

RECENT EFFECTS OF COVID-19 ON ALTERNATIVE FUEL TRENDS WORLDWIDE

The COVID-19 pandemic has altered the landscape of alternative fuels around the globe. While trends in alternative fuels have varied for each country, the world as a whole experienced a shift towards renewable electricity generation and faced a decrease in ethanol production. Government programs are possibly one important factor if we expect post-pandemic progress.

Introduction

Over the past three years, the COVID-19 pandemic has transformed the landscape of alternative fuels around the world. Before the pandemic, fossil fuels were increasingly used as energy sources in most places with various attempts at pushing alternative fuels. Biofuels, such as ethanol and B20 biodiesel, were being used in the transportation sector worldwide with varying success. Renewables, however, were not always given uniform attention, it really varied by where in the world one was looking at. While renewable energy sources were growing prior to the pandemic, they did not gain major traction in the U.S.' production of energy. Then, the pandemic hit the U.S. in early 2020. The global carbon emissions in 2020 were estimated to have fallen by around 10% due to widespread unemployment, economic downturns, and the global health crisis. Although the pandemic was a detrimental and catastrophic event for the human race, it was also a pivotal event that changed the realm of alternative fuels as all over the world we saw nature bloom and pondered a world with less pollution.

Biofuels during the Pandemic - The Ethanol Collapse

One of the biofuel sectors in the United States that faced a major shift in the wake of the pandemic was the ethanol production industry. Sugar cane and corn continue to be the major global feedstocks for the production of ethanol. It is estimated that currently 60% ethanol is produced from corn, 25% from sugar cane, 3% from wheat, 2% from molasses, and the rest from other grains, cassava and sugar beets [1]. The top five ethanol producers before the COVID-19 pandemic were the United States, Brazil, the European Union (EU), China, and Canada [1]. In 2020, India produced slightly more ethanol than Canada but the ranking of the top four ethanol producers did not change [1]. Recently, lignocellulosic biomass has been considered as a potential feedstock because it does not compete with food production and it is available in very large amounts. Lignocellulosic biomass includes waste plant-based products such as agricultural residues, woody crops, and waste paper. Even though companies such as DuPont and Poet have failed to successfully implement lignocellulosic biomass into ethanol production, New Energy Blue stated in July 2021 that they are planning to build a full-scale ethanol biorefinery. This biorefinery would use 250,000 megatons of annual agricultural residues generated locally for ethanol production [1].

Although global ethanol production had an upward trend overall from 2007 to 2018, the ethanol produced worldwide decreased

Market Response to COVID-19

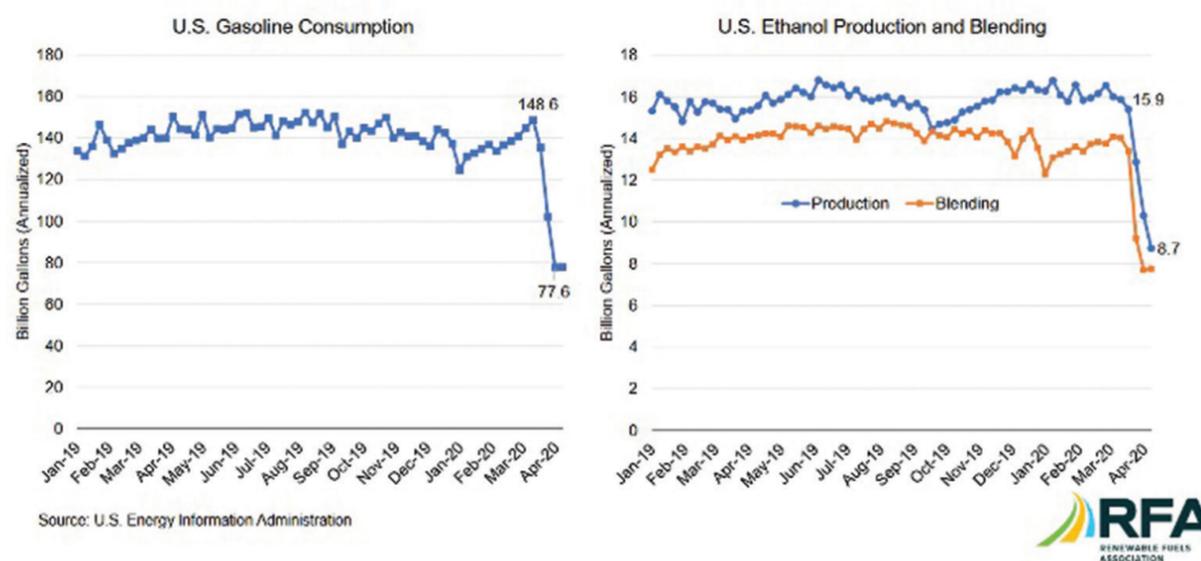


Figure 1. Graphs illustrating the change in U.S. gasoline consumption, ethanol production, and ethanol blending from January 2019 to April 2020. The steep decline in the consumption, production, and blending of ethanol occurred at the same time as a majority of stay-at-home orders were passed in March and April 2020 [6].

drastically in 2020. Countries such as Brazil, Canada, and China all experienced a decrease in the production of ethanol from 2019 to 2020. Brazil, the second leading producer of ethanol worldwide, faced a drop in ethanol production. All Brazilian states suffered negative impacts from the pandemic [2]. The United States, which is the world's leading producer of ethanol, experienced a historic decrease in ethanol production during the pandemic. The U.S. produced around 16 billion gallons of ethanol in 2018, which was a record high. Then, ethanol production fell to 15.78 billion gallons in 2019. This production fell even further to 13.93 billion gallons of ethanol in 2020. Importantly, the annual production of ethanol in the U.S. decreased by 1.85 billion gallons from 2019 to 2020 [3]. This is the largest annual decrease in U.S. ethanol production that has ever been recorded. The weekly plant production of ethanol almost halved in 2020 from 100 million barrels a day in the week of March 20th to 537 thousand barrels a day in the week of April 24th [4]. This was a historic decrease in U.S. ethanol production.

This drop in US ethanol production was largely due to the nationwide stay-at-home orders and the reduction in

transportation. From March 1st to March 31st of 2020, 42 states and territories put stay-at-home orders into place according to mandates and suggestions by the Centers for Disease Control and Prevention (CDC) [5]. This sparked the temporary closure of more than half of the ethanol plants in the US. The demand for ethanol also fell drastically due to decreased gasoline consumption during the pandemic as depicted in Figure 1 [6]. From March 20th to April 24th in 2020, the demand for gasoline dropped by 48%. In addition, there was a 45% decrease in ethanol blending [7]. The total decrease in ethanol consumption between March and June of 2020 compared to these same months from 2017 to 2019 surpassed 1.3 billion gallons [8]. Fuel demand was low, which caused the production of ethanol to decrease in 2019 and 2020.

While the pandemic greatly reduced ethanol prices in the US, COVID-19 had a much smaller effect on the ethanol market in the EU. There was no notable correlation between European and US ethanol prices. The COVID-19 pandemic did not have a measurable effect on European ethanol prices because the EU and the US had different regional influencing factors. According to factor analysis, the prices of raw materials such as corn and fertilizer were major

Proposed Volume Requirements for 2020-2022 (billion gallons)*

	2020	2021	2022
Cellulosic Biofuel	0.51	0.62	0.77
Biomass-Based Diesel	2.43**	2.43**	2.76
Advanced Biofuel	4.63	5.20	5.77
Total Renewable Fuel	17.13	18.52	20.77
Supplemental Standard	n/a	n/a	0.25

*All values are ethanol-equivalent on an energy consult basis, except for biomass-based diesel (BBD), which is biodiesel-equivalent.

**The 2020 and 2021 BBD volumes were established in previous RFS annual rulemakings.

Figure 2. Chart showing the volume requirements for biofuel blending into gasoline [9].

influencing factors for the ethanol market in the EU. Unlike the EU, crude oil and conventional gasoline prices had a greater impact on ethanol prices in the US. The main reason for the varying effects that the pandemic had on the US and EU markets are these regions' fundamentally different characteristics. The US is a major consumer and producer of oil and oil-based products. The US is a significant consumer of ethanol due to mandatory blending mandates. This caused the pandemic to have a doubled effect on the US oil and ethanol markets while the EU ethanol market was largely unaffected by the pandemic [8].

Bright but Uncertain Future for Biofuels

The ethanol production industry has been making somewhat of a recovery since late 2021, but the demand for ethanol still has not returned to a pre-crisis level. Several ethanol plants in the United States have reinitiated operations after the temporary shutdown in 2020. In addition, fuel demand is now rising due to increased transportation after the stay-at-home mandates have begun lifting in 2021. The future of ethanol is uncertain, but the government is strongly in support of the expansion of ethanol and other biofuels. On December 7th, 2021, the Environmental Protection Agency (EPA) released a proposal that set the renewable fuel blending mandates for the 2020, 2021, and 2022 compliance years. The blending mandates set by the US government indicate the amount of ethanol or renewable fuel that needs to be blended with gasoline. To compensate for the decreased ethanol production during the pandemic, the total renewable biofuel blending mandate for 2020 was changed to 17.13 billion gallons. This was a 14.7% decrease from the levels originally set months before COVID-19 reached the United States. The EPA mandate for 2021 was set at 18.52 billion gallons, which is an 8% drop from the original 2020 mandate. Although ethanol faced a major blow during the pandemic, the EPA set the mandate for total renewable fuel blending in 2022 at 20.77 billion gallons [9].

In addition to the 2022 mandate set by the EPA, advanced biofuels have been implemented in multiple industries. Companies such as ExxonMobil, Porsche, and BP have been ramping up their role in the biofuels industry. For instance, BP announced in 2019 that it would form a joint venture with leading agricultural company Bunge to create a bioenergy company in one of the world's fastest-growing and largest markets for biofuels. The new company, BP Bunge Bioenergia, is set to produce sugarcane ethanol to grow its existing biofuel business by over 50% [10]. Biodiesel blends are also increasingly being used in vehicles that experience rough weather conditions. For example, the Chicago Park District utilizes a B20 blend of biodiesel to power tower trucks, forestry trucks, pick-ups, and other heavy vehicles during winter months. This B20 biodiesel is also used year-round in their vehicle fleet to reduce carbon emissions. In 2019, the Park District upgraded two hauler trucks to have a biodiesel system created by Optimus Technologies that enables the use of 100% biodiesel (B100). This B100 fleet recently grew to include three other trucks [11]. Although B20 is still the most commonly-used type of biodiesel, biodiesel blends that include higher percentages of biofuel are being researched and increasingly used.

Renewable Energy Remains Relatively Resilient

While transportation fuels were in decreased demand due to a reduction in mobility during the pandemic, the need for electric power was still present. This gave renewable energy sources room for opportunities in expanding their use in electricity production.

Bans on travel, containment policies, and remote work and education around the world resulted in a drop in the usage of transportation. The global demand for natural gas was reduced by around 2% with the largest decreases in Europe, China, and the US. There was also a significant global drop in the demand for oil and coal. Even though the pandemic resulted in a global energy decline, there has been a steady increase in the demand for renewable energy in the past few years due to increasing concern for global warming. The percentage of renewable energy sources making up the global generation of electricity has grown due to a considerable amount of renewable energy production in the US, EU, Japan, Africa, and Southeast Asia [12].

On the other hand, the renewable energy sector in China was negatively affected by the COVID-19 pandemic. The deaths

caused by the pandemic negatively influenced the hydroelectric power energy and the nuclear energy produced in China. The pandemic disturbed the supply and demand of renewable energy due to casualties and economic downturn. For instance, a 1% increase in COVID-cases causes a 1.991% drop in nuclear energy production and a 0.471% decrease in hydroelectric power energy [13]. In order to recover from the consequences of the pandemic, the Chinese government should implement policies to encourage renewable energy generation.

Renewables in the US have shown promising growth over the past 3 years, despite the pandemic, due to government initiatives and increased demand for renewable energy. Renewable energy has grown over the past 10 years, especially for sources such as wind and solar. The amount of solar-generated power capacity used by the U.S. electric power sector at the end of 2021 was 20 times more than it was at the end of 2011. The U.S. wind power capacity has increased over 200% over the past 10 years [14]. A considerable amount of this growth took place during the pandemic. According to the Energy Information Administration (EIA), renewables were the only energy source in 2020 that exhibited an increased demand and consumption despite the pandemic. Wind, which is currently the most prevalent renewable energy source in the United States, grew 14% in 2020 compared to 2019. Small-scale solar generation, including grid-connected rooftop solar panels, increased by 19% in 2020 from 2019. Utility-scale solar power from projects that generated over 1 megawatt increased by 26% in 2020 [15]. Renewables including hydropower generated a record 834 billion kWh of electricity in 2020, which accounted for around 21% of all the electricity generated in the United States that year. Renewable energy surpassed nuclear and coal for the first time in history in 2020 due to the steady, increased use of wind and solar. The share of generation for non-hydropower renewables in 2021 was 13%, which was an increase from 2019 and 2020.

The rise of renewable energy will hopefully continue in 2022 and in the future with the support of government groups and large companies in the United States. According to the current short-term energy outlook proposed by the EIA, most of the growth in electricity generation in the United States is forecasted to come from new renewable energy sources in 2022. The EIA estimated that the electric power sector had 63 gigawatts (GW)

of pre-existing solar power generating capacity operating by the end of 2021. It is forecasted that solar capacity will grow by about 21 GW in 2022 and by 25 GW in 2023. Operating wind capacity totalled 135 GW at the end of 2021. It is expected that 7 GW of wind generating capacity will be added in 2022 and another 4 GW in 2023 [14]. Other renewable energy sources are also being increasingly researched, such as e-fuels. For example, ExxonMobil and Porsche are looking to transition their newest iteration of Esso Renewable Racing Fuel to eFuel as early as 2022 [16]. Hydrogen-powered vehicles are still in the developmental stage but offer a promising future for clean transportation.

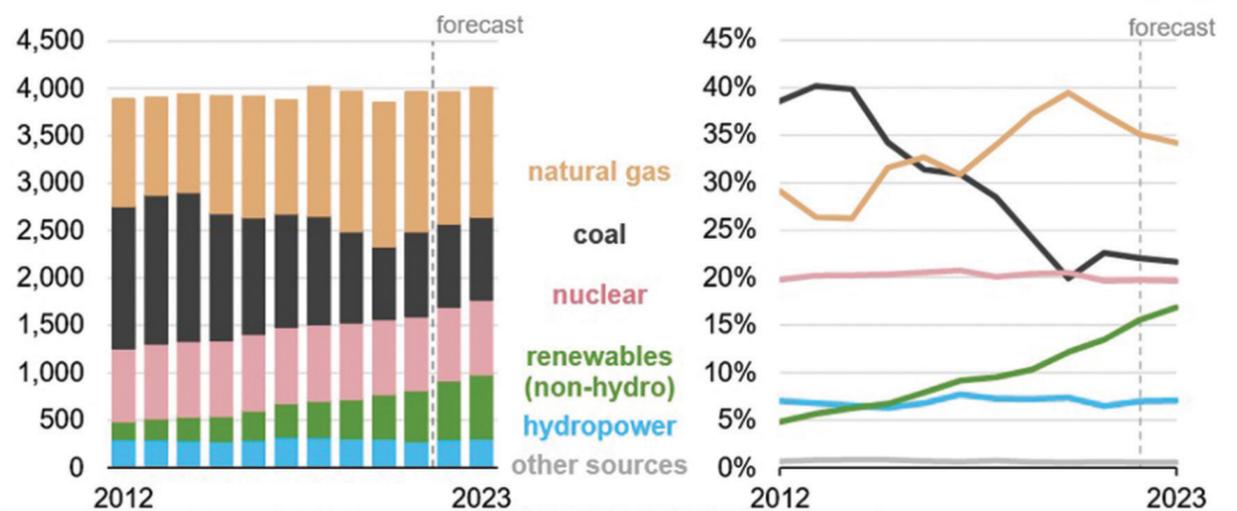
Conclusion

In order to meet the optimistic expectations made for the future growth of alternative fuels, the setbacks caused by COVID-19 must be overcome and the progress made in the past 3 years must not come to a halt. According to the EIA, global carbon emissions already rose 6 percent last year after a record 10 percent decline in 2020 due to an increase in the use of fossil fuels for transportation. The progress made with renewable energy needs to continue. Efficient biofuels must continue to make their recovery with the help of governments across the world. The current goals of the government of the United States include having 100% carbon emission-free electricity (CFE) by 2030 and 100% zero-emission vehicle (ZEV) acquisitions by 2035 [17]. These hefty expectations can only be achieved if clean and efficient alternative fuels continue to be researched and used in 2022 and beyond. The improvement of alternative fuels should not only occur for the sake of government initiatives, but also for the sake of our planet's future.

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Annual U.S. electric power sector generation by energy source (2012–2023)



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, January 2022

Figure 3. Graphs showing the sources of yearly U.S. electric power generation from 2012 to 2021 and the forecasts for 2022 and 2023 [14].

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