrafine) particles “without simultaneously limiting organics from automobile emissions is ineffective and can even exacerbate this problem”. [Detchon/Modlin 2021 comments, p. 2.] This has implications not only for GDI engine emissions effects, but also for the NPRM’s gasoline particulate filter (GPF) strategies.

Detchon and Modlin went on to note that *“Emissions from aromatic compounds in gasoline were thought to be short-lived, thus posing little threat to human health. But that was wrong. A recent General Motors study found that nearly 96% of the fine particle emissions from gasoline are caused by the aromatics in the fuel”*. [Ibid., p. 1]

In a letter to Acting OAR Administrator Joseph Goffman, former Senate Majority Leader Tom Daschle cited these experts and then cautioned EPA that failure to control BTEX would severely compromise, perhaps doom, EPA’s PM control strategies [DaschleGoffmanHOLCAexecutedjune2021.pdf](#):

“Given the role of aromatic hydrocarbons in PM formation and given the propensity of GDI engines to increase emissions of UFPs, EPA’s strategies for regulating fine particle pollution in urban areas are doomed to failure unless they significantly reduce gasoline aromatics.” A prescient statement that is proving itself to be even more true as GDI engines dominate the U.S. fleet.

⁴Supra, Grundler letter to Sombke, March 15, 2018.

EPA Experts Have Warned About “Atmospheric Transformation Products” from Aromatics for Many Years. Outside of OTAQ, EPA experts have been clear about EPA’s duty under the Clean Air Act to control carcinogenic and mutagenic atmospheric reaction products, the predominant precursors of which are gasoline aromatics.

*“Although oxidized VOCs can be components of primary emissions from a variety of sources, most result from secondary reactions of hydrocarbons emitted into the atmosphere, making them late-generation atmospheric reaction products. **Assessments of health effects based solely on direct emissions are incomplete if potentially important contributions from such products are neglected, as has been noted by the Clean Air Act, which mandates consideration of atmospheric transformation products.**”*

5. Conclusions and implications for control strategies

*Other than 1,2,4- and 1,3,5-trimethylbenzene, all of the precursor aromatic VOCs investigated here are classified as hazardous air pollutants by the U.S. EPA, and therefore emissions of these species from industrial activities are controlled under the Clean Air Act ([U.S. EPA, 2015a](#)). Nonetheless, of the 8 VOCs that produced mutagenic atmospheres, all did so only under irradiation. Thus, only late-generation reaction products were responsible for the mutagenicity, not the precursor VOCs, raising an interesting point regarding potential control strategies when the photochemistry of certain chemical species is similar to those described here. Non-mutagenic primary compounds may be less likely to be controlled; however, the resulting late-generation products may be more likely to be mutagenic. **Therefore, consideration should be given to precursor compounds based not only on their intrinsic health concerns but also on those of their potential late-generation atmospheric photochemical products. It seems that these products, which are typically not monitored or controlled, account for much of the gas-phase direct-acting mutagenicity. Based on these limited studies, reducing the concentrations of primary VOCs would likely result in a corresponding reduction in the concentrations of the products, with a parallel reduction in atmospheric mutagenicity.**”⁵*

[Dr. Riedel is a senior scientist at EPA’s National Exposure Research Lab in Research Triangle Park, NC. He and his colleagues published this study in 2018 [ResearchGate](#) https://www.researchgate.net/publication/315864231_Mutagenicity_and_Carcinogenicity]

Conclusion. Thus, the NPRM presents us with “insurmountable opportunities”, as Pogo would say. Recognizing that EPA’s primary thrust with this rulemaking is to drive the U.S. to an electrified transport system, we must also recognize that trillions of miles will be driven by ICEs powered by gasoline. Unless EPA moves urgently to improve the quality of that gasoline by substantially reducing gasoline BTEX content—as required by Congress—tens of millions of Americans will have their health unnecessarily damaged and die premature deaths. The Detchon/Modlin comments said it best:

⁵ “Mutagenic atmospheres resulting from the photooxidation of aromatic hydrocarbon and NO_x mixtures”, Theran P. Riedel,*, David M. DeMarinib, Jose Zavalac, Sarah H. Warrenb, Eric W. Corsed, John H. Offenberga, Tadeusz E. Kleindiensta, Michael Lewandowski]

“It doesn’t have to be this way. Technologies and products have come together to define a new solution for what the Clean Air Act requires: “the greatest degree of emission reduction achievable through the application of technology which will be available.” Along with a rapid transition to electric vehicles, a complementary program should include adoption of higher ethanol blends, which have been shown by U.S. National Laboratories to enable higher fuel economy and vehicle performance. Such blends would enable a 40% reduction in the use of toxic aromatics in gasoline. An important recent study, co-authored by the Nobel Prize winner Mario Molina, concluded that reducing the smallest (ultrafine) particles “without simultaneously limiting organics from automobile emissions is ineffective and can even exacerbate this problem.” (p. 2)

OTAQ’s exclusive reliance on vehicle technology improvements was not only a violation of clear Congressional directives, it has proven to be a colossal scientific miscalculation. The rapid adoption of gasoline direct injection (GDI) engines—absent a parallel reduction in gasoline BTEX levels—will increase emissions of the most harmful UFP + PAH carcinogens by more than a “septillion” particles over the next decade.

Detchon/Modlin conclude: *“Test programs in the rural Midwest have shown that today’s vehicles operate well on higher levels of ethanol blended with conventional gasoline. Automakers have affirmed that such benefits would be realized by both new and existing internal combustion engines and therefore should be encouraged as additional solutions as soon as possible.”*

The nation has waited 35 years for EPA/OTAQ to act. The nation’s public health and environment cannot afford to wait any longer. Higher ethanol blends cost less than gasoline BTEX, they are here today, they would save the nation hundreds of billions of dollars every year in reduced oil imports and health costs, and automakers require the additional octane. More importantly, EPA has a nondiscretionary duty to act—one it has ignored for far too long.

Supporting Documentation and End Notes

How Is Gasoline Blended? Two Groups Ask EPA to ...

<https://www.eesi.org/articles/view/how-is-gasoline...>

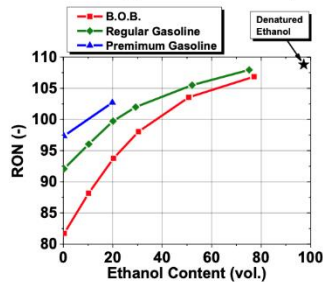


October 24, 2014. On October 20, the Energy Future Coalition (EFC), an initiative of the UN Foundation, and the **Urban Air Initiative (UAI)**, sent a **letter** to EPA Administrator **Gina McCarthy** urging the agency to reconsider the analysis that underpins EPA air toxic **modeling** for vehicle fuels, arguing that the **modeling** approach is flawed.

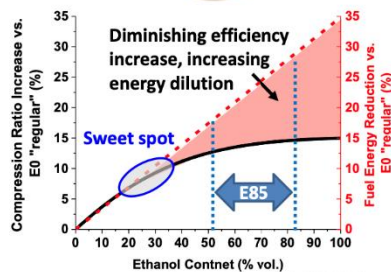
Oak Ridge Labs Confirm that E30 is “The Sweet Spot”

ALCOHOLS HAVE A HIGH OCTANE NUMBER, BUT FUEL ENERGY MUST BE BALANCED TO MEET CONSUMER DEMANDS AND ECONOMICS

- If octane number is the only concern then E85 is a great choice!
- Get 2/3 of octane increase in first 1/3 of ethanol addition (i.e., non-linear)
- Fuel energy reduces lineally with EtOH



Source: Stein et al., SAE 2012-01-1277



33 Historical Trends in Fuel and Engines: Key Influences and Developments Towards Continued Progress



MathPro/Ford – GM – Chrysler Study Confirmed E30’s Superior Octane, Carbon Reduction, and Cost Benefits

Table 2, p. 11068 sets forth MathPro’s linear program analysis that confirms E30’s superior ability to produce a finished 101+ RON gasoline. Refiners would require no additional capital investment, they would reduce crude throughput by 10% and CO2 emissions by 8%, and at today’s crude prices they would enjoy substantial savings. MathPro is a highly regarded consulting firm that EPA itself often relies upon for its modeling.

- David S. Hirshfeld, Jeffrey A. Kolb, James E. Anderson, William Studzinski, and James Frusti (2014) “Refining Economics of U.S. Gasoline: Octane Ratings and Ethanol Content,” *Environmental Science & Technology* doi: [10.1021/es5021668](https://doi.org/10.1021/es5021668)

[Study finds US refining sector could produce higher octane E20 and E30 at modest additional cost; enabling more efficient engines - Green Car Congress](#)

Leone/Ford Motor Study Confirmed E30 Fuel Efficiency & CO2 Superiority & Suitability for Use in Existing Vehicles

2015 Leone/Ford et al. Study Confirms Substantial Fuel Efficiency Improvements and Tailpipe Carbon Reductions with EXX/E30 Blends. [*The Effect of Compression Ratio, Fuel Octane Rating, and Ethanol Content on Spark-Ignition Engine Efficiency* Thomas G. Leone, † James E. Anderson, *, † Richard S. Davis, ‡ Asim Iqbal, § Ronald A. Reese, II, § Michael H. Shelby, † and William M. Studzinski ‡ † Ford Motor Company, P.O. Box 2053, Dearborn, Michigan 48121, United States ‡ General Motors Powertrain, 850 Glenwood, Pontiac, Michigan 48340, United States § FCA US LLC, 800 Chrysler Drive, Auburn Hills, Michigan 48326, United States]

P. 10781: "If the minimum octane rating of the fuel available to customers was increased, it may be technically feasible to update (or "reflash") the engine calibrations on existing vehicles to extract the most benefit from the improved fuel properties... The efficiency gains noted in Figure 2 are estimated assuming the engine was recalibrated to take full advantage of the higher fuel quality. A lesser gain would be realized on most, if not all, vehicles without a calibration change."

Comparing 101-RON E30 to 96-RON E20. Leone’s Table 2 confirmed significant improvements for E30 compared to E20 blends in terms of increased compression, fuel efficiency improvement, and tailpipe CO₂ reductions:

E30: Compression Ratio = +3.3; Total Fuel Efficiency = +7.0%; Tailpipe CO₂ Change = -7.0%

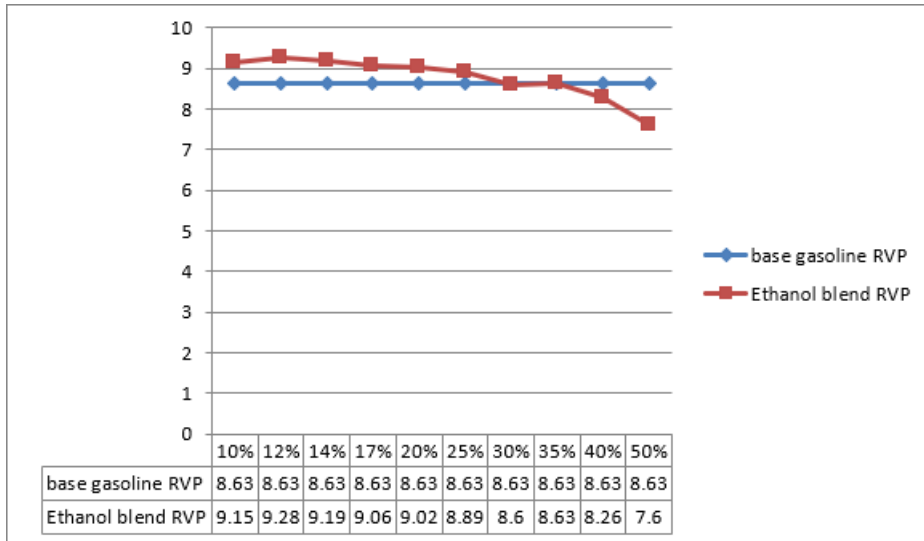
E20: Compression Ratio = +1.8; Total Fuel Efficiency = +4.4%; Tailpipe CO₂ Change = -4.5%

Table 2. Estimation of Efficiency, Volumetric Fuel Economy, and CO₂ Emissions for a GTDI Engine with Higher CR Enabled by Higher-Octane Fuel with Comparison to Ref 28 Engine Dynamometer and Vehicle Modeling Results^{a,b}

fuel	91-RON E10 (baseline)		96-RON E20		101-RON E30	
	ref 28		ref 28	estimate	ref 28	estimate
RON	90.8		96.2		100.7	
ethanol (%v)	10.2		20.4		31.5	
energy content (MJ/L)	30.8		29.7		28.5	
energy-based carbon content (gC/MJ)	72.7		72.5		72.4	
effective RON	90.8		n/a	96.2	n/a	100.7
CR	10.0		11.9	11.8	> 13.0	13.3
efficiency gain from higher CR (% vs baseline)	baseline		n/a ^c	3.48%	n/a	5.35%
efficiency gain from higher ethanol content (% vs baseline)	baseline		n/a ^c	0.51%	n/a	1.07%
Estimates without Downsizing:						
total efficiency gain (% thermal efficiency change vs baseline)	baseline		4.7% M/H	4.0%	6.0% M/H	6.5%
			4.8% US06		9.6% US06	
FE change (% MPG change vs baseline)	baseline		1.0% M/H	0.3%	-2.1% M/H	-1.7%
			1.1% US06		1.2% US06	
tailpipe CO ₂ change (% g CO ₂ /mi change vs baseline)	baseline		-4.8% M/H	-4.1%	-6.0% M/H	-6.5%
			-4.9% US06		-9.1% US06	
Estimates with Downsizing:						
efficiency gain multiplier from downsizing ($F_{downsize}$)	n/a		n/a ^d	1.1	n/a	1.1
efficiency gain from downsizing (% vs baseline)	baseline		n/a ^d	0.35%	n/a	0.54%
total efficiency gain (% thermal efficiency change vs baseline)	baseline		n/a ^d	4.4%	n/a	7.0%
FE change (% MPG change vs baseline)	baseline		n/a ^d	0.6%	n/a	-1.2%
tailpipe CO ₂ change (% g CO ₂ /mi change vs baseline)	baseline		n/a ^d	-4.5%	n/a	-7.0%

^aAll fuel property data taken directly from ref 28. ^b"M/H" indicates result for U.S. EPA metro-highway test cycle. "US06" indicates result for EPA US06 highway test cycle. ^cThe total efficiency gain was measured in ref 28. A breakdown of contributing factors was not reported. ^dThe calculated changes in vehicle efficiency, fuel economy, and CO₂ emissions in ref 28 did not include incremental benefits from additional downsizing.

National Renewable Energy Lab and Other Studies Confirm that E30+ Blends Solve Ethanol's RVP "Problem"



Only E30 Checks All Automaker “Ideal SI Fuel of the Future” Boxes

Summary of ACEC Recommendations for SI Fuel (Priority Rank Ordered)

		<u>Recommended Target Value</u>
1.	RON	
	1. Higher is better	
	2. Phase out current Regular (91 RON) Midgrade (95 RON), and Premium (98 RON) Grades - includes sub-octanes in regions like Colorado.	RON ≥ 100
2.	Sensitivity S = (RON-MON)	
	1. Phase out current range of sensitivity.	
	2. For now, higher is better for anticipated future engine pathways.	S > 12 or MON < 88
	3. More research is recommended to fully understand high values of S.	
3.	Sulfur	
	1. Lower is better	10 ppm maximum
	2. Harmonize US sulfur maximum with regulations in Europe, Japan, and others.	
4.	Volatility	
	1. Reduced regional variation in Drivability Index	Reduce DI variation
	2. Reduced seasonal variation in Drivability Index	
	3. Limit T90 to a maximum temperature	
5.	Properties governing Particulate Matter	
	1. Lower (Particulate Matter Index) PMI is better.	PMI < 1.5
	2. Research in progress to determine overall robustness of PMI	
6.	Heat of Vaporization (HoV)	
	1. For now, higher HoV is desirable for anticipated future DI engine pathways.	
	2. More research is recommended to fully understand HoV, especially to separate its RON-like effects versus other effects like volumetric efficiency.	HoV ≥ current



3/26/2022

6

To achieve higher thermal efficiency and thus better fuel economy and lower carbon emissions, automakers must increase engine compression ratios (see Leone/Ford Motor table). However, higher CRs require higher-octane gasoline.

E30 Clean Octane distinguishes itself as the only commercial octane enhancing additive that meets all six criteria of automakers’ spark ignition “fuel of the future”. The chart is largely self-explanatory but for some elaboration on #6 “Heat of Vaporization”, sometime known as ethanol “charge cooling effect”. The metric is a clear signal for more ethanol since no other component has the cooling effect.

Ethanol’s high latent heat of vaporization (HoV) and high sensitivity (RON minus MON, metric #2) contributes to improvements in knock-resistance in direct injection and turbocharged engines, allowing further increases in CR.

In addition to E30’s superior octane boost (130 RON), E30’s charge cooling effect is viewed by some as equally important as it contributes to more power and better engine efficiency that offsets E30’s lower energy content. It explains why testimonials of those using E30 in standard vehicles include “more power” and “can’t tell the difference in mileage”.

E30’s ability to restore the fuel’s volatility (metric #4, known as Reid Vapor Pressure and measured in pounds per square inch) is also a major advantage as it relates to EPA regulatory efforts to reduce evaporative emissions linked to ground level ozone. E30+ blends do not require EPA RVP waivers for use in summertime high ozone season.

EPA Mistakenly Relies on CRC Heat of Vaporization Studies to Pin Increased PM Emissions on Higher Ethanol Blends

The Coordinating Research Council (CRC) was formed in 1942 by the petroleum industry which is its primary funder. Acting inconsistent with Administrative Procedures Act guidelines, OTAQ collaborated with CRC in the development of the much-criticized MOVES Model which among other things concluded that adding more ethanol to gasoline would increase PM emissions.

Numerous experts pointed out that the claim is counter-intuitive—gasoline aromatics/BTEX are well known to be the predominant source of PM emissions. In its 2012 Tier 3 NPRM, EPA noted ethanol's superior octane properties and confirmed that ethanol does not produce SOAs.

Further investigation solved the mystery. It turns out that CRC admitted in the fine print of one of their subsequently released studies that ethanol's alleged propensity to increase PM emissions was observed ONLY WHEN ETHANOL WAS MIXED IN A HIGH-AROMATIC FUEL BLEND. Of course, the obvious question is why would EPA allow the blending of ethanol into fuel samples that contain elevated levels of aromatics, especially when Congress has directed it to promote technologies that REDUCE aromatics to the "greatest degree achievable"?

CRC clarified that "the two-phase vaporization is NOT seen in fuel blend with lower aromatic content". **In other words, if EPA had complied with Congressional directives to REDUCE aromatics content to the greatest degree achievable there would not be a MOVES PM controversy.**

"Notably, the more recent studies cited by EPA in the E15 Rule do not rehabilitate the MOVES model or present alternative credible evidence in support of the false narratives. The E-94-2 and E-94-3 studies Essentially, the theory in C-CERT Part 2 and other studies is that when ethanol is mixed in a high-aromatic fuel blend, because ethanol vaporizes at a much lower temperature than the aromatics, vaporized ethanol forms droplets that cool the non-vaporized aromatics. The ethanol vaporizes and condenses until essentially all of it has evaporated before the aromatics vaporize, generating higher PM emissions. However, this two-phase vaporization is not seen in fuel blend with lower aromatic content. The Butler and Burke studies cited in EPA's E15 Rule, which further analyze the droplet cooling effect, report the same general interaction as described above.

"Five different models derived from data collected through U.S. Environmental Protection Agency Energy Policy Act (EPAct) programs were used to predict LA92 Phase 1 particulate matter (PM) emissions for summer regular (SR) E0 (gasoline with 0% ethanol by volume), E10 (gasoline with 10% ethanol) and E15 (gasoline with 15% ethanol). Substantial reductions of PM for E10 and E15 relative to E0 were predicted when aromatics were displaced by ethanol to maintain octane rating. SR E0 and E10 were also matched to linear combinations of EPAct fuels and results showed a 35% PM reduction for SR E10 relative to SR E0. For GDI vehicles the Coordinating Research Council (CRC) E-94-3 study found that E10 had 23% or 29% PM increase. However, CRC E-129 found an E10 PM reduction of 10% when one E0 fuel and its splash blended (SB) E10 were compared. Both CRC project E-129 SB data and fuel triplets selected from the EPAct study showed variation for E15 emissions, although E-129 suggests that E15 in GDI offers about a 25% reduction of PM with respect to E0. Overall, data suggest that ethanol blending offers a modest to a substantial reduction of cold-start PM mass if aromatic levels of the finished products are reduced in response to ethanol addition...Aromatics are reduced in E10 or E15, compared with E0, and distillation changes. PFI-derived models show reductions in cold-start PM for expected average E10 versus E0 pump fuel, due to reduced aromatic content. Relative emissions effects

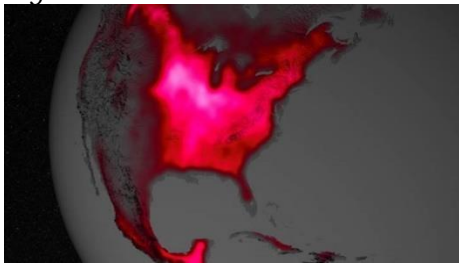
from older technology (PFI) engines do not predict newer engine (GDI) results reliably, but recent GDI data show reduced cold-start PM when ethanol displaces aromatics.”⁶

Numerous other studies have confirmed that E30 blends reduce PM/UFPs and associated toxics/black carbon emissions by 45 – 85% in direct- and port fuel-injected engines respectively.

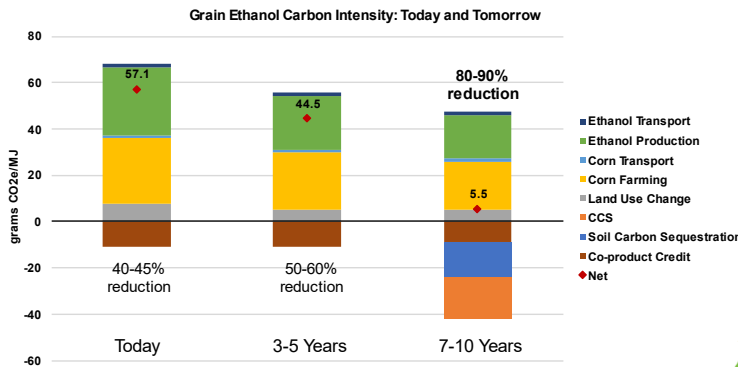
U.S. High-Yield Corn is the Most Efficient User of Solar Energy in the World

Despite what its detractors claim, U.S. corn producers are the most efficient users of solar energy in the world as confirmed by NASA satellite images. *“Data from satellite sensors show that during the Northern Hemisphere’s growing season, the Midwest region of the United States boasts more photosynthetic activity than any other spot on Earth, according to NASA and university scientists.”*

Healthy plants convert light to energy via photosynthesis, but chlorophyll also emits a fraction of absorbed light as fluorescent glow that is invisible to the naked eye. The magnitude of the glow is an excellent indicator of the amount of photosynthesis, or gross productivity, of plants in a given region.”



Ultra low carbon corn ethanol is coming



⁶ J Air Waste Manag Assoc. 2021 Jan;71(1):3-22.doi: 10.1080/10962247.2020.1754964. Epub 2020 Nov 19. **Quantification of gasoline-ethanol blend emissions effects**
 Nigel N Clark ¹, David L McKain Jr ¹, Tammy Klein ¹, Terence S Higgins

Automakers Have Urged EPA to Encourage HOLC Fuels in “New and Existing Fleet...As Soon As Possible”

The [letter from the Alliance for Automotive Innovation](#) (AAI) to Senator Daschle is particularly noteworthy—AAI’s 38 member companies include the manufacturers of 98% of all light-duty vehicles sold in the U.S.

AAI wrote: *Even so, as automakers invest significantly in the transition to expanded vehicle electrification, the auto industry is also continuing to invest in vehicle improvements that increase fuel economy and reduce greenhouse gases in internal combustion engine vehicles. Many of the technologies being used to make these improvements can be enhanced or complemented with the use of high octane, low carbon liquid fuels. These fuels would simultaneously support vehicle performance, including fuel economy, and further reduce greenhouse gas emissions during vehicle use. Such benefits would be realized by new and existing internal combustion engines and therefore should be encouraged as additional solutions as soon as possible to maximize environmental benefits across the fleet. Given the timespan over which combustion technology will continue to be sought by new car shoppers, and the timespan that those vehicles will remain in the field, low carbon liquid fuels are an increasingly important technology pathway to help achieve carbon reductions while the electric vehicle market continues to grow...*

“Use of high octane, low carbon liquid fuels supports ongoing efforts to improve air quality and can provide an important bridge in reducing emissions in low-income communities during the transition to expanded vehicle electrification. While today’s vehicles emit near zero levels of tailpipe and evaporative emissions and are further reducing these emissions under the Environmental Protection Agency’s Tier 3 standards, more can be done to support lower emissions and air toxics exposure, especially in disadvantaged communities. High octane, low carbon liquid fuels provide the benefit of lower aromatics, and therefore lower exposure to toxics, when combusted in a vehicle. High octane, low carbon liquid fuels provide a solution to further enhance the on-vehicle technologies and will promote cleaner air for all communities. In summary, Auto Innovators believes there is, and should be, an ongoing role for cost-effective solutions that further reduce greenhouse gas emissions, promote vehicle technology improvements, and lead to cleaner air. While vehicle electrification is a primary focus at this time, petroleum use will continue for years to come. As such, there are potential climate and air quality benefits that can be optimized through the encouragement and rollout of high octane, low carbon liquid fuels.”

EPA has paid little attention has been paid to the fact that unless EPA complies with the mandatory provisions in section 202(l) of the Clean Air Act to dramatically reduce gasoline aromatics (BTEX), the rapid adoption of Gasoline Direct Injection (GDI) engines will dramatically increase emissions of the most harmful ultrafine particulate (UFP)-borne PAH and other toxic emissions. OTAQ has indicated its intention to force automakers to install gasoline particulate filters (GPFs) in future vehicles to capture the nanoparticles. GPFs will interfere with fuel efficiency improvements, increase tailpipe carbon emissions, impose billions of dollars in unnecessary costs on consumers and automakers, and will degrade over time thus failing to achieve EPA’s emissions objectives (see 2016 HEI PM Workshop and Daschle letter to EPA OAR Director Goffman).

Senator Daschle wrote: *“Given the role of aromatic hydrocarbons in PM formation and given the propensity of GDI engines to increase emissions of UFPs, EPA’s strategies for regulating fine particle pollution in urban areas are doomed to failure unless they significantly reduce gasoline aromatics.”*

Adoption of Nationwide E30 Would Save Billions of Dollars Annually in Reduced Premature Mortalities & Morbidities

Senator Daschle to Goffman: *“As EPA acknowledged at a 2015 workshop it convened on UFPs, the agency’s models are incapable of predicting, identifying, and controlling harmful emissions of secondary organic aerosol (SOA)-bound PAHs. In fact, it appears that EPA has been under-reporting these emissions for many years now, harming public health and the environment – notwithstanding the clear Congressional directive in the 1990 Clean Air Act Amendments, specifically Section 202(l) (which Congress reaffirmed in the 2005 Energy Policy Act). At the 2015 workshop.*

EPA admitted that PAHs have a “synergetic” relationship with SOAs,⁵ such that the PAHs weaponize the SOAs – amplifying, insulating, and preserving them for long-range transport. Yet, in the six years since this critical failure was revealed, EPA has done nothing to correct it, despite numerous pleas from concerned groups like ours. In its 2007 MSAT Final Rule, EPA said it would be “compelled” to revisit Section 202(l) if “the science” showed a connection between gasoline aromatics and SOAs. That connection has now been demonstrated beyond a shadow of a doubt, yet the agency has failed to act.

Instead, 15 years later, the Streamlining Rule is eliminating even the measurement of aromatics in refinery gasoline, with data only on benzene, despite the fact that non-benzene aromatics in gasoline convert to benzene, PAHs, and other toxics in the combustion process, since existing emissions control systems cannot capture them effectively. Instead, the Office of Transportation and Air Quality (OTAQ) has failed to correct its substantial under-estimation of ethanol’s superior octane and emissions properties and its ability to displace aromatics in the U.S. gasoline pool, despite having been urged to do so for many years.

This history offers you an opportunity to act. The agency’s inaction to date is making U.S. urban areas dirtier, exposing millions of Americans – especially children and other vulnerable groups – to harmful air toxics on a 24/7 basis, with no means of escape, and causing thousands of premature deaths annually. The adverse health effects of this exposure will worsen unless gasoline aromatics levels are significantly reduced.”

Adoption of Nationwide E30 Clean Octane Would Provide a Multi-Trillion Dollar Boost to the U.S. Economy & Quick “Time to Market” Advantages

This worksheet suggests the enormous economic, environmental, and energy/national security benefits that would accrue from a nationwide E30 Clean Octane Standard:

COST SAVINGS FROM IMPROVED FUEL QUALITY STANDARDS: ACHIEVING MAJOR REDUCTIONS IN BTEX-RELATED MOBILE SOURCE EMISSIONS & OIL IMPORTS

Primary Pollutants	Conventional Gasoline	E30 ⁷	Approx. Annual Cost Savings
Gasoline aromatic hydrocarbons/BTEX (Benzene/Toluene/Ethylbenzene/Xylene)	Primary source of urban air toxics, SOA-borne PAHs, & tailpipe carbon	75% reduction	\$24+ billion
Secondary organic aerosols (SOAs)/UFPs	90% by 2022 ⁸	70% reduction	\$260 billion
VOCs & NOx	BTEX carbonaceous ultrafine particles are “uber-toxic” & penetrate organs via bloodstream	8 – 12% ⁹	\$26 - \$280 billion (GDI effect?) ¹⁰
Carbon Monoxide	90%	22 – 50% ¹¹	TBD
Carbon Emissions	25 – 40%	40 – 80% ¹²	\$9 billion ¹³
Crude Oil	70%	2.5 million BPD less	\$153 billion ¹⁴

⁷ For purposes of this analysis, E30+ blends are assumed to reduce approximately 50% of US gasoline BTEX (from 20 vol. % to 10%) substituting ultra-low sulfur high octane low carbon ethanol for BTEX. When used at levels 30% or higher, ethanol also reduces gasoline volatility (RVP) eliminating the need for EPA debits and RVP restrictions. A 2010 CARB study found that E35+ blends reduced PN emissions by more than 90% (see 2010 Zhang, et al. study, “A Comparison of Total Mass and Particle Number Emissions of Light Duty Vehicles from 2009 to 2010”, p. 19).

⁸ Toluene/BTEX are the primary man-made source of SOAs. New science including airborne real-time measurements confirm that gasoline, not diesel fuel, is the primary source of urban UFPs + PAHs. See EPA’s *Final Report on the Costs and Benefits of the 1990 Clean Air Act Amendments*, pp. 4-24-25 and Table 4-1, full report at http://www.epa.gov/air_sec1012/prospective2.html. [EPA PM2.5 emissions calculations = \$100 billion savings for each microgram per cubic meter reduction.]

⁹ Source: EPA Complex Model, as cited in Energy Future Coalition’s comments on EPA Proposed MSAT Rule, EPA-HQ-OAR-2005-0036, May 30, 2006, p. 46.

¹⁰ Detchon – Modlin Comments, p.13 – 21, [RDRMCommentsEPA-HQ-OAR.pdf \(cleanfuelsdc.org\)](#)

¹¹ *Supra*, p. 46. See also 1997 OSTP report found that “vehicle CO emissions are reduced from 2 to 10 percent per percent oxygen in the fuel”. E30 blends contain approximately 10 wt. % oxygen.

¹² BTEX is the most carbon intensive gasoline component, 50% or more carbon intensive than ethanol. Additionally, BTEX combustion and photo-oxidation products are orders of magnitude more carbon intensive, see “*Research Findings in Particulate Air Pollution from the Southern California Particle Center, 2006*”, Slide 21.

¹³ Argonne National Laboratory’s GREET Model has also confirmed that high-yield corn restores soil organic matter and captures substantial amounts of atmospheric carbon, see Detchon – Modlin comments *supra* p. 33, FN#190.

¹⁴ Calculation assumes a weighted average crude oil cost of \$100/barrel, that each barrel of crude oil yields 47% of finished gasoline, assumes no less than 31 billion GPY of ethanol in the US gasoline pool, and offsets ethanol’s lower energy density on a 1:1 basis due to its superior octane and fuel efficiency performance. Ethanol’s higher octane also cancels out the significant gasoline yield loss that occurs due to BTEX synthesis at the refinery level, see <http://www.nrel.gov/analysis/pdfs/44517.pdf>. P. 16 – 19.