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Balancing the Treatment of Ethanol Exports, Imports, and Consumption in the Renewable Fuel Standard

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1. Introduction

Through the EPA's current administration of the Renewable Fuel Standard (RFS), ethanol exports are disadvantaged relative to domestic uses of ethanol. Blending ethanol domestically results in a Renewable Identification Number (RIN) value that encourages increased ethanol production and use. The majority of export gallons are never assigned a RIN. The export gallons that are assigned RINs also receive a matching Renewable Volume Obligation (RVO), thus creating a disincentive for exporting ethanol relative to domestic blending of both US-produced ethanol and imported ethanol.

While US exporters have developed significant market share in several key markets based on relative agricultural economics, they face constant policy barriers and other dynamics that lead to high volatility in export volumes. They also face rising headwinds, such as increased tariffs and subsidies for domestic production in several key importing countries.

One of the proposed policy prescriptions for issues within the RFS could help US ethanol exporters overcome these headwinds. In response to concerns about the current RFS program, there exists a proposal to provide RINs for exported biofuels, without accompanying RVOs. These unobligated RINs could be sold by exporters to RFS obligated parties, thus eliminating the current program's export disincentives relative to domestic consumption. This would lead to increased exports, more equitable treatment in comparison to biofuel imports, and therefore increased production of biofuels in the US, providing employment benefits along the value chain. It would also moderate the price of RINs without directly impacting biofuel use in transportation fuels.

This report evaluates the economic impacts of providing unobligated RINs for ethanol exports. This is only a subset of the benefits of the proposal since we did not include other biofuels covered by the proposed regulatory change. The value of the RINs will improve the competitive position of US ethanol exports in the global market, increasing exports and demand for US-produced ethanol. The increase in export volumes depends on many factors, which were considered at a country level in our analysis. We also assessed the contributions of increased ethanol production to the US economy.

1.1. Key Findings

The following are our key findings:

- RIN values improve the competitive position of US exporters in each of the key ethanol import markets. The improved economics likely could be enough to overcome diverse policy barriers, such as tariffs and domestic production subsidies.

- The degree of benefit depends on factors such as: the RIN value/price, international fuel and feedstock prices, country-level policy assumptions, demand for gasoline in each market, and the specifics of the RFS regulatory adjustment.

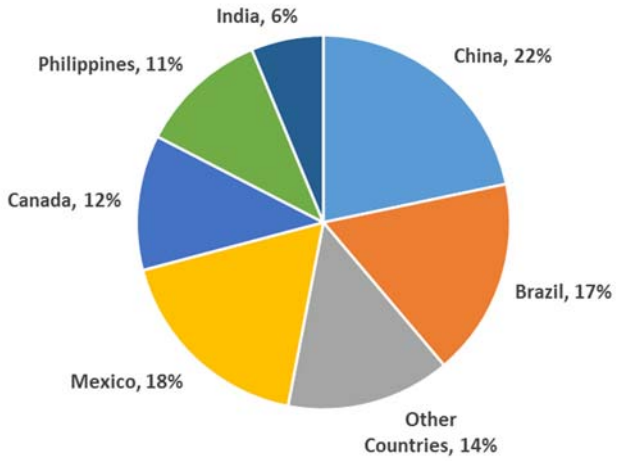
- Denatured ethanol is ethanol treated with additives to make it non-consumable except in industrial processes and as fuel. Undenatured ethanol can still be converted to spirits, but US exports of undenatured ethanol is generally used for the same purposes as denatured ethanol. Because of the similar end uses, both denatured and undenatured ethanol exports can be considered for unobligated RIN value.

- **The scale of the export expansion opportunity is estimated to be around 1.2 billion gallons a year at a moderate RIN value**. This includes increases from new

opportunities, reviving lost exports, and protecting exports that are currently at risk of being lost.

- With RIN values for exports, the countries projected to see the greatest increases in imports of US-produced ethanol include China, Brazil, Mexico and Canada. The following chart shows the share of export volume increases, compared to a baseline of existing RFS policy, in the major destinations for US ethanol exports.

Figure 1: Shares of Ethanol Export Expansion Opportunity by Country



- **This export increase would represent over 26,000 jobs annually**, mostly within the agricultural and services sectors.
- While assigning unobligated RINs to ethanol exports will contribute to the economy, it does not follow that higher RIN prices increase total economic activity. In fact, the opposite is likely true given the volume of ethanol exports compared to domestic ethanol consumption. RIN costs are mostly borne by US businesses and consumers. Therefore, the proposed regulatory change adds the most value when RINs for ethanol exports do not include expanded RFS obligations.

1.2. Report Structure

We begin with a background of the current treatment of exports under the RFS and a description of the proposed RFS regulatory prescription. We then evaluate the opportunity for expansion of export volumes if RIN value is attached to exports. We present this analysis through country-level evaluations in the key export markets. Lastly, we translate the expanded volume into economic benefits along the US ethanol value chain.

2. Background

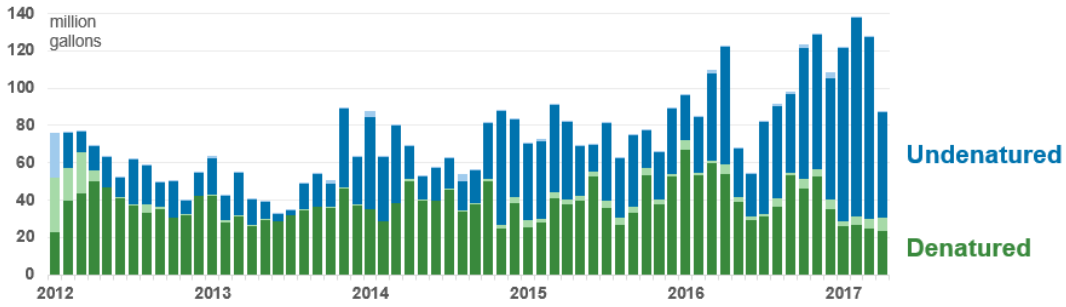
2.1. Ethanol Exports in the RFS

Under RFS2, exporters must separate any RINs assigned to the renewable fuel that they export. They are also assigned a Renewable Volume Obligation (RVO) that represents the separated RINs, creating a transaction with no net impact on the total renewable fuel obligation at the national level. Given the matching obligation, the exporter does not benefit from the RIN transaction. Instead, it actually serves as a disincentive to the exporter due to administrative costs for reporting and retiring RINs. The volumes of renewable fuel that do not have assigned RINs, which are mostly undenatured volumes, exist outside of the RFS.

Exports are not completely independent of RFS economics. They create an upward pressure on ethanol prices through increased ethanol demand. Because RIN prices are substantially driven by ethanol-to-petroleum product price spreads, the exports indirectly contribute to higher RIN prices. However, this impact is minimal given current volumes. In 2016, ethanol exports represented about 3.5% of total ethanol (D6) RINs. This is less than the 6% share of biodiesel (D4) RINs represented by biodiesel exports.

A limiting factor on the number of RINs separated for exports is the fact that RINs are generally only attached to denatured ethanol, and not undenatured ethanol. The standard practice guided by the RFS recognizes the process of denaturing as a distinguishing point between ethanol destined for transportation fuels versus ethanol destined for other uses. This is not an accurate distinction, as undenatured volumes are used as fuel and, even when not used directly as fuel, often indirectly increase biofuels use through displacement effects. The distinction is increasingly important given the gradual shift from denatured to undenatured ethanol exports. This shift is demonstrated in the chart below that shows monthly export volumes for since 2012 of both denatured and undenatured ethanol.

Figure 2: Monthly US Ethanol Exports, Denatured and Undenatured (million gallons)



Source: US Department of Commerce, Census Bureau

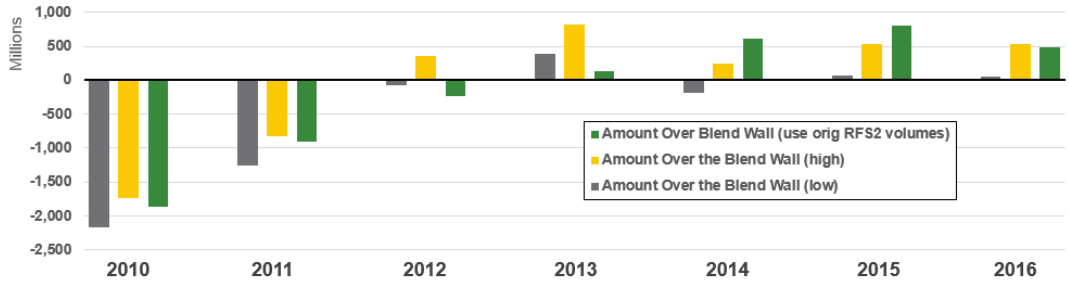
2.2. RFS Concern and a Proposed Regulatory Prescription

While from a national policy perspective it may make sense to remove obstacles to ethanol exports to increase agricultural and other economic activity, the current impetus for regulatory change is actually a proposed remedy to a concern with the RFS program. For several years, the RFS volumetric requirements for ethanol blended into transportation fuel have exceeded the amount that could be consumed in E10 gasoline. This breach of the “blend wall” has led to high RIN prices, which have negative economic impacts at both the refining and final consumer levels.

The exact amount of the blend wall breach is debated, due to competing estimates of E0, E15 and E85 gasoline consumption. The following chart shows various views on the blend

wall breach over the past seven years, with the original breach occurring in 2012, 2013 or 2014, depending on assumptions.

Figure 3: Historical Blend Wall "Breaching" (million gallons)



Sources: EPA, EIA, CRA calculations

Clear evidence of blend wall breaching is the rise in RIN prices since 2013. The rise is best explained by biodiesel (D4) RINs becoming the marginal source for ethanol (D6) RINs. The jump in price would not be a major concern if it was mitigated quickly by expanding ethanol use through additional consumption of higher blend fuels, but that has not happened in the four years of higher prices. Rather, prices have remained high without relief while ethanol consumption has not increased substantially.

Our previous work has demonstrated that a significant share of the burden of higher RIN prices fall on merchant and other non-integrated refiners.[1] This is due to blenders capturing margins from RINs. A relief from this burden is possible if more ethanol consumption pathways can contribute RINs, such as through providing unobligated RINs for ethanol exports, which would expand the pool of RINs available for purchase by obligated parties.

The specific proposal involves removing the export RVO and generating RINs for both undenatured and denatured ethanol. It is reasonable to include undenatured exports due to their primary use in transportation fuels (e.g., Brazil) and their potential to displace domestic ethanol in foreign non-fuel markets, which increases domestic ethanol volumes available for transportation fuels (e.g., India). The analysis in this report examines a scenario in which all export ethanol volumes receive unobligated RINs.

[1] "Evaluating the Response of Blender Margins to RIN Price Changes," Charles River Associates, February 2017

3. Estimating the Opportunity

3.1. RIN Value Impact on Ethanol Export Demand

There are a few, key global market indicators that influence overall demand for US ethanol exports. For example, the price of crude oil has several competing impacts on ethanol demand. Most directly, higher global oil prices increase ethanol demand due to substitution economics, since petroleum feedstocks and ethanol compete in the transportation fuels markets. Indirectly, higher oil prices lead to lower gasoline demand, particularly in countries with blending percentage mandates driving ethanol demand, which can cause a decrease in ethanol consumption.

Assuming these global indicators do not move significantly, the major drivers of demand for US ethanol exports are country dependent. Major policy-related drivers include policies in importing countries that: protect domestic ethanol producers, change mandated volumes of ethanol, or impact transportation fuel demand. Major economic drivers include overall economic growth, fuel demand, and domestic renewable fuel pricing.

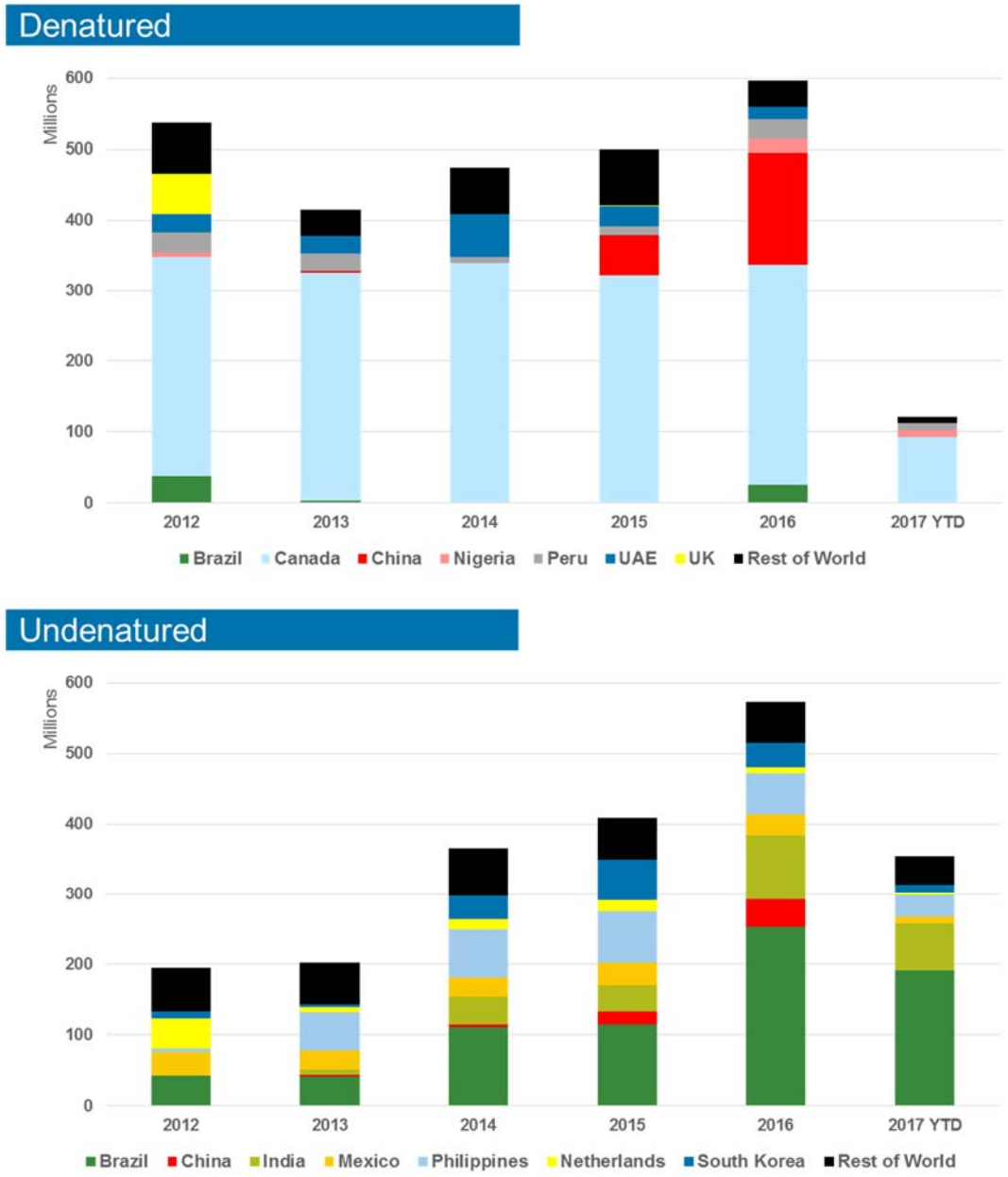
To estimate the demand impact of the proposed RFS regulatory change, we begin with a review of baseline demand in importing countries. We then evaluate how the demand for US exports would change based on a reduction in the relative price of US ethanol equal to the RIN value that would be generated by exports. Some of the ways in which a price reduction can increase demand for US exports include:

- Overcoming protective tariffs of importing countries
- Making increased mandates in other countries more economically palatable for foreign policymakers
- Directly competing on price with foreign produced renewable fuels and petroleum-based gasoline

3.2. Country Level Analyses

Our analysis focused on six key countries based on historic imports and projected future imports of US ethanol. The countries selected for deeper analysis were: China, Brazil, Mexico, Canada, India, and the Philippines. They were selected from the 34 different countries that reportedly received US ethanol exports in 2016. The following chart shows export volumes to different countries from 2012 through April 2017.

Figure 4: US Ethanol Exports by Receiving Country, 2012 through April 2017 (million gallons)



Source: US Department of Commerce, Census Bureau

In the following sub-sections, we evaluate the expanded export opportunity that could be driven by adding RIN value for exports. We focused on the year 2020. We evaluated the impact using an assumed RIN price of about $0.25 per RIN. This price is significantly lower than current prices, and is therefore a conservative assumption for estimating increased export volumes. It is a price that represents only one of the many possible future RIN price scenarios. Our export volume estimates are reasonably scalable with various RIN price assumptions, but there are limits to the expansion opportunities in each country that prevent a constant returns to scale assumption.

Except where otherwise noted, the trade statistics in the following sections are based on trade data obtained from the US Census Bureau.

3.2.1. China

Ethanol exports to China have seen the most explosive growth compared to 2012 levels of any destination country, but they are also experiencing the most precipitous decline over the past year. The rise was initially driven by increased ethanol demand that accompanied steadily increasing gasoline consumption, despite a relatively stable ethanol blend rate at the national level. The ethanol demand is driven by blending mandates similar to the RFS, but in China the mandates only exist at the provincial level. About 20% of gasoline consumed in China contains 10% ethanol, contributing to an achieved blend rate of about 2.5%.[2]

While domestic production increased 60% since 2012, it has not kept pace with consumption and production currently represents about 75% of fuel ethanol consumed. The production gap first appeared in 2015 and was initially filled by imports from the US, Pakistan, Brazil and, to a lesser extent, Vietnam and South Korea.[3]

The interesting dynamic has been the shift in sources of ethanol imports over the past two years. Just over a year ago, China dramatically reduced the import tariff on US denatured ethanol from 30% to 5%. As a result, the US provided 96% of imports in 2016, which represented an increase of nearly 150 million gallons over the prior year. Then, in December 2016, the government announced a return to the WTO-bound tariff rate of 30% starting January 1, 2017. This decimated import volumes from the US, shifting China back to imports from other ASEAN countries exempt from the tariff, as well as bolstering domestic ethanol production.

The volume impact on US imports is informative in estimating the impact of providing RIN value. The tariff change of 25% of the ethanol price was enough to cause a massive shift in imports from the US. Given prevailing ethanol prices, the tariff increase could represent about $0.45/gallon of ethanol, which is apparently enough to make US imports uncompetitive. A $0.25/gallon RIN value for exports translates to a $0.33/gallon reduction in cost of US ethanol to Chinese purchasers (due to the price reduction and avoided tariff), which covers a large share of the tariff increase.

We evaluated this benefit on a volume level, based on assumptions of static price elasticities and Chinese demand and domestic production rising at levels in line with national goals. We adjusted the government's production estimates based on the knowledge that the 2015 production levels were only 60% of the government's target, so future goals are also likely to be missed. Our analysis concluded that the proposed RFS regulatory change could have an impact of 260 million gallons in 2020, which represents an increase in US exporter market share to 70% of China's imports (similar to the share during low tariffs) from the currently diminished level.

3.2.2. Brazil

Ethanol exports to Brazil have seen the most steady and significant climb of any destination country over the past six years. The vast majority of exports are in denatured form, which is a required specification in Brazil. The largest leap in US exports was from 2015 to 2016, as volumes more than doubled. The driver behind the changes in US exports to Brazil is sugar production economics. Because the majority of ethanol produced in Brazil uses sugarcane as a feedstock, it competes with the global market for sugar, and recently has been losing due to high sugar prices.

The demand for ethanol in Brazil is expected to remain fairly steady despite a continuing recession. The national blending mandate is expected to remain steady at 27% and remain

[2] Shuyang Si, et al., "The effects of China's biofuel policies on agricultural and ethanol markets," Working Paper, January 2017.

[3] Global Agricultural Information Network (GAIN), "Biofuels Annual: China," USDA Foreign Agricultural Service, February 7, 2017.

non-binding due to high demand for ethanol. The demand is driven by fuel switching between gasoline and ethanol based on relative pricing, since over half of cars in Brazil are flex fuel and can easily switch between gasoline and ethanol.

The greatest threat to US exports to Brazil is a quota and tax enacted in August 2017.[4] Brazil's government approved a 20% tax on any imports after a tax-free quota of 600 million liters (159 million gallons) per year is exceeded, which represents approximately one quarter of imports expected in 2017.

The proposed RFS regulatory change will support US ethanol producers in their attempts to hold a consistent share of the Brazilian fuels market despite the new tariff. Given current ethanol prices, the assumed $0.25/gallon RIN value could negate the majority of the tariff's impact. Given the current estimates for sugarcane production and global demand, the price of sugar ethanol is not expected to decrease in the near-term, allowing US exporters to compete on price in spite of the new tariff.

3.2.3. Mexico

Ethanol exports to Mexico have been limited by a lack of policy-driven demand and a bias toward domestic ethanol. The Government launched a pilot program after which state-run PEMEX began selling E6 in selected cities. To meet that demand, it signed contracts with domestic suppliers. The US has provided a steady but small volume of undenatured ethanol, but the volume is a small share of total US exports.

The market is about to expand significantly. In June 2017, the Government of Mexico increased allowable ethanol levels from E6 (5.8%) to E10 (10%) in most of the country, with the exception of three major cities (Monterrey, Guadalajara, and Mexico City). The new demand represents 480 million gallons, which domestic suppliers are not currently prepared to meet.[5] This is a significant opportunity for US exports, if they can remain price competitive and overcome some infrastructure hurdles. The proposed RFS regulatory change will support US price advantages over Mexican-produced sugar ethanol.

3.2.4. Canada

Ethanol exports to Canada have been the most consistent of all the destination markets. They have not moved more than 6% year-to-year in either direction since 2012. Ethanol from the US represents about half of the ethanol consumed in Canada. The demand is mostly driven by a federal mandate of 5% ethanol in gasoline, as well as several provincial mandates at higher blending levels, which together lead to a total blend rate of about 6%.

Domestic production in Canada decreased slightly last year. It is expected that most incremental ethanol volumes could come from the US, assuming US ethanol producers are price competitive. One threat to competitive pricing is a possible change in NAFTA, which currently prevents tariffs on US ethanol.

To consider the benefit of the proposed RFS regulatory change, we evaluated the potential expansion of the Canadian blending mandate to 10% in response to lower cost imported ethanol from the US. The impact could be even greater if tariffs are placed on ethanol imports, with the RIN value representing a significant share of the WTO-bound rates.

[4] "Brazil approves quota, 20 percent tax on ethanol imports," Reuters, August 23, 2017.

[5] "Building A Billion Gallon Market For Ethanol In Mexico," US Grains Council, June 22, 2017.

3.2.5. India

Ethanol exports to India have grown substantially in recent years, but are limited by Indian law to undenatured products and industrial end uses. However, the volumes exported to India facilitate expansion of transportation fuel ethanol use by displacing domestic volumes in the industrial sector, which can then be used for gasoline blending. This is important because domestic demand has surpassed domestic supply and the shortage is expected to remain indefinitely.

The production gap will grow even larger if policymakers expand their blending goals from 5% to 10%, as they have repeatedly stated. However, such an expanded mandate cannot be met with domestic supplies in the near term, so an accompanying change in the fuel import ban would be required.

Imports from the US accounted for almost 80% of total Indian ethanol imports in 2016. The proposed RFS regulatory change could expand the US share in a time of increasing demand for imports. For our analysis, we assumed that imports would be capped at industrial demand for ethanol, but the opportunity would be much greater with the potential administrative change.

The benefits associated with US ethanol exports to India are dependent on how EPA treats those exports. For instance, if EPA required that RINs were to be generated for ethanol certified only as a transportation fuel, then the benefits of a growing export market in India would unlikely be fully realized due to domestic Indian law.

3.2.6. Philippines

Exports to the Philippines only represented about 7% of US exports over the past 5 years, but the opportunity is significant. The country has a growing population and stated biofuel aspirations of 20% ethanol by 2020 and 85% by 2025.[6] While there are infrastructure and other hurdles to such growth, the Philippines could become a key export market.

Current projections that do not take into account the government's ambitious blending goals foresee declining imports. However, there is little expectation that domestic production can keep pace with future goals, or even with enforcement of the existing 10% blending goal. There is significant opportunity for US ethanol exporters, under the proposed RFS regulatory change, to expand market share and support the government's enforcement of its aspirations. This is especially true with the current tariff on US imports of only 1%.

4. Contributions to the US Economy

Expanding ethanol exports can contribute significantly to the US economy, primarily in the agriculture, bulk transportation and services sectors. By assuming the exports are incremental to current volumes, the economic contributions can also be considered additional. Therefore, the proposal to provide unobligated RINs for ethanol exports will contribute to regional and national economic growth. The degree of impact is based on the expected volume expansion. The impact is greatest when the exports are significant enough to require new infrastructure development, which generates construction and investment benefits in corn producing and exporting areas of the country.

To determine the economic contributions of the proposed RFS regulatory change, we evaluated the existing literature on the benefits of ethanol exports and production and then

[6] GAIN, "Biofuels Annual: Philippines," USDA Foreign Agricultural Service, August 16, 2016.

scaled the benefits to the export expansion opportunity. From the literature, we gathered estimates of direct and indirect economic contributions per unit of ethanol produced or exported. We also considered the contributions of expanding infrastructure to support increased ethanol production. This involved the use of a government developed model and assumptions regarding production capacity utilization.

The following are key sources and their findings of economic contributions per unit of ethanol:

- According to a study for the US Grains Council, ethanol exports contributed nearly $3 billion and over 25,000 jobs in 2014, the majority of which was created along the value chain (agriculture production, services, etc.). [7] The analysis involved the input-output model IMPLAN, and thus captured both direct and indirect impacts. The study's calculations imply that 24 jobs are contributed for every one million gallons of exports.
- A recent study on the economic impact of the ethanol industry in 2016 also used the IMPLAN model.[8] The study estimated over $3 billion in output and nearly 15,000 jobs associated with ethanol exports in 2016. The employment estimate appears to only include activities directly involved in the export of ethanol, such as employment in transportation and export trade related administrative and financial industries. The industry as a whole contributed $42 billion and over 339,000. The share of ethanol production attributable to exports in 2016 suggests that about 23,000 of the 319,000 remaining jobs are related to exports. This suggests a total of 35,000 jobs in 2016 related to exports, or 20 jobs for every one million gallons of exports.

Given the level of consistency between the two studies, and methodologies that included a respected model and data gathering techniques, we used the midpoint of their per unit estimates as a reasonable approximation of employment per unit of ethanol export expansion. We estimate 22 jobs for every one million gallons of ethanol exports. **Under the RIN value export scenario from the previous section, the proposed RFS regulatory change would result in approximately 26,000 additional jobs in the US**.

This estimate does not include any specific investments in capacity expansion that could lead to temporary employment additions. The US Department of Energy's National Renewable Energy Laboratory provides a model for such purposes called the Jobs and Economic Development Impact (JEDI) model. It provides a model specifically for corn ethanol capacity investments.[9] This model estimates two jobs during the construction phase for every one million gallons of capacity expansion. The EIA estimates the production capacity as of January 2017 was 15.5 billion gallons per year. Given our estimates of the share of new exports that are new volumes versus those that are preserving volumes, we estimate production capacity expansion of about 600 million gallons per year. This would represent **1,200 jobs over the next three years to expand production capacity**.

[7] IEG, "Evaluating the Economic Contributions of U.S. Grain Exports…", April 2016.

[8] Urbanchuk, John, "Contribution of the Ethanol Industry to the Economy of the United States in 2016," ABF Economics, January 2017.

[9] JEDI Corn Ethanol Model, Release Number CE12..23.2016.

Disclaimer

The study was commissioned by Valero. The research, analysis, results and conclusions were all developed independently by the authors. The conclusions set forth herein are based on independent research and publicly available material.

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