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Technical Review of EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis for Non-GHG Pollutants

prepared for:

American Petroleum Institute

May 4, 2010

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1. EXECUTIVE SUMMARY

In order to expand the use of renewable fuels in the transportation sector, Congress passed the Energy Policy Act (EPACT) of 2005, which required the establishment of Renewable Fuel Standards (commonly referred to "RFS1"). In December 2007, Congress passed the Energy Independence and Security Act of 2007 (EISA), which further increased the volumes of renewable fuels required under the RFS (commonly referred to as "RFS2"). More specifically, the RFS2 mandated by EISA requires that annual renewable fuel use in the transportation sector be at least 15.2 billion gallons in 2012 and at least 36 billion gallons by 2022. The American Petroleum Institute engaged Sierra Research Inc. to perform an independent analysis and critical review of the RFS2 Final Regulatory Impact Analysis (FRIA). This study was prepared by Sierra Research Inc. using its own models and analysis.

Key issues associated with renewable fuels include their ability to reduce emissions of greenhouse gases (GHG) as well as the impacts of their production and use on emissions of criteria air pollutants and air toxics (non-GHG pollutants).

In light of the latter concern, section 209 of EISA modified Section 211 of the Clean Air Act (CAA) to require that the U.S. Environmental Protection Agency (EPA):

> *…complete a study to determine whether the renewable fuels volumes required by this section will adversely impact air quality as a result of changes in vehicle and engines emission of air pollutants… the study shall include consideration of different blend levels, types of renewable fuels and available vehicle technologies and appropriate national, regional, and local air quality control measures.*

And that the EPA:

> *…promulgate fuel regulations to implement appropriate measures to mitigate, to the extent achievable, considering the results of the study…any adverse impacts on air quality as the result of the renewable volumes required by this section; or make a determination that no such measures are necessary.*

EISA requires that the study described above related to adverse air quality impacts be completed by approximately July 2009 and that any regulations required to mitigate those impacts be promulgated by approximately January 2011. Such a study has not been published to date.

On May 26, 2009, EPA published a Notice of Proposed Rulemaking (NPRM)[1] for the RFS2 regulations. At the same time, EPA also published a Draft Regulatory Impact Analysis (DRIA)[2] for the proposed RFS2 rule. Although the DRIA does not fulfill all of the requirements specified by EISA for the air quality study, it does include an analysis of the impact of RFS2 on non-GHG pollutant emissions that accounts for the required volumes of renewable fuels and considers the different types of renewable fuels likely to be used under RFS2, different renewable fuel blend levels, and available vehicle technologies.

Given the obvious and direct linkage between the DRIA and the study required under Section 211 of the CAA, an independent critical review of the RFS2 DRIA analysis on non-GHG pollutant emission impacts was performed[3] at the request of the American Petroleum Institute and submitted to EPA during the RFS2 rulemaking process. That review focused on the three aspects of the DRIA that are critical to the assessment of the non-GHG pollutant emission impacts of the RFS2:

1. The assumed types and volumes of renewable fuels that will be used under RFS2 and required changes in vehicle technologies;

2. The methodology used to assess the direct non-GHG pollutant emission impacts associated with the use of renewable fuels in on- and non-road motor vehicles and engines; and

3. The methodology used to assess the indirect non-GHG pollutant emission impacts associated with growing and collecting renewable fuel feedstocks as well as the production and distribution of renewable fuels.

On February 3, 2010, EPA published the final RFS2 regulations[4] and associated documents. These included a FRIA[5] containing a revised analysis of the non-GHG pollutant emission impacts of RFS2, as well as a Summary and Analysis of Comments (SAAC).[6] In this report, the revised analysis of the impact of RFS2 on non-GHG pollutant emissions published by EPA in the FRIA is reviewed, as is EPA's response to the issues raised in the critical review of the DRIA.

Although the key findings of this review are summarized below, EPA acknowledges that there are significant problems with the FRIA, as, for example, in the following, which is from the first paragraph of the first page of the Overview section:

> *The estimates contained in this RIA should not be interpreted as the impact of the RFS2 standards themselves because market forces may lead to increased production of renewable fuels even in the absence of the RFS2 standards. Rather, the impacts estimated in this RIA must be understood to refer to the consequences of an expansion of renewable fuel use, whether caused by the RFS2 program or by market forces.*

As evidenced by the above, EPA is, in effect, stating that the FRIA should not be interpreted as an evaluation of the impacts of the RFS2 regulation. This is a highly unusual statement; by definition and by inclusion in the rulemaking docket, the primary purpose of any FRIA is, in fact, to evaluate the regulation. However, upon detailed review of the contents of this FRIA with respect to non-GHG emissions, the meaning of EPA's statement becomes clear. Due to numerous changes relative to the DRIA and internal inconsistencies in the evaluation of the Final Rule, it is our assessment that the FRIA fails to evaluate the impacts of the RFS2 regulation.

Four critical aspects of the FRIA were identified, as summarized below.

Critical Aspect 1: Renewable Fuels Types and Volumes – With respect to assumed renewable fuel types, volumes, and vehicle technology changes, the FRIA projects lower consumption of ethanol relative to the DRIA, for reasons that include the following:

1. More appropriate accounting of future transportation energy demand; and

2. Revised forecasts of E85 demand for use in flexible-fueled vehicles (FFVs).

However, the FRIA still appears to substantially overstate future ethanol use in FFVs as the result of unrealistic assumptions regarding FFV volumes and the propensity of motorists to fuel those vehicles with E85. In addition, the FRIA projects that large volumes of cellulosic Diesel fuel will be produced, whereas none was assumed to be produced in the DRIA. Along with this change, EPA has reverted to the use of equivalency factors to account for the higher energy content of renewable Diesel fuel relative to ethanol in attempting to demonstrate that the renewable fuels requirements of RFS2 and EISA2007 will be achieved. In addition, the FRIA eschews any analysis of the potential impacts of E15 or E20.

Critical Aspect 2: Direct Impacts on Non-GHG Emissions – With respect to the direct impacts on non-GHG pollutant emissions, the FRIA (1) incorporates some changes to address issues identified earlier in the DRIA, (2) fails to address some other important issues in the DRIA, and (3) raises new issues. The most notable change vs. the DRIA is the elimination of non-GHG emission reductions benefits claimed for FFVs during operation on E85.

Unaddressed and new issues include the following:

- Continued use in the FRIA of the piecemeal methodology used in the DRIA for estimating direct non-GHG emission impacts that is based on the current (NMIM) and now-obsolete versions of future (MOVES) emission inventory models; and, perhaps most importantly,

- Development of an updated non-GHG emission inventory impact analysis for the FRIA, but continued use of the obsolete and abandoned DRIA emission inventory analysis results in the FRIA air quality impact analysis.

In addition (and similar to the DRIA), the FRIA analysis of direct non-GHG emissions impacts is very poorly documented and explained; this limits independent review, precludes detailed understanding, and makes replication of the FRIA results impossible.

Critical Aspect 3: Indirect Non-GHG Emissions – With respect to indirect non-GHG emissions, the FRIA addresses an issue raised earlier about the reasonableness of emission reductions occurring as the result of biomass-derived electricity from ethanol plants displacing electricity from fossil fuels. However, the FRIA continues to be overly optimistic with respect to its estimates of the potential emission reductions due to displacement of petroleum-based fuel production. In addition, the FRIA's assumptions regarding the production of large volumes of cellulosic Diesel fuel raise a new issue, as emissions associated with the production of that fuel are not estimated or accounted for in the FRIA.

Critical Aspect 4: FRIA Inconsistencies – There are several inconsistencies in the evaluation of the Final Rule, as the FRIA employs two different methodologies for the air quality and emission inventory evaluations. Presumably due to the lead time required to complete photochemical grid modeling, the fuel scenarios and inventory methods employed in the FRIA air quality evaluation are largely unchanged from those employed in the DRIA. Conversely, the FRIA's emission inventory evaluation contains EPA's final assessment of regulatory fuel scenarios and inventory modeling methods for RFS2, which were significantly updated.

Table 1-1 highlights the profound differences in underlying modeling methods and fuel scenarios of the FRIA air quality and emission inventory evaluations. Significant differences include the following updates incorporated into the emission inventory analysis:

- The RFS2 primary control case for the inventory evaluation contains substantially less ethanol consumption in gasoline and considerably more renewable fuel consumption in Diesel;

- The consumption of E85 and production of FFVs are revised substantially lower in the emission inventory evaluation;

- Key modeling values for VMT and fuel economy were updated with more current values in the emission inventory evaluation; and

- Emissions methods for exhaust impacts, evaporative impacts, and indirect emission impacts are all updated for the emission inventory evaluation.

In summary, the two evaluations in the FRIA are entirely different. This inconsistency is problematic in that the air quality evaluation is based on several incorrect premises as directly demonstrated by EPA's own updates and incorporated in the FRIA emission inventory evaluation. Moreover, since the FRIA air quality evaluation results are used as key input into the cost-benefit analysis of the Final Rule, the costs related to air quality changes are also based on incorrect premises.

In conclusion, it is our assessment that the FRIA fails to properly evaluate the impacts of the RFS2 regulation.

Table 1-1 Key Modeling Parameters Used in FRIA Air Quality and Emission Inventory Evaluations		
Modeling Parameter	FRIA Air Quality Evaluation	FRIA Emission Inventory Evaluation
Renewable volumes (primary control case, 2022):[a] Total ethanol Ethanol in E85 Total biodistillates Renewable Diesel	 34.1 billion gallons 21.7 billion gallons 1.2 billion gallons 0.4 billion gallons	 22.2 billion gallons 9.3 billion gallons 8.3 billion gallons 6.7 billion gallons
VMT projection update to AEO2009?	No	Yes
Fuel economy updated to latest CAFÉ?[b]	No	Yes
FFV sales (primary control case, total 2010 – 2022 model years)	68.0 million	48.0 million
FFV E85 refueling rate (primary control case, 2022)	74%	29%[c]
RVP effect on evaporative emissions for E10?	Yes	No
Updated E10 permeation effect on evaporative emissions?	No	Yes
Tier 1 exhaust effect for E10?	No	Yes (Tier 0 extrapolation)
Tier 2 exhaust effect for E10?	No	No
Pollutants with E85 exhaust effects	NOx PM Formaldehyde Benzene 1,3-Butadiene Acetaldehyde Ethanol	Acetaldehyde Ethanol
Renewable Diesel (RD) NOx reduction?	No (minimal quantity of RD under RFS2)	No (substantial quantity of RD under RFS2)
Updated upstream emissions for ethanol transport?	No	Yes

[a] As reported in FRIA tables 3.1-9 and 3.3-1.
[b] Fuel economy update impacts (i.e., reduces) volumes of fuel consumed.
[c] Value represents the combined FRIA assumptions of 70% E85 availability nationwide and a 42% refueling rate where available.

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2. REVIEW OF TRANSPORTATION SECTOR FUEL DATA AND ANALYSIS SCENARIO DEVELOPMENT

This section reviews and compares the FRIA and the DRIA estimates of renewable fuel composition and consumption. As noted above, this review focuses on the issues and areas of concern raised in our earlier review of the DRIA,[3] changes that were made to address those concerns in the FRIA, and new issues identified with the methodology and results of the FRIA.

In evaluating the impacts of the RFS2 on emissions of non-GHG pollutants, the FRIA defines and analyzes scenarios—referred to as "cases"—that assume RFS2 either is or is not in place. These are referred to as "reference" and "control" cases, respectively. There are two reference cases (i.e., no RFS2) and three control cases (i.e., including RFS2). The two reference cases provide a bounding estimate of the renewable fuel consumption in the absence of RFS2. The three control cases differ in the quantity of ethanol (EtOH) assumed to be consumed in transportation fuels, and are referred to in the FRIA as "low-ETOH," "mid-ETOH," and "high-ETOH" cases, respectively. The mid-ETOH case is designated by the FRIA as the "primary" control case because EPA deems it to be the best representation of the actual implementation of the RFS2.

One key point that needs to be stressed is that the five cases described above are used in the FRIA to assess the impacts of the RFS2 on the emission inventory of non-GHG pollutants, which is cast in terms of the mass of pollutants emitted during a certain period of time. Unlike the DRIA, the FRIA also contains an evaluation of the impact of RFS2 on air quality, which has at its foundation an emission inventory. However, the emission inventory used for the air quality analysis is not based on the same cases as the inventory used to assess the impact of RFS2 on emissions. This inconsistency in the FRIA methods is significant and noteworthy. This review focuses primarily on the FRIA analysis of the impact of RFS2 on emissions, but areas where there are important differences between that analysis and the analysis that underlies the air quality evaluation are also highlighted.

2.1 Reference Case Renewable Fuel Consumption Estimates

In our review of the DRIA,[3] one issue identified was that the DRIA overestimated the baseline consumption level for renewable fuels in absolute terms at 13 billion gallons, a value taken directly from the Energy Information Administration's (EIA) AEO2007 for calendar year 2022. It was recommended that the baseline consumption estimate for renewable fuels in 2022 should instead be about 9 billion gallons. This was based on an assumed 73% market share for 10% ethanol-gasoline (E10) blends taken from AEO2007, but carried over to the AEO2009 estimate of transportation energy demand, which is considerably lower than that in AEO2007. The reasons for the reduced transportation energy demand in AEO2009 relative to AEO2007 and the lower baseline for renewable fuels include reductions in fuel demand due to reductions in estimates of vehicle travel and increased new vehicle fuel economy resulting from new corporate average fuel economy (CAFE) requirements that were also mandated by EISA2007.

EPA did not respond to this issue in the SAAC, and the FRIA's renewable fuel consumption for the reference case remains effectively unchanged and overstated at approximately 13 billion gallons. This reference case is referred to as the "AEO2007 Reference Case" in the FRIA and is also the "primary reference" case of the FRIA. Unlike the DRIA, however, the FRIA includes a second reference case—referred to as the "RFS1 Reference Case"—that assumes a baseline 2022 renewable fuel consumption of 7.1 billion gallons of ethanol. As a result, the two FRIA reference cases bound the recommended baseline of 9 billion gallons. Notably, both reference cases of the FRIA were evaluated in the air quality evaluation. However, the FRIA emission inventory results reported do not include the results from the RFS1 Reference Case; therefore, the baseline emission inventory is based on an overestimate of likely renewable fuel consumption.

2.2 Control Case Renewable Fuel Consumption Estimates

The renewable fuel consumption estimates in the FRIA for the control cases (e.g., with RFS2) were completely revised relative to those in the DRIA. To highlight these changes, the now-familiar renewable fuel requirements of EISA2007, shown in Table 2-1, are used as a point of departure. The terms listed below are used to characterize renewable fuels in Table 2-1. These are defined by EISA2007 in terms of the percentage reduction in lifecycle GHG emissions they achieve relative to a 2005 baseline.

- Renewable fuel – 20% GHG emission reduction
- Advanced biofuel – 50% GHG emission reduction
- Biomass-based Diesel – 50% GHG emission reduction
- Cellulosic biofuel – 60% GHG emission reduction

The volumes of each type of renewable fuel assumed with RFS2 in the DRIA control case and the FRIA primary control cases are shown in Tables 2-2 and 2-3, respectively. Finally, the differences between the FRIA primary control case and the DRIA control case are presented in Table 2-4, where positive values indicate that greater volumes were assumed in the FRIA relative to the DRIA and negative values indicate the opposite. Note that EPA added additional fuel descriptors, shown in Tables 2-2 through 2-4, and corn ethanol is treated as renewable fuel while imported ethanol derived from sugarcane is treated as an advanced biofuel. Note also that the volumes listed in Tables 2-2 through 2-4 are given in terms of actual gallons of renewable fuels.*

* The FRIA reinstated the use of equivalency values (defined relative to the energy content of ethanol) to calculate ethanol-equivalent gallons for defining compliance levels shown in Table 2-1, which were not included in the DRIA.

Table 2-1
Minimum Renewable Fuel Requirements Mandated by EISA2007
(Units = Billion Gallons)

Calendar Year	Total Renewable Fuel	Advanced Biofuel Total	Advanced Biofuel Cellulosic Biofuel	Advanced Biofuel Biomass-Based Diesel
2009	11.1	0.6		0.5
2010	12.95	0.95	0.1	0.65
2011	13.95	1.35	0.25	0.8
2012	15.2	2.0	0.5	1.0
2013	16.55	2.75	1.0	
2014	18.15	3.75	1.75	
2015	20.5	5.5	3.0	
2016	22.25	7.25	4.25	
2017	24.0	9.0	5.5	
2018	26.0	11.0	7.0	
2019	28.0	13.0	8.5	
2020	30.0	15.0	10.5	
2021	33.0	18.0	13.5	
2022	36.0	21.0	16.0	

Table 2-2
DRIA Control Case Renewable Fuel Consumption[a]
(Units = Billion Gallons)

	Advanced Biofuel							
	Cellulosic		Biomass Diesel		Other Advanced Biofuel			
Year	Ethanol	Diesel	Biodiesel	Non-Co-Processed Renewable Diesel	Co-Processed Renewable Diesel	Imported Ethanol	Corn Ethanol	Total Renewables
2010	0.10	0.00	0.64	0.01	0.01	0.29	11.55	12.60
2011	0.25	0.00	0.77	0.03	0.03	0.16	12.29	13.53
2012	0.50	0.00	0.96	0.04	0.04	0.18	12.94	14.66
2013	1.00	0.00	0.94	0.06	0.06	0.19	13.75	16.00
2014	1.75	0.00	0.93	0.07	0.07	0.36	14.40	17.58
2015	3.00	0.00	0.91	0.09	0.09	0.83	15.00	19.92
2016	4.25	0.00	0.90	0.10	0.10	1.31	15.00	21.66
2017	5.50	0.00	0.88	0.12	0.12	1.78	15.00	23.40
2018	7.00	0.00	0.87	0.13	0.13	2.25	15.00	25.38
2019	8.50	0.00	0.85	0.15	0.15	2.72	15.00	27.37
2020	10.50	0.00	0.84	0.16	0.16	2.70	15.00	29.36
2021	13.50	0.00	0.83	0.17	0.17	2.67	15.00	32.34
2022	16.00	0.00	0.81	0.19	0.19	3.14	15.00	35.33

[a] As reported in Table 1.2-1 of the DRIA.

Table 2-3 **FRIA Primary Control Case Renewable Fuel Consumption**[a] (Units = Billion Gallons)								
	Advanced Biofuel							
	Cellulosic		Biomass Diesel		Other Advanced Biofuel			
Year	Ethanol	Diesel	Biodiesel	Non-Co-Processed Renewable Diesel	Co-Processed Renewable Diesel	Imported Ethanol	Corn Ethanol	Total Renewables
2010	0.03	0.04	0.61	0.04	0.22	0.29	11.24	12.48
2011	0.08	0.10	0.72	0.08	0.17	0.16	12.07	13.38
2012	0.15	0.20	0.92	0.08	0.12	0.18	12.83	14.48
2013	0.31	0.41	0.92	0.08	0.28	0.19	13.42	15.61
2014	0.54	0.71	0.85	0.15	0.39	0.20	14.09	16.93
2015	0.92	1.22	0.85	0.15	0.53	0.39	14.79	18.85
2016	1.31	1.73	0.85	0.15	0.56	0.63	15.00	20.23
2017	1.69	2.24	0.85	0.15	0.60	1.07	15.00	21.60
2018	2.15	2.85	0.85	0.15	0.64	1.51	15.00	23.15
2019	2.61	3.46	0.85	0.15	0.68	1.96	15.00	24.71
2020	3.23	4.28	0.85	0.15	0.72	1.88	15.00	26.11
2021	4.15	5.50	0.85	0.15	0.77	1.81	15.00	28.23
2022	4.92	6.52	0.85	0.15	0.82	2.24	15.00	30.50

[a] As reported in Table 1.2-3 of the FRIA. The categorization of distillates follows the regulatory defined scheme and is not precise for separating the actual volumes of biodiesel and renewable Diesel in the control case. Elsewhere in the FRIA (see Table 3-1 of this report), 2022 biodiesel consumption is estimated to equal 1.67 billion gallons.

Table 2-4 **Difference in DRIA and FRIA Control Case Renewable Fuel Consumption** (Defined as FRIA minus DRIA, Units = Billion Gallons)								
	Advanced Biofuel							
	Cellulosic		Biomass Diesel		Other Advanced Biofuel			
Year	Ethanol	Diesel	Biodiesel	Non-Co-Processed Renewable Diesel	Co-Processed Renewable Diesel	Imported Ethanol	Corn Ethanol	Total Renewables
2010	-0.07	0.04	-0.03	0.03	0.21	0.00	-0.31	-0.12
2011	-0.17	0.10	-0.05	0.05	0.14	0.00	-0.22	-0.15
2012	-0.35	0.20	-0.04	0.04	0.08	0.00	-0.11	-0.18
2013	-0.69	0.41	-0.02	0.02	0.22	0.00	-0.33	-0.39
2014	-1.21	0.71	-0.08	0.08	0.32	-0.16	-0.31	-0.65
2015	-2.08	1.22	-0.06	0.06	0.44	-0.44	-0.21	-1.07
2016	-2.94	1.73	-0.05	0.05	0.46	-0.68	0.00	-1.43
2017	-3.81	2.24	-0.03	0.03	0.48	-0.71	0.00	-1.80
2018	-4.85	2.85	-0.02	0.02	0.51	-0.74	0.00	-2.23
2019	-5.89	3.46	0.00	0.00	0.53	-0.76	0.00	-2.66
2020	-7.27	4.28	0.01	-0.01	0.56	-0.82	0.00	-3.25
2021	-9.35	5.50	0.02	-0.02	0.60	-0.86	0.00	-4.11
2022	-11.08	6.52	0.04	-0.04	0.63	-0.90	0.00	-4.83

The main points arising from a comparison of the FRIA and DRIA control case estimates for renewable fuel consumption are outlined below.

1. The DRIA control case effectively assumed RFS2 compliance would be achieved through ethanol consumption (up to a maximum of 34 billion gallons of ethanol in 2022) in the gasoline transportation sector, of which 16 billion gallons would be cellulosic ethanol.

2. Relative to the DRIA, the FRIA primary control case forecasts considerably less ethanol consumption—22 billion gallons of ethanol consumed in 2022, of which 5 billion gallons is from cellulosic sources. These translate into reductions of about 35% in ethanol consumption and about 70% in cellulosic ethanol relative to the DRIA.

3. The drop in ethanol consumption in the FRIA primary control case is due to revisions in the assumptions regarding the FFV fleet and E85 usage as well as reduced overall energy demand in the gasoline sector. The reduction in energy demand is due in large part to the fact that the FRIA accounts for the changes in new vehicle CAFE requirements that were not accounted for in the DRIA.

4. The FRIA forecasts a significant cellulosic Diesel production and consumption (6.5 billion gallons in 2022) in contrast to the DRIA, which did not consider the production of cellulosic Diesel fuel. Further, the FRIA assumes cellulosic fuel production would be distributed at 43% ethanol and 57% Diesel for all calendar years 2010 to 2022.

5. The FRIA assumes 2022 total renewable distillate consumption to be about 8 billion gallons, compared to the DRIA's estimate of 1 billion gallons. AEO2009 estimates 56 billion gallons of transportation sector distillate consumption in 2022, which means that the FRIA renewable distillate consumption estimate amounts to 15% of total Diesel consumption in 2022.

6. As a result of the reduction in forecast ethanol consumption, EPA was required to use equivalency factors that reflect the higher energy content of distillates to demonstrate compliance with the EISA2007 requirements. The FRIA assumes equivalency factors of 1.5 for biodiesel or 1.7 for cellulosic Diesel and renewable Diesel, respectively.

As noted above, the FRIA has multiple reference and control cases. Table 2-5 compares the forecast 2022 ethanol consumption of each of these cases to the primary reference and control cases from the DRIA. As noted above, the FRIA control cases assume lower ethanol consumption than the DRIA control case. As the FRIA control cases all assume nationwide sales of E10, the differences between them represent different assumptions regarding the amount of ethanol consumed as E85 in FFVs.

Table 2-5 **Ethanol Consumption Under Each Reference and Control Case**		
Version	Inventory Case	2022 U.S. Ethanol Consumption (Billion Gallons per Year)
DRIA	AEO2007 Reference Case	12.9
	Primary Control Case	34.1
FRIA	RFS1 Reference Case	7.1
	AEO2007 Reference Case	13.2
	Low-ETOH Control Case	17.5
	Mid-ETOH Control Case (Primary Control)	22.2
	High-ETOH Control Case	33.2

In our review of the DRIA,[3] several issues of concern were raised regarding the definition of renewable consumption levels under the control cases. The primary issue with the DRIA was that only a single RFS2 control case was represented. This issue is important due to the uncertainty with actually meeting RFS2 and the non-linearity of the environmental consequences of all the possible RFS2 compliance pathways. EPA apparently attempted to address this issue in the inventory analysis of the FRIA through the use of multiple control cases. However, EPA's failure to include more than one control scenario evaluated in the FRIA air quality analysis and the selection of the DRIA control case that was abandoned in the FRIA emission inventory analysis render the FRIA air quality analysis irrelevant. This stems from the fact that EPA did not carry its own updated assumptions through to the air quality evaluation.

2.3 Inconsistent VMT and Fuel Economy Assumptions

Our review of the DRIA found that EPA (1) had failed to account for the new CAFE standards mandated by EISA2007 and therefore overstated transportation energy demands; and (2) had used vehicle travel (VMT) estimates that were outdated and inconsistent with recent (AEO2009) travel demand estimates, again leading to an overestimate of transportation energy demand.[3] These findings were important because reduced transportation energy demand makes RFS2 compliance more difficult, given that compliance is measured in terms of the actual amount of renewable fuel consumed. As a result, lower overall energy demand increases the percentage that must be renewable fuels if compliance with RFS2 is to be achieved.

The EPA SAAC explicitly addresses these two issues. EPA generally concurred that there was a modeling discrepancy in the DRIA and indicated that these issues were resolved in the FRIA. The current review of the FRIA found that this was the case and that changes were reasonable. The reduction in energy demand (from reduced VMT and increased fuel economy) of the FRIA is evident in the reduced ethanol consumption in the primary control case which, as shown in Table 2-5, is about 12 billion gallons less than that estimated in the DRIA.

Updated VMT and fuel economy estimates, however, were included only in the FRIA emission inventory evaluation. The FRIA states on page 581 that the outdated VMT assumption of the DRIA remains a part of the FRIA air quality evaluation. Moreover, the use of the DRIA primary control case (of 34 billion gallons of ethanol consumption) in the FRIA air quality evaluation inherently overestimates energy demand (due to incorrect VMT and fuel economy assumptions), something which again renders the air quality evaluation of the FRIA meaningless as critical updates were not fully incorporated. In this instance, the air quality evaluation inherently overstates VMT and fuel consumption.

2.4 Unrealistic Assumptions Regarding FFVs and E85 Consumption

A key finding in our review of the DRIA was that the E85 consumption rates and the level of FFV sales were significantly overestimated.[3] The EPA SAAC document responded to these findings as well as similar comments received on E85 and FFV usage. The FRIA was updated and changes to the assumed FFV and E85 refueling rates were made. However, the FRIA assumptions regarding the frequency of FFV fueling with E85 remain significantly higher than the proportion of stations dispensing E85 and continue to overstate likely E85 consumption levels.

As noted above, the differences in ethanol consumption for the three FRIA control cases are directly related to differences in assumed E85 consumption rates, which are in turn directly related to assumptions regarding the number of FFVs produced. Table 2-6 presents FFV sales assumptions for the three FRIA control cases as well as the primary control case of the DRIA. Several observations are noted below.

1. The high-ETOH case assumes mandated production of FFVs which EPA, as stated in the FRIA, has no authority to implement.[*]

2. The mid-ETOH case represents a continuation of the current "Big 3" voluntary agreement to produce FFVs for 50 percent of their light-duty product lines.

3. The low-ETOH case represents the FFV sales forecast in AEO2009. These are the FFV sales levels the previous critical review of the DRIA concluded were the most reasonable.[3]

4. The primary control case of the DRIA assumed FFV sales of 3 million in 2010 and 6 million in 2022. Effectively, the DRIA control case FFV sales (termed "Optimistic FFV Sales" in the DRIA) lies between the mid-ETOH and high-ETOH cases of the FRIA.

5. Overall, the FRIA primary control case assumes between 1.2 and 2.0 million fewer FFVs sold per model year from 2010 to 2022, relative to the DRIA primary control case. This change in FFV sales assumptions results in significantly less ethanol consumed as E85 in the FRIA.

[*] In the DRIA, the mandated FFV sales level would reach 100% of light-duty sales. In the FRIA, the mandated FFV sales level would reach 80% of light-duty sales.

Table 2-6 FRIA FFV Sales Assumptions Scenarios by Control Case (Total Light-Duty Sales)				
Model Year	DRIA, Optimistic (Primary Control)	FRIA, Low-ETOH	FRIA, Mid-ETOH (Primary Control)	FRIA, High-ETOH
2010	3,040,000	1,253,426	1,848,835	3,617,298
2011	3,720,000	1,598,610	2,661,252	5,439,471
2012	4,400,000	1,903,862	3,523,548	7,393,103
2013	4,720,000	2,251,284	3,740,737	9,418,573
2014	5,040,000	2,523,575	3,881,960	11,403,172
2015	5,360,000	2,693,557	3,957,744	13,286,614
2016	5,680,000	2,761,794	3,968,776	13,323,649
2017	6,000,000	2,804,322	4,003,948	13,441,727
2018	6,000,000	2,929,336	4,043,259	13,573,697
2019	6,000,000	2,825,574	4,084,529	13,712,247
2020	6,000,000	2,771,285	4,117,519	13,822,998
2021	6,000,000	2,669,883	4,099,459	13,762,369
2022	6,000,000	2,607,584	4,096,590	13,752,738

The change in the FFV sales assumptions in the FRIA deals with the problem that the DRIA's primary control case contained escalating FFV sales rates in the absence of any regulatory requirement or regulatory incentive (e.g., CAFE credits are due to phase-out in the post 2015 timeframe). The primary control case of the FRIA reverts to a reduced level of FFV sales that equals the voluntary agreement between the agency and the Big 3 domestic automobile manufacturers.

In terms of the rate at which FFVs would fuel with E85, the DRIA assumed a 74% rate of refueling for all FFVs, even for those FFVs without E85 access. This rate of refueling was adjusted in the FRIA to account for the proportion of motorists (defined by population at the county level) with and without E85 access.

"Access" in the FRIA is defined at a level of one in four refueling stations in a county with at least one dedicated pump for E85. For the FRIA control cases, EPA assumed levels of 40%, 60%, and 70% access to E85 for the low-ETOH, mid-ETOH, and high-ETOH cases, respectively.*

Moreover, for those motorists in counties with E85 access, the rate of refueling in the FRIA was back-calculated by the rate needed to achieve the total targeted volumes of ethanol consumption. For 2022, the FFV refueling rates are 57%, 58%, and 42% of the time for the low-ETOH, mid-ETOH, and high-ETOH cases, respectively. These rates are significantly higher than the rate of availability (i.e., a single dedicated pump installed at 25% of stations within a county), and the FRIA continues to presume an E85 pricing structure that would overcome the limited distribution and added inconvenience costs of refueling with a fuel that has a 22% to 24% lower energy content by volume.

Table 2-7 presents the change in ethanol consumption of the three FRIA control cases if the FFV rate of refueling with E85 were to equal the proportion of stations dispensing E85 (i.e., 25 percent in counties with E85 access). Under this level of refueling, the FRIA primary control case would result in a reduction of 4.1 billion gallons of ethanol consumed. This still may be an overestimate as, at any station with both fuels, a FFV will have the option to refuel with E85 or gasoline and disproportionately more pumps will be available for dispensing gasoline. Moreover, the many unaffiliated fueling stations whose owners are not subject to the RFS may not have a vested interest in selling E85 fuel or adopting the required pricing strategy needed to influence consumer fuel selection; therefore, the pricing structure is uncertain and the energy penalty and inconvenience of E85 will remain important factors.

Table 2-7
Change in Control Case Ethanol Consumption
Assuming FFV-E85 Refuel Rate is Equal to E85 Availability

Version	Inventory Case	2022 U.S. Ethanol Consumption (Billion Gallons per Year)
FRIA	Low-ETOH Control Case	-2.0
	Mid-ETOH Control Case (Primary Control)	-4.1
	High-ETOH Control Case	-6.9

In total, the updates to the FFV sales and E85 usage rates in the FRIA significantly lower the amount of ethanol forecasted to be consumed in E85. The DRIA primary control case assumptions resulted in about 22 billion gallons of ethanol in E85 (out of a total of 34 billion gallons of ethanol for the control case). The FRIA primary control case assumptions result in about 8 billion gallons of ethanol in E85 (out of a total of 22 billion gallons). This represents a 64% reduction in E85. Yet, in spite of these changes, the FRIA continues with overly optimistic assumptions for E85 usage, including substantial

* Notably, even those stations offering E85 will also have significantly more pumps dedicated to dispensing gasoline. E85 access as defined in the FRIA would be better termed “limited access,” as access refers to a minority of pumps in a minority of stations in a given county actually dispensing E85. The FRIA narrative for E85 marketing certainly does not equate to equal access to both E85 and gasoline. Given that FFVs can operate on both E85 and gasoline, this disparity in access is a critical element.

FFV sales rates in the absence of regulatory requirements, an aggressive infrastructure development schedule, and consumer preferences for E85 use that do not appear to account for the realities of E85 pricing and availability.*

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* Not all of the 64% reduction in E85 consumption is due to changing the FFV sales and E85 refueling assumptions alone. As noted previously in this discussion, updated VMT and fuel economy assumptions also reduce total energy demand and result in reduced E85 consumption as well, although this effect is secondary to the impact of updated FFV sales and refueling rates.

3. DIRECT NON-GREENHOUSE GAS POLLUTANT EMISSIONS IMPACTS

This section reviews and compares the FRIA and the DRIA estimates of non-greenhouse gas pollutant impacts, again with a focus on how EPA addressed areas of concern identified in our earlier review of the DRIA. As was discussed above, it is important to note that the FRIA defines and analyzes two reference cases and three control cases, and the assessment of the RFS2 on direct emissions of non-GHG pollutants performed for purposes of evaluating emission inventory impacts is different from that used to assess air quality impacts. Again, this is a fatal flaw in the FRIA as the air quality impacts analysis is not linked to the actual RFS2 control cases.

3.1 General Methodology for Estimating Direct Non-GHG Pollutant Impacts

The following was a key finding from the review of the DRIA:

> *As indicated above, there are a number of issues that EPA must address in finalizing its assessment of the impacts of the RFS2 regulation on direct emissions of non-GHG pollutants. First and foremost is the issue of the agency's piecemeal approach to the analysis in which it uses certain draft versions of MOVES for some aspects and NMIM for others. Clearly a single, consistent, modeling approach needs to be used and the agency needs to provide documentation regarding that approach and the results for public comment and review.*

Unfortunately, EPA did not respond to this comment in the SAAC and this piecemeal approach was carried through to the FRIA. Despite the fact that an updated version of MOVES has been used in the FRIA, EPA has again used it only to estimate emissions from on-road gasoline vehicles.

The situation is made worse in the FRIA due to the internal inconsistency between the emission inventory and air quality evaluation methods and models. Concerns with the piecemeal approach used in the FRIA include the following:

1. The FRIA uses a draft version of MOVES for the light-duty gasoline vehicle analysis that differs from the draft version of MOVES used in the DRIA and also from the final version of MOVES released to the public.

2. In both the DRIA and FRIA, the version of MOVES used did not contain methods for vehicle classes other than light-duty gasoline. For the remaining vehicle classes the National Mobile Inventory Model (NMIM) was used, which is based on MOBILE6.2.

3. The emission inventory and air quality evaluation methods of the FRIA differ in the underlying quantity of renewable fuels assumed and the mix by type of fuel (as described in Section 2 of this report).

4. The emission inventory and air quality evaluation methods of the FRIA differ in terms of the pollutant impacts of gasoline-ethanol blends and E85. For example, the FRIA emission inventory method dropped the RVP effect for gasoline-ethanol blends. Secondly, the FRIA emission inventory method dropped all E85 impacts, except for ethanol and acetaldehyde, due to insufficient data.

Despite the continued use of the piecemeal approach, EPA does acknowledge that it creates potential issues with respect to the FRIA analysis. For example, on page 559 of the FRIA, EPA states that had the final version of MOVES (i.e., MOVES2010) been used instead of NMIM, Diesel on-road inventories (and the impacts of biodiesel) would have been doubled relative to the values presented in the FRIA.

With respect to the inconsistencies between the emission inventory analysis and the emission inventories used in the air quality modeling analysis, these are summarized in Table 3.3-3 (page 568) and the differences are large. The RFS2 emission impacts (defined as the primary control case minus the AEO2007 reference case) are significantly lower in the FRIA emissions inventory analysis than those used in the FRIA air quality analysis, with the differences being 28% for NOx, 36% for HC, 17% for $PM_{2.5}$, and 34% for acetaldehyde. As such, the impacts associated with RFS2 in the air quality evaluation are incorrectly overstated given the overstated emissions impacts. Once again, this issue calls into the question the relevance of the FRIA air quality evaluation. Overall, the FRIA’s air quality evaluation using outdated assumptions results in an overestimation of the inventory impacts and, therefore, an overestimation of the air quality impacts.

A second major issue raised in our review of the DRIA was the need to assess the emission impacts associated with all of the potential RFS2 compliance scenarios put forth by EPA as being plausible demonstrations of the feasibility of compliance, which at the time included scenarios involving higher ethanol blends (e.g., E15 and E20). Rather than addressing the emission impacts associated with higher ethanol blends, EPA simply eliminated them from the control cases analyzed in the FRIA.

3.2 Summary of Changes in Direct Non-GHG Emissions from the DRIA to the FRIA

3.2.1 On-Road Vehicles

As noted above, the FRIA examines on-road emissions using the same piecemeal approach as the DRIA based on EPA's National Mobile Inventory Model (NMIM) and the Motor Vehicle Emission Simulator (MOVES) emissions modeling tools. However, the version of the MOVES model used in the FRIA was different: a preliminary version of the final MOVES2010 model was used instead of the preliminary draft version of MOVES2009, which was used only for E85 impacts on emissions of acetaldehyde and ethanol. There was no change in the NMIM software and MOBILE6 model version used for estimating emissions from on-road Diesel vehicles.

3.2.1.1 Gasoline Vehicles

The version of MOVES used in the FRIA reflected several important updates. These included modifications to incorporate direct calculation of fuel adjustments and the capability of distinguishing the relative impact of E10 on vehicles certified to enhanced evaporative standards as compared to vehicles certified to previous standards. In addition, the version of MOVES used in the FRIA reflects the 2007 mobile source air toxic (MSAT) rule of 0.62% fuel benzene standard.

As noted in the previous section, the analysis of non-GHG pollutant emissions from gasoline-fueled on-road vehicles was conducted using three control cases: "low-ETOH," "mid-ETOH" (primary), and "high-ETOH." MOVES runs were prepared to estimate emissions from gasoline-fueled vehicles. A unique set of run specification files was created for the 2022 reference case and control cases. The impact of the RFS2 renewable fuel volumes was compared against the AEO2007 reference case emissions.

The lack of available documentation, however, has been a major problem in reviewing the FRIA. Specifically, key supporting citations for the FRIA were not posted to the public docket at the time of this review. RFS2 personnel at EPA were contacted via telephone and e-mail to get three key citations, listed below. Although the documents were promised, they were never provided by EPA staff.

> 657 "Summary of recent findings for fuel effects of a 10% ethanol blend on light duty exhaust emissions," Memo from Aron Butler to Docket EPA-HQ-OAR-2005-0161.
>
> 658 "MOVES runs performed to support RFS2 final rule emission inventories," Memo from John Koupal to Docket EPA-HQ-OAR-2005-016.
>
> 665 "Analysis of ethanol evaporative permeation effects from CRC E-77 and E-65 programs," Memo from David Hawkins to Docket EPA-HQ-OAR-2005-0161.

With respect to fuel adjustments on emissions from gasoline-powered vehicles, exhaust emission effects from E10 fuel were estimated from EPA's Complex model, Predictive model, and MOBILE6 Sulfur model. However, in the FRIA, the "less sensitive" effects of NOx, HC, and toxics emissions applied to Tier 0 in the DRIA were extended to Tier 1 and NLEV cars and light-duty trucks through the 2003 model year. In addition, in the FRIA EPA eliminated from consideration any change in emissions associated with the use of ethanol in Tier 2 vehicles based on a single citation not provided in the docket (657):

> *In the final rule, we are reflecting preliminary results from work sponsored by EPA and DOE which suggests that emissions from Tier 2 vehicles show little sensitivity to E10.*[657]

With respect to the application of the Tier 0 vehicle effect to Tier 1 vehicles, the FRIA provides a single citation of the CRC E74b project as the basis for this change in methodology. However, the FRIA misuses the conclusions of the CRC E-74b project in this context and is therefore misleading.

Important, relevant conclusions and observations from the CRC E74b Project are as follows.

1. CRC E74b collected a stratified vehicle sample specifically designed to capture representative vehicles including exhaust standards from Tier 1 through Tier 2, inclusive.

2. CRC E74b examined ethanol-blend, volatility, and temperature corrections on exhaust emissions to determine which vehicle technologies, if any, were statistically significant and, if so, which were statistically similar or different.

3. For ethanol-gasoline blends through 20 volume percent (i.e., E20), CRC E74b found significant FTP exhaust effects of ethanol blends for HC, CO, and NOx.[*] The ethanol blend exhaust effects were found to be statistically the same for Tier 1 through Tier 2 vehicles.

Moreover, an examination of the CRC E74b ethanol impacts (and underlying test data) confirms these as statistically similar to those test results from Environment Canada, which also utilized ethanol gasoline blends up to E20 (testing also completed on Tier 1 and later vehicles).[†] In comparing the CRC E74b results against those of the DRIA (for Tier 0 vehicles), the CRC E74b Tier 1 and Tier 2 impacts are greater for NOx (a larger

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[*] Statistically distinct exhaust impacts for each bag of the FTP and the FTP composite were determined. All FTP composite results are statistically significant. All FTP bag results are statistically significant except for Bag 2 and Bag 3 THC exhaust.

[†] This analysis was completed by Sierra under contract to Environment Canada to develop updated fuel corrections for the version of MOBILE used in Canadian inventory development. Statistically similar exhaust impacts were observed from the FTP composite results; some individual bag differences were observed between CRC and Environment Canada test results.

increase in NOx due to adding ethanol to gasoline) and also larger for CO (a larger decrease in CO due to adding ethanol to gasoline). The CRC E74b results for THC are similar to the DRIA's Tier 0 effects for THC as defined on a proportional scale.*

The results of the CRC E74b project do not support the narrative of the FRIA and should not be cited as a supporting reference for the change in methods. CRC E74b does not support the extrapolation of Tier 0 E10 exhaust corrections to Tier 1 vehicles; further CRC E74b contradicts the FRIA's elimination of Tier 2 vehicle exhaust impacts for E10.

With respect to ethanol impacts on evaporative emissions, the FRIA dropped the RVP effect on evaporative emissions due to adding ethanol to obtain E10 (for the emissions evaluation only; the RVP effect is retained for the air quality evaluation). This is an important inventory modification for analyses relative to the RFS1 reference case of 7.5 billion gallons in 2022. The RVP effect was included in the DRIA. There is no justification for eliminating this effect, and it only adds further discrepancies between the emissions and air quality evaluations of the FRIA.

3.2.1.2 E85 FFVs

In our review of the DRIA, a number of issues were raised regarding EPA's assessment of the emission impacts of FFV operation on E85.[3] Our DRIA review presented an alternative methodology for estimating E85 impacts that differed from the DRIA assessment in that it also included cold temperature emission effects whereas the DRIA methodology did not. The technical basis for including the winter/cold data in our DRIA review is as follows.

1. The findings of EPA's mobile source air toxics (MSAT) rulemaking and the sponsored underlying test studies show that significantly higher VOC emissions and HC-toxics occur at cold temperatures and fuels,[7, 8] and the MSAT rulemaking thus included a cold temperature HC standard. Therefore, in terms of toxic emissions and exposure as it relates to the RFS2 evaluation, the winter data are more representative than the summer results.

2. The MSAT-sponsored studies, Environment Canada studies,[9,10] and the SwRI E85 study[11] show that toxic to VOC ratios remain constant for individual test vehicles across both summer and winter temperatures and fuels.† Toxic ratios developed from the combined summer and winter data are more reliable and show improved statistics from the additional amount of data.

3. The E85 factors developed are applied to both winter and summer inventory conditions for the evaluations contained in the DRIA and FRIA.

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* Comparisons reported here were made from FTP composite results. DRIA fuel corrections were developed only from FTP composite test data.

† In effect, the increase in emissions at cold temperatures is proportionally equivalent between VOC and key toxics.

In our DRIA review, we also disagreed about the significance of the PM results from the SwRI report in which we found considerable PM measurement uncertainty and multiple reporting discrepancies. Any reduction in PM due to E85 usage could not be supported by the test data available, yet the DRIA assumed a 68% reduction in PM due to E85 usage.

Overall the alternative analysis our DRIA review found that emissions of four pollutants—CO, benzene, formaldehyde, and acetaldehyde—were significantly lower from FFVs using E85 than FFVs using ethanol-free gasoline.[3] If only the summer season data were evaluated, then six pollutants were significantly different (1,3-butadiene and NOx, in addition to the previous four), which matches the DRIA analysis.[*] However, the winter SwRI results had vehicle tests showing increased 1,3-butadiene and NOx with E85 usage. Moreover, the winter test data include replicate tests on both ethanol-free gasoline and E85 whereas the summer results included only single tests on each fuel, giving the winter results added certainty.

In the SAAC, EPA chose to respond and discuss some of the pollutant discrepancies and issues raised in our review of the DRIA, but not others. More significantly, the FRIA chose to eliminate consideration of all E85 emission impacts except those for acetaldehyde and ethanol, as stated in the following:

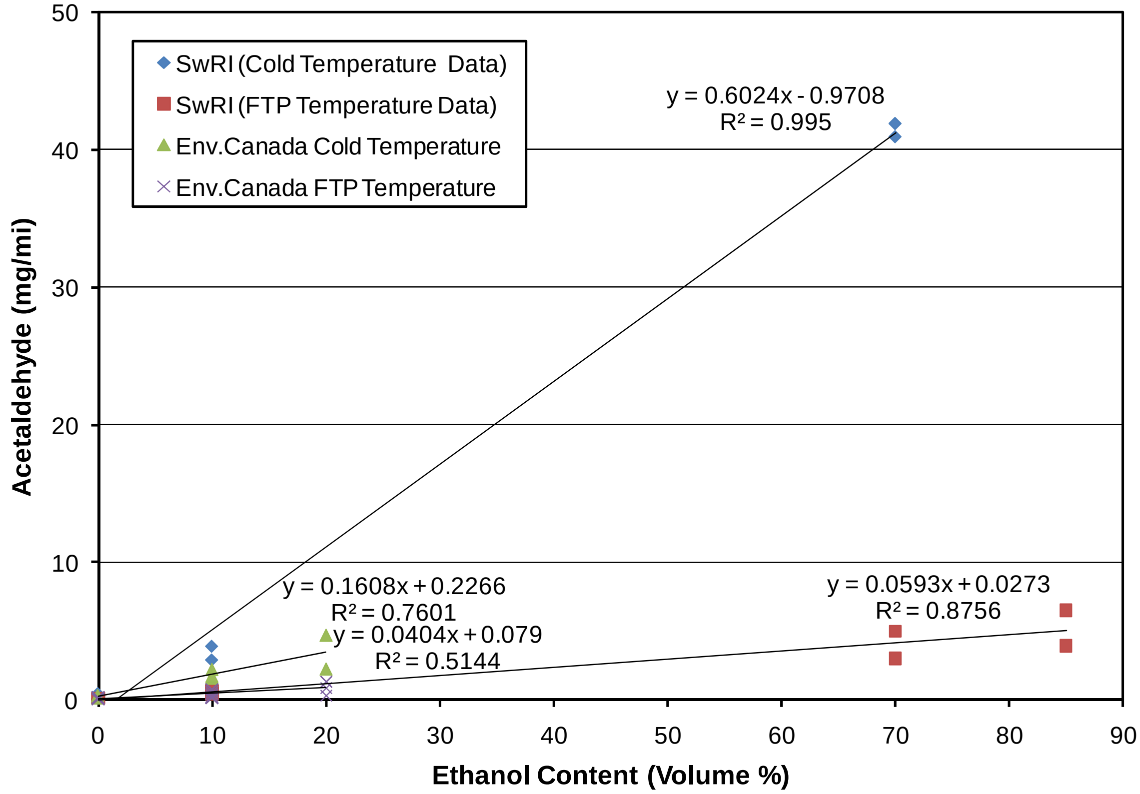
> *For the final rule we have decided not to apply these effects to the potential increase in E85 use, with the exception of acetaldehyde and ethanol. The rationale for this is the large range of uncertainty imposed by the limited nature of the dataset.*

Importantly, though, the updated E85 assumptions in the FRIA are implemented only for the emission inventory evaluation. The air quality evaluation of the FRIA retains the DRIA methodology for E85 impacts.

EPA's elimination of E85 emission impacts is more reasonable than the methodology used in the DRIA given the limited available data. For acetaldehyde (and ethanol) notably, the impacts of increasing ethanol in gasoline on these two pollutants are more certain and therefore retaining effects for these two pollutants is reasonable. Figure 3-1 shows the change in acetaldehyde emissions as a function of ethanol content for vehicles tested on multiple ethanol-containing fuels.[9,11] The results are clear: acetaldehyde emissions increase proportionally with increasing ethanol volume percent in gasoline. The FRIA assumptions for E85 impacts on acetaldehyde are consistent with that effect and are therefore reasonable.

[*] For acetaldehyde, formaldehyde, and CO, the E85 emission impacts calculated showed added statistical certainty when utilizing both the winter and summer blend results.

Figure 3-1
Acetaldehyde Emission Rates versus Ethanol Content



The discrepancy between the FRIA emission and air quality evaluations in terms of the assumed E85 methods is significant, however, and adds further concern about the relevance of the FRIA air quality evaluation results. In the control case of the FRIA air quality evaluation, 22 billion of the 34 billion gallons of renewable fuel are assumed to be in the form of E85, and the impacts are based on highly uncertain E85 effects for PM, NOx, and 1,3-butadiene. In the control case of the FRIA emission inventory evaluation, only 8 billion gallons of renewable fuels are assumed to occur in the form of E85 (and this review still finds that level of E85 consumption to be an optimistic upper bound), and the emissions impacts for all pollutants have been eliminated except for exhaust ethanol and acetaldehyde.

3.2.1.3 Diesel Vehicles

Like the DRIA, the reference case emissions from Diesel-fueled vehicles are calculated using NMIM and MOBILE6 in the FRIA. Baseline 2022 on-road Diesel emissions of NOx and PM have increased significantly from the DRIA to the FRIA. However, VOC and CO emissions have not changed for Diesel-fueled vehicles. This would indicate that the VMT for these vehicles has not changed, but that the NOx and PM emission factors changed. The documentation does not provide any indications of significant changes to the on-road Diesel emission calculation methodology. There is no indication in the available documentation of what might be driving this change.

Biodiesel and renewable Diesel (RD) are two distinct types of renewable distillates.* The DRIA evaluated biodiesel, but did not evaluate RD given that RD was assumed not to occur in significant quantities. The FRIA completely revised the renewable distillate assumptions. The largest source of renewable distillates in the FRIA's primary control case is RD—at about 7 billion gallons in 2022—versus only about 1 billion gallons of biodiesel in 2022.

Biodiesel and RD have distinct properties and emissions impacts. Esters are compounds that contain oxygen, so biodiesel (i.e., FAME) is an oxygenated Diesel whereas RD has no oxygen content. RD has higher cetane levels (relative to biodiesel) and results in a NOx reduction when added to conventional Diesel. Biodiesel, especially when derived from plant feedstocks, has relatively lower cetane levels and results in a NOx increase when added to conventional Diesel.[12,13]

The FRIA failed to address the emissions impacts of RD—specifically, the reduction in NOx emissions from Diesel-powered vehicles. It is unclear from the FRIA documentation of methods if RD was assumed to have no effect on exhaust emissions or if RD was assumed to have the same effect as biodiesel on exhaust emissions (i.e., an increase in NOx emissions). In either approach, however, the result would be wrong and the FRIA emissions impact assessment of NOx would not address the reduction expected from RD usage.

3.2.2 Non-Road Equipment

The FRIA shows a significant increase in reference case emissions from gasoline-powered non-road equipment relative to the DRIA while emissions from other non-road sources have decreased by about the same magnitude. The reason for this change cannot be determined from the FRIA. The only documented change in the non-road reference case inventories for the DRIA and FRIA was that the FRIA used a more recent inventory for certain commercial marine vessels. This change, which was not large, affected only the other non-road sources.

3.3 Comparison of FRIA Air Quality and Emission Inventory Evaluations

As discussed previously at several points in the report, the FRIA used fundamentally different methodologies for the air quality and emission inventory evaluations of the impact of the RFS2. The differences in the methodologies are summarized in Table 3-1. As shown, the methodology used in the air quality impact analysis bears little resemblance to the emission inventory impact analysis. Key differences include the total assumed volumes of ethanol and biodistillates, FFV production volumes, as well as E85

* "Biodiesel" specifically refers to the transesterification process to produce Diesel from oils (either plant or animal feedstock). Biodiesel, as the term is explicitly defined by ASTM and used by the petrol industry, refers to mono-alkyl esters, also termed fatty acid methyl esters or FAME. The biodiesel analysis of the DRIA and FRIA applies only to FAME. "Renewable Diesel" (RD) is used to define the other processes for refining oils into Diesel (other than transesterification), including hydrogenation (or hydro-cracking) and thermal processing (e.g., by the Fischer-Tropsch process).

Table 3-1 Key Modeling Parameters Used in FRIA Air Quality and Emission Inventory Evaluations		
Modeling Parameter	FRIA Air Quality Evaluation	FRIA Emission Inventory Evaluation
Renewable volumes (primary control case, 2022):[a] Total ethanol Ethanol in E85 Total biodistillates Renewable Diesel	 34.1 billion gallons 21.7 billion gallons 1.2 billion gallons 0.4 billion gallons	 22.2 billion gallons 9.3 billion gallons 8.3 billion gallons 6.7 billion gallons
VMT projection update to AEO2009?	No	Yes
Fuel economy updated to latest CAFÉ?[b]	No	Yes
FFV sales (primary control case, total 2010 – 2022 model years)	68.0 million	48.0 million
FFV E85 refueling rate (primary control case, 2022)	74%	29%[c]
RVP effect on evaporative emissions for E10?	Yes	No
Updated E10 permeation effect on evaporative emissions?	No	Yes
Tier 1 exhaust effect for E10?	No	Yes (Tier 0 extrapolation)
Tier 2 exhaust effect for E10?	No	No
Pollutants with E85 exhaust effects	NOx PM Formaldehyde Benzene 1,3-Butadiene Acetaldehyde Ethanol	Acetaldehyde Ethanol
Renewable Diesel (RD) NOx reduction?	No (minimal quantity of RD under RFS2)	No (substantial quantity of RD under RFS2)
Updated upstream emissions for ethanol transport?	No	Yes

[a] As reported in FRIA tables 3.1-9 and 3.3-1.
[b] Fuel economy update impacts (i.e., reduces) volumes of fuel consumed.
[c] Value represents the combined FRIA assumptions of 70% E85 availability nationwide and a 42% refueling rate where available.

usage rates and emissions impacts. Again, if one assumes that the FRIA control case for the inventory analysis represents the best available assessment of what will occur under RFS2, the air quality analysis in the FRIA is effectively rendered meaningless because it is based on already outdated underlying assumptions as demonstrated by the agency's own updates incorporated into the emission inventory evaluation.

3.4 Comparison of Direct Non-GHG Emissions in the DRIA and FRIA

Table 3-2 shows the relative impacts of this final rule on various types of vehicle and equipment emissions. The impacts presented for the FRIA were based on the primary case (mid-EtOH) relative to AEO2007 reference case. The relative impacts for the DRIA's more sensitive case relative to the AEO2007 reference case are also provided for comparison. Note that negative values in FRIA and DRIA columns indicate a reduction in emissions associated with the RFS2 and positive values an increase in emissions. The differences (absolute) between the FRIA and DRIA are also shown in the table: positive values indicate higher emissions in the FRIA than in the DRIA, and negative values indicate lower emissions in the FRIA than in the DRIA. As shown, the FRIA estimates smaller increases in emissions of VOC and NOx under the RFS2 than did the DRIA, with CO emissions being far higher under the FRIA. The FRIA also indicates higher emissions of particulate matter and sulfur oxides. With respect to toxics and ethanol, the RFS2 impacts in the FRIA are generally smaller than those reported in the DRIA.

As shown, the FRIA estimates smaller increases in emissions of VOC and NOx under the RFS2 than did the DRIA, with significantly lower CO emission reductions under the FRIA than under the DRIA. The FRIA also indicates much smaller emission reductions of particulate matter from the AEO2007 reference case for the FRIA than the DRIA. With respect to toxics and ethanol, the RFS2 impacts in the FRIA are generally smaller than those reported in the DRIA.

While the changes in the CO emission impacts from the DRIA to the FRIA, as shown in Table 3-2, appear to be more significant than any of the other emission impacts, the overall magnitude of the CO emission totals must be taken into consideration when evaluating the significance of these changes. Table 3-3 shows an estimate of the total emissions under the FRIA and DRIA RFS2 scenarios analyzed in this report, based on the emission tables published by EPA in the FRIA and DRIA for the RFS2. This table shows that, overall, emissions modeled in the RFS2 scenarios increased by about 6.5% for on-road gasoline vehicles from the DRIA to the FRIA. This change is reasonable given the changes in MOVES model versions that affect fuel impact calculations between the draft and final analyses as well as the differences in modeling assumptions for the RFS2 scenarios between the two analyses. The percentage change in CO emissions is much smaller for both on-road Diesel vehicles and non-road gasoline engines than for on-road gasoline vehicles.

The percentage change in VOC emissions from on-road gasoline vehicles from the DRIA to the FRIA RFS2 scenarios is just slightly greater then the CO change, at an 8.4% increase. The percentage changes in VOC emissions for on-road Diesel vehicles and non-road gasoline engines are similar to the corresponding changes in CO emissions. As with the CO emissions, the changes in VOC emissions are expected due to the changes in the way the different versions of MOVES account for fuel adjustments along with the other changes in modeling assumptions of the RFS2 scenario from the DRIA to the FRIA.

In contrast to the VOC and CO emission changes between the DRIA and the FRIA, the changes in NOx are less understandable and more significant. The 49% increase in NOx emissions under the RFS2 scenarios for on-road gasoline vehicles from the DRIA to the FRIA cannot be easily explained based on the information available. Even less understandable are the changes in NOx and PM emissions for on-road Diesel vehicles from the DRIA to the FRIA (a 161% increase for NOx, a 108% increase for PM_{10}, and a 125% increase for $PM_{2.5}$). Without further information, our analysis of these numbers indicates that the most probable cause for these changes is an error in the reported AEO2007 reference case emissions for NOx and PM emissions from on-road Diesel vehicles. Based on the available documentation, minimal changes were made to the modeling of the AEO2007 reference case for on-road Diesel vehicles between the DRIA and the FRIA. This should be investigated further given that EPA has now made available the databases and modeling runs used in the mobile source analyses, which were not available at the time our review was performed.

Table 3-2
Vehicle and Equipment Emission Inventory Impacts by Source Type
Relative to the AEO2007 Reference Case
(annual short tons)

Vehicle and Equipment	VOC[a]			CO			NOx		
	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change
Light-duty gasoline vehicle exhaust	-1,437	-1,945	508	-72,872	-1,418,363	1,345,491	10,034	14,258	-4,224
Light-duty gasoline vehicle evap	3,447	-2,549	5,996	n/a	n/a		n/a	n/a	
Light-duty gasoline vehicle refueling	2,015	4,476	-2,461	n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle exhaust	2,168	-141	2,309	-21,163	839	-22,002	58	1,060	-1,002
Heavy-duty gasoline vehicle evap	-750	44	-794	n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle refueling	440	977	-537	n/a	n/a		n/a	n/a	
Non-road gasoline equipment exhaust	-6,413	-6,810	397	-408,453	-422,725	14,272	9,212	10,530	-1,318
Non-road gasoline equipment evap	6,702	7,216	-514	n/a	n/a		n/a	n/a	
Non-road gasoline equipment refueling	563	6,609	-6,046	n/a	n/a		n/a	n/a	
Portable fuel containers	1,037	1,037	0	n/a	n/a		n/a	n/a	
On-road Diesel vehicles	-2,422	-753	-1,669	-4,104	-1,275	-2,829	1,346	418	928
TOTAL	5,350	8,161	-2,811	-506,592	-1,841,524	1,334,932	20,650	26,266	-5,616

[a]"VOC" values shown are actually THC for on-road gasoline exhaust and evaporative emissions.
"na/" – not applicable.

Table 3-2 (continued)

Vehicle and Equipment	PM_{10}			$PM_{2.5}$			SO_2		
	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change
Light-duty gasoline vehicle exhaust	0	-4,112	4,112	0	-3,786	3,786	0	0	0
Light-duty gasoline vehicle evap	n/a	n/a		n/a	n/a		n/a	n/a	
Light-duty gasoline vehicle refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle exhaust	0	0	0	0	0	0	0	0	0
Heavy-duty gasoline vehicle evap	n/a	n/a		n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Non-road gasoline equipment exhaust	0	0	0	0	0	0	21	0	21
Non-road gasoline equipment evap	n/a	n/a		n/a	n/a		n/a	n/a	
Non-road gasoline equipment refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Portable fuel containers	n/a	n/a		n/a	n/a		n/a	n/a	
On-road Diesel vehicles	-569	-177	-392	-315	-98	-217	0	0	0
TOTAL	-569	-4,289	3,720	-315	-3,884	3,569	21	0	21

"na/" – not applicable

Table 3-2 (continued)

Vehicle and Equipment	NH_3			Benzene			Ethanol		
	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change
Light-duty gasoline vehicle exhaust	0	0	0	-287	-2,758	2,471	8,773	19,850	-11,077
Light-duty gasoline vehicle evap	n/a	n/a		7	27	-20	500	7,981	-7,481
Light-duty gasoline vehicle refueling	n/a	n/a		7	15	-8	770	1,034	-264
Heavy-duty gasoline vehicle exhaust	0	0	0	-47	-19	-28	57	109	-52
Heavy-duty gasoline vehicle evap	n/a	n/a		-1	0.39	-2	315	77	238
Heavy-duty gasoline vehicle refueling	n/a	n/a		1	3	-2	157	214	-57
Non-road gasoline equipment exhaust	0	0	0	-737	-156	-581	2,497	3,071	-574
Non-road gasoline equipment evap	n/a	n/a		106	128	-22	4,556	4,937	-381
Non-road gasoline equipment refueling	n/a	n/a		106	108	-2	972	1,645	-673
Portable fuel containers	n/a	n/a		0	-0.3	0	646	646	0
On-road Diesel vehicles	0	0	0	-30	-9	-21	0	0	0
TOTAL	0	0	0	-875	-2,661	1,785	19,243	39,564	-20,321

"na/" – not applicable

Table 3-2 (continued)

Vehicle and Equipment	1,3-Butadiene			Acetaldehyde			Formaldehyde		
	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change
Light-duty gasoline vehicle exhaust	22	-474	496	2,034	4,489	-2,455	73	1,948	-1,875
Light-duty gasoline vehicle evap	n/a	n/a		n/a	n/a		n/a	n/a	
Light-duty gasoline vehicle refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle exhaust	0	0.46	0	19	33	-14	-2	4.6	-7
Heavy-duty gasoline vehicle evap	n/a	n/a		n/a	n/a		n/a	n/a	
Heavy-duty gasoline vehicle refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Non-road gasoline equipment exhaust	57	32	25	189	308	-119	54	63	-9
Non-road gasoline equipment evap	n/a	n/a		n/a	n/a		n/a	n/a	
Non-road gasoline equipment refueling	n/a	n/a		n/a	n/a		n/a	n/a	
Portable fuel containers	n/a	n/a		n/a	n/a		n/a	n/a	
On-road Diesel vehicles	-16	-5	-11	-66	-21	-45	-182	-57	-125
TOTAL	63	-447	510	2,176	4,809	-2,633	-57	1,959	-2,016

"na/" – not applicable

Table 3-2 (continued)

Vehicle and Equipment	Naphthalene			Acrolein		
	FRIA	DRIA	Absolute Change	FRIA	DRIA	Absolute Change
Light-duty gasoline vehicle exhaust	0	-180	180	1	-29	30
Light-duty gasoline vehicle evap	1	-4	5	n/a	n/a	
Light-duty gasoline vehicle refueling	1	2	-1	n/a	n/a	
Heavy-duty gasoline vehicle exhaust	0	0	0	0	0	0
Heavy-duty gasoline vehicle evap	0	0.02	0	n/a	n/a	
Heavy-duty gasoline vehicle refueling	0	0.11	0	n/a	n/a	
Non-road gasoline equipment exhaust	0	0	0	-8	1.2	-9
Non-road gasoline equipment evap	0	0	0	n/a	n/a	
Non-road gasoline equipment refueling	0	0	0	n/a	n/a	
Portable fuel containers	0	0.13	0	n/a	n/a	
On-road Diesel vehicles	0	-0.12	0	-9	-3	-6
TOTAL	2	-182	184	-16	-31	15

"na/" – not applicable

Table 3-3
Vehicle and Equipment 2022 Emission Totals in the FRIA Primary Case as Compared to the DRIA "More Sensitive" Case
(annual short tons)

Emission Category	VOC	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	NH_3
FRIA Primary Case (mid-ethanol)							
On-road Gasoline	987,315	26,453,134	2,011,635	46,284	42,619	34,031	390,486
On-road Diesel	138,432	239,716	1,308,496	61,684	37,042	4,352	11,426
Non-road Gasoline	1,435,512	14,310,356	237,844	54,432	50,077	1,443	1,112
DRIA "More Sensitive" Case							
On-road Gasoline	910,822	24,833,007	1,349,295	44,360	40,847	34,031	390,486
On-road Diesel	140,101	242,545	502,078	29,717	16,435	4,352	11,426
Non-road Gasoline	1,441,675	14,296,084	239,162	54,432	50,077	1,422	1,112
Percentage Change in Emissions from the DRIA "More Sensitive" Case Emissions to the FRIA Primary Case Emissions							
On-road Gasoline	8.40%	6.52%	49.09%	4.34%	4.34%	0.00%	0.00%
On-road Diesel	-1.19%	-1.17%	160.62%	107.57%	125.38%	0.00%	0.00%
Non-road Gasoline	-0.43%	0.10%	-0.55%	0.00%	0.00%	1.46%	0.00%

Note: Emissions in this table have been estimated by adding the reported 2022 AEO2007 Reference Case emissions to the reported corresponding emission changes for the specified RFS2 cases.

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4. INDIRECT NON-GREENHOUSE GAS POLLUTANT IMPACTS

This section evaluates the FRIA analysis of the indirect non-GHG emissions impacts associated with the production and distribution of renewable fuels and again focuses on how EPA responded to issues raised in our previous review of the DRIA as well as issues identified with new methods and data applied in the FRIA.

4.1 Non-GHG Pollutant Emissions Associated with Growth and Collection of Renewable Fuel Feedstocks

4.1.1 Non-GHG Pollutant Emissions from Agricultural Equipment

The emission factors and methodology for estimating emissions from agricultural equipment are unchanged from the DRIA. However, based on a review of the emission impacts from the overall agricultural sector, it would appear that the impacts of agricultural emissions have changed. This is most likely due to changes in the assumed volumes of renewable fuels produced and consumed in the control cases of the DRIA and the FRIA.

4.1.2 Non-GHG Pollutant Emissions from Fertilizer/Pesticide Production and Application

One issue identified in the review of the DRIA related to where the marginal production of pesticides/herbicides is going to occur. EPA acknowledged the issue, but did nothing to correct it, stating that an analysis of localized impacts was beyond the scope for the rule.

There were no changes to the air emission factors for agricultural chemical production and transport. However, the changes in agricultural chemical use in the FRIA are different than the changes reported in the draft RIA. For example, the FRIA projects that nitrogen use will increase 5.73 % as opposed to the 2.42 % reported in the DRIA. While the outputs of FASOM (Forest and Agricultural Sector Optimization Model) included in the docket support the information provided in the FRIA, there is no explanation of why the FASOM outputs between the DRIA and FRIA are different.

The emission factors for herbicide and pesticide application in the FRIA are the same as those in the DRIA. However, the air emissions impact reported in the FRIA is less than the impact reported in the DRIA. For example, the FRIA projects that VOC emissions from herbicide and pesticide application will decrease by 614 tons per year as opposed to a decrease of 6,531 tons reported in the DRIA. Again, a lack of documentation precludes an explanation of the basis for the changes.

4.1.3 Non-GHG Pollutant Emissions from Agricultural Burning and Dust Generation

In the review of the DRIA, it was noted that the agricultural burning emissions were too generic and that using an "average" burning figure may not be accurate for the areas where renewable fuel feedstocks are grown. As a result of concerns with the agricultural burning estimate, the estimate was eliminated entirely in the FRIA. EPA claims that this was done because of the uncertainty associated with agricultural burning estimates and because the crops likely to change as a results of the RFS2 do not typically involve agricultural burning.

Another area where the FRIA differs from the DRIA is with respect to emissions from livestock dust. In the FRIA, PM_{10} emissions associated with dairy and beef cattle have decreased from -0.9 tons annually to -148 tons. The emissions factors for these pollutants are listed as the same, so the activity data must have decreased as a result of the revised RFS2 control cases.

4.1.4 Agricultural Emissions of Ammonia

As was the case in other areas, there are differences in the ammonia emission impact estimates of the FRIA relative to the DRIA that appear to be due to changes in activity related to the differences in the control cases.

4.2 Non-GHG Pollutant Emissions from Renewable Fuel Production

As noted above, the volumes and types of renewable fuels assumed in the FRIA differ substantially from those in the DRIA. In particular, ethanol volumes in the FRIA are substantially lower than in the DRIA and cellulosic Diesel volumes are substantially higher. In the review of the DRIA, it was noted that ethanol emissions associated with ethanol production were far higher than the total VOC emissions from fuel production and that this appeared to be an impossibility given that ethanol is only one component of VOC emissions. Although EPA's response to this comment in the SAAC did not fully address the issue, ethanol emissions associated with ethanol production in the FRIA are lower that VOC emissions although questions remain about the EPA ethanol emission factor.

To better illustrate this issue, VOC and ethanol emissions reported in the DRIA and FRIA are presented in Tables 4-1 and 4-2. Table 4-1 shows the emissions factors and total emissions of VOC and ethanol reported in the DRIA while Table 4-2 shows the same information as reported in the FRIA.

Table 4-1 Biofuel Production VOC and Ethanol Emissions Estimates from the DRIA					
Feedstock	Fuel Quantities (Billion Gallons)	Ethanol Emissions Factor (g/gal)	Estimated Ethanol Emissions (short tons)	VOC Emissions Factor (g/gal)	Estimated VOC Emissions (short tons)
Dry Mill NG Corn Ethanol	1.58	1.66	2,876	4.00	6,952
Other Corn Ethanol	0.88	N/A	1,606	N/A	3,850
Onsite Cellulosic Ethanol, Thermochemical Forest Waste	5.92	2.38	15,473	0.36	2,364
Onsite Cellulosic Ethanol, Enzymatic, Corn Stover	8.55	1.66	15,565	1.94	18,217
Onsite Cellulosic Ethanol, Enzymatic, Switchgrass	1.28	1.66	2,330	1.94	2,727
Offsite Biofuel Production Emissions	N/A	N/A	0	N/A	-2,452
Cellulosic Diesel	0	0	0	0	0
Total (from DRIA)	18.2		37,856		32,278

Table 4-2 Biofuel Production VOC and Ethanol Emissions Estimates from the FRIA						
Feedstock	Additional Billion Gallons (DRIA)	Additional Billion Gallons (FRIA)	Ethanol Emissions Factor (g/gal)	Estimated Ethanol Emissions (short tons)	VOC Emissions Factor (g/gal)	Estimated VOC Emissions (short tons)
Dry Mill NG Corn Ethanol	1.58	1.58	unknown	2,876	unknown	6,952
Other Corn Ethanol	0.88	0.88	unknown	1,606	unknown	3,850
Onsite Cellulosic Ethanol, Thermochemical Forest Waste	5.92	1.76	unknown	4,588	unknown	701
Onsite Cellulosic Ethanol, Enzymatic, Corn Stover	8.55	2.54	unknown	4,615	unknown	5,402
Onsite Cellulosic Ethanol, Enzymatic, Switchgrass	1.28	0.38	unknown	691	unknown	809
Offsite Biofuel Production Emissions	N/A	N/A	unknown		unknown	-727
Cellulosic Diesel	0	6.52	unknown		unknown	
Total (calculated)	**18.2**	**13.7**		**14,376**		**16,986**
Total (from FRIA)	**18.2**	**13.7**		**6,435**		**18,867**

Table 4-2 shows how the assumed quantities of renewable fuels have changed in the FRIA relative to the DRIA, with a significant reduction in cellulosic ethanol and an increase in cellulosic Diesel production. The quantities of individual feedstocks are not documented in the FRIA, so the ratio of cellulosic feedstocks from the DRIA used is an approximation. Emissions are then estimated using the emission factors shown in Table 4-1 as EPA provided no update regarding emissions factors used in the FRIA for cellulosic ethanol production. In addition, the FRIA provides no estimates of cellulosic Diesel production so emissions from this source cannot be estimated.

Based on the emission factors from the DRIA, the renewable fuel production volumes in the FRIA should have over 14,000 short tons of ethanol emissions associated with them (even assuming no ethanol emissions from the production of cellulosic Diesel). However, the 6,435 tons of ethanol emissions reported in the FRIA is less than half of the value computed using the DRIA emission factors. Given the lack of documentation in the FRIA, this inconsistency cannot be resolved.

The review of the DRIA also identified unlikely assumptions by EPA with respect to the impact of the RFS2 on SOx emissions. In the DRIA, EPA estimated that the RFS2 would decrease SOx emissions because excess electricity generated by cellulosic ethanol plants would displace electricity generated from fossil fuel combustion. In the DRIA, electricity was assumed to be produced and sold to the grid at a rate of 3.59 kWh/gal based on information from NREL that was not made publicly available. Other NREL studies cited in the FRIA have found that a cellulosic ethanol plant could produce and sell a smaller amount of electricity[14] or assumed that production and on-site demand for electricity would be equal.[15] In the FRIA, SOx emissions are estimated to be positive, but it is unclear if this is due to the shift away from cellulosic ethanol and towards cellulosic Diesel, or a change in assumed electricity production. Nonetheless, EPA's further assumptions regarding electricity production at cellulosic ethanol plants remain poorly documented and the results of the FRIA cannot be understood or reproduced based on the available information.

Another issue raised in the review of the DRIA dealt with EPA's claims that the RFS2 would reduce emissions associated with gasoline and Diesel fuel production. As identified in the DRIA review, examples of why such reductions might not occur included the potential for generating emission offsets as the result of refinery shuttering that could be used to create new emission sources or the potential for refined products to be exported from U.S. refineries. EPA's responses to these examples were that it is not certain that emission reductions projected in refineries would meet the criteria that would allow them to be used as offsets; that U.S refinery products were unlikely to be exported; and that the RFS2 would reduce imports of gasoline and Diesel fuel, not lead to exports. While it is possible that reductions in refinery emissions might yield emission offsets, it is difficult to see how EPA can claim reductions in U.S. refinery emissions if the main impact of the RFS2 is to reduce imports of gasoline and Diesel fuel into the U.S.

4.3 Non-GHG Pollutant Emission Impacts from Renewable Fuel Transport

In the FRIA, EPA corrected an emission factor error in the calculation of VOC storage and distribution emissions.

Emissions associated with biofuel transportation did not change dramatically between the DRIA and the FRIA except for VOC, where the refinery to bulk terminal emission factor for E100 transportation was increased in the FRIA from 3.56 g/MMBtu to 28.78 g/MMBtu. This change leads, at least in part, to an increase in VOC emissions for biofuel transportation and distribution from the DRIA estimate of -2,200 tons to the FRIA value of over 18,000 tons annually.

4.4 Non-GHG Pollutant Emission Impacts from Reduced Consumption of Petroleum Based Fuels

The emissions estimate for most pollutants changed relatively little between the DRIA and the FRIA draft for displaced gasoline and Diesel consumption. The most significant change in emissions comes in VOC, where the DRIA emissions estimate was -43,000 tons annually compared to the FRIA estimate of -20,000 tons. This change is likely a result of increased Diesel displacement compared to gasoline in the FRIA. Diesel has a much lower VOC emission factor associated with fuel transportation emissions (1.3 g/MMBtu) than that of gasoline (15.1 g/MMBtu) or RFG (10.3 g/MMBtu).

4.5 Air Toxics

In the review of the DRIA, it was noted that benzene emissions from pesticide application accounted for 26% of VOC emissions, which appeared to be too high. In the SAAC, EPA pointed out that this estimate was based on EPA's National Emissions Inventory, but noted that benzene is no longer used in pesticide products and the DRIA inventory was inaccurate. However, EPA also noted that, due to time constraints, the error was not corrected in the FRIA.

Another issue raised in the review of the DRIA was that EPA stated toxic emission factors for ethanol production facilities came from wet mill plants, whereas most plants in the future will be dry mill plants. In the SAAC, EPA claimed that this was a typographical error and that over 90% of the available emissions data used to develop emission factors were from dry mill plants.

Finally, in the review of the DRIA, it was noted that EPA had failed to acknowledge potential biases in its air toxic emission factor development from the 2005 NEI. There were limited state data submitted for calendar year 2005 because EPA de-emphasized state submittals for that year due to budgetary issues. Therefore, the state sample may be biased according to the states that elected to submit their data. EPA acknowledged this point.

4.6 Summary of Issues and Recommendations Related to Indirect Non-GHG Pollutant Impacts

The list below summarizes the issues identified and our recommendations related to the indirect non-GHG pollutant impacts from our review of the RFS2 FRIA.

- In general, EPA has not yet provided sufficient documentation related to the FRIA needed for us to perform a thorough review of its methodologies. At the time of our review, the docket for the final RFS2 rulemaking did not include many of the newly referenced documents for the FRIA.

- In many cases, the text for the FRIA is the same as the text for the DRIA while emissions have changed between these two analyses. Without better documentation, we cannot determine whether these changes are reasonable.

- Information is needed from EPA on pesticide/herbicide application to determine why the EPA-estimated VOC emissions decrease changed so dramatically from the draft to the final RIA.

- The assumed volumes of fuel in the FRIA have changed from those in the DRIA. The most significant of these changes is that cellulosic ethanol has been reduced from 16 billion gallons (in 2022) in the DRIA to less than 5 billion gallons in the FRIA. In addition, cellulosic Diesel, which was not included in the FRIA, is now estimated at more than 6.5 billion gallons in 2022.

- Information is needed from EPA to determine how the agency estimated non-GHG emissions for cellulosic Diesel production. The emission factors used and total emissions from cellulosic Diesel are not documented in either the FRIA or the DRIA.

- No documentation has been provided on the emission factors and feedstocks used in the FRIA, which makes it essentially impossible to determine the accuracy and validity of the emission estimates in the FRIA.

- Information is needed from EPA in order to perform a more thorough review of EPA's ethanol emission factors and application in the FRIA.

- Using the appropriate NREL report, the analysis that estimates electricity production from various biofuel production facilities—especially cellulosic Diesel—should be reviewed and evaluated.

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5. REFERENCES

1. Federal Register, Vol. 74, No. 99, Page 24904, May 26, 2009.

2. EPA, “Draft Regulatory Impact Analysis: Changes to Renewable Fuel Standard Program,” EPA-420-D-09-001, May 2009.

3. “Technical Review of 2009 EPA Draft Regulatory Impact Analysis for Non-GHG Pollutants Due to Changes to the Renewable Fuel Standard,” Sierra Research Report No. SR2009-09-01, September 22, 2009.

4. http://www.epa.gov/otaq/fuels/renewablefuels/regulations.htm.

5. “Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis,” EPA-420-R-10-006, February 2010.

6. “Renewable Fuel Standard Program (RFS2) Summary and Analysis of Comments,” EPA-420-R-10-003, February 2010.

7. “Cold Temperature Effects on Vehicle HC Emissions,” EPA420-D-06-001, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, February 2006.

8. “VOC/PM Cold Temperature Characterization and Interior Climate Control Emissions/Fuel Economy Impact, Final Report,” Volumes I and II, SwRI Project No. 03.11382.04, October 2005.

9. L.A. Graham et al., “Emissions from Light Duty Gasoline Vehicles Operating on Low Blend Ethanol Gasoline and E85,” *Atmospheric Environment*, 42 (2008) 4498–4516.

10. “Emissions from 4 Different Light Duty Vehicle Technologies Operating on Low Blend Ethanol Gasoline, Report B: Tailpipe Regulated & Unregulated Gaseous Emissions (CO, NOX, THC, NMHC, NMOG, Ethanol, Carbonyls, VOC),” ERM REPORT # 04-27 B, Environment Canada, 2004, Environmental Technology Centre.

11. “Flex Fuel Vehicles (FFVs) VOC/PM Cold Temperature Characterization when Operating on Ethanol (E10, E70, E85),” Interim Final Report (Revised), Southwest Research Institute, February 8, 2007.

12. “Investigation of Biodistillates as Potential Blendstocks for Transportation Fuels,” CRC Project No. AVFL-17 (Final Report), June 2009.

13. "Evaluation of the Effects of Alternative Diesel Fuel Formulations on Exhaust Emission Rates and Reactivity," Center for Environmental Research and Technology, University of California Riverside, April 1999.

14. A. Aden, M. Ruth, K. Ibsen, J. Jechura, K. Neeves, J. Sheehan, and B. Wallace National Renewable Energy Laboratory (NREL); L. Montague, A. Slayton, and J. Lukas Harris Group, Seattle, Washington, Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover; June 2002; http://www1.eere.energy.gov/biomass/pdfs/32438.pdf.

15. S. Phillips, A. Aden, J. Jechura, and D. Dayton, National Renewable Energy Laboratory, Golden, Colorado 80401-3393, T. Eggeman, Neoterics International, Inc., Thermochemical Ethanol via Indirect Gasification and Mixed Alcohol Synthesis of Lignocellulosic Biomass, Technical Report, NREL/TP-510-41168, April 2007.

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