U.S. Domestic Ethanol Policy[1]

INTRODUCTION

According to the National Agricultural Statistics Service, 91.7 million acres of corn were planted by American farmers in 2019.[2] Humans consume less than a third of that corn, slightly under another third goes into animal feed in meat production, and the remaining forty percent is used to make ethanol.[3] Ethanol primarily serves as a fuel alternative or fuel additive. It is blended into almost all U.S. gasoline.[4]

Over the past forty years, the United States has supported ethanol as a means to reduce dependence on foreign sources of fuel by offering economic incentives to aid ethanol production and by mandating that gasoline refiners, blenders, and importers meet a renewable blend quota. Recently, more administrative and judicial attention has been placed on the Environmental Protection Agency's (EPA) exemptions from the renewable blend quotas.

Ethanol has been touted as a better, more sustainable alternative to gasoline. However, this proposition has been subject to debate and the environmental impacts of ethanol made from corn are still substantial. Additionally, ethanol is still used primarily as an additive, not as a replacement to gasoline, thus some view ethanol usage as continuing to prop up the oil and gas industry, shifting focus away from other renewable alternatives. In determining future energy policy, the substantial toll that corn ethanol takes on air, water, soil, biodiversity, and human health must be assessed to determine whether it is sustainable to continue propping up the ethanol industry the way we have up to this point.

I. BACKGROUND

Ethanol, a basic organic compound, is an alcohol.[5] It can be used in a multitude of different ways, such as a commercial chemical in alcoholic beverages, a solvent in cleaners, and an ingredient in pharmaceuticals, perfumes, and cosmetics.[6] The most well-known use for ethanol, however, is as a fuel additive.

Fuel ethanol can be made from a variety of different feedstocks. Ethanol feedstocks are categorized by generations, each of which represent an evolution in the production of ethanol as a result of economic and/or environmental concerns.[7] The more common or first-generation feedstocks are food products with high starch or sucrose content, including crops such as corn and sugarcane.[8] The second generation of ethanol feedstocks consist of non-food products, like wood chips and inedible crops (both of which are considered

---

[1] The following people contributed to this report: Tala M. DiBenedetto (Food Law Initiative, Pace University Elisabeth Haub School of Law), Allison Fausner (Food Law Initiative, Pace University Elisabeth Haub School of Law), and Emma Scott (Harvard Law School Food Law & Policy Clinic).
[2] Tom Capehart & Susan Proper, *Corn is America's Largest Crop in 2019*, U.S. DEP'T OF AGRIC. (Aug. 1, 2019), https://www.usda.gov/media/blog/2019/07/29/corn-americas-largest-crop-2019.
[3] *Id.*; *Feedgrains Sector at a Glance*, U.S. DEP'T OF AGRIC, ECON. RSCH. SERV. (2020), https://www.ers.usda.gov/topics/crops/corn-and-other-feedgrains/feedgrains-sector-at-a-glance/.
[4] *Almost All U.S. Gasoline is Blended with 10% Ethanol*, U.S. ENERGY INFO. ADMIN. (May 4, 2016), https://www.eia.gov/todayinenergy/detail.php?id=26092.
[5] *Ethanol*, NAT'L LIBRARY OF MED., https://pubchem.ncbi.nlm.nih.gov/compound/Ethanol (last visited Aug. 22, 2020).
[6] *Id.*
[7] *See* Roland Arthur Lee & Jean-Michel Lavoie, *From First- to Third- Generation Biofuels: Challenges of Producing a Commodity from a Biomass of Increasing Complexity*, 3 ANIMAL FRONTIERS 6, 8 (2013).
[8] *Id.* at 6.

cellulosic feedstocks), and solid municipal wastes.[9] The third generation of feedstock is algae.[10] Because the feedstocks that create ethanol are made of biomass—i.e. organic materials taken from plant and animals—the end product, ethanol, is considered a renewable resource.[11] It is also the reason why, after ethanol is mixed with gasoline, the new mixture is called a biofuel.

Fuel ethanol can be manufactured through a dry or wet mill process.[12] The more prevalent method, dry mill processing, proceeds in several steps. First, the feedstock is completely ground up.[13] Second, the ground up product is liquefied and enzymes are added to convert the starch into sugar.[14] Third, the addition of yeast starts the fermentation process and sugar begins to transform into ethanol.[15] Fourth, excess water is separated and removed from the ethanol.[16] Finally, a denaturant is added and the ethanol is ready to be blended into gasoline.[17]

Once ethanol is blended into gasoline, it is ready to be used as a transportation fuel. The amount of ethanol blended into gasoline can vary between 10-83%.[18] E-10, a blend of fuel using 10% ethanol, may be used in all "conventional light-duty vehicles."[19] E15, consisting of 10.5-15% ethanol, may be used in light duty vehicles made after the year 2001.[20] E85, the highest ethanol blend available, consists of 51-83% ethanol.[21] A vehicle using E85 must be a flexible fuel vehicle (FFV). FFVs can use gasoline, ethanol, or a combination of the two.[22] There are around 3,600 public E85 fueling stations in the United States[23] and, as of 2017, there were 393,553 FFVs operated by federal agencies, state governments, fuel providers, and transit agencies, consuming just under 28 million gasoline equivalent gallons of E85.[24] In 2018, vehicles in the U.S. consumed around 14.4 billion gallons of fuel ethanol, mostly in E10 gasoline mixtures, which amounted for 10% of motor gasoline consumption.[25]

---

[9] *Id.* at 8. Some commentators include algae within second generation feedstocks. *See* Jadwiga R. Ziolkowska, *Prospective technologies, feedstocks and market innovations for ethanol and biodiesel production in the US*, 4 BIOTECHNOLOGY. REP. 94 (2014).
[10] Lee & Lavoie, *supra* note 7, at 10. Recently, a fourth generation of ethanol feedstocks have emerged but remain largely in the research and development stage. *See* Eva-Mari Avo, *From First Generation Biofuels to Advanced Solar Biofuels*, 45 AMBIO 24 (2015).
[11] Lee & Lavoie, *supra* note 7, at 6.
[12] RENEWABLE FUELS ASS'N, POCKET GUIDE TO ETHANOL POLICY 2017 1 (2017), https://ethanolrfa.org/wp-content/uploads/2017/02/Pocket-Guide-to-Ethanol-2017.pdf. The following paragraph describes the process of converting first generation feedstocks into ethanol. Later generations of feedstocks often require increasingly complex processes to convert the feedstocks into ethanol and will not be explored within this paper. *See* Lee & Lavoie, *supra* note 7, at 8–10.
[13] RENEWABLE FUELS ASS'N, *supra* note 12, at 1.
[14] *Id.*
[15] *Id.*
[16] *Id.*
[17] *Id.*
[18] U.S. DEP'T OF ENERGY, ETHANOL BASICS 1 (2018), https://afdc.energy.gov/files/u/publication/ethanol_basics.pdf.
[19] *Id.*
[20] *Id.*
[21] *Id.*
[22] *Id.*
[23] *Biofuels Explained: Basics*, U.S. ENERGY INFO. ADMIN. (last updated June 24, 2020), https://www.eia.gov/energyexplained/biofuels/use-of-ethanol.php.
[24] *Alternative Fuel Vehicle Data: E85*, U.S. ENERGY INFO. ADMIN. (May 2019), https://www.eia.gov/renewable/afv/users.php?fs=a&ufueltype=E85.
[25] *Biofuels Explained: In Depth*, U.S. ENERGY INFO. ADMIN. (last updated June 21, 2019), https://www.eia.gov/energyexplained/biofuels/use-of-ethanol.php.

II. U.S. ETHANOL HISTORY & POLICY DEVELOPMENT

Until around forty years ago, United States ethanol policy was practically nonexistent. It was only after the oil crisis of the 1970s and the subsequent push for reduced dependence on foreign oil sources that the federal government began to enact favorable economic incentives for ethanol. These developments, however, were scattered among various bills, none of which were solely or primarily dealing with ethanol. It would take another thirty years for the Congress to issue its first comprehensive policy on the use of ethanol and renewable fuels. The Energy Policy Act of 2005 not only established economic incentives for ethanol, but also—more importantly—created a program mandating that increasing volumes of ethanol be blended into gasoline. The Energy Independence and Security Act of 2007 expanded upon this program by creating increased annual volume targets. However, these statutory targets have not been met in the past few years leading to growing tensions between the ethanol industry and the EPA.

A. History of Ethanol Use in the United States: 1800s-1970s

The use of ethanol as a transportation fuel in the United States can be traced back to the early nineteenth century. In 1826, Samuel Morey developed an internal combustion engine that ran on a combination of ethanol and turpentine.[26] In the following decades, Americans primarily used ethanol as a lighting fuel.[27] However, ethanol use was severely curtailed during the Civil War, when the Union Congress passed a $2 per gallon excise tax on ethanol.[28] The Tax Revenue Act of 1862 was intended to raise funds for the Union's effort in the Civil War but ultimately stayed on the books for over forty years.[29] In 1906, the tax was repealed, making ethanol a viable fuel source once again.[30] However, it was difficult for ethanol to compete with gasoline, which had amassed extensive infrastructure in the latter half of the nineteenth century.[31]

Both World Wars increased demand for ethanol in the United States.[32] Wartime need for fuel and a growing resistance against reliance on foreign fuel sources boosted ethanol's appeal.[33] However, once World War II ended, with reduced need for war materials and with the low price of oil, ethanol use as a fuel reduced drastically and virtually no commercial fuel ethanol was available in the United States until the 1970s.[34]

B. The Origins of Incentivizing Ethanol: 1970-1990s

In the 1970s, the United States experienced an oil crisis as a result of the Organization of Petroleum Exporting Countries oil embargo.[35] During the crisis, oil prices quadrupled, leading the Nixon Administration to declare the need to drastically alter United States energy policy to lower consumer energy prices and eliminate dependence on foreign suppliers.[36] At the same time, the Environmental Protection

---

[26] D. D. Songstad et al., *Historical Perspective on Biofuel: Learning from the Past to Rediscover the Future*, 45 CELLULAR & DEVELOPMENTAL BIOLOGY 189, 189 (June 2009). *See also*, United States Patent 4378X, https://en.wikisource.org/wiki/United_States_patent_4378X.
[27] *See Biofuels Explained*, U.S. ENERGY INFO. ADMIN. (last updated Jun. 18, 2020), https://www.eia.gov/energyexplained/biofuels/ethanol.php.
[28] *See* Kaylan Lytle, *Driving the Market: The Effects on the United States Ethanol Industry if the Foreign Ethanol Tariff is Lifted*, 28 ENERGY L. J. 693, 698 (2007)
[29] *See* Songstad et al., *supra* note 26, at 190.
[30] *Id.*
[31] *Id.*
[32] *See* Lytle, *supra* note 28, at 698.
[33] *Id.*
[34] *Id.*
[35] *Oil Embargo, 1973-1974*, U.S. DEP'T OF STATE, OFF. OF THE HISTORIAN, https://history.state.gov/milestones/1969-1976/oil-embargo (last visited Aug. 22, 2020).
[36] *Id.*

Agency began phasing out leaded gasoline.[37] Ethanol became an attractive alternative that now had the dual benefits of promoting domestic energy independence and avoiding the harms of lead. However, ethanol would need extensive help from Congress to be able to compete with other fuels.

By the late 1970s, the United States had begun to see the establishment of federal benefits for domestic ethanol.[38] Congress passed the Energy Tax Act of 1978, which established a four cents per gallon exemption from federal gasoline excise taxes for motor fuels blended with a minimum of 10% ethanol.[39] A series of other economic incentives followed: the Energy Security Act of 1980 authorized the dispersal of funds to build ethanol plants and the Omnibus Reconciliation Tax Act of 1980 placed a tariff on imported ethanol used in gasoline blends.[40] Throughout the next decade, ethanol continued to receive increased tax benefits and economic incentives.[41] As a result of all of these factors, the United States once again increased its ethanol production and consumption.[42]

C. Mandating Ethanol Usage: The Energy Act of 2005

By the early 2000s, the Energy Information Administration began to predict the next two decades would see increasingly high oil prices.[43] Both the energy price volatility and supply uncertainty prompted the federal government to reexamine its domestic fuel source policies, culminating in the Bush Administration signing into law the Energy Policy Act of 2005 (EPAct).[44] In a radical departure from past policy, the Act mandated the blending of ethanol into gasoline. It also continued the practice of creating economic incentives for ethanol production.

The EPAct mandated the use of ethanol by amending the Clean Air Act and creating the Renewable Fuel Standard (RFS) program.[45] The RFS program requires that gasoline sold or introduced into commerce in the United States must include a minimum amount of renewable fuel each year, starting at four billion gallons in 2006 and reaching seven and half billion gallons in 2012.[46] EPA is responsible for establishing annual rates thereafter.[47] Although other biofuels, such as biodiesel, qualify for the RFS, ethanol was expected to and has been the dominant fuel under the program.[48]

Refiners, blenders, and importers of gasoline must meet EPA's annual renewable fuel obligation by blending increasing volumes of biofuels into gasoline,[49] unless an exemption applies. Small refiners that face financial hardships in achieving its renewable fuel obligation may be granted an exemption from

---

[37] *EPA Takes Final Step in Phaseout of Leaded Gasoline*, U.S. ENVTL. PROT. AGENCY (Jan. 29, 1996), https://archive.epa.gov/epa/aboutepa/epa-takes-final-step-phaseout-leaded-gasoline.html.
[38] U.S. GEN. ACCT. OFFICE, TAX POLICY: EFFECTS OF THE ALCOHOL FUELS TAX INCENTIVES 32 (1997) https://www.gao.gov/assets/230/223785.pdf.
[39] *Id*.
[40] *Id*.
[41] *Id*. at 33.
[42] Wallace E. Tyner, *The U.S. Ethanol and Biofuels Boom: Its Origins, Current Status and Future Prospects*, 58 BIOSCIENCE 646, 648 fig. 2 (2008).
[43] James A. Duffield et al., *Ethanol Policy: Past, Present, and Future*, 53 S. D. L. REV. 425, 434 (2008).
[44] *Id*. *See* Energy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005) (codified at 42 U.S.C. § 7545) ("EPAct").
[45] EPAct § 1501 *et seq*.; 42 U.S.C. § 7545 (2006).
[46] 42 U.S.C. § 7545(o) (2006).
[47] *Id*.
[48] BRENT D. YACOBUCCI, CONG. RSCH. SERV., FUEL ETHANOL: BACKGROUND AND PUBLIC POLICY ISSUES 18 (2008). "Biodiesel is a synthetic diesel fuel made from oils such as soybean oil." *Id*.
[49] 42 U.S.C. § 7545(o)(3)(A)-(B) (2006). EPA enforces the blend requirements among obligated parties by assigning every gallon of renewable fuel blend a Renewable Identification Number (RIN) that allows EPA to track industry compliance with the mandate. *See* 40 C.F.R. §§ 80.1125–26.

obligations under the RFS program on an annual basis.[50] Small Refinery Exemptions (SREs) effectively reduce the amount of biofuel required to enter the nation's fuel supply by exempting a percentage of the total renewable fuel obligations for a given year. EPA is responsible for taking into account a previous year's SREs when establishing the following year's renewable fuel obligation.[51]

The RFS program also establishes a credit trading system.[52] This gives obligated parties the flexibility to use less renewable fuel than required by the RVO and still meet the standard by purchasing credits from those parties who have exceeded the standard in a given year.[53] In 2007, EPA issued a final rule that created a system for credit generating and trading.[54]

Aside from mandating ethanol use in the RFS program, the EPAct created economic incentives for ethanol producers. It established a program to incentivize the production of cellulosic biofuels by allowing a reverse auction to purchase the first billion gallons of cellulosic ethanol.[55] Congress also established tax credits for installing alternative fuel stations and modified the small ethanol producer credit to expand the definition.[56]

D. Expanding the RFS Program: The Energy Independence and Security Act of 2007

Congress passed the Energy Independence and Security Act of 2007 (EISA) to ensure greater American energy independence and increase the production of renewable fuels.[57] EISA altered the RFS program by expanding which fuels are implicated in the mandate, establishing separate categories of advanced biofuels, increasing the annually mandated renewable fuel obligations, and adding greenhouse gas accounting requirements.[58]

EISA expanded the central mandate of the RFS program by requiring that all transportation fuels sold or introduced into the United States include the applicable renewable volume.[59] It defined transportation fuel as fuel used in motor vehicles and nonroad vehicles;[60] previously, the EPAct only applied to gasoline.[61] EISA also recategorized renewable fuels into two categories: conventional and advanced.[62] Conventional biofuels are made from ethanol derived from corn starch.[63] Advanced biofuels are renewable fuels other than corn ethanol, such as cellulosic ethanol, biomass-based diesel, ethanol derived from sugar and waste material, and biogas and butanol.[64]

EISA further expanded the RFS program by increasing the total annual renewable fuel obligation, as well as extending the program a decade longer until 2022.[65] In 2022, a total of thirty-six billion gallons of

---

[50] 42 U.S.C. § 7545(o)(9) (2006).
[51] 42 U.S.C. § 7545(o)(3)(C) (2006).
[52] 42 U.S.C. § 7545(o)(5) (2006).
[53] *Id*.
[54] Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program, 72 Fed. Reg. 23899 (May 1, 2007) (Final Rule). Due to changes in the RFS program resulting from the passage of the Energy Independence and Security Act of 2007, EPA needed to create new rules to reflect those changes.
[55] EPAct § 942(c) (codified at 42 U.S.C. § 16521).
[56] EPAct §§ 1342, 1347.
[57] Energy Independence and Security Act of 2007, Pub. L. No. 110-140, 121 Stat. 1492 ("EISA").
[58] *Id*. §§ 201, 202.
[59] *Id*. § 202(a).
[60] *Id*. § 201(L).
[61] EPAct § 1501(a).
[62] EISA § 201.
[63] *Id*. § 201(F).
[64] *Id*. § 201(B)(i)-(ii).
[65] *Id*. § 202(a)(2).

renewable fuel is required.[66] Congress also established separate renewable fuel obligations for advanced biofuel, as well as two subcategories of advanced biofuels: cellulosic biofuel and biomass-based diesel.[67] To meet the total renewable fuel requirement for a specific year, the applicable volumes of advanced biofuels must be met, and then the remaining portion of the total renewable fuel standard can be met with conventional biofuels. The advanced biofuel proportion of the obligation increases each year, comprising about 58% in 2022.[68] Importantly, the RFS statute grants EPA certain waiver authorities that may be used to waive the statutory renewable fuel volume.[69] EPA has relied on the cellulosic biofuel waiver to reduce cellulosic biofuel volume *as well as* the advanced biofuel and total renewable fuel volume since 2014.[70]

EISA also created provisions to limit the greenhouse gas emissions of renewable fuels. First, to qualify under the RFS program, all renewable fuels from new biofuel refineries must achieve at least a 20% reduction in lifecycle greenhouse gas emissions.[71] Second, to qualify as advanced biofuels, renewable fuels must achieve lifecycle greenhouse gas emissions that are 50% less than baseline lifecycle greenhouse gas emissions.[72] Lifecycle greenhouse gas emissions include the aggregate quantity of greenhouse gas emissions related to the full fuel lifecycle, including fuel and feedstock production and distribution and use of the finished fuel to by the ultimate consumer.[73] Baseline lifecycle greenhouse gas emissions means the average lifecycle greenhouse gas emissions for gasoline in 2005.[74] EPA is tasked with developing regulations to rate fuels on their lifecycle emissions, and determining which fuels qualify under the new standard.[75]

Following the enactment of EPAct and EISA, ethanol production and consumption drastically increased from a total of 7,963 million gallons (combined) in 2005 to 30,442 million gallons in 2018.[76] It is indisputable that this increase can be attributed to the RFS mandate.

E. Recent Administrative Actions and Judicial Response to RFS Small Refinery Exemptions

Although support for ethanol originated as a means of reducing American reliance on foreign fuel suppliers, it quickly gained support from agricultural interests. As a result, corn and ethanol industry players often speak out against and have sued the EPA when they believe its actions are detrimental to ethanol policy. EPA's increased granting of exemptions from the RFS blending quotas and other recent EPA proposed rulemakings have been on the receiving end harsh critiques from the corn and ethanol industry. And, as a recent Tenth Circuit decision demonstrates, these industry critiques of EPA exemptions are not without statutory support.

---

[66] *Id*.
[67] *Id*.
[68] CONG. RSCH. SERV., R44045, THE RENEWABLE FUEL STANDARD (RFS): WAIVER AUTHORITY & MODIFICATION OF VOLUMES 2 (2020), https://fas.org/sgp/crs/misc/R44045.pdf.
[69] *Id.* at 4.
[70] *Id.* at 6.
[71] EISA § 202(a).
[72] *Id*. § 201(B)(i).
[73] *Id*. § 201(H).
[74] *Id*. § 201(C).
[75] *See* Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program, 75 Fed. Reg. 14670 (Mar. 26, 2010).
[76] *U.S. Production, Consumption, and Trade in Ethanol*, U.S. ENERGY INFO. ADMIN. (last updated May 2020) https://afdc.energy.gov/data/10323.

In 2018, the EPA granted thirty-five small refinery exemptions (SREs) for compliance year 2017, a number significantly higher than in past years.[77] Then, in July of 2019, EPA issued a proposed rule establishing the renewable fuel obligations for 2020.[78] This rulemaking proposed increasing the renewable fuel volumes from the previous year, but to an amount less than the volume called for in the statute.[79] Under the proposed rule, corn-based ethanol has a 15 billion gallon target.[80] Biofuel organizations heavily criticized the rule for hampering ethanol production and failing to reallocate the loss of renewable fuel consumption caused by waivers.[81] The EPA compounded the ire of the corn and ethanol producers when, in August of 2019, it granted thirty-one SREs for compliance year 2018.[82] The eighty-five exemptions granted within the Trump Administration's tenure have removed four billion gallons of corn-based ethanol from the market, severely impacting corn producers who rely on the ethanol industry.[83]

On October 15, 2019, the EPA proposed a new method of estimating the amount of gasoline and diesel that would be exempt from biofuel blending requirements due to SREs.[84] Offered through a Supplemental Notice, the calculation would be used to increase the amount of biofuel that is blended into transportation fuel by accounting for and offsetting any exemptions granted to small oil refiners.[85]

The EPA's newly proposed calculation purports to offset the amount of biofuel lost through these exemptions.[86] It would base the amount of relief on three-year averages of the numbers of exemptions recommended by the Department of Energy (DOE).[87] The decision to rely upon DOE recommendations rather than actual exemptions granted by EPA was the primary source of controversy. The distinction between these data points is important. When evaluating a petition for an SRE, EPA refers the petition to DOE for a recommendation on what relief, if any, should be granted.[88] After receiving the DOE recommendation, the EPA Administrator must determine whether the small refinery petitioner would suffer economic harm and, if harm is found, grant the necessary relief.[89] Congress has previously directed EPA to follow DOE recommendations on SREs.[90] However, EPA has not been following DOE's recommendations, instead granting full relief to small refineries when DOE recommended 50% relief.[91]

---

[77] *RFS Small Refinery Exemptions*, U.S. ENVTL. PROT. AGENCY, Table 2 (last updated Aug. 20, 2020), https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rfs-small-refinery-exemptions. *See supra* Section III.C. for a brief description of SREs.

[78] Renewable Fuel Standard Program: Standards for 2020 and Biomass- Based Diesel Volume for 2021, Response to the Remand of the 2016 Standards, and Other Changes, 84 Fed. Reg. 36762 (Jul. 29, 2019) (Proposed Rulemaking).

[79] *Id.* at 36764.

[80] *Id.*

[81] David Pitt, *Trump Escapes Blame for Ethanol Policy Hurting Farmers*, A.P. NEWS (July 12, 2019) https://apnews.com/28dd29a4e0f7499e94453c26639946c1. The EPA estimates that the SREs for calendar years 2017 and 2018 have resulted in the exemption of 30.4 million gallons of gasoline and diesel from the RFS blending quotas. *RFS Small Refinery Exemptions*, *supra* note 77, at Table 1.

[82] *RFS Small Refinery Exemptions*, *supra* note 77, at Table 2.

[83] David Pitt, *Farmers Blame Trump for Biofuels Rule they see as a Betrayal*, A.P. NEWS (Oct. 15, 2019) https://apnews.com/f48166606bcd4ea2b3f0bc3d7934a1e8.

[84] Renewable Fuel Standard Program: Standards for 2020 and Biomass- Based Diesel Volume for 2021, and Response to the Remand of the 2016 Standards, 84 Fed. Reg. 57677 (Oct. 28, 2019) (Supplemental Notice of Proposed Rulemaking).

[85] *Id.*

[86] *Id.*

[87] *Id.*

[88] *Id.*

[89] *Id.*

[90] S.R. 114-281, 114th Congress (2016), https://www.congress.gov/114/crpt/srpt281/CRPT-114srpt281.pdf.

[91] Jarrett Renshaw & Stephanie Kelly, *EPA Granted Full Biofuel Waivers to Refineries Despite Energy Department Advice*, REUTERS (Sept. 24, 2019), https://www.reuters.com/article/us-usa-biofuels-epa/epa-granted-full-biofuel-waivers-to-u-s-refineries-despite-energy-dept-recommendations-memo-idUSKBN1W91S6.

Considering EPA's decisions not to follow DOE's recommendations on SREs, the proposed calculation appears at odds with its intention to boost of biofuel consumption.

The calculation has not been well received by many in the biofuel industry who believe the method of calculation is illogical and will result in less biofuel use than other methods. For instance, the National Farmers Union pointed out that the use of actual averages would have increased the amount of biofuel consumption by approximately 1.35 billion gallons per year, while the use of recommended averages will increase it by just 770 million gallons.[92] The RFA's President and CEO Geoff Cooper also pointedly criticized the EPA's plan to rely on DOE recommendations that it has repeatedly ignored.[93] Despite the blowback, administration officials have continued to say the fifteen billion gallon target will be met.[94] EPA announced the finalized rule in December 2019—published in February 2020—adopting the new methodology.[95]

Regarding EPA's process for granting SREs, a recent Tenth Circuit decision ruled that EPA must reconsider a few of its granted SREs because the Agency's justification for approving the exemptions was flawed.[96] In this case plaintiffs, several prominent corn and ethanol industry organizations, alleged that EPA exceeded its statutory authority when it granted three oil refineries' SRE petitions.[97] The Tenth Circuit agreed and vacated the EPA's orders granting the SRE petitions, holding that EPA exceeded its statutory authority when it granted *new* exemptions to the small refineries under the statutory provision that authorizes the grant of *extension* of—existing—exemptions.[98] The Circuit also found that EPA acted outside the scope of its authority when it relied, even just in part, on hardship caused by factors other than compliance with RFS blending obligations—e.g., "adverse structural conditions" like an "industry-wide downward trend"—as a basis for granting the extensions (or, in this case, exemptions).[99] Following this decision, a number of refineries filed "gap year" petitions for prior years in order to be eligible for future exemption extensions.[100] The EPA denied these gap filling petitions in September 2020.[101]

III. ENVIRONMENTAL IMPACTS OF ETHANOL

Given the purported justifications of relying on ethanol as a renewable fuel, environmental impacts are paramount in assessing the desirability of ethanol. There are a number of environmental costs and benefits to ethanol use that span across the many stages of ethanol production from feedstock production, transportation, production of corn into ethanol, and the burning/use of ethanol. Impacts include those to air and water quality from ethanol production (land conversion, growing, fertilizing, harvesting, and refining) and use, reductions in soil quality from industrial corn production, impacts to biodiversity resulting from

---

[92] *See EPA's Biofuel Fix is Another Broken Promise to American Farmers*, NAT'L FARMERS UNION (Oct. 15, 2019), https://nfu.org/2019/10/15/epas-biofuels-fix-is-another-broken-promise-to-american-farmers/.
[93] *RFA Statement on EPA Supplemental Proposal for 2020 RVO*, RENEWABLE FUELS ASS'N (Oct. 15, 2019), https://ethanolrfa.org/2019/10/rfa-statement-on-epa-supplemental-proposal-for-2020-rvo/.
[94] *Id*.
[95] Renewable Fuel Standard Program: Standards for 2020 and Biomass Based Diesel Volume for 2021 and Other Changes, 85 Fed. Reg. 7016, 7019 (Feb. 6, 2020) (Final Rule).
[96] Renewable Fuels Ass'n v. EPA, 948 F.3d 1206, 1258 (10th Cir. 2020).
[97] *Id*. at 1242.
[98] *Id.* at 1245
[99] *Id*. at 1253–54.
[100] *See* Erin Voegele, *EPA: 52 'Gap Year' Small Refinery Exemption Petitions Filed*, BIOMASS MAG. (Mar. 24, 2020), https://www.agri-pulse.com/articles/13362-refineries-ask-10th-circuit-to-reconsider-rfs-exemption-decision.
[101] U.S. ENVTL. PROT. AGENCY, DENIAL OF SMALL REFINERY GAP-FILLING PETITIONS (2020), https://www.epa.gov/sites/production/files/2020-09/documents/rfs-denial-small-refinery-gap-filling-petitions-2020-09-14.pdf.

pesticide use and habitat destruction, and harm to human health from the release of pollutants (including carcinogens) in the burning of ethanol.

A. Air & Climate

Air quality may be measured by the concentration of air pollutants in the ambient atmosphere.[102] The increased production and use of biofuels impacts air quality through changes in emissions at each stage of ethanol's lifecycle, including through its impact on agricultural land use and petroleum fuel consumption.[103] Ethanol production also emits several greenhouse gasses (GHGs), including nitrogen oxide, sulfur oxide, carbon, volatile organic compounds, ammonia, and particulate matter (PM).[104]

In order to fully understand the environmental impacts associated with ethanol production, we must consider impacts every stage of the "lifecycle" of the product.[105] First, we look at impacts to air quality at the production stage. Impacts to air quality during this stage depend largely on feedstock type, land use changes, and land management/cultivation practices.[106] At the feedstock production stage, studies have shown that life cycle fine PM emissions were higher from production of corn grain ethanol than ethanol derived from stover (leaves, stalks, and cobs).[107] During ethanol production, the most significant emissions come from production plants fueled by coal.[108] However, coal-powered production plants make up only small percentage of ethanol production plants (currently about 10%), and the number is steadily decreasing.[109]

Even when coal-powered plants are not involved, the process of growing, processing, and transporting the necessary materials has a significant environmental impact. Considering the energy-intensive nature of the agricultural activities involved (such as fertilizer production) and "upstream emissions" (emissions from feedstock extraction, transport, conversion to fuel, and then distribution of the fuel),[110] emissions of air pollutants and GHGs are considerably high for corn ethanol, even compared to gasoline.[111] Finally, at the burning/use stage, there are a number of varying impacts on air quality from the burning of ethanol and ethanol blends compared to the burning of gasoline. Because ethanol adds oxygen to fuel, use of ethanol blends result in higher emissions of nitrogen oxide compared to gasoline.[112]

---

[102] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT: SECOND TRIENNIAL REPORT TO CONGRESS 56 (2018), https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=IO&dirEntryId=341491.
[103] *Id.*
[104] *Id.* at 64.
[105] *Lifecycle Analysis of Greenhouse Gas Emissions under the Renewable Fuel Standard*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/renewable-fuel-standard-program/lifecycle-analysis-greenhouse-gas-emissions-under-renewable-fuel (last visited Feb. 10, 2020).
[106] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 64.
[107] *Id.* at 58.
[108] *Id.* at 55.
[109] *Id.* at 59.
[110] *Fuels: Assumptions & Calculations*, U.S. ENVTL. PROT. AGENCY, https://www3.epa.gov/otaq/gvg/learn-more-fuels.htm (last visited Feb. 10, 2020).
[111] S. Kent Hoekman, Amber Broch, & Xiaowei Liu, *Environmental Implications of Higher Ethanol Production and Use in the U.S.: A literature review. Part I – Impacts on water, soil, and air quality*, 1 RENEWABLE & SUSTAINABLE ENERGY R. 3140, 3151 (2018); S. Kent Hoekman & Amber Broch, *Environmental Implications of Higher Ethanol Production and Use in the U.S.: A Literature Review. Part II – Biodiversity, land use change, GHG emissions, and sustainability*, 1 RENEWABLE & SUSTAINABLE ENERGY R. 3159, 3169 (2018).
[112] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 55.

Another significant concern regarding ethanol and its implications for climate change is that mixing ethanol with gasoline perpetuates use of and reliance on fossil fuels. Biofuels are also less efficient than gasoline.[113] Research shows that biofuels, particularly from corn, have small climate benefits, while doing little to curb fuel imports.[114] Biofuels contain less energy than fossil fuels, so more must be burned to travel the same number of miles.[115] Increasing the production of an alternative fuel helps make fossil fuels cheaper, tempering the reductions in fossil fuel demand – otherwise known as the "fuel rebound effect."[116] This observation has led some researchers to conclude that America's fuel standard actually leads to a net *increase* in GHG emissions.[117]

B. Water

Producing ethanol impacts water systems both through intensive water usage and water pollution. Intensive agriculture results in runoff, releasing large amounts of sediment, nutrients, pesticides, and pathogens into U.S. waters.[118] This can have devastating effects on marine ecosystems as well as human health. Nutrient runoff contributes to eutrophication, algal growth, and hypoxia in downstream water bodies, as well as elevated nitrate pollutant levels in drinking water sources.[119] For example, in 2011, there was a record-breaking algal bloom in Lake Erie off the coast of Ohio, largely due to agricultural runoff.[120] Algal blooms consume oxygen as they die and decompose, suffocating aquatic life and leading to massive fish die-offs.[121] According to a team of University of Michigan researchers, because ethanol derived from corn uses a substantial amount of phosphate-based fertilizers that contribute to nutrient runoff, increased ethanol production coupled with declining land used for conservation in the area will exacerbate water quality issues.[122]

The intensive agriculture involved in feedstock production also has a significant impact on water usage compared to gasoline. This varies depending on where corn is grown. For example, in Ohio only 1% of the corn is irrigated while the proportion is 72% in Nebraska.[123] Water requirements of corn ethanol vary significantly among corn-growing states depending upon the amount and type of irrigation used.[124] Due to this variation, further expansion of ethanol production could lead to significant demands on irrigation and water systems in certain regions.[125] A significant amount of water is also required in the various stages of processing corn to make ethanol.[126] According to the Department of Energy, it takes an average of 76

---

[113] *See*, Jason Hill, Liaila Tajbaeva, & Stephen Polasky, *Climate Consequences of Low-Carbon Fuels: The United States Renewable Fuel Standard*, 97 ENERGY POLICY 351–353 (2016).
[114] *Id.*
[115] *Id.*
[116] *Id.*
[117] *Id.*
[118] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 65–66.
[119] *Id.* at 78.
[120] Mary Kuhlman, *Lake Erie's Toxic Algae: Does Ethanol Mandate Make it Worse?*, PUBLIC NEWS SERVICE (Oct. 26, 2017) https://www.publicnewsservice.org/2017-10-26/water/lake-eries-toxic-algae-does-ethanol-mandate-make-it-worse/a59997-1.
[121] *Nutrient Pollution*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/nutrientpollution/effects-environment (last visited Feb. 10, 2020).
[122] Jim. Erickson, *Record-Breaking 2011 Lake Erie Algae Bloom May Be Sign of Things to Come*, NOAA RESEARCH NEWS (Apr. 1, 2013), https://research.noaa.gov/article/ArtMID/587/ArticleID/1529/Record-breaking-2011-Lake-Erie-algae-bloom-may-be-sign-of-things-to-come.
[123] Renee Cho, *Ethanol's Impacts on Our Water Resources*, EARTH INST. COLUMBIA UNIV. (Mar. 21, 2011) https://blogs.ei.columbia.edu/2011/03/21/ethanol's-impacts-on-our-water-resources/.
[124] Hoekman, Broch, & Liu, *supra* note 111, at 3154.
[125] *Id.* at 3140.
[126] *Id.*

gallons of water to produce one gallon of ethanol,[127] while it takes an average of 5.6 gallons of water to produce one gallon of gasoline.[128]

Although ethanol production uses a significant amount of water and harms water quality through agricultural runoff, impacts on water use and quality by the oil and gas industry arguably have been more detrimental. Fracking and oil production are very water-intensive processes.[129] These industries have also caused environmental disasters that have devastated communities and aquatic habitats. In the case of fracking, "faulty well construction or improper handling may result in leaks and spills of fracturing fluids."[130] Resultant wastewater may then be contaminated and require treatment.[131] Just recently, the highly controversial Keystone XL pipeline burst in North Dakota.[132] According to state environmental regulators, the pipeline released about 383,000 gallons of crude oil in North Dakota, covering an estimated half-acre of wetland.[133] Offshore oil spills can be particularly devastating. On April 20, 2010, an explosion on the Deepwater Horizon, an offshore oil rig, caused approximately 134 million gallons of oil to spill into the Gulf of Mexico.[134] This was the largest offshore oil spill in U.S. history and caused ecological damage that is still present.[135] Floating oil reached barrier islands and shorelines,[136] while countless fish, bird, and marine mammals came into contact with oil by swimming through it, ingesting it, or inhaling it at the surface, resulting in the death of hundreds of thousands of animals. The spill killed as many as 102,000 birds alone, spanning across 93 species.[137]

C. Soil

Production of corn for ethanol also harms soil quality. Ethanol production contributes to soil erosion, in part by depleting soil organic matter and increasing concentrations of soil nutrients. Soil erosion negatively impacts soil quality by removing topsoil, which provides critical benefits to plant health and sequesters carbon.[138] Increases in ethanol production may lead to increased conversion of grasslands to cornfields, which, in turn, increases this type of harmful erosion and leads to the loss of soil nutrients and organic matter.[139] Shifts toward conservation tillage and no-till practices can reduce these negative impacts.[140]

---

[127] ARGONNE NAT. LABORATORY, CONSUMPTIVE WATER USE IN THE PRODUCTION OF ETHANOL AND PETROLEUM GASOLINE — 2018 UPDATE 6 (2018), https://publications.anl.gov/anlpubs/2019/01/148043.pdf.
[128] *Id.* at 9.
[129] *Oil and Petroleum Products Explained*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/oil-and-petroleum-products/oil-and-the-environment.php (last visited Dec. 11, 2019).
[130] *Id.*
[131] *Id.*
[132] Emily S. Rueb & Niraj Chokshi, *Keystone Pipeline Leaks 383,000 Gallons of Oil in North Dakota*, N.Y. TIMES (Oct. 31, 2019), https://www.nytimes.com/2019/10/31/us/keystone-pipeline-leak.html.
[133] *Id.*
[134] *Deepwater Horizon*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://darrp.noaa.gov/oil-spills/deepwater-horizon, (last visited Dec. 11, 2019).
[135] *Affected Gulf Resources*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.gulfspillrestoration.noaa.gov/affected-gulf-resources/ (last visited Dec. 11, 2019).
[136] *Id.*
[137] Nanciann Regalado, *Deepwater Horizon Oil Spill Killed as Many as 102,000 Birds Across 93 Species*, U.S. FISH & WILDLIFE SERV. (Jun. 1, 2016), https://www.fws.gov/southeast/news/2016/06/deepwater-horizon-oil-spill-killed-as-many-as-102000-birds-across-93-species/.
[138] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 93.
[139] *Id.* at 97.
[140] *Id.* at 94–95.

D. Biodiversity and Habitat Loss

Conversion of environmentally-sensitive land to grow corn for ethanol also negatively affects ecosystem health and biodiversity through conversion of natural habitats.[141] Biodiversity is also negatively impacted by increasing pesticide use, which harms pollinators, birds, and soil-dwelling organisms. Aquatic biodiversity is also negatively impacted by pesticide and nutrient runoff.

A 2017 study found that approximately 2 million acres of grassland, 60,000 acres of forests, 52,000 acres of shrublands, and 14,000 acres of wetlands were converted to row crops for biofuel production[142] between 2008 and 2012.[143] Conversion of natural landscapes such as forests and prairie pothole lands into cornfields for ethanol production destroy wildlife habitat, thus reducing biodiversity and decreasing resilience and valuable ecosystem services like carbon sequestration and flood mitigation.[144] Ethanol demand is destroying North America's Prairie Pothole region across Iowa, Minnesota, North Dakota, and South Dakota.[145] These shallow wetlands are home to millions of waterfowl and migratory birds.[146] "[Approximately] seventy five percent of all North American waterfowl use the region for breeding and nesting."[147] A study by the National Wildlife Federation concluded that species loss in these areas have been as high as thirty percent across several bird species.[148] Land conversion also decreases flora biodiversity, which in turn negatively impacts fauna.[149]

Pesticide use also drives biodiversity loss associated with ethanol production. Scientists believe that increased ethanol production were a driving factor in the decline of wild bee populations, which decreased by almost a quarter between 2008 and 2013.[150] Between land conversion and increased pesticide use, ethanol has been devastating for the United States' pollinators and other non-target organisms.[151]

Because corn production requires substantial levels of fertilizer, ethanol production leads to nutrient loading into streams, rivers, and lakes, adding to high levels of impairment due to eutrophication, causing harmful algal blooms and hypoxia. Nutrient and pesticide runoff leads to fatalities in fish, aquatic phase amphibians, and aquatic invertebrates.[152]

The impact of ethanol production on biodiversity is so significant that in 2019, the D.C. Circuit Court ruled that the 2018 EPA rule under the CAA Renewable Fuel Program that established targets for renewable fuel (including corn-based ethanol) violated the Endangered Species Act (ESA).[153] The ESA requires federal agencies to "insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any [listed] species or result in the destruction or adverse

---

[141] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 84–92.
[142] The study used proximity to a biorefinery plant (50 miles) as a proxy for estimated land converted for biofuel production. *Id.* at 22, 85.
[143] *Id.* at 85.
[144] *Id.* at 91–92.
[145] Scott Streater, *Ethanol-Fueled Corn Boom Advances Conversion of Prairie Potholes*, E&E NEWS (Jan 21, 2010), https://www.eenews.net/stories/86690/print.
[146] *Id.*
[147] *Id.*
[148] *Id.*
[149] C. Ford Runge, *The Case Against More Ethanol: It's Simply Bad for Environment*, YALE ENV'T 360 (May 25, 2016) https://e360.yale.edu/features/the_case_against_ethanol_bad_for_environment; Insu Koh et al., *Modeling the Status, Trends, and Impacts of Wild Bee Abundance in the United States*, 113 PNAS 140 (2016), https://www.pnas.org/content/113/1/140.full.
[150] *See* Insu Koh, et al., *supra* note 149.
[151] U.S. ENVTL. PROT. AGENCY, BIOFUELS AND THE ENVIRONMENT, *supra* note 102, at 88.
[152] *Id.* at 90.
[153] *See* Am. Fuel & Petrochemical Manufacturers v. Envtl. Prot. Agency, 937 F.3d 559 (D.C. Cir. 2019).

modification" of designated critical habitat by adhering to the consultation process."[154] Unless an agency determines that an action will not affect these species and habitat, the agency must consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.[155] The Court held that the EPA failed to establish that the 2018 rule would not impact species and their habitat, and thus violated its consultation requirement under the ESA.[156]

E. Human Health

While ethanol has been advertised as the lung healthy alternative to gasoline,[157] it comes with its own slew of potential impacts to human health. A Stanford University study found that while E85 vehicles (those that are equipped to run fuel that is 15% gasoline and 85% ethanol) reduce atmospheric levels of carcinogens benzene and butadiene, they increase two others, formaldehyde and acetaldehyde, resulting in similar cancer rates to those for gasoline.[158] The study also found that E85 significantly increased ozone (a prime ingredient of smog) in some parts of the country, and was likely to increase annual numbers of asthma and respiratory-related hospital visits in 2020.[159]

CONCLUSION

Ethanol policy is complex and holds implications for a broad range of interest groups and constituencies. The initial halo around ethanol as an environmentally preferable alternative to petroleum gasoline has come under increased scrutiny as researchers examine its environmental impacts across the life cycle. Given the substantial investments producers have made in joining the industry, however, it may be difficult to reverse course despite the negative externalities and the distorting impact on the agricultural economy.

[154] 16 U.S.C. § 1536(a)(2).
[155] Am. Fuel & Petrochemical Manufacturers v. Envtl. Prot. Agency, 937 F.3d 559, 591 (D.C. Cir. 2019).
[156] *Id.*
[157] *These Classic Ethanol Commercials are a Clean Air Blast from the Past*, MINN. CORN GROWERS ASS'N (Feb. 26, 2015), https://www.mncorn.org/2015/02/26/these-classic-ethanol-commercials-are-a-clean-air-blast-from-the-past/.
[158] *See*, Mark Z. Jacobson, *Effects of Ethanol (E85) versus Gasoline Vehicles on Cancer and Mortality in the United States*, 41 ENVTL. SCI. TECH. 4150 (2007).
[159] *Id.*