Corn ethanol and climate change

How the Renewable Fuel Standard mandates the consumption of biofuels that contribute to climate change

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Summary

In 2007, Congress passed the Renewable Fuel Standard (RFS2), which mandates the production of 36 billion gallons of renewable fuels, i.e. biofuels, a year by 2022. Seeking to address the dangerous effects of climate change on America's energy security, Congress required that the biofuels used to fulfill the RFS2 mandate would have to achieve at least a 20 percent reduction in greenhouse gas emissions compared to gasoline. Corn ethanol has been promoted as a readily available, 'home-grown' renewable fuel that will reduce climate change impacts from the transportation sector. However, contrary to popular belief, scientific analysis — including analysis from the Environmental Protection Agency — proves that the net greenhouse gas impact of corn ethanol is much worse than that of gasoline. The EPA has followed the letter of the law by conducting a full lifecycle greenhouse gas analysis of corn ethanol. However, EPA's final analysis of the RFS2 presents many different hypothetical emission scenarios for corn ethanol that may or may not achieve reductions in greenhouse gases in the future. This has understandably led to confusion amongst the public, media and in Congress.

This report reviews the climate protections built into the RFS2 and discusses how these protections fail to apply to corn ethanol. The report identifies the sources of greenhouse gas emissions from corn ethanol, including evidence of significant contributions from indirect land use change. The report reveals how EPA's decision to regulate corn ethanol based on potential future emissions has confused the public, members of Congress and the media on the actual impact of the RFS2. And, finally, the report concludes that according to a careful analysis of EPA data, corn ethanol releases more greenhouse gases than gasoline. In fact, per gallon, corn ethanol will result in 36 percent more greenhouse gas emissions than gasoline in 2012 and 12 percent more greenhouse gas emissions than gasoline in 2017. By the year 2022, the average gallon of corn ethanol will achieve only a mere 15 percent reduction in greenhouse gas emissions as compared to gasoline.

Greenhouse gas emission regulations in the Renewable Fuel Standard 2

Leading up to the creation of the Renewable Fuel Standard in 2005, it was widely assumed that biofuels would provide benefits to the climate and the environment as a whole. This was a logical assumption: plants absorb carbon dioxide — the most abundant greenhouse gas — during photosynthesis. The theory suggested that biofuels were carbon neutral because burning plants for fuel would release the same amount of carbon dioxide taken up during growth. In addition to the "green" allure of biofuels, they also feed in to the desire to produce energy within the U.S. in order to alleviate dependency on foreign oil.

These two factors made the RFS extremely popular. In December 2007 Congress expanded and revised the RFS. This revised RFS became known as RFS2. RFS2 mandated a four-fold increase in the volume of renewable fuel (i.e. biofuels) for transportation: the original 2005 RFS contained a nine billion gallon annual mandate by 2008 which was to increase to a 36 billion gallon annual mandate by 2022. Of the 36 billion gallons, 15 billion gallons are expected to be filled with ethanol derived from corn starch (or "corn ethanol").[1] As a result, the production of corn ethanol has quickly ramped up.

To ensure that the biofuels promoted in RFS2 were actually good for the climate, the RFS2 stipulated that biofuels could only qualify for the RFS2 if they achieve at least a 20 percent reduction in lifecycle greenhouse gas emissions as compared to gasoline.[2] Greenhouse gas emissions result from biofuels in the course of growing the crop the biofuel is made from as well as from refining the crop into the fuel. Changing how the crop is grown, how far it is transported and the efficiency of the facility where the crop is processed into a biofuel could result in greater or lesser greenhouse gas emissions. The RFS2 clearly defines the lifecycle greenhouse gas emissions as "the emissions from production, delivery and use of the fuel." The definition includes direct emissions from fuel production facilities powered by natural gas, coal and/or biomass, as well as indirect emissions, such as those from domestic and international land use changes that result from increased demand for biofuels.

Greenhouse gas regulation exemptions for corn ethanol in the Renewable Fuel Standard 2

As written, RFS2 exempts some 40 percent of all ethanol from the 20 percent greenhouse gas emission reduction thanks to two exclusions. First, the law would "grandfather in" conventional biofuels (i.e. corn ethanol) produced in facilities that started construction on or before December 19, 2007. The reason for this was that lawmakers did not want those facilities that were built prior to the new RFS2 to be dis-incentivized over newer facilities. Second, lawmakers also exempted biofuels produced at facilities powered by natural gas, biomass, or any combination thereof.[3]

EPA assessed corn ethanol plants that fall under these criteria and estimated the production capacity of corn ethanol from these facilities to be at 14.8 billion gallons a year and includes almost the entire fleet of existing ethanol plants.

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1 The Renewable Fuel Standard (RFS2) mandates increasing the consumption of biofuels to 36 billion gallons annually by 2022. Specifically, of the total 36 billion gallons, 21 billion gallons are mandated to be comprised of "advanced" biofuels. "Advanced" biofuels are defined by two distinctions: 1) they are not produced from corn starch, and 2) they achieve a 50% reduction in greenhouse gas emissions as compared to gasoline. EPA assumes that 15 billion gallons of non-advanced biofuel mandated by the RFS2 will continue to be derived from corn-starch. To date, 95 percent of the biofuels used in the U.S. have been produced from corn starch.

2 The RFS2 specified that 2005 – the year that the original RFS was passed - would be considered the baseline year.

3 Much like biofuels, it has also been long assumed that electricity produced from biomass was carbon neutral. New evidence suggests that this is not necessarily true and that the emissions from burning biomass for energy can be just as bad as those emissions from coal (see, for example: Manomet, 2010 http://www.manomet.org/node/322). Similarly, natural gas was once considered to be better for the climate than coal. However, research is beginning to show that extracting natural gas causes methane emissions. These emissions can be so significant that they actually make natural gas out to be just as bad as coal.

By exempting these facilities and by extension the corn ethanol they produce from meeting the 20 percent greenhouse gas emission reduction, the RFS2 eliminates any incentive for existing biofuel facilities to change the energy source, technology or efficiency of their operations. In other words, nearly all of the 15 billion gallons of corn ethanol mandated to be consumed annually by 2015 — and continue to be included in the total mandated biofuel volumes each year until 2022 — could have the same greenhouse gas emissions as they do today. And in turn, by 2022 the average gallon of ethanol still may not achieve the 20 percent greenhouse gas emission reduction threshold.

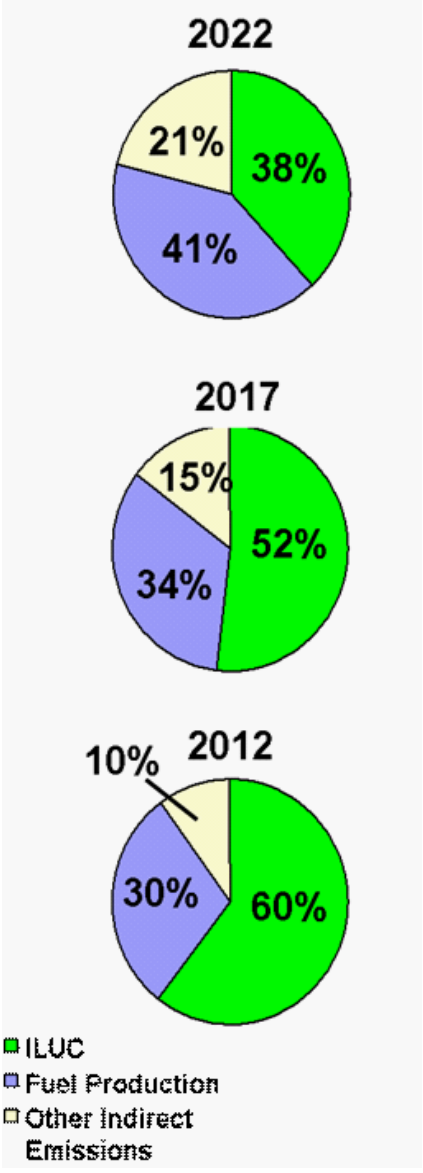
Indirect land use change emissions from biofuels

"Land use change" is simply defined as the conversion of land for one purpose into that for another purpose. Land use change can occur directly or indirectly. In the context of biofuels, land use change occurs when land currently used for food (or fiber or feed) production is converted into land for biofuel production. The result is that supply falls short for food (or fiber or feed) demand and the price for those commodities goes up. Indirect land use change occurs internationally when landholders around the world respond to this market price signal, and produce more to meet demand. As a result, natural ecosystems are converted around the world — and greenhouse gas emissions are emitted — to grow more food (or feed or fiber) in response to market pressure to expand agricultural production. One example of indirect land use change is when deforestation occurs in Brazil in order to grow more soybeans in response to a decrease in U.S. supply of soybeans for food and grain as soybean fields in the U.S. are converted to corn for ethanol. That deforestation in Brazil represents significant greenhouse gas emissions.

Shortly after the enactment of RFS2 scientific evidence showed that the emissions from indirect land use change from biofuels were greater than was anticipated, and that these emissions could actually indicate that biofuels were worse for the climate than conventional fossil fuels (for example, Searchinger *et al.* 2008; Fargione *et al.* 2008). This was particularly true for corn ethanol due to its low yield, large land-footprint and likelihood to compete with food production for land.

The EPA completed its Regulatory Impact Analysis of RFS2 in 2010, and made public its data that included projections on the greenhouse gas emissions for biofuels for the years 2012, 2017 and 2022. These three years were chosen as near–, short– and long–term target dates for EPA's complete lifecycle greenhouse gas emissions analysis of corn ethanol from an array of current and potential future production scenarios. EPA's analysis found that the percent of corn ethanol lifecycle greenhouse gas emissions from indirect land use

Image A: Percentage of Emissions from Various Sources in Corn Ethanol's Lifecycle



Source: EPA's Regulatory Impact Assessment of RFS2

change goes down from 60 percent in 2012, to 52 percent in 2017 and 38 percent in 2022. However, despite the decreasing percentage, the contribution that indirect land use change has on total emissions remains significant for the duration of RFS2 (Image A).

EPA data reveals that corn ethanol is worse for climate than gasoline

When EPA announced its final rule for the RFS2, it neglected to mention that its analysis found that corn ethanol produced in the U.S. today and in the near future produces more greenhouse gas emissions than gasoline. Instead, EPA simply mentions the different types of corn ethanol that will achieve a 20 percent reduction in greenhouse gas emissions, without explaining that achievement of these emission reductions will only occur in later years. However, after digging into the data, EPA's analysis actually shows that, on average, corn ethanol contributes more to climate change than gasoline.

EPA's analysis evaluates 33 types of corn ethanol facilities in order to estimate the greenhouse gas emissions of a gallon of ethanol compared to a gallon of gasoline for the years 2012, 2017, and 2022. Although EPA's analysis covers types of facilities that are currently in existence, the greenhouse gas emissions that have been reported by EPA represent hypothetical production scenarios that assume that 100 percent of U.S. corn ethanol is produced at just one type of facility — natural gas powered. EPA completed this analysis separately for each of the 33 ethanol facilities based on predictions on how corn ethanol could be produced. However, EPA's analysis does not show the total amount of greenhouse gases that will be emitted from the *existing* fleet of U.S. corn ethanol production facilities, which can fulfill nearly all of the 15 billion gallons of fuel that the RFS2 would fill with corn ethanol.

Image B: Corn Ethanol Production Facilities in the U.S.

The number of U.S. corn ethanol production facilities listed by energy source and plant type.[a]

Facility Energy Source	Facility Type	# of Plants
Natural Gas	Dry Mill, Base Plant (DDGS)[b]	138
Natural Gas with CHP[c] Technology	Dry Mill, w/ CHP (DDGS)	13
Natural Gas and Landfill Biogas and Wood	Dry Mill, w/ CHP and Fractionation (DDGS)	1
Natural Gas and Coal with CHP Technology	Dry Mill, w/ CHP and Fractionation (DDGS)	1
Natural Gas and Biomass	Dry Mill, w/ CHP (DDGS)	2
Natural Gas and Biomass with CHP Technology	Dry Mill, w/ CHP and Fractionation (DDGS)	1
Coal	Dry Mill, Base Plant (DDGS)	9
Coal with CHP Technology	Dry Mill, w/ CHP (DDGS)	8
Total		**173**

a: Table 1.5-4, U.S. EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis (February, 2010), EPA-420-R-10-006. Available at: http://www.epa.gov/otaq/renewablefuels/420r10006.pdf.

b: DDGS is "Dry distiller grains and solubles," a byproduct from corn ethanol production that can be used as cattle feed.

c: CHP is "Combined Heat and Power," an energy saving technology.

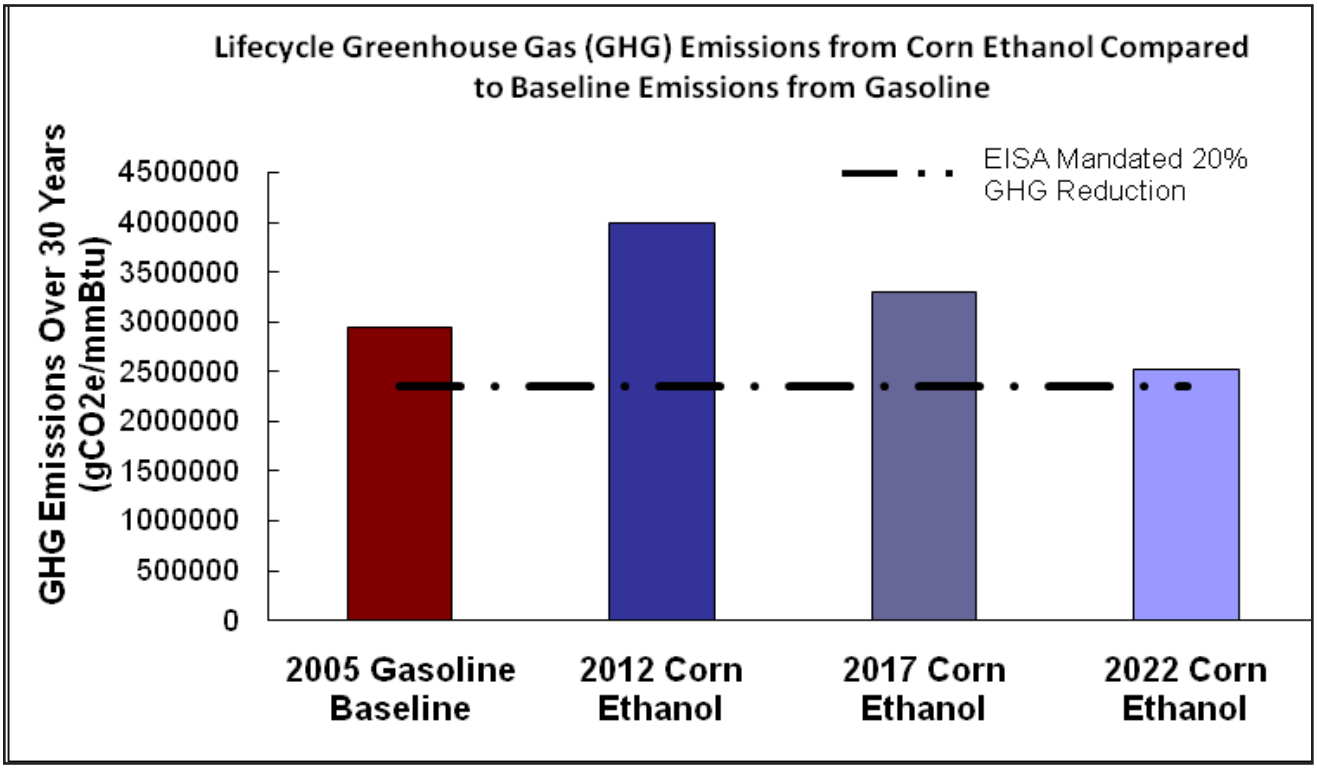
According to EPA, approximately 80 percent of all corn ethanol facilities in the U.S. use natural gas for power. These facilities are analogous to the "Base Case Dry Mill" scenario, which assumes that all corn ethanol would come from natural gas facilities using dry mill inputs. EPA's data estimates that if all corn ethanol was produced from natural gas powered facilities the ethanol produced would result in a 33 percent increase in greenhouse gas

emissions in the year 2012, a 10 percent increase in greenhouse gas emissions in the year 2017 and a 17 percent reduction in greenhouse gas emission by the year 2022.

However EPA's estimates don't take into account that some facilities have energy saving technologies that produce corn ethanol with a lower greenhouse gas portfolio. Conversely, some facilities, like those powered by coal, produce corn ethanol with a worse greenhouse gas impact.

A more accurate estimate of the greenhouse gas emissions from U.S. corn ethanol facilities can be calculated using EPA's own data on existing facilities. According to EPA, in the U.S., 138 facilities use natural gas, 18 use natural gas combined with energy saving technologies, and 17 use coal (Image B). By calculating the emissions from one type of each of these facilities and then multiplying that times the number of each type of facility it is possible to get an alternate set of data. Based on EPA data for the years 2012, 2017 and 2022, the result is that the greenhouse gas emissions from corn ethanol in 2012 are 36 percent greater than baseline lifecycle gasoline emissions[4] and 12 percent greater than gasoline in 2017 (Image C). It is also clear that the 20 percent reduction threshold for greenhouse gas emissions will not be met by corn ethanol in each year considered by the EPA. In other words, corn ethanol mandated by the RFS2 is already producing more greenhouse gas emissions than gasoline and will continue to do so for several years. More alarmingly, corn ethanol is unlikely to ever meet the 20 percent reduction threshold in the RFS2.

Image C: Corn Ethanol Greenhouse Gas Emissions in Differing Years in the U.S.[a]



a: Lifecycle greenhouse gas (GHG) emissions in gCO2e/mmBtu projected by the EPA RFS2 RIA for the years 2012, 2017 and 2022 over the thirty year lifetime of corn ethanol facilities compared to baseline emissions from gasoline emitted in 2005. The RFS2 20% mandated greenhouse gas emission reduction threshold applied to renewable fuels is shown by the dashed line. Emissions in 2012, 2017 and 2022 from corn ethanol are weighted by the number of facilities in operation in the U.S. as shown in Image B.

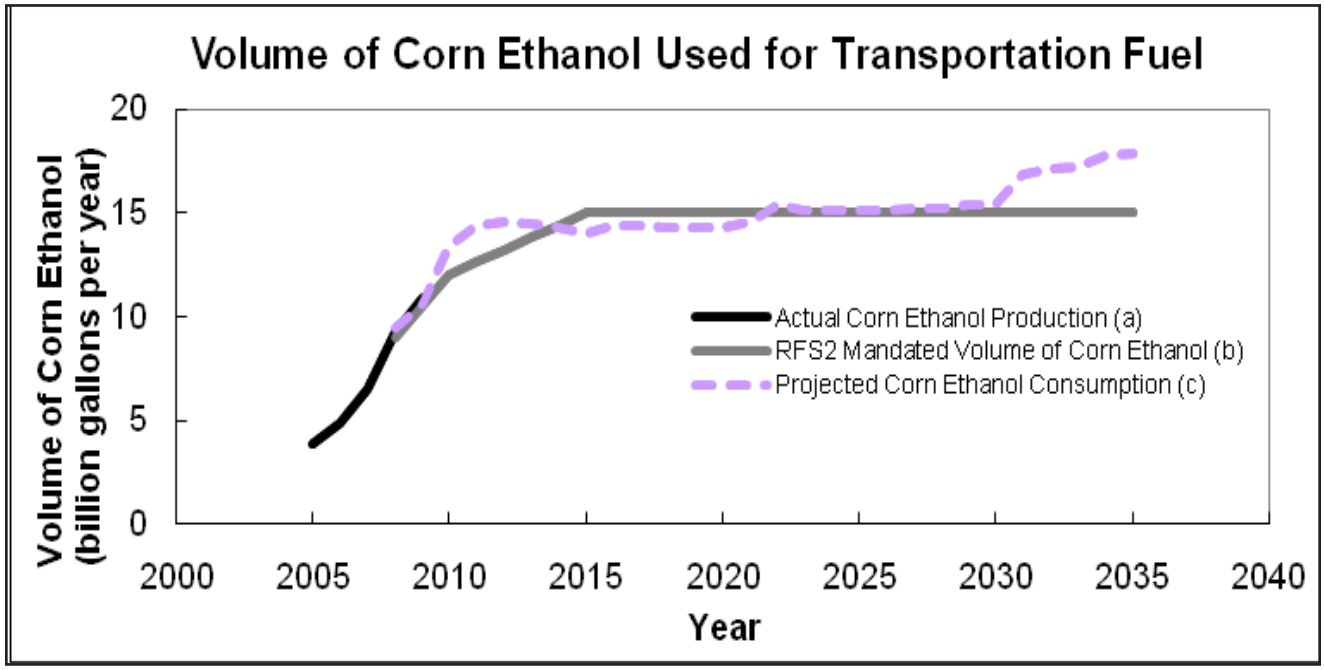
4 The RFS2 specified that 2005 – the year that the original RFS was passed - would be considered the baseline year.

EPA favors rosy projections

The EPA projected the greenhouse gas emissions from corn ethanol over the course of short–, mid– and long–term, yet the agency's final decision on how to regulate biofuels under the RFS2 is based solely on the projections for 2022. When EPA says that corn ethanol achieves a 21 percent reduction in greenhouse gas emissions in the year 2022, it is referring to the lifecycle emissions for a specific type of corn ethanol produced in facilities different than the existing fleet.

EPA's stated rational for using the 21 percent reduction figure is because by 2022 the RFS will be fully implemented. However, it is only in the later years that EPA's analysis indicates that corn ethanol may actually achieve greenhouse gas emission reductions. This was in part based on the assumption that the corn ethanol industry will become more energy efficient over time and that the yield for corn will increase. In addition, the 2022 figure assumes that the impact from land use change will be less significant since EPA assumes that corn ethanol consumption will not grow above the 15 billion gallon target for 2015.[5] However, it is clear that corn ethanol may actually exceed RFS2's mandated minimum volumes.

Image D: Actual, Mandated and Projected Volumes of Corn Ethanol Consumption in the U.S.



a: Energy Information Administration International Energy Statistics. Available at: http://tonto.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=79&pid=80&aid=1&cid=r1,&syid=2005&eyid=2009&unit=TBPD

b: U.S. EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis (February, 2010), EPA-420-R-10-006. Available at: http://www.epa.gov/otaq/renewablefuels/420r10006.pdf.

c: Energy Information Administration (EIA), Independent Statistics & Analysis. Annual Energy Outlook 2011, assuming that the energy content of ethanol is 83,333 Btu per gallon as reported by the EIA. Available at: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=10-AEO2011&table=24-AEO2011&region=0-0&cases=ref2010-d111809a

EPA's decision to regulate corn ethanol based on a 2022 emissions portfolio recklessly ignored significantly higher emissions from corn ethanol production calculated by the EPA analysis in the near– and short–term. It also looks past the fact that the 2022 mandated volume for corn ethanol (15 billion gallons) is actually mandated to

5 According to EPA, Indirect Land Use Change's contribution to corn ethanol's lifecycle GHG emissions goes down from 60% in 2012, to 52% in 2017 and 38% in 2022, the contribution to total emissions remain significant, indicating that market forces will continue to respond to changes in global food and feed supply

be achieved by 2015, and by 2022 it is projected that consumption will actually exceed 15 billion gallons a year.[6] (Image D).

EPA should have acknowledged in its public statements the impact that a mandate for corn ethanol would have on climate change. EPA should also have regulated the fuel based on its current emissions rather than those from 2022. By taking either of these steps, the EPA would have in no way impacted the amount of corn ethanol used to comply with the RFS. This is because the facilities in which the corn ethanol would be produced are exempted from the 20 percent greenhouse gas emission reduction anyway.

Conclusion: The RFS2 mandates use of climate-damaging fuel

The reality is that corn ethanol used in the RFS increases greenhouse gas emissions at present and will do so for a number of years. Despite EPA projections that corn ethanol will have less of a greenhouse gas footprint in the future based upon its modeling, the facilities that are producing corn ethanol today are producing more greenhouse gas emissions than gasoline. In fact, on average, the corn ethanol we produce today contributes 36 percent more greenhouse gas emissions than gasoline. EPA has estimated this will fulfill 14.8 billion gallons of the conventional biofuel bucket. Only in the final years of the RFS2 will corn ethanol become marginally better than gasoline. Even then, our current corn ethanol production facilities will not achieve the 20 percent greenhouse gas emission reduction that non-grandfathered fuels are supposed to achieve under the RFS2.

6 The RFS2 mandates that by the year 2015, the US consume at least 15 billion gallons of non-advanced (or corn ethanol). This minimum mandate of 15 billion gallons remains constant throughout the remainder of the RFS's implementation through 2022.