growth energy™
America's Ethanol Supporters

777 North Capitol Street, NE, Suite 805, Washington, D.C. 20002
PHONE 202.545.4000 FAX 202.545.4001 GrowthEnergy.org

February 13, 2012

Docket Management Facility, M-30
U.S. Department of Transportation West
Building, Ground Floor
Rm. W12-140
1200 New Jersey Avenue S.E.
Washington, D.C. 20590

Environmental Protection Agency
EPA Docket Center (EPA/DC)
Air and Radiation Docket
Mail Code 28221T
1200 Pennsylvania Avenue N.W.
Washington, D.C. 20460

Re: EPA–HQ–OAR–2010–0799; FRL–9495–2; NHTSA–2010–0131 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

Growth Energy, an association of the nation's leading ethanol manufacturers and other companies who serve America's need for alternative fuels, is pleased to submit these comments regarding the joint proposed rulemaking ("Joint NPRM") by the National Highway Traffic Safety Administration ("NHTSA") and the U.S. Environmental Protection Agency ("EPA") to establish automotive fuel economy and motor vehicle greenhouse gas ("GHG") emissions standards for model years 2017-2025. The members of Growth Energy supply the renewable fuels that are a critical part of the nation's energy independence and greenhouse gas reduction efforts. Growth Energy and its members salute the efforts by NHTSA and EPA (collectively, "the Agencies") to solicit data, analysis and views on the Joint NPRM, and to respond to the public's comments.

The fuel economy and GHG standards proposed by the Agencies sent ambitious targets for the automobile industry. The standards and other requirements that the Joint NPRM propose, along with other safety and emissions programs, will determine how the U.S. automobile industry allocates its human and financial resources for the next decade. The new-vehicle market will determine whether the automobile industry's efforts to comply with the Agencies' GHG and fuel economy standards are successful. Greenhouse gas standards of the type being proposed by EPA are, for all practical purposes, fuel economy standards, and like fuel economy standards such standards affect nearly every attribute of vehicle design and performance, as well as vehicle retail and operating costs. One of the most ambitious aspects of the Joint NPRM is that it would set standards for the industry over a much longer time frame than any previous fuel economy standards established by NHTSA, including the model-year ("MY") 2012-2016 GHG standards recently promulgated by EPA.

Growth Energy's comments, which are explained in detail in the attachments to this letter, address three subjects: (1) the Joint NPRM's reliance on electric vehicles; (2) the impact of the program envisioned by the Joint NPRM on the nation's ability to comply with the biofuels provisions of the Energy Independence and Security Act of 2007 ("EISA"); and (3) the Joint NPRM's assumptions about the feasibility of compliance with the proposed GHG and fuel economy standards in the absence of additional fuels regulation, as well as the benefits of additional fuels regulation to enhance the benefits of those proposed standards.

I.

Although not required by Congress in EISA or in the other statutes governing this rulemaking, the proposed standards in the Joint NPRM place great reliance on the production, sale and use of vehicles powered from the electrical grid, far exceeding any prior federal regulatory program. As noted above, the success or failure of the regulations that the Agencies are proposing will ultimately be determined by the consumer market for new motor vehicles. Insofar as the Agencies' program is based on regulatory templates from California, which has attempted for more than 20 years to implement requirements for widespread sale and use of pure electric vehicles, there is reason for great skepticism about the Joint NPRM's view that grid-powered electric vehicles (pure electric vehicles and plug-in hybrid vehicles) can provide a "game-changing" strategy to reduce GHG emissions and dependence on foreign oil.

Programs that try to force the market to purchase electric vehicles that the public does not want to buy require public subsidies, increases in the prices of conventional vehicles to subsidize the manufacturers' cost, or both. While California may have some discretion under the Clean Air Act to experiment with its own new-vehicle market, and while the Joint NPRM's approach may have the support of some stakeholders in addition to California, NHTSA and EPA have independent duties to determine whether the standards it adopts are economically practicable and take proper account of the state of technology, including the costs of technology. *See* 49 U.S.C. § 32902(f); 42 U.S.C. § 7521 (a)(2). If the reliance on electric vehicles is misplaced, because there is no statutory mandate for such vehicles in federal law nor any requirement that the Agencies rely on such vehicles in writing GHG or fuel economy standards, the proposed standards in the Joint NPRM need to be scaled back to conform to levels that are economically practicable and also technologically feasible after accounting for costs.

Attachment 1 to this letter explains why Growth Energy believes that the analyses supporting the Joint NPRM's electric vehicle cost estimates are not reliable. Under the applicable Executive Orders governing cost-benefit analyses, we believe that the Agencies need to reconsider and revise the current cost-benefit analyses. In addition, given the significant under-estimation of electric vehicle costs in the Joint NPRM's current analysis, Growth Energy questions whether EPA and NHTSA can properly determine that proposed standards are economically practicable and take proper account of the state of technology, as required by the governing statutes. If EPA and NHTSA believe that those methods of estimating the market impacts of regulatory programs that rely upon or require electric vehicles are inadequate or unnecessary, the Agencies should explain why.

II.

Title II of EISA directed EPA to adopt and enforce regulations to "ensure," 42 U.S.C. § 7545(o)(2)(A)(i), the use of at least 36 billion gallons of biofuels annually by 2022. Congress further directed that EPA's regulations meet that goal within a regulatory framework that phases down the fuel economy credit provisions for the production of dual-fueled vehicles in the Energy Policy and

Conservation Act of 1975, as amended. *See* Pub. L. No. 110-140 § 109 (amending 49 U.S.C. § 32906). EPA adopted comprehensive regulations in 2010 to implement the biofuels requirements of the 2007 Energy Act, in amendments to the Renewable Fuels Standard ("RFS 2"). *See* 75 Fed. Reg. 14,670 (Mar. 26, 2010).

In the RFS 2 regulation, and consistent with EISA, EPA chiefly relies on the production and sale of domestically-produced ethanol and flexible fuel vehicles ("FFVs") to meet the volumetric renewable fuels requirements now codified in section 211(o)(2)(B) of the Clean Air Act. The volumetric requirements were fully considered by Congress, were adopted by strong bipartisan majorities, and have been and remain provisions of the statute that representatives of the fossil fuel industry do their best to undercut. *See, e.g., Nat'l Petrochemical & Refiners Ass'n v. EPA*, 630 F.3d 145 (D.C. Cir. 2010) (denying petitions for review). EPA has a duty to carry out EISA's mandates, and other federal agencies have provided strong financial support with public funds authorized by Congress to promote the development of biofuels. Growth Energy's members have invested heavily in the production of renewable fuels, including cellulosic biofuels, and Growth Energy has been a staunch defender of the RFS requirements in EISA.

The GHG and fuel economy standards that the Agencies are now proposing will define, far more than any other step that the Agencies can take under federal law, the types of vehicles that the automobile industry will produce for many years into the future. EPA, however, has not reconciled the options presented for vehicle manufacturers under the regulations proposed in the Joint NPRM with the requirements of Title II of EISA and the strategy for achieving the volumetric requirements of Title II in the RFS 2 regulations. If the GHG reductions that FFVs can be expected to achieve when operated on renewable fuels are not translated into practical incentives for vehicle manufacturers to continue and expand production of FFVs, then the volumetric requirements in Title II of EISA will not be achieved. The Joint NPRM does not propose any program that provides vehicle manufacturers with the necessary incentives, and indeed seems to disfavor the use of ethanol as a vehicle GHG reduction strategy in comparison with a fossil fuel (natural gas) and electricity. This important issue is examined in Attachment 2 to this letter, which also introduces concepts that could bring EPA's vehicle-based GHG reduction goals back into line with EISA and the RFS 2 regulation.

The problem is not simply that EPA has neglected biofuels in the Joint NPRM. EPA and NHTSA are instead embarking on a course that will make the volumetric biofuels requirements of Title II in EISA unachievable. Vehicle manufacturers operate in a highly competitive environment, face a complex set of regulatory expectations from EPA, NHTSA, and the State of California, must plan their compliance strategies many years before the start of a given model year, and have no resources to waste on programs that will not help ensure regulatory compliance. The Joint NPRM is rooted in the policy preference of one State (California) for electric vehicles, and EPA has bifurcated this rulemaking from other emissions and fuels rulemakings. The Joint NPRM leaves no room for vehicle manufacturers to rely on biofuels and the mandates in Title II of EISA as part of an overall compliance strategy.

Notably, EPA does not try to explain in the Joint NPRM or in its regulatory support document why and how it thinks the program outlined in the Joint NPRM will ensure compliance with Title II of the 2007 Energy Act. Nor does the Agency claim, nor could it claim in light of the scope and duration of the standards outlined in the Joint NPRM, that any steps that EPA might take in future regulations under the Clean Air Act could address the conflict between its currently proposed prescriptions to the automobile industry and the mandate for renewable fuels in Title II of EISA. As with the electric vehicle elements of the Joint NPRM, the guiding strategy appears to have been brokered with California, and not to have been based on the requirements of federal law.[1] If EPA does not correct the direction it is now setting for the automobile industry with respect to FFVs, there will be few FFVs produced after MY 2016. And, in the absence of a large and growing fleet of FFVs, the volumetric mandates in Title II of EISA cannot be met.

Given the neglect of the RFS 2 program in the current rulemaking, EPA appears to be setting the RFS 2 program on a course that is quite contrary to what Congress expected in EISA. That is completely unnecessary, because all EPA has to do in this rulemaking is to give vehicle manufacturers practical incentives for continued and expanded production and sale of FFVs ***that would be based on the volumes of biofuel required by Congress***. EISA includes provisions allowing EPA to make adjustments in the RFS 2 program, if there are proper determinations of unforeseen, "severe" economic harm, "severe" unintended environmental impacts, or an "inadequate domestic supply" of biofuels. See 42 U.S.C. § 7545(o)(7)(A),(F). But those provisions merely provide narrowly-drawn "off-ramps" for the renewable fuels program to address paramount economic or environmental interests. They are hardly a license for EPA to set the RFS 2 program up for failure. It would be ironic in the extreme, and contrary to law, if regulations adopted by EPA in the exercise of administrative discretion, like the regulations in the Joint NPRM, were to deprive the nation of an adequate supply of biofuels, and thus to provide a pretext to abandon or curtail the requirements of Title II in EISA.

When it enacted EISA, Congress had lengthy experience with the efforts of the fossil fuel industry to retard the use of non-fossil fuels, and with the fossil fuel industry's history of resistance to regulation under the mobile-source provisions of the Clean Air Act. Congress therefore spoke with clarity about its expectations for the volumetric requirements for biofuels in Title II of EISA. EPA was directed in mandatory terms to adopt regulations to "ensure" the sale of gasoline with the specified volumes of biofuels. See 42 U.S.C. § 7545(o)(2)(A) (the Administrator "shall" adopt regulations "to ensure" the use of specified volumes of biofuels). The only federal court that has needed to construe this provision has stated that the term "ensure" as used in EISA means "to make sure, [or] certain." *Nat'l Petrochemical & Refiners Ass'n*, *supra*, 630 F.3d at 153 (internal quotation marks and citations omitted); *see also Nat'l Treasury Employees Union v. Chertoff*, 452 F.3d 839, 863 (D.C. Cir. 2006) (construing "ensure" under other statute as mandatory). Congress has left EPA no room to effect a *de facto* reduction in the domestic supply of biofuels when EPA adopts other regulations. EPA must "obey the Clean Air Act as written by Congress." *Natural Resources Defense Council v. EPA*, 643 F.3d 311, 314 (D.C. Cir. 2011) (internal quotation marks and citation omitted).

As noted above, Attachment 2 to this letter provides further analysis of the treatment of FFVs in the current rulemaking. If EPA decides not to reform the program outlined in the Joint NPRM to conform with and to support the RFS 2 program, EPA must at a minimum address fully and in detail each of the following questions, in order to explain why it has not done so:

[1] California's own version of a biofuels strategy, its "low-carbon fuel standards" regulation, will be infeasible unless the California new-vehicle market can somehow absorb large numbers of pure electric and grid-connected hybrid electric vehicles.

- EPA should explain how it expects the automobile industry and fuels providers to meet the RFS 2 requirements within the framework of the regulations contained in the Joint NPRM or in the Final Rule it adopts in this rulemaking;

- If EPA disagrees with Growth Energy's view that it is unrealistic to expect continued significant production of FFVs after model year 2016 if the Joint NPRM's provisions are adopted, the Agency should explain why;

- EPA should explain how it interprets the requirement to "ensure" the use of biofuels under the statutory text of EISA (*see* 42 U.S.C. § 7545(o)(2);

- EPA should explain how the vehicle production plans and strategies assumed in the regulatory analysis for the Joint NPRM will "ensure" that the country can meet the volumetric mandates for biofuels in Title II of the 2007 Energy Act;

- If EPA believes that it is not obligated in the current rulemaking to take account of and comply with its duty to ensure compliance with the biofuels mandate in EISA, EPA should explain why it is not required to do so.; and

- EPA should explain whether the absence of an adequate domestic supply of biofuels arising from reductions in the production and sale of FFVs could provide, in whole or in part, a basis of a waiver of any part of the biofuels mandate in EISA.

III.

The Joint NPRM presents a comprehensive (though in Growth Energy's view, in some respects flawed, for the reasons outlined above) strategy for GHG reductions and increases in fuel economy that will be borne by the automobile industry, its customers, suppliers, and employees. That strategy does not, however, appear to have been based on any systematic examination of the role that fuels regulation could play in meeting EPA's GHG reduction targets. While NHTSA may lack regulatory authority in this arena, before proceeding further, EPA needs to determine if its broad powers under section 211 of the Clean Air Act permit it to adopt and enforce new certification fuels requirements and in-use gasoline specifications in aid of the motor vehicle GHG regulatory program. EPA also needs to determine if, in order to mitigate or avoid potentially adverse impacts on its control of emissions other than GHGs, it is required to adopt such requirements and specifications.[2]

As explained in Attachment 3 to this letter, there are strong policy reasons for EPA to establish regulations for a new gasoline certification fuel at 94 octane (AKI), and to provide for the general commercial availability of such a fuel for vehicles produced in or after MY 2017, in the same manner that "regular" gasoline at a lower octane level is now currently sold. Because such an increase in octane cannot be accomplished by increases in gasoline aromatic content without compromising the control of emissions other than GHG emissions, EPA should evaluate increases in octane that rely on increases in

[2] Under such an analysis, the elements of a vehicle or engine's design used to control GHG emissions would be considered for purposes of the analysis to be part of the vehicle's "emission control … system" under 42 U.S.C. § 7545(c)(1)(B).

ethanol content. Increased ethanol content for gasoline to obtain higher octane levels, implemented in a manner consistent with the product planning and validation cadences of the automobile industry and without disruption to existing liquid transportation fuels delivery systems, would have a number of benefits for the public. By enabling a greater mix of engine technologies to meet GHG reduction requirements on a fleet-wide basis, the automobile industry might be able to reduce the costs of GHG reductions.   Carefully managed increases in ethanol content can also help reduce engine particulate emissions.

If EPA believes that the examination of the proposal to increase octane outlined in Attachment 3 is unnecessary or inappropriate because it lacks authority under section 211 of the Clean Air Act to take the recommended action, then the Agency should fully explain why it believes it lacks that authority, among other reasons so that Congress can consider appropriate changes in the statute. Attachment 3 also explains why examination of the potential increases in emissions that EPA has regulated for many years (more specifically, fine particulate matter) in the current rulemaking is important even if EPA decides that it cannot take regulatory action under section 211 as the statute currently exists.   The Agencies' cost-benefit analysis of the standards in the Joint NPRM assumes reductions in fine particulate matter.   If, as explained in Attachment 3, those standards would have the unintended effect of increasing engine PM emissions, then the cost-benefit analysis mandated by governing Executive Orders must be revised.

*   *   *

Growth Energy appreciates the opportunity to provide these comments to the Agencies. If there are questions about our comments, please contact Chris Bliley or me at 202/545-4000.

Sincerely,

Tom Buis

Tom Buis, CEO

EPA–HQ–OAR–2010–0799; FRL–9495–2; NHTSA–2010–0131
2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

Comments of Growth Energy

Attachment 1 (Electric Vehicles)

EPA's proposed greenhouse gas (GHG) emissions standard in the Joint Notice of Proposed Rulemaking provides incentives for electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell vehicles (FCVs), but essentially eliminates incentives for flexible fuel vehicles (FFVs). The incentives have no clear foundation in a relative comparison of the overall GHG emissions or costs of each of these vehicles. EPA should undertake a thorough study of the lifecycle emissions and total costs, including the cost of the refueling infrastructure of these vehicles, in determining incentives. This Attachment to the Comments of Growth Energy explains why EPA needs to reconsider its analysis of the electric vehicle component of the Joint Notice of Proposed Rulemaking (Joint NPRM).

*　　　*　　　*

As part of the Joint NPRM, EPA includes incentives for electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) intended "To facilitate market penetration of the most advanced vehicle technologies as rapidly as possible…" [1] EPA goes on to provide the following rationale for providing these incentives:[2]

> EPA has identified two vehicle powertrain-fuel combinations that have the future potential to transform the light-duty vehicle sector by achieving near-zero greenhouse gas (GHG) emissions and oil consumption in the longer term, but which face major near-term market barriers such as vehicle cost, fuel cost (in the case of fuel cell vehicles), the development of low-GHG fuel production and distribution infrastructure, and/or consumer acceptance.
>
> - Electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) which would operate exclusively or frequently on grid electricity that could be produced from very low GHG emission feedstocks or processes.
>
> - Fuel cell vehicles (FCVs) which would operate on hydrogen that could be produced from very low GHG emissions feedstocks or processes.

[1] Page 74878
[2] Page 75010

> EPA believes that these advanced technologies represent potential game-changers with respect to control of transportation GHG emissions as they can combine an efficient vehicle propulsion system with the potential to use motor fuels produced from low-GHG emissions feedstocks or from fossil feedstocks with carbon capture and sequestration.

However, EPA also notes[3] that during the 2017 to 2025 time frame that the production of the electricity and hydrogen required to power these vehicles:

> …will decrease the overall GHG emissions reductions associated with the program as the upstream emissions associated with the generation and distribution of electricity are higher than the upstream emissions associated with production and distribution of gasoline…

and quantifies the magnitude of these lost emission reductions as between 80 million and 120 million metric tons of CO_2 over the period from 2017 to 2025 alone.[4] According to EPA, the loss in benefits associated with EV, PHEV, and FCV incentives equals 4 to 5% of the total GHG reductions expected from the proposed rule.

`Given that EPA admits that the incentives it is providing for EVs, PHEVs, and FCVs will undermine the goal of the GHG regulation at least during the period from 2017 to 2025, the obvious question is why are these incentives being provided? The answer to this question is that as indicated above, EPA believes these advanced technologies are potential game-changing technologies.

As discussed in detail below, not only does EPA overstate the potential GHG benefits of EVs, PHEVs, and FCVs, but the Agency fails to accurately address the serious challenges facing these vehicle technologies. As a result, EPA's decision to incentivize these technologies seems completely at odds with the goal of the proposed rule, which is to lower GHG emissions.

In contrast, the proposed rule ignores the fact that vehicles designed to operate on ethanol-blended fuels are truly "…potential game-changers with respect to control of transportation GHG emissions…" Given this, EPA must modify the proposed rule to provide incentives that will ensure that vehicles capable of operation on ethanol blends continue to enter the vehicle fleet in substantial numbers so that the tremendous "game-changing" GHG benefits of ethanol-blended fuels can be realized in the real world.

The fact that vehicles operating on ethanol-blends can deliver significant GHG benefits can be seen in the results of numerous studies. One straightforward study is a

---

[3] Page 75010
[4] Page 75015

summary of "well to wheels" analysis results published by the U.S. Department of Energy.[5] Selected results from this publication are summarized in Table 1.

There are several conclusions that can be drawn from the data shown in Table 1. The first of these is that the use of E85 derived from corn[6] or from cellulosic materials will reduce GHG emissions by about 11% and 60%, respectively, relative to gasoline without the need for any substantial change in a given vehicle technology. The second is that the use of E85 in hybrid vehicles in the near term will result in substantially larger reductions relative to gasoline than will EVs, PHEVs, and FCVs. The third is that the use of E85 derived from cellulosic feedstocks in any FFV will yield larger reductions in GHG emissions than will be achieved with EVs, PHEVs, or FCVs.

These data and similar data from other related studies, clearly indicate the potential for ethanol-blends to provide "game-changing" reductions in GHG emissions without the need for the fundamental changes in vehicle technology associated with EVs, PHEVs, and FCVs or the fundamental changes in the technology used to generate electricity and hydrogen that would be necessary in order for these vehicles to provide meaningful GHG reductions.

---

[5] Nguyen T. and Ward J., Well-to-Wheels Greenhouse Gas Emissions and Petroleum Use for Mid-Size Light-Duty Vehicles, U.S. DOE Record 10001, October 5, 2010.

[6] The DOE values provided for corn ethanol did not include indirect land use effects. Growth Energy does not believe current analytical models and data permit reliable estimation of indirect land use effects for Midwest corn ethanol, particularly in regulatory settings. For purposes of this analysis, however, the values shown in Table 1 use the latest version of GREET (GREET2011) was used to estimate a lifecycle GHG emission rate for corn ethanol that included indirect land use effects, which was then used to adjust the DOE corn ethanol values relative to those for gasoline.

Table 1 Comparison of Well to Wheels GHG Emissions Based on DOE Results for Mid-Size Cars			
Vehicle Type	Fuel(s)	Emissions (gCO_2eq/mile)	GHG Reduction Relative to Gasoline Hybrid
Current conventional	Gasoline	450	0%
Current conventional	E85 (corn)	402	11%
Current conventional	E85 (cellulosic)	172	62%
Future conventional	Gasoline	340	0%
Future conventional	E85 (corn)	304	11%[7]
Future conventional	E85 (cellulosic)	130	62%
Hybrid	Gasoline	235	0%
Hybrid	E85 (corn)	210	11%
Hybrid	E85 (cellulosic)	90	62%
PHEV (40 mile range)	Gasoline/Grid Mix	270	-15%
EV (100 mile range)	Grid Mix	230	2%
FCV	Natural Gas	200	15%

Further evidence of the inappropriateness of providing incentives for EVs, PHEVs, and FCVs while failing to do so for vehicles capable of operation on ethanol blends can be seen through even a cursory examination of the costs associated with these vehicles, their fuels, and the infrastructure required to supply those fuels.

Beginning with vehicle costs, as noted in the EPA proposal,[8] "owners of ethanol FFVs do not pay any more for the E85 fueling capability" that affords the

[7] The 11% reduction using GREET is conservative. EPA, in its RFS RIA, estimated a 20% reduction for the average corn ethanol dry mill in calendar year 2022.
[8] Page 75019

potential for "game-changing" reductions in GHG emissions. In contrast, although misguided subsidies and incentives may affect the prices consumers pay, the actual incremental costs at a retail cost level for EVs, PHEVs, and FVCs during the 2017 to 2025 time frame are expected to be thousands to tens of thousands of dollars. That this will be the case can be easily seen in Table 2 presented below which is taken (along with original footnotes) from a recently released California Air Resources Board (CARB) rulemaking document.[9] As shown, incremental costs for even subcompact vehicles in 2025 are forecast by CARB to remain at levels from around $7,500 to $11,000. This means that unlike the case with vehicles capable of operation on ethanol-blends, substantial costs will have to be incurred before EVs, PHEVs, and FCVs can even be hoped to be capable of providing "game-changing" reductions in GHG emissions.

Table 2

Table 5.4: Incremental technology package prices above average MY2016 baseline technology (2009$)[1]

Vehicle Class	Technology Package (energy capacity) [2]	Incremental Vehicle Price in 2016	Incremental Vehicle Price in 2025
Subcompact	PHEV20 [3] (6.6 kWh)	13,233	8,448
	PHEV40 (13.4 kWh)	16,580	10,259
	BEV75 [4] (23 kWh)	17,010	9,405
	BEV100 (30 kWh)	19,655	10,829
	FCV [5] (3.3 kg H_2)	19,060	7,513
Midsize car / Small MPV	PHEV20 (7.7 kWh)	13,807	8,876
	PHEV40 (15.5 kWh)	17,818	11,043
	BEV75 (27 kWh)	17,562	9,794
	BEV100 (35 kWh)	20,785	11,551
	FCV (3.8 kg H_2)	23,472	9,334
Large Car	PHEV20 (9.1 kWh)	17,280	11,205
	PHEV40 (18.7 kWh)	23,134	14,390
	BEV75 (30 kWh)	20,820	11,628
	BEV100 (40 kWh)	23,959	13,363
	FCV (4.3 kg H_2)	33,238	13,406

[1] Refer to the LEVIII ISOR Section III-A-4.3 and Appendix R for additional vehicle packages
[2] Energy capacity for BEV/PHEV is kWh rated battery pack capacity, kg H_2 for FCV
[3] EPA and NHTSA designation for a PHEV is a "range extended electric vehicle" or REEV.
[4] For BEVs and PHEVs, the residential charging equipment costs are included in these technology packages.
[5] FCV costs include the fuel cell system (as shown in later figures), the hydrogen storage system, the hybrid battery module, and other EV components and power electronics similar to the BEV technology package.

Another major factor with respect to vehicle costs for EVs, PHEVs, and FCVs are the durability of batteries and fuel-cells. Most analyses of EVs, PHEVs, and FCVS, including that associated with CARB's recent rulemaking (which used the

[9] Table 5.4 of California Air Resources Board, Staff Report: Initial Statement of Reasons, Advanced Clean Cars, 2012 Proposed Amendments to the California Zero Emission Vehicle Program Regulations, December 7, 2011.

same data that supports the NPRM) are based on two highly uncertain assumptions which are:

1. The useful lives of EVs, PHEVs, and FCVs will be the same as conventional vehicles in terms of miles travelled; and

2. Vehicle owners will not have to replace batteries or major fuel cell system components over the course of a vehicle's useful life.

Obviously if either shorter vehicle life or the need to incur replacement costs for batteries or fuel cell systems occurs, the costs associated with EV, PHEV and FCV will be even higher than described above making these vehicles even less likely to provide "game-changing" reductions in GHG emissions.

Turning to the costs of fuel, the production costs of ethanol are well known for corn derived ethanol and production costs for much lower carbon intensity ethanol produced from cellulosic sources are ultimately expected to be similar or lower than those associated with production from corn. The price of E85 and gasoline is expected to be similar to or lower than those associated with petroleum based fuels over the 2017 to 2025 period based on the latest fuel price forecasts from U.S. Energy Information Administration (EIA).[10] Therefore, it does not appear that there will be a significant fuel price related disincentive to operate FFVs on fuels other than E85. Moreover, as RFS volumes are ramped-up, as discussed in the next section, the additional ethanol beyond E10 will need to go into the available on-road FFVs. Therefore, ethanol vehicles do not have to overcome either vehicle price or fuel price barriers in order to provide "game-changing" reductions in GHG emissions.

In supporting the proposed credits for EVs and PHEVs, EPA notes[11] that "…electricity is considerably cheaper, on a per mile basis, than gasoline." While that may be true at present for electricity from the existing electrical grid and generation mix, it is not at all clear that will be the case for the electricity produced "…from low-GHG emissions feedstocks or from fossil feedstocks with carbon capture and sequestration" that EPA makes clear will need to be used to power EVs and PHEVs in order for them to provide "game-changing" reductions in GHG emissions. Generation costs for electricity from low-GHG sources or fossil-fired sources with carbon sequestration may be far higher than current generation costs and need to be carefully considered by EPA to the extent that decisions to provide incentives to EVs and PHEVs are based on the premise that electricity costs less than gasoline. Evidence that generation costs for low-GHG sources are likely to be higher than for existing plants can be seen, for example, in substantially higher capital cost estimates for those

[10] See http://www.eia.gov/forecasts/aeo/er/pdf/tbla3.pdf. In 2015 in later calendar years, the prices of E85 are projected to be lower on a BTU basis than gasoline.

[11] Page 75018

sources.[12] Again, construction and operation of these low-GHG electricity sources are a necessary condition that must be met in order for EVs and PHEVs to provide "game-changing" reductions in GHG emissions.

The situation with respect to fuel costs for hydrogen is far less clear than for electricity. Hydrogen dispensed as a transportation fuel for use in FCVs is currently more expensive than gasoline and even in large scale wide spread production, the cost of low-GHG hydrogen is going to be considerably higher than that of central steam reforming of natural gas.[13] Therefore, there will likely be substantial cost premiums associated with low GHG hydrogen that will have to be paid in order for FCVs to provide "game-changing" reductions in GHG emissions.

In order to put the fuel cost issues for EVs, PHEVs, and FCVs into perspective, the "Payback Calculator" developed by CARB for its recent rulemaking[14] was used to estimate the prices at which fuel costs for EVs and FCVs would equal those for gasoline vehicles based on low and average gasoline price forecasts which range from about $3.10 to $4.10 from 2017 to 2025. Using this CARB spreadsheet and its optimistic assumptions regarding EV and FCV energy efficiency, the electricity price at which electric vehicle fuel costs equal those for gasoline ranges from about $0.36 to $0.45 per kilowatt-hour while the hydrogen price ranges from about $7.50 to $9.00 per kilogram.

Although these prices for electricity and hydrogen may seem high relative to current electricity prices and prices for hydrogen produced using steam methane reforming at centralized plants, it should be recalled that they have to be compared to the prices that will be associated with electricity from marginal new ultra-low GHG generation capacity that would not otherwise be built and hydrogen production using ultra-low GHG processes. Given this, it is not at all clear that when proper cost accounting is made for ultra-low GHG electricity and hydrogen production that EVs, PHEVs, and FCVs will provide any meaningful fuel costs savings relative to conventional vehicles which in turn will create yet another hurdle to their ever providing "game-changing" reductions in GHG emissions.

Turning finally to the cost of refueling infrastructure, there will be costs associated with the development of a widespread distribution infrastructure for higher ethanol blends. However, that infrastructure will be integrated into the existing transportation fuel infrastructure in the U.S. and not require revolutionary changes to that infrastructure. Further, as ethanol blends will displace petroleum fuels, the capacity of the existing infrastructure will remain relatively constant.

---

[12] See for example, Figure 25 of "Renewable Power in California, Status and Issues, Staff Report, California Energy Commission, CEC-150-2011-002, August, 2011.
[13] Satyapal, S., "Overview of Hydrogen and Fuel Cells", U.S. Department of Energy, March 22, 2011.
[14] Available at http://www.arb.ca.gov/msprog/clean_cars/clean_cars_ab1085/clean_cars_ab1085.htm

Although it might seem that the situation would be similar with respect to the distribution of electricity for use by EVs and PHEVs, that is in fact not the case. First, there are direct costs associated with residential charging equipment (referred to as electric vehicle service equipment or EVSE) which EPA[15] has estimated range from about $1,300 to $1,500 for equipment and installation labor over the 2017 to 2025 period with the lower end of the range applying in the later years. These costs must be added on top of the already large incremental purchase prices of EVs and PHEVs.

Next there is the possibility that additional costs will be incurred to develop public EV and PHEV recharging infrastructure. While it is not clear that this infrastructure will be necessary, CARB will be studying the need for it and may at some point mandate its construction, and EPA may have to follow suit in the remainder of the nation. [16] Again, to the extent that public EV and PHEV recharging infrastructure does have to be constructed to improve the viability of these vehicles those costs will obviously also have to added to the ledger.

Another potentially substantial cost associated with the deployment of EVs and FCVs is the need to upgrade the existing electrical transmission and distribution system. This is a problem that is already facing California[17] that will almost certainly have to be dealt with across the country before EVs and PHEVs could even be hoped to provide "game-changing" reductions in GHG emissions.

FCVs face even more serious issues with respect to the development of refueling infrastructure. First, refueling stations will either have to be located in reasonably proximity to existing hydrogen production facilities and receive hydrogen by truck or pipeline or utilize expensive onsite hydrogen generation capability. In addition, there may be significant facility siting and permitting issues and concerns regarding the high pressures and special equipment required for FCV refueling.

Although EPA has not attempted to analyze the costs associated with the development of the hydrogen refueling infrastructure that will be required to support FCVs regardless of how the hydrogen they use is produced, CARB has performed an analysis that likely represents a "best case" scenario.[18] This analysis includes numerous optimistic assumptions regarding hydrogen station costs as well and assumes both that stations can be carefully located using knowledge of where FCVs will be sold and in general 100% utilization rates for hydrogen refueling stations. Even with these very optimistic assumptions, the direct capital costs for refueling

---

[15] Table 3-95, Draft Joint Technical Support Document.

[16] California Air Resources Board, Staff Report, Initial Statement of Reasons, Advanced Clean Cars, 2012 Proposed Amendments to the Clean Fuels Outlet Regulation, December 8, 2011.

[17] See http://www.energy.ca.gov/research/integration/transmission.html

[18] See the "H2 Station Cost Calculator" available at http://www.arb.ca.gov/msprog/clean_cars/clean_cars_ab1085/clean_cars_ab1085.htm

stations amount to about $1,700 per FCV over roughly the same period as the 2017 to 2025 period considered by EPA. Again, these costs have to be added on top of the already large incremental purchase costs for FCVs and must be incurred before it can even be hoped that FCVs will provide “game-changing” GHG reductions.

To summarize, EPA has proposed to provide incentives under the GHG regulation for EVs, PHEVs, and FCVs because according to EPA these vehicles have the potential to yield “game changing” reductions in GHG emissions. However, in order for those reductions to be realized the following things **all** have to occur:

1. The public (directly or indirectly) must be willing to pay substantially higher prices for these vehicles;

2. The public (directly or indirectly) must be willing to pay substantial costs in order to develop the infrastructure required to provide fuel to these vehicles;

3. The public must be willing (directly or indirectly) to pay the costs associated with low-GHG electricity and/or hydrogen, which are not likely to be substantially lower than the costs for petroleum based fuels.

In contrast, EPA has elected not to provide to incentives for vehicles capable of operating on ethanol blends despite the fact that they can provide “game changing” reductions in GHG emissions by being used in what are essentially conventional vehicles with little incremental cost for either the vehicles or the fuels using an existing refueling infrastructure that needs only to be modified to a fairly limited degree.

Given the above, it is clear that EPA’s policy on providing incentives under the GHG regulation makes little sense and must be modified to provide incentives for the use of ethanol blends that are at least commensurate with those provided with much less certain and much more expensive technologies.

EPA–HQ–OAR–2010–0799; FRL–9495–2; NHTSA–2010–0131
2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

Comments of Growth Energy

Attachment 2 (Flexible Fuel Vehicles)

EPA's current GHG proposal would have the effect of eliminating any meaningful incentives for vehicle manufacturers to produce flexible fuel vehicles (FFVs) capable of operation on both gasoline and ethanol for the 2016 and later model years. FFVs are the backbone of the federal Renewable Fuel Standard (RFS), as they are expected to consume most of the ethanol that is produced to meet the RFS after the on-road fleet is all operating on E10, a blend of 90% gasoline and 10% ethanol by volume. One important goal of the RFS program is to help the United States do its part to control GHG emissions. If vehicle manufacturers stop selling FFVs after 2016, the GHG benefits of the RFS program will be lower than currently anticipated. To address this potential problem, Growth Energy recommends that EPA/NHTSA develop and permit the use of E85 "usage factors" for FFVs utilizing volumes of ethanol projected by the U.S. Energy Information Agency, so that vehicle manufacturers can decide when developing their product plans whether to provide FFVs, and to create incentives for the manufacturers to do so. In these comments, we lay out a reasonable method of projecting these usage factors.

* * *

FFVs typically have GHG emissions on E85 that are approximately 5% below the GHG emissions on E0, but this can vary between 3-6%. [1]

Automakers currently sell FFVs because they receive fuel economy and GHG credits for these vehicles under EPA/NHTSA credit provisions, at least through model year 2015. Automakers can receive up to 1.2 miles per gallon in fuel economy credit against the applicable NHTSA CAFÉ standards through 2014. After 2014, this credit declines by 0.2 mpg per year until it is fully phased-out in 2020. EPA's GHG emission standards between 2012 and 2015 are consistent with the NHTSA fuel economy credit.

EPA's current rules for GHG emissions for 2016 model year FFVs, and its proposal for 2017 and later FFVs are found in the following discussion [2]:

[1] "Ethanol – the primary renewable liquid fuel", Datta, Maher, Jones, and Brinker, J. Chem Technol. Biotechnol. 2011; 86:473-480

> Beginning in MY 2016, EPA ended the GHG emissions compliance incentives and adopted a methodology based on demonstrated vehicle emissions performance. This methodology established a default value assumption where ethanol FFVs are operated 100 percent of the time on gasoline, but allows manufacturers to use a relative E85 and gasoline vehicle emissions performance weighting based on either national average E85 and gasoline sales data, or manufacturer-specific data showing the percentage of miles that are driven on E85 vis-à-vis gasoline for that manufacturers' ethanol FFVs. EPA is not proposing any changes to this methodology for MYs 2017-2025.

Regarding current national average E85 use by FFVs, EPA states[3]:

> The data confirm that, on a national average basis for 2008, less than one percent of the ethanol FFVs used E85.

The reason for the low adoption rate of E85 is that the E10 market was the first to consume all the available ethanol. Only now do we have more ethanol supply than is needed for E10 demand, so adoption rates should increase.

The vast majority of FFVs are sold to the general public (and not fleets that may have more control over fuel type), and it would be very difficult for manufacturers to determine the fraction of use on E85 for these vehicles. Under either current EPA requirements for 2016 vehicles or the proposed EPA requirements for 2017 and later vehicles, manufacturers would have to certify FFVs on 100% gasoline, or under the EPA proposal, use some national average E85 use, which as EPA indicates is still quite low. Since FFVs have a non-zero cost, but are assumed to have zero or very near zero benefit under either California or EPA requirements, the chances of automakers providing FFVs after 2016 is also zero, or near zero. [4]

EPA expected that when they required model year 2016 FFVs to demonstrate use on E85, that this would provide incentive for automakers to optimize their FFVs on E85[5]:

> However, if a manufacturer can demonstrate that a portion of its FFVs are using an alternative fuel in use, then the FFV emissions compliance value can be calculated based on the vehicle's tested value using the alternative fuel, prorated based on the percentage of the fleet using the alternative fuel in the field….EPA believes this approach will provide an actual incentive to ensure that such fuels are used. The incentive arises since actual use of the flexible fuel typically results

---

[2] Federal Register/ Vol. 76, No 231/Thursday, December 1, 2011/Proposed Rules, page 75019
[3] Ibid.
[4] The fact that they may have a non-zero CAFÉ credit until 2020 will mean little if there is no credit under GHG requirements.
[5] Federal Register / Vol. 75. No. 88 / Friday, May 7, 2010/Rules and Regulations, 25433

in lower tailpipe GHG emissions than use of gasoline and hence improves the vehicles' performance, making it more likely that its performance will improve a manufacturers' average fleetwide performance. Based on existing certification data, E85 FFV CO_2 emissions are typically about 5 percent lower on E85 than CO_2 emissions on 100 percent gasoline. Moreover, currently there is little incentive to optimize CO_2 performance for vehicles when running E85. EPA believes the above approach would provide such an incentive to manufacturers and that E85 vehicles could be optimized through engine redesign and calibration to provide additional CO_2 reductions.

Manufacturers typically utilize at least a four-year lead-time in designing vehicles, therefore, in 2012 most manufacturers are working with the 2016 model year.[6] While such an approach as outlined by the EPA above could provide incentive for manufacturers to optimize 2016 model year FFVs on E85, if they have no idea or guidance from the EPA what E85 use could be in 2016, and current use is close to zero, then it does not matter how much they optimize FFVs on E85, a larger GHG benefit times a current zero usage factor is still zero.

While current E85 refueling frequencies are quite low, EPA is counting on FFVs to use a significant amount of E85 due to the Renewable Fuel Standard requirements, which expand biofuel use in the U.S. to 36 billion ethanol equivalent gallons per year by calendar year 2022. EPA projected a range of ethanol volumes in the RFS, a "low", "mid" and "high".[7] Figure 1.7-11 from the RFS Regulatory Impact Analysis shows necessary FFV E85 refueling rates in the future with the RFS. In 2016, FFV E85 refueling rates are between 38% and 55%, and increase to 40% to 70% by 2020.

The E85 refueling rates shown in Figure 1 were estimated by EPA with the 2012-2016 GHG emission standards, but without the 2017-2025 GHG emission standards. If the 2017-2025 GHG emission standards were included, the E85 refueling rates would be higher than shown in Figure 1. For model year 2016, Figure 1 implies E85 usage factors of between 40-50%. The usage factors between for model years 2017-2020 would be higher because the fuel economy of the 2017-2020 model year vehicles would be higher than was used by EPA to produce Figure 1.

[6] Assessment of Fuel Economy Technologies for Light-Duty Vehicles, National Research Council, (page 109) 2011

[7] Renewable Fuel Standard (RFS) Regulatory Impact Analysis, EPA-420-R-10-006 February 2010.

Figure 1

Figure 1.7-11.
Necessary FFV E85 Refueling Rates
(Given 1-in-4 Access to Fuel)

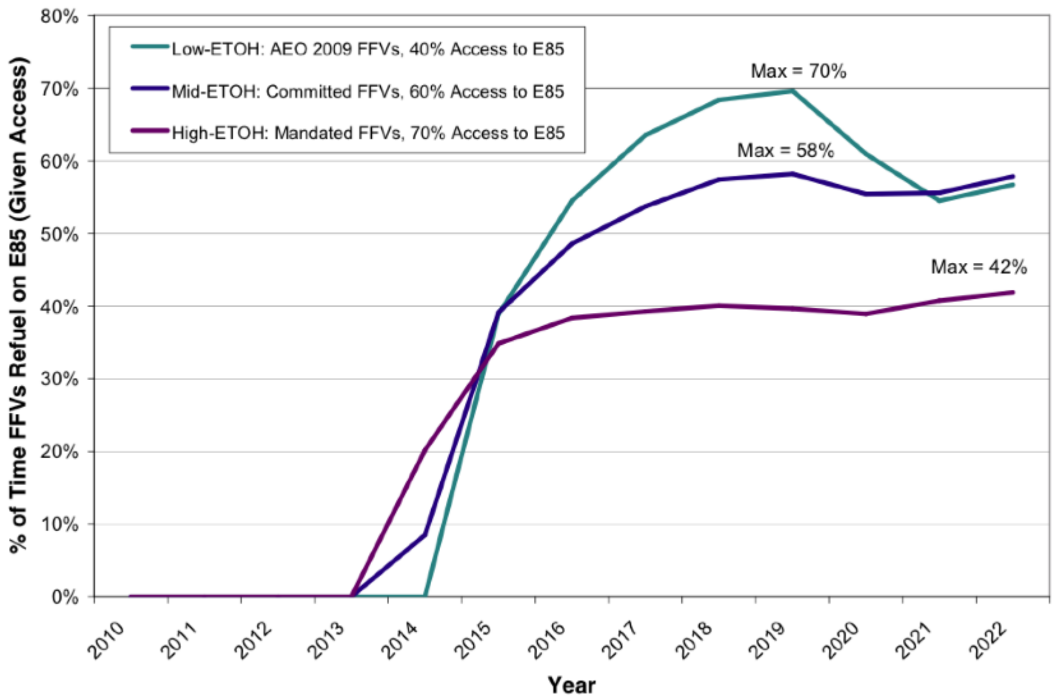


Figure 2 shows the Energy Information Agency's projection of ethanol volume in the AEO2011 forecast.[8] We also show the ethanol volume predicted in the latest AEO2012 Early Release forecast.[9] EIA's 2011forecast is very close to EPA's mid level case through 2023, and then goes much higher than the EPA mid case. The early release 2012 forecast is between the low case and the mid case prior to 2028, and higher than EPA's mid case after then.

[8] Annual Energy Outlook 2011, Report No. DOE/EIA-0383 (2011)
[9] Annual Energy Outlook 2012 Early Release Overview, http://www.eia.gov/forecasts/aeo/er/index.cfm.

Figure 2

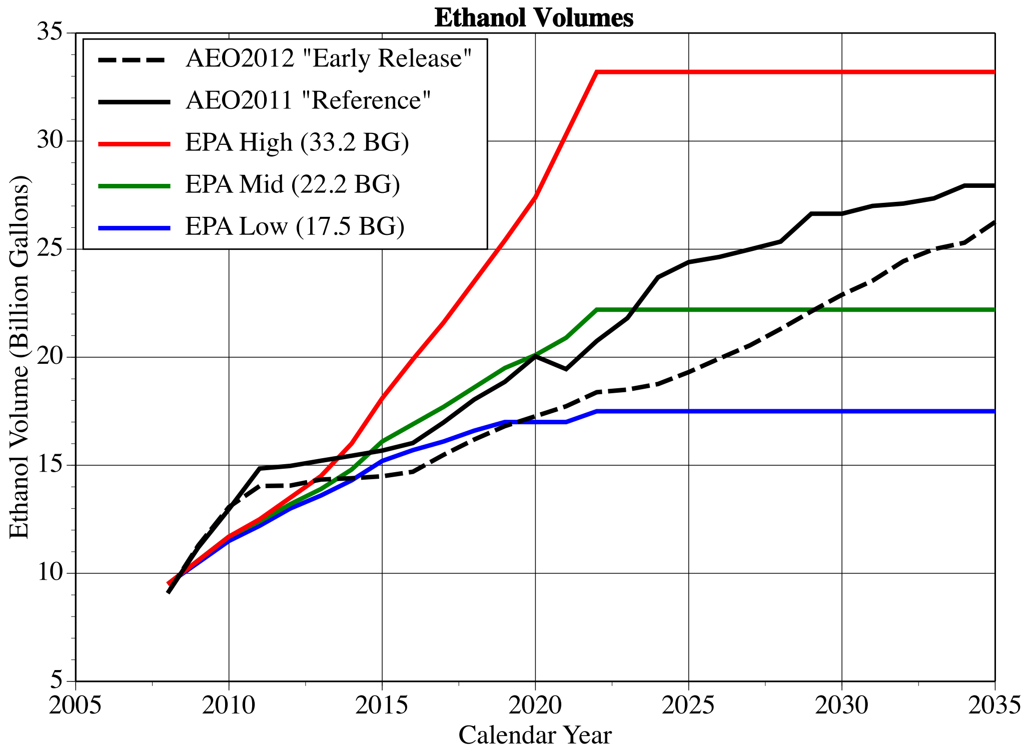
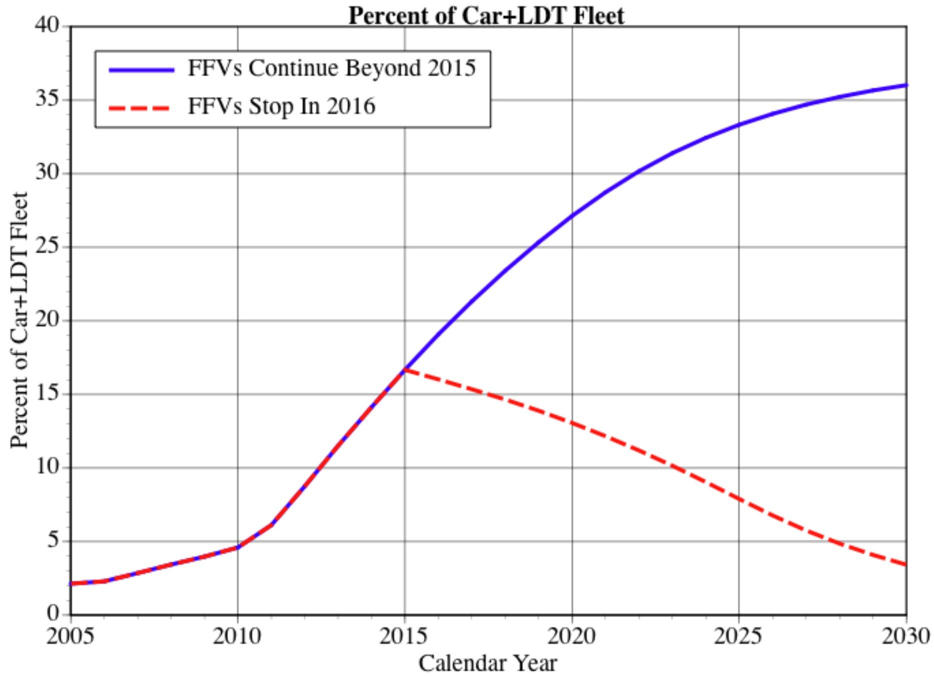


Figure 3 shows FFV fractions of the national on-road car + LDT fleet from 2010 through 2030 with two assumptions – that FFV sales would continue at about 23% from 2012 on, and that FFV sales stop in 2016. In 2020, if FFV sales continue, then 25% of the on-road fleet would be FFVs. Alternatively, if FFV sales stop in 2016, then only 12% of the fleet would be FFVs in 2020. Clearly, if FFV sales stop in 2016, it may be difficult for the FFV fleet to absorb RFS ethanol volumes.

Figure 3 FFV Percent of On-Road Car + LDT Fleet



EPA's RFS benefits analysis depends on E85 being consumed to claim GHG benefits under these rules. And yet, EPA is not rolling these use projections into its guidance on FFVs to the manufacturers so they can continue to build FFVs to support the RFS. Thus, EPA should either provide guidance to the manufacturers on likely E85 use in the 2016-2025 timeframe, or EPA should downgrade the GHG benefits of the RFS due to lack of availability of FFVs, and charge these benefit downgrades against their current GHG proposal.

Growth Energy therefore recommends that EPA develop new default projections of E85 use based on EPA's projections of overall ethanol volumes that will be required under EISA. These projections should also incorporate the Agencies' new fuel economy levels for 2017-2025. The projections should be provided to the auto industry as usage factors so that they can make a clear determination of whether to optimize FFVs on E85 and whether to continue building FFVs after model year 2015. A further projection to calendar year 2025 can be made around calendar year 2016.

EPA–HQ–OAR–2010–0799; FRL–9495–2; NHTSA–2010–0131
2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards

Comments of Growth Energy

Attachment 3 (Fuel Parameters and Cost-Benefit Analysis)

This Attachment explains why, in the Joint NPRM, the Agencies should have thoroughly examined the impacts of new technologies used to meet the GHG standards on PM emissions. There are many studies that indicate that gasoline direct injection, a technology which will be used to meet the GHG standards, will increase both particulate matter mass and particulate number emissions. The Agencies need to consider an alternative approach, which would include fuel parameter changes that could enable additional engine technologies to be used to improve efficiency and reduce emissions. The Agencies' proposal requires new technology to be used on vehicles using old technology fuels. It has long been recognized that vehicles and fuels operate as a system. To undertake significant changes and increases in the stringency of tailpipe GHG standards without a parallel and integrated examination of potential changes in the fuel used by these vehicles is inappropriate.

Growth Energy recommends enforceable requirements for the gasoline marketing industry in the U.S. that will ensure the commercial availability of gasolines that have an octane value of 94, for use in optimizing the GHG performance of new vehicles certified to the proposed GHG emission standards. Growth Energy's proposal would provide for a certification and in-use fuel for 2017 and later vehicles with an octane value of 94, accomplished with E30 instead of E10. This fuel would only be intended for the 2017+ vehicles, and not the legacy fleet (2016 and earlier), although legacy FFVs could also use it if doing so was consistent with the vehicle manufacturers' instructions or recommendations to owners and approved by the Agencies on that basis. The non-FFV legacy fleet (i.e., Tier 1, Tier 2, and LEVs in Section 177 states) would continue to operate on E10.

It is important that the increase in octane be accomplished with ethanol and not other gasoline blending components because of ethanol's many advantages relative to the other high octane blending components as explained below. Ethanol has a very high octane number relative to other gasoline hydrocarbons, has a lower carbon content than the gasoline components it generally replaces, and has many other benefits that assist in combustion to increase engine efficiency and reduce both tailpipe GHG and criteria pollutant emissions. The use of a 94 octane E30 blend for 2017+ vehicles would also provide additional GHG and PM emission reductions in the U.S., greater than could be achieved by the current Agencies' proposal. We note that some vehicle manufacturers have also requested that EPA study higher octane fuels as a part of the GHG program, and have also recommended continued control of multi-substituted alkyl aromatics, since they can lead to increased HC and PM emissions. [1]

I. Relevant Emissions Impacts

The Joint NPRM includes extensive discussion of the technologies, costs, and benefits of the proposal, seeking comments on many aspects of the proposal. In addition, EPA "seeks comment on whether there are any other health and environmental impacts associated with advancements in vehicle GHG reduction technologies that should be considered."[2] These are the salient points:

- EPA and NHTSA project widespread use of gasoline direct injection (GDI) in meeting the proposed CAFÉ and GHG standards.
- There is substantial evidence that GDI increases PM mass and PM number emissions compared to the conventional port fuel injection (PFI) technology now in widespread use.
- There is also substantial evidence that increased ethanol use will decrease PM mass and PM number emissions from the affected vehicles.
- The EPA and NHTSA proposal does not account for the increased PM emissions from GDI technology.
- The benefits from the proposal are sensitive to the PM effects assumed by the Agencies.
- Therefore, the final rule should evaluate and consider both the increased PM due to GDI use and the potential for more widespread ethanol use to decrease PM mass and number emissions.

A. EPA and NHTSA project widespread use of gasoline direct injection (GDI) in meeting the proposed CAFÉ and GHG standards.

The proposed rule discusses technologies that can increase fuel economy, indicating that many of the technologies are already available, and that manufacturers will be able to meet the standards through significant efficiency improvements in these technologies as well as a significant penetration of these technologies across the fleet.[3]

[1] California LEVIII E10 Gasoline Certification – Alliance Fuels Group Position, Alliance of Automobile Manufacturers, September 8, 2010.
[2] 76 Federal Register 74854, December 1, 2011, at 75112.
[3] Ibid., at 74860.

The proposed rule indicates:[4]

> There are a number of competing gasoline engine technologies, with one in particular that the agencies project will be common beyond 2016. This
> is the gasoline direct injection and downsized engines equipped with turbochargers and cooled exhaust gas recirculation, which has performance characteristics similar to that of larger, less efficient engines.

The Joint NPRM also provides estimates of the penetration of various technologies in 2021 and 2025. GDI penetrations are forecast to be greater than 90 % in both cars and trucks by 2025 as shown in Tables III-42 and III-43.[5] Therefore, widespread use of GDI is one of the technologies that the Agencies are relying on in the proposal.

B. There is substantial evidence that GDI increases PM mass and PM number emissions compared to the conventional PFI technology now in widespread use.

A recent Myung and Park review of nano-particle emissions from internal combustion engines[6] indicates that GDI engines produce considerably more particles than conventional port fuel injection ones and that "much of the research indicates that GDI engines produce significantly more particulates than conventional PFI engines, especially during the cold start phase and during stratified operation." Myong and Park provide numerous references to support their findings, including textbooks, literature surveys, research studies using single-cylinder and multi-cylinder engines in which various parameters can be changed, measurements from production engines, and studies of various potential aftertreatment systems.

The California Air Resources Board (CARB) in 2010 acknowledged that GDI increased PM mass and number emissions substantially. The CARB report[7] indicated "GDI technology tends to have higher PM mass and particle number emissions than conventional PFI technology." The CARB report noted that the published literature points to GDI PM mass emissions in the range of 2 to 20 mg/mi, and indicated that, if not abated, the GDI combustion system has the potential to emit two to eight times more PM mass than PFI vehicles.

Szybist et al., 2011[8] also report that "while gasoline DI technology is beneficial for

[4] Ibid., at 74860, footnote 12.
[5] Ibid., at page 75066.
[6] C. Myung and S. Park, Exhaust Nanoparticle Emissions From Internal Combustion Engines: A Review, *International Journal of Automotive Technology*, Vol. 13, No. 1, pp. 9−22 (2012), at page 11.
[7] State of California Air Resources Board. Preliminary Discussion Paper—Proposed Amendments to California's Low-Emission Vehicle Regulations—Particulate Matter Mass, Ultrafine Solid Particle Number, and Black Carbon Emissions; State of California Air Resources Board: Sacramento, CA, 2010.
[8] J. Szybist, A. Youngquist, T. Barone, J. Storey, W. Moore, M. Foster, and K. Confer,

fuel economy, it produces an increase in particulate matter emissions in comparison to PFI engines" and provide several references to support that fact. Maricq also notes the DI PM issue:[9]

> GDI engines offer a number of opportunities for improved fuel efficiency, such as reduced pumping losses, charge air cooling, and downsizing when turbocharged. But, direct injection of fuel into the engine cylinder is susceptible to incomplete fuel evaporation and to fuel impingement on piston and cylinder walls, both of which lead to combustion of liquid fuel and, consequently, to increased PM emissions.

A recent report by the Health Effects Institute's Special Committee on Emerging Technologies[10] states that the need to improve fuel economy and the need to reduce GHG emissions are driving the introduction of gasoline direct injection (GDI) technology because it improves fuel economy and performance. They state GDI is more expensive than the port fuel injection (PFI) system that it is replacing. They also point out that because of less complete mixing of the fuel vapor and air in GDI systems, particulate emissions of the engine increase, including the number of ultrafine particles (UFPs defined as particles that are less than 100 nanometers (nm) in diameter). Thus additional technological fixes may be required to meet the Tier 2 $PM_{2.5}$ emission standards for GDI vehicles which would incur additional costs. More recently, similar concerns were echoed by Ayala, Brauer, Mauderly and Samet.[11]

With respect to current production vehicles, Piock et al., 2011[12] present results for particle number and particle mass for a number of production European vehicles that meet the Euro 4 (2005) standards in their Figure 1. The seven GDI vehicles have an order of magnitude higher PM mass and PM number emissions than do the three PFI vehicles.

Because a limit on PM number emissions is under discussion for implementation in 2014 in Europe, effort toward understanding and reducing PM mass and PM number emissions from GDI engines is underway. There are two basic approaches on the

---

Ethanol Blends and Engine Operating Strategy Effects on Light-Duty Spark-Ignition Engine Particle Emissions, *Energy and Fuels*, vol. 25, pp. 4977-4985 (2011).

[9] M. Matti Maricq, Soot formation in ethanol/gasoline fuel blend diffusion flames, *Combustion and Flame*,159 (2012) 170–180.

[10] HEI Special Committee on Emerging Technologies, 2011, "The Future of Vehicle Fuels and Technologies: Anticipating Health Benefits and Challenges," HEI Communication 16, February 2011.

[11] Ayala, A., Brauer, M., Mauderly, J.L. and Samet, J.M., 2011, Air pollutants and sources associated with health effects, *Air Qual. Atmos. Health,* DOI 10.1007/s11869-011-0155-2.

[12] W. Piock, G. Hoffmann, A. Berndorfer, P. Salemi, and B. Fusshoeller, Strategies Towards Meeting Future Particulate Matter Emission Requirements in Homogeneous Gasoline Direct Injection Engines, SAE paper 2011-01-1212.

vehicle, (1) optimization of hardware and engine control parameters to reduce the PM emitted by the engine, and (2) aftertreatment particulate filters. It is not clear how successful either of these approaches can be. With manufacturers under strong incentives to optimize engines for fuel economy and cost, optimization for minimum PM mass and number emissions may conflict with optimization for fuel economy or may add additional cost for hardware and development. With regard to particulate filters, Piock et al. indicate:

> In principle, particulate filters already in standard use on modern Diesel engine powered passenger cars can be applied to gasoline engines as well. The typically smaller particles generated by gasoline engines require a finer filter characteristics (e.g. cell density, mean pore size and porosity) which consequently leads to a higher exhaust system backpressure with a negative impact on performance, fuel consumption and CO_2 emissions. The addition of a particulate filter system would cause a significant increase of the overall after-treatment system complexity and cost.

The proposed rule is silent on the potential increase in PM mass and number emissions due to the widespread use of GDI. As noted above, this is a major oversight. EPA and NHTSA have an obligation to insure that any new fuel or technology developed for transportation must not adversely impact health or the environment.

C. Increased ethanol use can decrease PM emissions

There is substantial evidence that increased ethanol use will reduce PM mass and number emissions from the vehicle fleet. Szybist et al., 2011 also summarize recent literature for ethanol effects in production engines:[13]

> A number of investigations have examined the effect of ethanol content on particle emissions in vehicles. Storey et al. found that blends of 10 and 20% ethanol in gasoline (E10 and E20) decreased particle number emissions during vehicle drive cycles, with the 20% blend decreasing particles by about 40% during the high-load US06 vehicle drive cycle. In comparison to gasoline, He et al. found a 20% reduction in particle emissions with E20 but no change with E10. Khalek and Bougher showed that E10 increased particle emissions compared to two different gasoline formulations, both with higher volatility than the E10. This work showed the importance of the hydrocarbon fraction of the E10 blend and suggests that the heavier hydrocarbons used to control vapor pressure of E10 may also increase particulate emissions. Aakko and Nylund found that the particle mass emissions from 85% ethanol (E85) were comparable to those with gasoline in a PFI vehicle but that DI (direct injection) fueling with gasoline produced particle emissions that were an order of magnitude higher. (reference numbers omitted)

[13] Szybist et al., supra note 8.

The Szybist et al. study investigated the effects of fuel type, fueling strategy, and engine breathing strategy on particle emissions in a flexible spark ignited engine that was designed for optimization with ethanol. They report:

> When DI fueling is used for gasoline and E20, the particle number emissions are increased by 1 to 2 orders of magnitude compared to PFI fueling, depending upon the fuel injection timing. In contrast, when DI fueling is used with E85, the particle number emissions remain low and comparable to PFI fueling. Thus, by using E85, the efficiency and power advantages of DI fueling can be gained without generating the increase in particle emissions observed with gasoline and E20. The main finding of the study is that use of E85 results in 1 to 2 orders of magnitude reduction in particle emissions relative to sDI (spray-guided DI) fueling with gasoline and E20. Furthermore, sDI particle emissions with E85 are similar to that for PFI fueling with gasoline. Thus, an increase in particle emissions beyond that of PFI engines can be prevented while gaining the efficiency of DI engines using E85.

Storey et al., 2010[14] characterized the emissions, including PM and aldehydes, from a U.S. legal stoichiometric direct injected spark ignited (DISI) vehicle operating on E0, E10, and E20. The PM emissions were characterized for mass, size, number concentration and OC-EC (organic carbon-elemental carbon) content. The DISI particle number-size distribution curves were similar in shape to light-duty diesel vehicles without Diesel Particle Filters, but had lower overall particle number and mass emissions. The aggressive US06 transient cycle had much higher PM mass emissions in comparison to the PM mass emission observed for the FTP. With respect to added ethanol, Storey et al. concluded:

> Ethanol blends reduced the PM mass and number concentration emissions for both transient and steady-state cycles. By increasing the ethanol blend level from E0 to E20, the average mass emissions declined 30% and 42% over the FTP and US06, respectively. Measurements during hot cycle transient operation demonstrated that E20 also lowered particle number concentrations. The adoption of small displacement, turbocharged DISI engines into the U.S. fleet is likely to continue in the future, and the results of this study suggest that increasing ethanol blend levels in gasoline will lower DISI PM emissions. In addition, increasing ethanol content significantly reduced the number concentration of 50 and 100 nm particles during gradual and wide open throttle (WOT) accelerations.

Maricq et al., 2012[15] tested a light-duty truck equipped with a 3.5-L V6 gasoline

---

[14] J. Storey, T. Barone, K. Norman, and S. Lewis, Ethanol Blend Effects On Direct Injection Spark-Ignition Gasoline Vehicle Particulate Matter Emissions, SAE publication 2010-01-2129.

[15] M. Maricq, J. Szente, and K. Jahr (2012): The Impact of Ethanol Fuel Blends on PM Emissions from a Light-Duty GDI Vehicle, *Aerosol Science and Technology*, 46:5, 576-583.

turbocharged direct injection engine that is representative of current GDI products, but contained prototype elements that allowed changes in engine calibrations. Because PM formation in GDI engines is sensitive to a number of operating parameters, two engine calibrations were examined to gauge the robustness of the results. The study used four fuels: certification test gasoline (E0), a commercial E10 fuel similar to that expected for future certification, a commercial pump grade E10, and a commercial E100 fuel used for blending. E100 and E0 were splash-blended to produce E17, E32, and E45 fuels. Maricq et al. report:

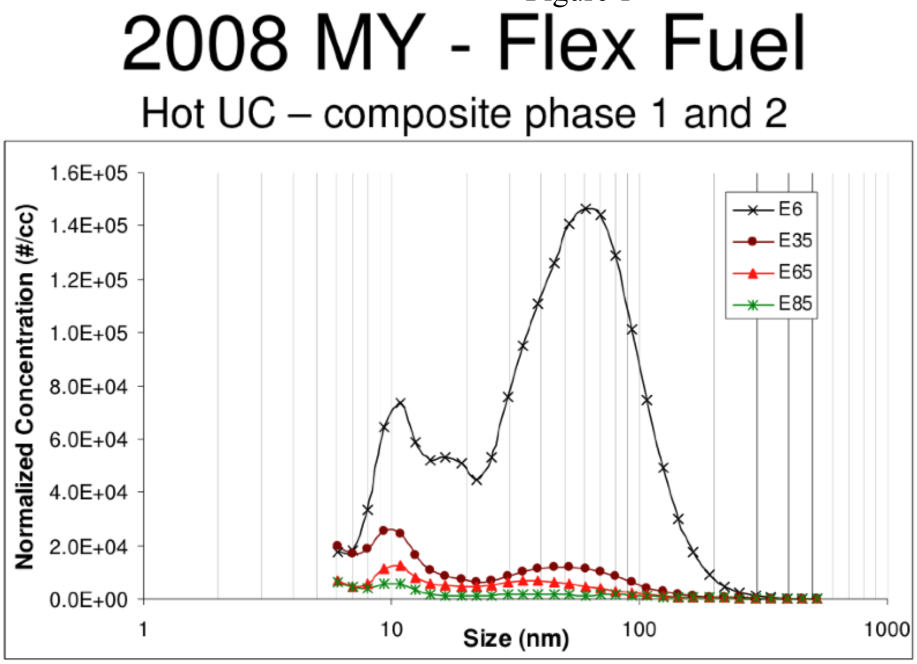
> As the ethanol level in gasoline increases from 0% to 20%, there is possibly a small (<20%) benefit in PM mass and particle number emissions, but this is within test variability. When the ethanol content increases to >30%, there is a statistically significant 30%–45% reduction in PM mass and number emissions observed for both engine calibrations.

The results reported by Zhang [16] are also particularly informative. The key results are shown in Figure 1 below. In this testing, a 2008 FFV was tested on a hot Unified Cycle on E6, E35, E65, and E85. Ethanol appears to have caused a large reduction in PM emissions (an particularly PN) from E6 to E35, with further PM reductions as ethanol concentration increased. However, the most significant PM and PN reductions are between E6 and E35.

---

[16] Zhang et al, "A Comparison of Total mass, Particle Size Distribution and Particle Number Emissions of Light Duty Vehicles tested at Haagen-Smit Laboratory from 2009 to 2010," In *Proceedings of 21st CRC Real World Emissions Workshop*, San Diego, CA, USA, 20–23 March 2011.

Figure 1



Ethanol Fuel	PM mg/mile	PN 10^{12} #/mile
E6	1.60	4.70
E35	N/A	0.70
E65	0.60	0.30
E85	0.27	0.14

Thus, there are now a substantial number of studies showing that ethanol blends of 20 % and higher reduce PM mass and number emissions in a variety of engines and vehicles.

In addition to the evidence that increased ethanol use will reduce PM mass and number, the Agencies acknowledge that the proposal will increase the fraction of the U. S. fuel supply that is made up of renewable fuels. The proposal indicates:[17]

> For the purposes of this emission analysis, we assume that all gasoline in the timeframe of the analysis is blended with 10 percent ethanol (E10). However, as a consequence of the fixed volume of renewable fuels mandated in the RFS2 rulemaking and the decreasing petroleum consumption predicted here, we anticipate that this proposal would in fact increase the fraction of the U.S. fuel supply that is made up by renewable fuels.

D. The EPA and NHTSA proposal does not account for the increased PM emissions from GDI technology

---

[17] Fed. Reg., supra note 2, at 75103.

Despite the evidence that widespread use of GDI may increase PM emissions, the proposal does not address the issue. The proposal does note that:

> EPA has the discretion under the CAA to consider many related factors, such as the availability of technologies, the appropriate lead time for introduction of technology, and based on this the feasibility and practicability of their standards; the impacts of their standards on emissions reductions (of both GHGs and non-GHGs);[18]

The Joint NPRM considers several impacts of the proposal on non-GHGs, both positive and negative. For example, the analysis evaluates the impact that reductions in domestic fuel refining and distribution due to lower fuel consumption will have on U.S. emissions of various pollutants. In addition, the analysis evaluates the increase in emissions from additional vehicle use associated with the rebound effect from higher fuel economy. As the various positive and negative impacts on non-GHGs and considered, the proposal indicates:[19]

> Thus the net effect of stricter CAFE standards on emissions of each pollutant depends on the relative magnitudes of its reduced emissions in fuel refining and distribution, and increases in its emissions from vehicle use.

However, there is no discussion in the in the proposal indicating that EPA considered whether the technologies assumed in the proposal would increase non-GHG emissions. This is an important oversight. Instead, EPA merely assumed that they would not. For example, the proposal indicates:[20]

> The agencies' analysis assumes that the per-mile emission rates for cars and light trucks produced during the model years affected by the proposed rule will remain constant at the levels resulting from EPA's Tier 2 light duty vehicle emissions standards.

Thus, EPA assumed there would be no impact of the fuel economy technologies on non-GHG or air pollutant emissions. In this regard, it is important to note that NHTSA's draft Environmental Impact Statement (DEIS) does not comply with the National Environmental Policy Act (NEPA). The DEIS notes that "complex" factors determine how the proposed standards will affect criteria or precursor emissions and air toxics. [21]

---

[18] Ibid., at 74903.
[19] Ibid., at 74899.
[20] Ibid., at 74933.
[21] The DEIS states:

> "The increases and decreases in [criteria and toxic air pollutant] emissions reflect the complex interactions among tailpipe emission rates of the various vehicle types, the technologies assumed to be incorporated by manufacturers

One aspect of these "complex interactions" that certainly merits attention is the potential effect of technological innovation on criteria and toxic pollutants, in the absence of improved in-use fuel standards. As HEI's February 2011 study noted, the use of GDI technology increases some current gasolines' particulate emissions.[22] Without NHTSA having directly addressing that study in the DEIS, the Agencies simply note in the NPRM that "the net effect of stricter standards on emissions of each criteria pollutant depends on the relative magnitudes of reduced emissions from fuel refining and distribution, and increases in emissions resulting from added vehicle use." 76 Fed. Reg. at 74,933. That cursory observation does not meet the requirements of NEPA for a "thorough investigation" and a "candid acknowledgment" of risks. *Nat'l Audubon Soc. v. Dept. Navy*, 422 F.3d 174, 185 (4th Cir. 2005; *see also Natural Resources Defense Council, Inc. v. Morton*, 458 F.2d 827, 838 (D.C. Cir. 1972); *Kleppe v. Sierra Club*, 427 U.S. 390, 410 fn. 21 (1976); *'Ilio'ulaokalani Coalition v. Rumsfeld*, 464 F.3d 1083, 1094 (9th Cir. 2006; *accord, Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1223 (9th Cir. 2008).

II. Potential Fuel Parameter Changes

A. Background

In the Joint NPRM EPA did not evaluate potential fuel quality changes in the GHG proposal. The proposed rule contains the following discussion with respect to the Tier 3 standards and possible fuel changes: [23]

> In the May 21, 2010 Presidential Memorandum, in addition to addressing GHGs and fuel economy, the President also requested that EPA examine its broader motor vehicle air pollution control program. The President requested that ''[t]he Administrator of the EPA review for adequacy the current nongreenhouse gas emissions regulations for new motor vehicles, new motor vehicle engines, and motor vehicle fuels, including tailpipe emissions standards for nitrogen oxides and air toxics, and sulfur standards for gasoline. If the Administrator of the EPA finds that new emissions regulations are required, then I request that the Administrator of the EPA promulgate such regulations as part of a comprehensive approach toward regulating motor vehicles.'' [24]

> in response to the proposed standards, upstream emission rates, the relative proportions of gasoline and diesel in total fuel consumption reductions, the proportion of electric vehicles in the passenger car and light truck population, and increases in VMT."

DEIS at S-13.

[22] Health Effects Institute, Communication 16: The Future of Vehicle Fuels and Technologies: Anticipating Health Benefits and Challenges (Feb. 2011). *See id*. at 3-5.

[23] The 3 footnotes in this section are from the EPA proposal

[24] The Presidential Memorandum is found at: http://www.whitehouse.gov/the-press-office/ presidential-memorandum-regarding-fuel-efficiency-standards.

EPA is currently in the process of conducting an assessment of the potential need for additional controls on light-duty vehicle non-GHG emissions and gasoline fuel quality. EPA has been actively engaging in technical conversations with the automobile industry, the oil industry, nongovernmental organizations, the states, and other stakeholders on the potential need for new regulatory action, including the areas that are specifically mentioned in the Presidential Memorandum. EPA will coordinate all future actions in this area with the State of California.

Based on this assessment, in the near future, EPA expects to propose a separate but related program that would, in general, affect the same set of new vehicles on the same timeline as would the proposed light-duty GHG emissions standards. It would be designed to address air quality problems with ozone and PM, which continue to be serious problems in many parts of the country, and light-duty vehicles continue to play a significant role.

EPA expects that this related program, called ''Tier 3'' vehicle and fuel standards, would among other things propose tailpipe and evaporative standards to reduce non-GHG pollutants from light-duty vehicles, including volatile organic compounds, nitrogen oxides, particulate matter, and air toxics. EPA's intent, based on extensive interaction to date with the automobile manufacturers and other stakeholders, is to propose a Tier 3 program that would allow manufacturers to proceed with coordinated future product development plans with a full understanding of the major regulatory requirements they will be facing over the long term. This coordinated regulatory approach would allow manufacturers to design their future vehicles so that any technological challenges associated with meeting both the GHG and Tier 3 standards could be efficiently addressed.

It should be noted that under EPA's current regulations, GHG emissions and CAFE compliance testing for gasoline vehicles is conducted using a defined fuel that does not include any amount of ethanol. [25] If the certification test fuel is changed to some ethanol-based fuel through a future rulemaking, EPA would be required under EPCA to address the need for a test procedure adjustment to preserve the level of stringency of the CAFE standards. [26] EPA is committed to doing so in a timely manner to ensure that any change in certification fuel will not affect the stringency of future GHG emission standards.

The discussion indicates EPA will evaluate changes to certification fuel in Tier 3, and if there are changes made to this certification fuel, that EPA would be required under EPCA to preserve the stringency of the GHG standards. Thus, EPA acknowledges that certification fuel has an effect on GHG emissions, and therefore also acknowledges that

[25] See 40 CFR 86.113–94(a).

[26] EPCA requires that CAFE tests be determined
from the EPA test procedures in place as of 1975, or procedures that give comparable results. 49 USC 32904(c).

vehicles and fuels operate as a system, not only for the critieria pollutants like PM and NOx, but also GHGs. And yet, EPA did not evaluate changes in fuel for the GHG rule. Growth Energy believes that because vehicles and fuels are obviously inseparable when it comes to both criteria pollutants and GHG emissions, that the Agencies should have evaluated both changes to vehicles and fuels for the GHG rule.

EPA has not yet published its Tier 3 proposal, and it is possible that EPA will propose new certification fuel requirements that directly affects the ability of automakers to meet the GHG requirements. Therefore, new certification fuels should have been examined in the GHG requirements, and it is in this context that Growth Energy proposes a new certification *and* in-use fuel for 2017 and later cars and light duty trucks. We believe that EPA and the Agencies should examine this proposed certification and in-use fuel as an alternative in developing the final GHG/CAFÉ rules for 2017-2025 vehicles.

B. Growth Energy's Proposal

Growth Energy's proposal for 2017 certification fuel is shown in Table 3. This certification fuel is essentially the same as the Alliance of Automobile Manufacturer's proposal to CARB, but with the addition of 20 volume percent more ethanol, so that octane is higher, the distillation parameters are changed, and other parameters are lower by dilution.

Table 3. Growth Energy's 2017+ Certification Fuel Proposal

Property	Growth Energy Proposal
Octane (min - AKI or FON)	94
Sulfur (ppm)	7-8, max.
RVP (psi)	6.2-6.8
Total Aromatics (vol %)	12-16
Multi Substituted Alkyl Aromatics (vol %)	10, max.
Olefins	4
T50	150-190
T90	280-295
Benzene	0.4
Oxygen (wt %)	10-10.5
Ethanol (vol %)	29.5 – 30.5

Fuel marketers would be required to produce fuel that would be similar to this proposed fuel for 2017+ vehicles.[27] In conventional areas of the U.S., it would meet EPA's sulfur, MSAT and RVP regulations, but still have 94 octane and 30% ethanol. In reformulated gasoline areas, it would meet the requirements of the RFG regulations, the

[27] Subject to approval/oversight by EPA and others, E30 could be marketed to FFVs prior to calendar year 2017. Current FFV customers probably often have E30 in their fuel tanks if they switch back-and-forth between E85 and E0.

low sulfur regulations, and the MSAT and RVP regulations, but otherwise have 94 octane and 30% ethanol.

Most of the U.S. already has E10, so both RFG and conventional fuel already contains E10 for the current fleet. Adding 20% more ethanol to these fuels would increase octane, reduce sulfur, reduce RVP, reduce total and multi-substituted aromatics, olefins, benzene, and change the T50 and T90 points.

Other concepts of this proposal are as follows:

- Automakers would certify 2017+ vehicles only on E30, they would not be required to certify on E10. The legacy fleet would continue to operate on E10

- Ramp-up of ethanol for E30 would build with the introduction of each successive model year of 2017+ vehicles. Ethanol would have to be used preferentially for E30, then for E10 in the legacy fleet.

- There may be a net positive impact on upstream GHG emissions from producing the base gasoline (normalized to gasoline volume); this would have to be evaluated

The primary advantages of implementing this type of fuel are:

- Low carbon intensity ethanol volumes ramp up slowly from calendar year 2017 as the new vehicles using this fuel are introduced into the fleet, and continue ramping up well beyond the 2020-2022 timeframe, providing ongoing *upstream* (i.e., lifecycle) GHG reductions well into the future (through 2040) beyond the RFS.

- Currently the cellulosic projections in the RFS are not being met in part because the United States ethanol market is saturated by E10. Creating an E30 certification fuel would send a fresh market signal to the cellulosic industry that market space is being created through this new fuel standard. To meet the 36 billion gallon biofuel projection by 2022, market access for advanced (50% lifecycle emissions reduction) and cellulosic ethanol (60% lifecycle emissions reduction) must be offered a path. This proposal would provide that opportunity as well as the other benefits a higher octane standard would offer.

- Automakers should be able to use the higher octane ethanol fuel to boost engine efficiency beyond the engine efficiency obtained from the current Agency proposal (tailpipe GHG emissions would be the same as the Agency proposal), maintaining the same fuel economy and vehicle range

- Importantly, exhaust Particulate Matter (PM) emissions and carbon monoxide (CO) emissions from 2017-2025 model year vehicles would be much lower than the current proposal because of increased fuel oxygen content

Other criteria pollutant emissions (exhaust and evaporative NMOG and NOx) from on-road 2017+ motor vehicles should be the same with E30 as with current certification fuel, whether they are Tier 2 or Tier 3 vehicles, since the same tailpipe and evaporative standards must be met. Distribution of the E30 fuel should ultimately be no more difficult than E85 distribution, which has to take place anyway because of the RFS. The slow phase-in of E30 gives time for additional low carbon intensity (i.e., cellulose and other) ethanol supplies to develop.

C. The Ramp-up of Low CI Ethanol and Additional GHG Reductions

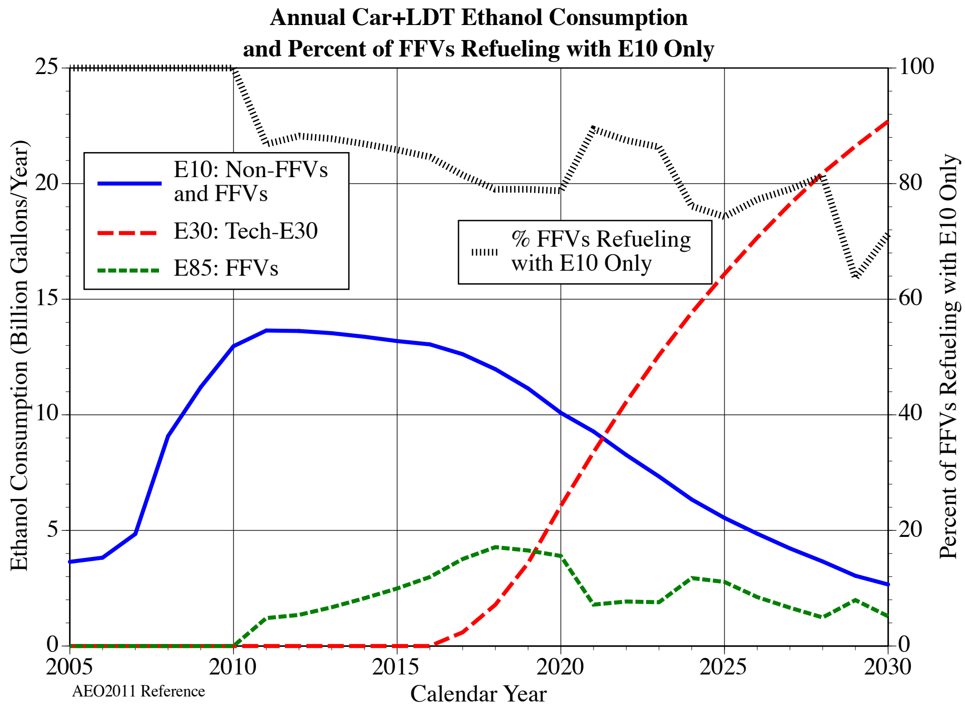
For the RFS, EPA estimates that ethanol from cornstarch peaks at 15 bgy in 2014. Additional increases in ethanol volumes are projected to come from advanced ethanol and cellulosic ethanol. Advanced ethanol is required to have a 50% reduction in lifecycle GHG emissions from gasoline, and cellulosic ethanol is required to have a 60% reduction in lifecycle emissions from gasoline. These additional volumes currently are projected to go into FFVs.

The ethanol volumes produced above E10 level could go into the 2017 and later vehicle fleet as E30, and additional ethanol volumes (as E85 or E3), would go into FFVs. The amount of ethanol needed for the 2017 and later model year vehicles would slowly build as these vehicles are introduced. These advanced and cellulosic volumes would increase steadily until the on-road fleet is fully turned over to 2017 and later vehicles.

Figure 2 shows the allocation of ethanol into different fleet sectors, assuming the AEO2011 volumes. This figure was developed using a fuel consumption model for the passenger car and LDT fleet, which was adjusted to include the effects of the 2012-2016 regulations and the 2017-2025 proposed rule. The decision priority for the use of ethanol was:

- E30 in 2017+ vehicles first
- E10 in legacy fleet, including FFVs
- E85 in FFVs (if E30 were used, refueling frequency with E30 would be higher)

Figure 2



During the 2005 to 2010 period, E10 is ramping up in the fleet. Between 2010 and 2015, E85 use starts to increase. In the 2015-2020 period, E30 use starts in the 2017 and later fleet. This directly affects the frequency of E85 use in the FFVs. E10 volumes start to decline because the fleet is more fuel efficient, and vehicles using E10 (2016 and earlier) are declining in population. Between 2020 and 2025, E30 use is expanding rapidly, and E10 and E85 use continues to decline (although E30 could be used in FFVs as well). In 2030, E30 use is still increasing, and E10 use and E85 use are low by comparison.

We performed the same analysis for the AEO2012 Early Release values, and the E30 fleet did not utilize all of the ethanol from the FFVs, indicating expected available supplies of ethanol.

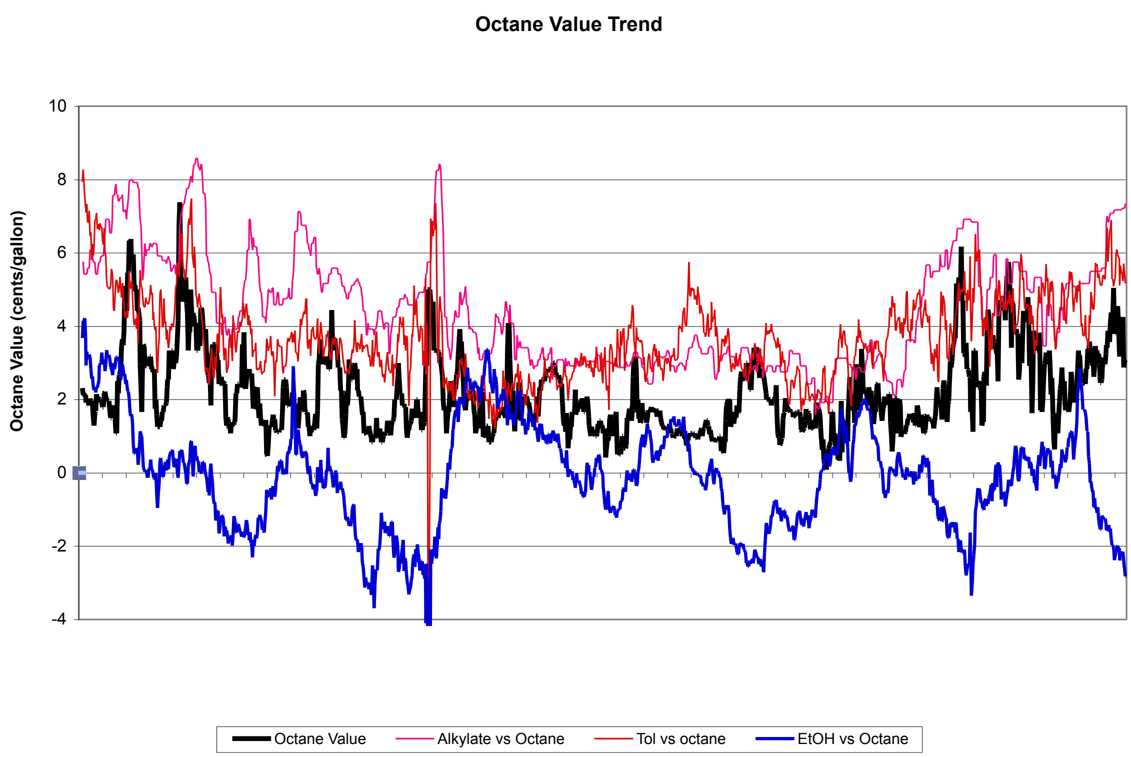
The addition of 20% more ethanol into E10 to boost octane value is expected to reduce the price of the blend relative to regular E10, not increase it. Table 4 shows average octane values for three octane blending components (alkylate, toluene, and ethanol) averaged over the period from January 2007 through February 2012. These values are determined by the bulk market price (Gulf Coast) of each component divided the blending octane of each component. For example, if ethanol is priced at 26 cents over unleaded gasoline and ethanol has a 113 blending octane, then the octane value of ethanol would be 26 cents divided by 26 (113 ethanol octane less 87 unleaded gasoline octane) or 1 cent per ethanol octane number.

The results show that ethanol is the cheapest octane blending component, and that the addition of ethanol reduces the price of the blend, and does not increase it like the other blending components.

Octane Values (cents per gallon) of Several Blending Components from January 2007 through February 2012			
Octane Value	Alkylate	Toluene	Ethanol
2.19	4.48	3.71	-0.12

In Figure 3 we evaluated Ethanol, Alkylate and Toluene as components in a gasoline blend. We focused on formula octane as the sole value of each component, similar to a refiner evaluation of a commercially available stream. The solid black line represents the commercial gasoline value of octane as represented in the market by the relative cost of premium 93 FON conventional gasoline versus regular 87 FON conventional gasoline in the Gulf Coast spot bulk market. This is a good benchmark of octane value to a refiner as they optimize the mix of premium versus regular gasoline they make relative to the properties of the blending components they produce or purchase. The remaining lines represent Alkylate, Ethanol and Toluene. Over the entire period, ethanol is the least expensive octane blending component.

Figure 3



C. Engine Efficiency

Ethanol has several properties that make it very desirable blendstock with gasoline. These were discussed in a paper referred to earlier.[28]

> The high octane of ethanol allows the use of higher compression ratios, particularly in dedicated ethanol vehicles. The high heat of vaporization produces a charge cooling effect, which is particularly effective with direct injection engines, that can again allow higher compression ratios. This effect is enhanced by the increased volume of fuel that is required to compensate for the lower energy content of ethanol. Even when a vehicle is not optimized to take advantage of some of ethanol's attributes, the higher octane and faster flame propagation speeds for ethanol result in increased efficiency (miles per BTU of energy present in the fuel used) for high ethanol blends relative to gasoline.

The paper goes on to show that there is an approximate 2% efficiency gain for E85 in 2010 FFVs on E85, which are not optimized on E85 but on E0, and some companies are able to do better than this across their portfolio.

A second study by Delphi examined changes in performance and efficiency on an engine equipped with gasoline direct injection and other control technologies at different gasoline/ethanol blend levels.[29] The study investigated methods of improving fuel consumption when fueled with E85.

> The benefit of the improved strategies for reducing the disparity between fuel consumption with gasoline and E85 is almost entirely offset on the FTP city cycle but is less effective as the demands of the driving conditions increase. At highway cruise speeds the shift schedule has no effect since the vehicles is in overdrive in all cases, only the benefits of the lower final driver ratio and the engine modifications are evident.

The paper then goes on to discuss the potential benefits of lower ethanol blends:

> It is also important to consider that many of the techniques used to improve performance on E85 would also improve fuel consumption with gasoline or lower ethanol blends. Differences will show up more in performance and may need a shift schedule dependent on the ethanol blends torque capability. Ethanol blends from near E20 provide a good compromise, enabling most of the performance of

---

[28] Ethanol – the primary renewable liquid fuel", Datta, Maher, Jones, and Brinker, J. Chem. Technol. Biotechnol., 2011; 86:473-480

[29] "Engine Efficiency Improvements Enabled by Ethanol Fuel Blends in a GDi VVA Flex Fuel Engine", Moore, Foster, and Hoyer, SAE2011-01-0900, 4/12/2011.

> an E85 blend with a significantly reduced energy penalty. Blends in this range would likely be able to offset the fuel density penalties with improved efficiency while providing superior performance to gasoline.

The above discussions highlight the need to focus more on the power density of ethanol (power per unit volume) rather than the energy density (heat content per unit volume). When automakers can optimize on a particular ethanol blend, they are able to take increased advantage of ethanol's power density as opposed to its energy density, thereby improving vehicle fuel economy and extending vehicle range between refills. Much additional research is taking place in this area which will be released in the coming months.

D. Cost-Benefit Analysis

The oversight with regard to potential PM increases due to widespread DGI use is important because PM effects are a substantial consideration in the cost-benefit analysis. In summarizing the benefits analysis, the proposal emphasizes PM benefits noting:[30]

> The benefits include all benefits considered by EPA such as GHG reductions, PM benefits, energy security and other externalities such as reduced refueling time and accidents, congestion and noise.

In a description of the major components of the cost-benefit analysis the proposal indicates:[31]

> The net benefits of EPA's proposal consist of the effects of the proposed standards on:
>
> • The vehicle costs;
> • Fuel savings associated with reduced fuel usage resulting from the proposed program
> • Greenhouse gas emissions;
> • Other air pollutants;
> • Other impacts, including noise, congestion, accidents;
> • Energy security impacts;
> • Changes in refueling events;
> • Increased driving due to the ''rebound'' effect.

The proposed rule also acknowledges that the agencies' analysis includes no estimates of the direct health or other benefits associated with reductions in emissions of criteria pollutants other than PM.[32] Therefore, two of the major drivers in the list of cost-benefit categories above, "other air pollutants" and "increased driving due to the rebound effect" are determined by PM emissions. The reason that PM dominates the EPA non-

[30] Federal Register, supra note 2, at 74893.
[31] Ibid., at 75113.
[32] Ibid., at 74933.

GHG analysis is that the damage cost in Table II-8 is much greater for PM than for other criteria pollutants.[33]

Therefore, even if EPA determines that it cannot implement Growth Energy's proposal at the current time, given the limits on the current rulemaking, the Final Rule should evaluate and consider both the increased PM due to GDI use and the potential for more widespread ethanol use to decrease PM emissions. In considering the increased PM due to widespread use of GDI technology, the final rule should consider the increase in PM mass as well as particle number.[34] The emission of, effects from, and potential mitigation of ultrafine particles from vehicles are all active research areas. In addition, various approaches for setting particle number standards for vehicles are being considered in Europe and California. Within the time frame of the regulations in the proposed rule, the importance of ultrafine particles and their control will be understood.

The final rule should also consider potential ways of mitigating the PM increases from GDI use. The mitigation methods examined should include both fuel-related methods and aftertreatment. Higher ethanol use should be thoroughly evaluated. Higher ethanol use will increase octane, reduce PM (as shown above), and improve the GHG benefits of the rule. In contrast, aftertreatment (particle filters) works against improving GHG emissions by increasing vehicle cost and increasing backpressure that reduces performance and fuel economy.

Among the fuel-related mitigation methods, further regulation of the composition of gasoline should be considered since there is evidence that the heavier components of gasoline, i.e., the aromatics, contribute substantially to PM emissions.[35]

It is also important to note that Tier 2 and Tier 3 vehicles will have to meet very low emission standards for evaporative NMOG, exhaust NMOG, CO, and NOx, no matter what fuel they are certified on. So ultimately, there should be no difference in these emissions between an E10 fuel and an E30 fuel. A number of manufacturers offer

---

[33] Ibid., at 74936.

[34] In the recent California GHG rulemaking, the Air Resources Board avoided this issue by assuming that PM mass emissions from PFI and GDI would be similar based primarily on speculative assumptions about future GDI technology and deterioration rates.

[35] Iizuka, M., Kirii, A., Takeda, H., Watanabe, H. (2007). Effect of Fuel Properties on Particulate Matter Emissions from a Direct Injection Gasoline Vehicle. *JSAE Technical Paper* 20074414, 2007, http://www.pecj.or.jp/japanese/overseas/asian/asia_symp_5th/pdf_5th/15-MasashiIizuka.pdf; Jetter, J. (2010). Effect of Fuel Composition on PM Emissions, LEV III Workshop, May 18, 2010, El Monte, California; Aikawa, K., Sakurai, T., Jetter, J.J. (2010). Development of a Predictive Model for Gasoline Vehicle Particulate Matter Emissions. *SAE Technical Paper* 2010-01-2115. DOI: 10.4271/2010-01-2115; Khalek I.A., Bougher T., Jetter, J. (2010). Particle Emissions from a 2009 Gasoline Direct Injection Engine Using Different Commercially Available Fuels. *SAE Technical Paper* 2010-01-2117. DOI: 10.4271/2010-01-2117.

FFVs that meet Tier 2 and emission standards on E85 and E0 now. Increasing ethanol from E10 to E30 reduces fuel volatility, so depending on a final volatility specification, meeting evaporative requirements could be somewhat less difficult with an E30 blend. Fuel system permeation also contributes to evaporative emissions. Permeation emissions have not been studied on E30 blends, but a Coordinating Research Council study on permeation from ethanol blends between E6 and E20 found that increasing ethanol content from E10 to E20 increased diurnal permeation emissions by about 16% on five vehicles, however, one FFV that was tested experienced lower permeation emissions on E20 than E10.[36] This factor should also be considered in a revised cost-benefit analysis.

[36] CRC Report No. E-65-3, “Fuel Permeation From Automotive Systems: E0, E6, E10, E20, and E85”, Harold Haskew and Associates and McClement of ATL for Coordinating Research Council, December 2006.