Ethanol Supply Chain & Industry Overview: More Harm than Good?

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**Summary:** This research examines key aspects of ethanol including its material characteristics, supply chain, and government legislation that affect its market demand and availability. In addition, it discusses the social and environmental impacts of the growing biofuel industry stemming from government mandates. The goal of the project was to investigate existing studies and evaluate the aggregated findings to determine if ethanol provides a net benefit to society.

**Key Findings**

1. The environmental impact of ethanol is not always better than gasoline. The lifecycle analysis of ethanol which includes feedstocks, land-use impacts and transportation logistics should all be taken into account before making broad claims because of the significant variability they can have on ethanol’s environmental impact.

2. There remain challenges in the ethanol supply chain that continue to hinder ethanol from becoming viable on a large scale including transport, service stations, and vehicle compatibility.

3. Customer demand is uncertain due to ethanol’s reduction in fuel economy.

4. Tomorrow’s energy solutions will include ethanol, but to minimize its negative impacts investors and policy makers must take into consideration its global effects.

**Introduction**

As the world’s energy industry has evolved rapidly over the last decade and in order to meet existing energy challenges, it has become increasingly important to diversify national energy portfolios. Some of the factors influencing energy evolution are: a global focus on the regulation for the reduction of Greenhouse Gas (GHG) emissions in order to help control global climate change; traditional fuel sources becoming more expensive to extract and refine; and instability in regions that currently provide much of the world’s oil. Arguably, an important part of a country’s successful energy strategy includes (or will include) biofuels in order to reduce the risk of energy shortages and decrease environmental impacts.

As a result of these issues, the biofuel industry has made significant strides that have demonstrated biofuels can be a viable alternative to fossil fuels. The U.S. Energy Independence and Security Act (EISA) of 2007 mandated production of biofuels as a way to decrease our impact on the environment from the production of...
CO2 and other Greenhouse Gases (GHG) as well in the interest of national security.

**Background**

Ethanol is a plant based fuel that has combustion properties similar to that of gasoline. Ethanol can be produced from a number of different feedstocks; a majority produced in the US comes from corn. The most influential legislation for ethanol was passed as a part of the EISA in 2007 called the Renewable Fuel Standard (RFS2). It mandates increasing amounts of biofuel, up to 36 billion gallons by 2022. Corn starch based ethanol is capped at a maximum of 15 billion gallons (bgrams) and the rest must come from advanced biofuels. Advanced biofuels have lower lifecycle greenhouse gas emissions; some examples are cellulosic ethanol or ethanol from sugarcane. Transporting ethanol requires a variety of infrastructure upgrades in order to handle some of its unique material characteristics. Additionally, some of the unintended consequences of the fuel have created a heated debate in media and the legislative parts of the US.

**Ethanol Goals**

One important aspect of ethanol is to recognize that there are three main goals of fostering renewable energy:

1. To eliminate our dependence on foreign oil
2. To reduce our use of fossil fuels
3. To lower the amount of carbon emissions

It is in the context of these three goals that ethanol should be evaluated alongside alternatives.

**Driving Material Characteristics**

Ethanol creates difficulties with logistics and demand because of the following traits:

1. It is corrosive
2. It absorbs water
3. It has lower energy content than gasoline, resulting in lower fuel efficiency.

**Supply Chain of Ethanol**

The supply chain of ethanol begins at the farm and ends in a consumer’s vehicle. There are both logistics considerations as well as greenhouse gas emissions to consider throughout each stage of the ethanol lifecycle as it moves through the supply chain. The graphic below depicts in general how the lifecycle of ethanol works. What the graphic does not capture are the global unintended effects of ethanol’s supply chain and how this impacts its net greenhouse gas emissions.

**Farm**

The lifecycle of ethanol begins with the feedstock at the farm. Though the cultivated plant absorbs carbon dioxide, there are various inputs to consider that also generate carbon emissions including the use of pesticides, fertilizers and farm equipment.

**Transport from Farm to Ethanol Plant**

The feedstock is bulky and expensive to transport. Therefore, it is important to keep the ethanol plant close to the harvest site of the feedstock. Most of the production takes place in the Midwest, whereas most of the consumption takes place on the coasts. Additionally, ethanol needs to be blended with gasoline at blending facilities that are located near the coasts.

**Transport from Ethanol Plant to the Blender**

The majority of gasoline is transported via pipeline. This cuts down on Greenhouse Gas emissions as well as expenses. Since ethanol is corrosive and absorbs water it becomes very difficult and expensive to move via pipeline. Because of these characteristics, ethanol is moved via rail, barge and truck. This in turn results in additional demand on these transport mechanisms and requires some $2.6 billion in capital investment to accommodate the additional capacity.
Transport from Blender to Dispenser

Ethanol that has been blended with gasoline is also difficult to transport because if it comes in contact with water, the ethanol will come out of suspension. So the gasoline-ethanol blends also need to be transported mostly via rail or truck. Refueling stations also need to upgrade its storage and dispensing components to ensure that they are compatible. This is on the order of an additional $1.6 billion USD just to convert 10% of today’s gasoline stations.

Consumption

There are 8 million Flex Fuel Vehicles on the road today. Vehicles manufactured after 2001 were approved by the EPA to accept up to E15. The majority of vehicles cannot accept higher blends of ethanol. Additionally with ethanol’s lower energy content, which results in reduced fuel economy, ethanol retailers have seen a plateau in demand for E85. It is possible to retrofit non-compatible vehicles for approximately $1300 which can help boost demand if ethanol prices become competitive with gasoline.

Unintended Impacts of Ethanol

Food versus Fuel

Critics blame ethanol for causing a rise in demand for corn, resulting in a rise in corn prices. Corn for direct human consumption is “sweet corn” and only about 10% of the crop. The rest is used for ethanol and feedstock feed. Forty percent of the corn crop in 2012 went to ethanol. A byproduct of ethanol can be used as livestock feed, so 48% of crops goes directly and indirectly to livestock feed.

Most studies still indicate that there is some increase in food prices from the demand for biofuels.

Indirect and Direct Land Use Change

Land use change, an effect of biofuel mandates, is the conversion of more land to cultivation. Because the ethanol feedstock footprint is growing, it leaves less land for conservation, development, and other purposes. The fear is that land scarcity will start to convert land better suited for carbon sequestration instead used for ethanol. This will offset the benefits from ethanol or other biofuels. However corn yields have been improving over the decades.

Increased Economic Activity of Rural Areas

Increases in crop prices actually benefit farmers in rural areas. The US Farm sector grew 27% in 2010 and another 20% in 2011. Farm income has reached the 3rd highest levels in 50 years. Supporting rural communities is an important part of domestic security.

Conclusion

The key takeaway is that in order for ethanol to become successful, the full impact of its supply chain must be considered along with its unintended effects. However when combined with improved energy conservation, continued research and development to improve ethanol’s carbon footprint, it could provide some help to reduce the environmental impact of our energy needs. Ethanol also can provide other benefits such as energy independence, reduced fossil fuel consumption and rural economic stimulation. Corn-starch based ethanol can provide a stepping stone to cellulosic ethanol. However it can also be mismanaged and misguided legislation can help create a larger problem if it does not take into account to both industries.