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The Greenhouse Gas Emissions Impacts of Small Refinery Exemptions under the Renewable Fuel Standard

During President Donald Trump's four years in office, the U.S. Environmental Protection Agency (EPA) issued 85 waivers to oil refiners allowing them to ignore their legal obligations under the Clean Air Act's Renewable Fuel Standard (RFS).[1] In essence, oil companies used these "small refinery exemptions" to avoid blending renewable fuels (e.g., ethanol and biodiesel) with the petroleum-based fuels produced at their refineries.

The 85 waivers issued by the Trump administration marked a nearly four-fold increase over the 23 exemptions issued by the Obama administration. In addition, the Trump administration's exemptions reduced the 2016-2018 RFS blending requirements by a cumulative total of 4.04 billion gallons of renewable fuel, a six-fold increase over the cumulative total of 690 million gallons waived by the Obama administration for 2013-2015.[2]

As the administration transitions from President Trump to President-Elect Joe Biden, an additional 66 small refinery exemption petitions are still pending. If all of those pending exemption petitions were to be approved, we estimate it would result in another 3.14 billion gallons of lost demand for renewable fuels.

The dramatic increase in refinery exemptions under the Trump administration has been a source of significant controversy, leading to numerous legal challenges. In one landmark case, *Renewable Fuels Association et al. v. EPA*, the U.S. Court of Appeals for the Tenth Circuit in January 2020 overturned certain exemptions that had been illegally granted by EPA and found the agency had grossly exceeded its authority in granting the waivers.[3] A year later, EPA has not yet implemented the Tenth Circuit court's mandate.

It is an indisputable fact that renewable fuel producers and the farmers who supply corn, sorghum, soybeans, canola, and other crops to the biofuel supply chain have experienced significant financial damages due to the loss of demand stemming from the refinery exemptions. As recognized by President-Elect Biden, "Those waivers severely cut ethanol production, costing farmers income and ethanol plant workers their jobs."[4]

But in addition to the economic harm, the refinery exemptions have caused substantial environmental damages as well. When refiners are inappropriately released from their

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[1] EPA. RFS Small Refinery Exemptions. https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions

[2] *Id*. The statute required a temporary exemption for *all* small refineries through calendar year 2010. EPA then exempted 24 small refineries in 2011 and 23 in 2012, based on the results of a DOE study required by Congress. Thus, 2013 was the first year in which refineries had to proactively petition EPA for exemptions and demonstrate that their RFS compliance obligation would cause "disproportionate economic harm."

[3] 948 F.3d 1206 (10th Cir. 2020)

[4] Biden Campaign: "Statement on commitment to renewable fuel standard amid Trump administration's repeated attacks on farmers and producers." Aug. 25, 2020.

renewable fuel blending obligations, they supply more petroleum-based fuels—like gasoline and diesel—to the market in lieu of renewable fuels. Of course, the lifecycle greenhouse gas emissions associated with producing and using those petroleum fuels are much larger than the GHG emissions associated with the renewable fuels that would have been used in the absence of the refinery waivers. In other words, the exemptions lead to higher GHG emissions from the transportation sector than would have been the case if the exemptions had not been issued and the required volumes of renewable fuel had been used. Or looked at a different way, the refinery exemptions cause a significant amount of low-cost GHG reductions to be "left on the table."

Further, Trump's EPA has failed to comply with a 2017 decision and remand from the U.S. Court of Appeals for the D.C. Circuit in *Americans for Clean Energy v. EPA,* in which the court ordered the agency to restore 500 million gallons of conventional renewable fuel blending requirements illegally waived by EPA in 2016.[5] EPA's failure to follow the court's order has resulted in additional GHG emissions from fossil fuels that would not have occurred if EPA had complied with the court's mandate.

This brief analysis estimates the additional GHG emissions that resulted from EPA's issuance of waivers allowing small refiners to escape their 2016-2018 RFS obligations. We also estimate the GHG emissions implications of granting or denying the 66 pending exemption petitions, as well as implementation of the 500-million-gallon remanded volume. In summary, we found:

- The 85 exemptions granted for 2016-2018 reduced refiners' renewable fuel blending obligations by more than 3.8 billion "wet" gallons of renewable fuel. The likely mix of avoided renewable blending was 3.16 billion gallons of grain-based ethanol; 608 million gallons of biodiesel, renewable diesel, sugarcane ethanol, and other advanced biofuels; 48 million ethanol-equivalent gallons of biogas; and 2.5 million gallons of cellulosic ethanol.
- In place of the forgone renewable fuel blending for 2016-2018, roughly 2.76 billion gallons of gasoline and diesel were used instead.
- The use of gasoline and diesel in lieu of the 2016-2018 waived renewable fuel volumes led to an increase in GHG emissions from the transportation sector of 12.6 million metric tons of CO2-equivalent GHG.
- Moving forward, the denial of the 66 pending exemption petitions (as justified by the Tenth Circuit decision and past EPA practice) would protect demand for 2.4 billion gallons of grain-based ethanol; 508 million gallons of biodiesel, renewable diesel, sugarcane ethanol, and other advanced biofuels; 52 million ethanol-equivalent gallons of biogas; and more than 1 million gallons of cellulosic ethanol.

[5] 864 F.3d 691 (D.C. Cir. 2017)

- Denying the 66 pending exemption petitions would prevent 2.14 billion gallons of gasoline and diesel from being produced and entering the marketplace, reducing GHG emissions by 10.7 million metric tons from the transportation sector.
- Restoring the 500 million gallons of conventional renewable fuel blending that was illegally waived in 2016, as ordered in 2017 by the U.S. Court of Appeals for the D.C. Circuit in *Americans for Clean Energy v. EPA*, would prevent another 350 million gallons of gasoline from entering the market and would provide additional GHG reductions of 1.2 million metric tons.
- **Thus, simply by denying all 66 pending SRE petitions and restoring the illegally waived 500-million-gallon volume from 2016, as justified by the Tenth Circuit and D.C. Circuit decisions, President-Elect Biden's incoming administration could immediately secure 11.9 million metric tons of GHG reductions on Day One in office.**
- GHG savings of 11.9 million metric tons is equivalent to taking 2.6 million passenger cars (the number of registered vehicles in New Jersey) off the road for a year or shutting down three coal-fired power plants.[6] It is also equivalent to the GHG savings achieved by removing 3.7 million vehicles using gasoline from the road and replacing them with battery electric vehicles (akin to replacing the total number of registered gasoline vehicles in Georgia with BEVs).[7]
- These estimates are conservative because they rely on California Air Resources Board estimates of carbon intensity for various renewable fuel types rather than the more accurate Department of Energy/Argonne National Laboratory GREET model.

[6] EPA. "GHG Equivalencies Calculator." https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
[7] Assumes national average lifecycle GHG emissions for a BEV are 1.9 metric tons of CO2e per year and lifecycle GHG emissions for a vehicle operating strictly on gasoline are 5.1 metric tons of CO2e per year. See DOE. Alternative Fuels Data Center. "Emissions from Hybrid and Plug-In Electric Vehicles." https://afdc.energy.gov/vehicles/electric_emissions.html

APPROACH FOR ESTIMATING GHG EMISSIONS INCREASES LINKED TO SMALL REFINERY EXEMPTIONS

We used the following approach to estimate the GHG emissions increases linked to small refinery exemptions, as well as the GHG emissions impacts of granting or denying the 66 pending exemption petitions and the impacts of implementing the 500-million-gallon remand.

1. Determining the number of exemptions granted and the associated exempted volumes for 2016-2018 compliance years, the number of exemption petitions currently pending, and the estimated renewable fuel volume associated with pending petitions.

EPA provides data on the status of refinery exemption petitions that is updated monthly.[8] The data show a total of 85 waivers were granted for 2016-2018, reducing RFS blending requirements for those years by a total of 4.04 billion gallons (ethanol-equivalent). The data also show 32 petitions are pending for the 2019 compliance year, 14 are pending for 2020, and 20 "gap year" petitions are pending for 2011-2018.

The potential exempted volumes associated with pending petitions is not disclosed by EPA, so we estimate those volumes based on the average volume exempted per refinery waiver in the 2016-2018 compliance years (on average, each waiver resulted in 47.5 million gallons of lost renewable fuel blending requirements).

Number of Exemptions Granted and Waived Renewable Fuel Obligations per Year

Compliance Year	Refinery Exemptions	Reduction in Renewable Fuel Obligation (Million Gallons, ethanol-equivalent)
2016	19	790
2017	35	1,820
2018	31	1,430
2019 (pending)	32*	*1,521***
2020 (pending)	14*	*665***
Gap Years (pending)	20*	*951***

*Pending petitions **Estimated based on average gallons per exemption for 2016-2018

2. Estimating the actual "wet gallon" volumes of the various renewable fuels that were replaced by gasoline and diesel due to small refinery exemptions.

To determine the GHG impacts of small refinery exemptions, we need to first estimate what types of renewable fuels would have been used if not for the exemptions. For each compliance year, we use the annual final Renewable Volume Obligation (RVO) percentages published by EPA to determine what share of the total exempted volume (or potential exempted volume for 2019, 2020 and Gap Year petitions) is conventional renewable fuel, biomass-based diesel, advanced biofuel, and cellulosic biofuels.

Then, EPA's EMTS data is then used to examine what specific types of renewable fuel were used to meet RFS obligations for cellulosic biofuel, advanced biofuel, biomass-based

[8] https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions

diesel, and conventional renewable fuel in each compliance year.[9] These proportions are then applied to the exempted volumes for each compliance year to estimate what renewable fuels would have likely been used in the absence of the small refinery exemptions.

"Wet" Gallons of Renewable Fuel Blending Lost due to Refinery Exemptions, by Type (Million gallons)

	Granted			Pending		
	2016	2017	2018	2019	2020	Gap Year
Grain Starch Ethanol	633	1,415	1,112	1,145	496	761
Sugar Ethanol	11	46	27	63	16	24
Other Advanced	21	45	36	41	12	23
Renewable Diesel	14	36	31	46	24	27
Biodiesel	68	151	123	110	55	67
Biogas	1	27	21	31	20	1
Cellulosic Ethanol	0.2	2	0.3	1	1	0
TOTAL	**748**	**1,722**	**1,350**	**1,438**	**623**	**902**
	3,819			2,963		

It is important to note that the 3.819 billion gallons of forgone renewable fuels use for 2016-2018 is slightly less than the commonly cited 4.04 billion gallons of exemptions issued by EPA for 2016-2018. This is due to the fact that the 4.04 billion figure is actually in reference to RIN credits, where 1 RIN credit is equal to 1 ethanol-equivalent gallon based on energy content. Because certain renewable fuels—like biodiesel and renewable diesel—have more energy content per volume than ethanol, they generate more than 1 RIN credit per gallon (1.5 RINs per gallon for biodiesel and 1.6-1.7 RINs per gallon for renewable diesel). Thus, the cumulative 2016-2018 requirement for 4.04 billion RINs that was wiped away by the 85 exemptions likely would have been met with an estimated 3.8 billion "wet gallons" of renewable fuel.

3. Estimate the volume of gasoline and diesel fuel used in place of renewable fuels due to the exemptions (including potential exemptions in the case of 2019, 2020 and Gap Years).

We assume that the waived renewable fuel volumes were replaced with an energy-equivalent amount of gasoline (replacing ethanol) and diesel (replacing biodiesel, renewable diesel, other advanced, biogas). The energy content per gallon for various renewable fuels, gasoline, and diesel comes from the California Air Resources Board.[10]

[9] https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rins-generated-transactions
[10] See "Notes" tab of CARB spreadsheet "LCFS Quarterly Data Spreadsheet." https://ww3.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm

Gasoline and Diesel Fuel Used in Lieu of Renewable Fuels due to Refinery Exemptions, by Type (Million gallons)

	Granted			Pending		
	2016	2017	2018	2019	2020	Gap Year
Gasoline replacing Grain Starch Ethanol	437	976	767	790	342	525
Gasoline replacing Sugar Ethanol	8	32	19	44	11	17
Diesel replacing Other Advanced	19	41	32	37	11	21
Diesel replacing Renewable Diesel	13	34	29	45	23	26
Diesel replacing Biodiesel	64	142	115	104	51	63
Diesel replacing Biogas	0.5	18	14	21	13	1
Gasoline replacing Cellulosic Ethanol	0.1	1.4	0.2	0.4	0.3	0.1
TOTAL	**541**	**1,244**	**977**	**1,040**	**452**	**651**
	2,763			2,143		

4. Estimate the total GHG emissions associated with the gasoline and diesel used in lieu of waived renewable fuel volumes.

Using the volumes determined in Step 3 and lifecycle carbon intensity estimates for gasoline/diesel from California Air Resources Board, we are able to estimate the total GHG emissions associated with using gasoline/diesel in lieu of waived renewable fuel volumes.

Gasoline and Diesel Fuel Average Carbon Intensity (grams CO2e/mega joule)

	2016	2017	2018	2019	2020	Gap Year
Gasoline	99.8	99.8	99.8	100.8	100.8	99.8
Diesel	99.0	99.0	97.6	100.3	100.3	

GHG Emissions from Gasoline and Diesel Used in Lieu of Waived Renewable Fuels (metric tons CO2-equivalent)

	Granted			Pending		
	2016	2017	2018	2019	2020	Gap Year
Gasoline replacing Grain Starch Ethanol	5,209,226	11,644,637	9,151,121	9,520,904	4,124,339	6,262,593
Gasoline replacing Sugar Ethanol	91,738	378,554	223,373	527,516	130,382	197,506
Diesel replacing Other Advanced	222,223	483,031	386,216	444,682	130,151	246,883
Diesel replacing Renewable Diesel	179,711	456,072	393,133	602,639	313,299	343,552
Diesel replacing Biodiesel	854,625	1,904,377	1,543,856	1,400,244	694,989	836,814
Diesel replacing Biogas	6,297	212,534	162,706	249,427	155,097	7,872
Gasoline replacing Cellulosic Ethanol	1,646	16,459	2,469	4,989	4,158	823
TOTAL	**6,565,467**	**15,095,664**	**11,862,875**	**12,750,401**	**5,552,415**	**7,896,042**
	33,524,007			26,198,858		

5. Estimate the total GHG emissions if the renewable fuel volumes from Step 2 were used in place of the gasoline and diesel volumes from Step 3.

We used the renewable fuel volumes from Step 2 and the annual average lifecycle carbon intensity estimates for grain ethanol, sugar ethanol, cellulosic ethanol, and biogas from CARB to derive total emissions for each renewable fuel. Biodiesel and renewable diesel lifecycle carbon intensity estimates are based on CARB and information from the National Biodiesel Board. Lifecycle carbon intensity for all "other advanced biofuels" is assumed to be a 52% reduction compared to diesel fuel. For Gap Years, the 2016 average carbon intensity for each renewable fuel is used.

Average Carbon Intensity (grams CO2e/mega joule) of Various Renewable Fuels (CARB)

	2016	2017	2018	2019	2020	Gap Year
Grain Starch Ethanol	71.5	71.1	69.8	65.9	64.4	71.5
Sugar Ethanol	49.1	46.7	44.5	45.9	45.8	49.1
Other Advanced	48.0	48.0	48.0	48.0	48.0	48.0
Renewable Diesel	36.4	30.4	32.2	34.6	33.6	36.4
Biodiesel	36.0	35.0	35.0	34.0	34.0	36.0
Biogas	33.8	44.9	46.6	44.4	31.8	33.8
Cellulosic Ethanol	29.6	29.6	29.6	29.6	29.6	29.6

GHG Emissions from Renewable Fuels Replacing Gasoline and Diesel in the Absence of Small Refinery Exemptions (metric tons CO2-equivalent)

	Granted			Pending		
	2016	2017	2018	2019	2020	Gap Year
Grain Starch Ethanol	3,689,102	8,200,436	6,326,611	6,150,378	2,603,625	4,435,081
Sugar Ethanol	44,585	175,002	98,355	237,574	58,514	96,051
Other Advanced	80,999	176,062	140,773	160,412	46,950	89,987
Renewable Diesel	66,028	139,946	127,776	208,477	105,251	126,225
Biodiesel	308,707	668,789	542,180	487,094	234,854	302,273
Biogas	2,131	95,566	75,931	109,762	48,882	2,664
Cellulosic Ethanol	483	4,825	724	1,448	1,206	241
TOTAL	**4,192,035**	**9,460,625**	**7,312,348**	**7,355,145**	**3,099,283**	**5,052,524**
	20,965,009			15,506,951		

6. Derive the foregone GHG reductions associated with the refinery waivers.

This step is completed simply by comparing the renewable fuel emissions from Step 5 with the gasoline/diesel emissions from Step 4. The difference is the amount of GHG emission increases attributable to small refinery exemptions (or potential exemptions in the case of 2019, 2020 and Gap Years). Thus, small refinery exemptions for 2016-2018 led to forgone GHG emissions reductions of 12.6 million metric tons CO2e. If the 66 pending exemption petitions are denied, the resulting increase in renewable fuels usage would reduce GHG emissions by 10.7 million metric tons.

Foregone GHG Reductions Due to Small Refinery Exemptions (metric tons CO2-equivalent)

	Granted			Pending		
	2016	2017	2018	2019	2020	Gap Year
Grain Starch Ethanol	1,520,124	3,444,201	2,824,510	3,370,526	1,520,714	1,827,511
Sugar Ethanol	47,153	203,552	125,018	289,942	71,868	101,455
Other Advanced	141,225	306,970	245,443	284,271	83,201	156,896
Renewable Diesel	113,683	316,127	265,358	394,161	208,049	217,327
Biodiesel	545,918	1,235,588	1,001,677	913,149	460,135	534,541
Biogas	4,166	116,968	86,776	139,665	106,214	5,207
Cellulosic Ethanol	1,163	11,633	1,745	3,542	2,951	582
TOTAL	**2,373,432**	**5,635,039**	**4,550,527**	**5,395,257**	**2,453,132**	**2,843,518**
	12,558,998			10,691,907		

7. Estimating the GHG Savings Associated with the 500 Million Gallon Remand.

Using the same approach described above, we can determine the estimated GHG savings that would occur if EPA restores the 500 million gallons of conventional renewable fuel blending requirements that were illegally waived in 2016.

Because the court's remand applied only to conventional renewable fuels, we assume the 500 million gallon requirement would be met with grain starch ethanol, displacing the use of 345 million gallons of gasoline. The GHG emissions associated with burning 345 million gallons of gasoline total 4.145 million metric tons. Meanwhile, the GHG emissions associated with using 500 million gallons of grain starch ethanol are 2.914 million metric tons.

Accordingly, if EPA implements the court's order to restore the 500 million gallons of conventional renewable fuel, it will reduce gasoline demand by 345 million gallons and save 1.201 million metric tons of GHG emissions.