Renewable Fuels Association

"The Voice of the Ethanol Industry for More Than a Quarter Century"

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RFA Analysis:

"CLIMATE CHANGE AND HEALTH COSTS OF AIR EMISSIONS FROM BIOFUELS AND GASOLINE"

(Hill, et al.)

The report's erroneous finding that modern corn ethanol actually increases greenhouse gas (GHG) emissions relative to gasoline is completely predicated on the baseless assumption that additional corn demand for increased ethanol production will cause conversion of large amounts of grassland enrolled in the Conservation Reserve Program (CRP). Thus, like several other highly controversial studies published recently, the conclusion that corn ethanol does not offer climate change benefits relative to gasoline is **based almost entirely upon insufficient and extremely uncertain analysis of potential land use changes**.

EVALUATION OF ETHANOL INCLUDES EMISSIONS FROM UNLIKELY LAND USE CHANGES

Because there is no consensus within the academic community on the best methods for analyzing highly uncertain potential land use changes, the results of this study must be viewed with extreme caution.

There is not a shred of empirical, peer-reviewed evidence existing today that positively links increased corn ethanol production to conversion of non-agricultural lands such as grassland or forest. Increased demand for corn so far has been met largely through higher productivity per unit of land; this trend is expected to continue at an accelerated rate in the future.

If the authors' assumed land use change emissions are removed from the analysis, the paper suggests **average corn ethanol reduces greenhouse gases by 30% compared to gasoline and advanced corn ethanol reduces GHGs by 46%**. Further, the paper finds cellulosic ethanol has the potential to reduce direct GHGs 78-92% relative to gasoline. These GHG reduction values are consistent with those derived from other ethanol lifecycle analyses (Liska et al., 2009; Wang et al., 2007; Mueller, 2007; Kim & Dale, 2005).

Important details of the land use change modeling done for the paper are omitted. Since a central conclusion of the paper is that most corn ethanol increases GHGs relative to gasoline because of land use change, greater detail should be provided about the analysis and methodology used to produce this result. The supporting information provided online contains no detail on the baseline used, the amount of land assumed to be converted, the types of CRP grassland converted, and other important factors.

Additionally, the paper assumes CRP ground converted to crops for ethanol would have otherwise remained enrolled in the CRP indefinitely. This assumption is highly questionable and overly simplistic. A number of economic and policy factors—which could be completely unrelated to biofuels production—could stimulate conversion of previous CRP ground to crop production. It is also unclear if the carbon storage rates assumed in this paper are appropriate for grassland enrolled in CRP for 15 years. Logically, the carbon storage capacity of previously cultivated land that has been enrolled in CRP for 15 years would be much lower than the capacity of undisrupted or native grassland.

Further, it is unclear how the authors' land use change analysis treats ethanol feed co-products. Not only do feed co-products provide a significant energy credit (which is presumably accounted for in the authors' GREET analysis), but they also mitigate considerably the amount of land required to produce ethanol from grain. More detail on the treatment of co-products is needed.

STUDY FAILSTO MAKE APPROPRIATE COMPARISONS TO GASOLINE

By contrasting modern and future ethanol technologies only to today's average gasoline, the paper fails to make appropriate comparisons. While the authors acknowledge that "…a shift from crude oil to oil sands or coal-to-liquids technology would greatly increase emissions…" they fail to quantify the climate impacts of the marginal oil sources that are supplying an increasing share of U.S. gasoline.

Modern corn ethanol is displacing some of the need for gasoline from marginal sources of oil with high carbon intensity (this will be especially true for future ethanol from all sources). Thus, the climate impacts of modern and future ethanol should be compared to the climate impacts of gasoline refined from today's marginal sources of oil (such as Canadian tar sands, Venezuelan heavy crude, etc.) *as well as* future marginal sources. In simpler terms, the paper fails to consider that, as the GHG impacts of ethanol continue to improve, the impacts of gasoline will continue to worsen.

Further, the authors include indirect GHG effects for ethanol, but not for gasoline (e.g. induced deforestation/land clearing due to oil exploration). Thus, the boundaries for the comparisons are inconsistent and skewed to favor gasoline.

MONETIZING CLIMATE CHANGE EFFECTS IS HIGHLY UNCERTAIN

Carbon social cost modeling is extremely uncertain and in its infancy, as demonstrated by the wide variation in currently available estimates (Tol, 2005). Further, carbon mitigation costs vary widely based on technology, governmental policies, and other factors. Additionally, the value of carbon is dramatically different in different regions, based on wide variations in market and policy frameworks. Therefore, the application of monetary units for the quantification of uncertain climate effects is highly questionable.

REPORT IGNORES ETHANOL'S ABILITY TO REDUCE VEHICULAR PARTICULATE MATTER

The use of ethanol has been proven to significantly reduce vehicular particulate matter (PM) emissions. It is clear the study does not offset PM emissions from the fuel production phase with avoided PM emissions from fuel combustion resulting from ethanol blending. Fine particulates can be emitted directly from vehicles (primary $PM_{2.5}$) or formed in the atmosphere (secondary $PM_{2.5}$). Ethanol helps on both fronts, as it enhances the level of oxygen in gasoline. Oxygen in the fuel has been shown to reduce primary exhaust particulate from cars (Mulawa et al., 1997, and Colorado, 1999) while raising aromatics has been found to increase PM (Graskow et al., 1998). The Colorado study suggests that with 3.5 percent oxygen, the PM reduction at 35F is 36 percent for the normal fleet and 64.6 percent for the high emitters studied. If the PM inventory is 50 percent from high emitters, the reduction in PM for 3.5 percent oxygen is estimated to be 50.3 percent.

Since both ethanol and aromatics add octane, it can be expected that using ethanol in place of aromatics for octane would reduce primary $PM_{2.5}$emissions even more than had been seen in the Colorado (1999) study. Mulawa et al. (1997) also showed that PM reductions were observed from –20F to 75F and an analysis of all available data suggests the oxygen effect is proportional to the PM emission and independent of temperature.

The formation of secondary $PM_{2.5}$is a very complicated process currently being studied by several scientists. One notable result published by Odum et al (1997) from Caltech showed that the organic fraction of secondary $PM_{2.5}$, attributable to gasoline in the atmosphere could be completely accounted for by the aromatics content of the gasoline. In fact, the EPA's REMSAD model for particulates and the Caltech secondary organic aerosol model (see Griffin et al, 1999) now assume that all anthropogenic PM comes solely from aromatic compounds. Hence, the use of ethanol in place of aromatics can be expected to reduce secondary $PM_{2.5}$as well.

REPORT IS SELECTIVE IN ITS DISCUSSION OF ETHANOL'S IMPACT ON AIR QUALITY

Many studies have shown that the oxygen in ethanol leads to a significant reduction in mobile carbon monoxide (CO) emissions. A statistical analysis of ambient CO concentrations in areas using ethanol-blended fuels indicates that these fuels appear to reduce local CO by an average of 14 percent nationally (Whitten and Cohen, 1996). Carbon Monoxide is the single largest contributor to ozone formation.

Further, ethanol reduces significant toxic compounds resulting from the combustion of gasoline. Benzene appears to be the most significant toxic compound emitted from vehicles. The EPA Complex Model indicates that benzene emissions account for nearly 70 percent of the total toxic emissions from vehicles using conventional gasoline and that exhaust benzene accounts for nearly 90 percent of the total benzene. The EPA Complex Model indicates that a 10 percent ethanol blend can reduce benzene by 25 percent compared to conventional gasoline. In addition to a 25 percent benzene reduction, the use of 10 percent ethanol is shown by the EPA Complex Model to reduce total toxic mass emissions by 13 percent.

These facts regarding ethanol's impact on air quality are conveniently omitted from the Hill et al. paper and must be considered in order to make a fair assessment of ethanol's air quality benefits.

CONCLUSION

Ultimately, the paper relies on debatable methodologies for which no consensus exists (e.g. land use change, carbon social cost), fails to make appropriate comparisons between ethanol and gasoline, and fails to provide important details on key assumptions (e.g. land use change assumptions, For these reasons and others, the results of Hill et al. should be seriously questioned and require careful scrutiny.