biofuture platform
Kickstarting a global, advanced bioeconomy
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

Policy Blueprint

Country Profile
United States

Policy Blueprint
Country Profile – United States

Adam Brown

DISCLAIMER

This document was prepared in consultation with Biofuture Platform Clean Energy Ministerial Initiative national focal points, as well as selected experts.

Considerations, opinions, conclusions and recommendations expressed in this publication do not necessarily represent a consensus among consulted experts on any given point, and do not necessarily reflect consensus views of Biofuture Initiative members.

CONTENTS

ACKNOWLEDGEMENTS

This profile is part of the analysis carried out for the Biofuture Platform Policy Blueprint project.

The report was produced by Dr Adam Brown and Andrea Rossi, members of the Biofuture Platform IEA Facilitation Team, with guidance from Paolo Frankl (IEA) and members of the Biofuture Platform Core Management Group, under the chairmanships of Renato Godinho (Brazil) and Jim Spaeth (US).

Thanks are especially due Jim Spaeth and Alicia Lindauer from US DOE and to Michael Wang at Argonne National Laboratory who provided details on US policies and provided feedback on draft versions.

Thanks also to staff at the IEA, IEA Bioenergy, IRENA and FAO/GBEP who reviewed the documents – their helpful comments have been incorporated.

SUMMARY

This report is part of the work carried out as part of the Biofuture Platform Policy Blueprint project. It should be read in conjunction with the other reports prepared under the project including similar project profiles for Netherlands and Brazil, the methodology statement and the summary report, which will be available via the Biofuture Platform website.

Use of bioenergy, and biofuels in transport in USA

- Bioenergy contributed 5.3% to final energy consumption in the USA in 2019, and 5.0% of transport energy.
- With 50% of global annual production, the USA is the world's largest producer of bioethanol (principally from corn) and is also one of the leading producers of FAME biodiesel (principally from soy oil). Most of this production is used within the USA but some 8% of production of ethanol is exported.
- Biofuels use in transport reached 1.58 EJ in 2019. Bioethanol use grew strongly between 2000 and 2017 but has plateaued recently. Biodiesel use has grown strongly since 2017, increasing by 76% over that period. Production and use of HVO and biomethane for transport have also grown significantly in recent years.

Benefits and Policy Costs

- In 2019 use of biofuels is estimated to have reduced emissions from transport by 75 $MTCO_2e$. These savings are equivalent to 47 kTCO2e for each PJ of energy.
- Biofuels provide 414,000 jobs in USA, equivalent to 345 jobs/PJ of biofuels used.
- Policy costs are estimated to be between 55 and 188 USD/GJ, which is equivalent to 55-188 USD/TCO2e.

Strategic Priority

- Following the US announcement to withdraw from the Paris Agreement in 2017 it subsequently withdrew a number of measures intended to reduce emissions, and US does not currently have federal overall GHG reduction targets nor specific targets for transport. The US has announced it will re-join the Paris Agreement and future energy policy is now expected to prioritise measures addressing climate change including in the transport sector.
- The US EIA reference scenario shows biofuels use growing by some 7% by 2022 but then remaining substantially stable throughout the period, growing by only 8% by 2050.
- The IEA Sustainable Development Scenario shows the need for much stronger growth – from 1.5 EJ in 2019 to 4.0 EJ in 2030. Current rate of growth in biofuels use would need to grow 9-fold to reach these levels.

Policy clarity and certainty

- The Renewable Fuel Standard (RFS) has provided long term policy certainty that has successfully stimulated investment in bioethanol and biodiesel production in the past 15 years. The RFS and state initiatives such as the Californian Low Carbon Fuel Standard (LCFS) are strongly stimulating development of increased biofuels use and production capacity especially for Renewable Diesel[i] and Renewable Natural Gas (RNG)[ii]. There are uncertainties around future levels of the RFS and its future post 2022.

Market access

- The RFS promoted market access for ethanol and biodiesel. The maximum level of corn ethanol has now been reached and other gasoline substitutes are not so far being produced in significant quantities.
- The standard ethanol blend in the USA is E10 and recently, the EPA has also authorised the sale of E15 nationwide. E85 has been available for a long time, while sales volume has been limited. B20 is the most commonly available biodiesel blend. Renewable diesel (using HVO or HEFA fuels) can also be used at levels up to 100%.

[i] Often called HVO or HEFA.
[ii] Often called biomethane.

Financial support or incentives

- Support for biofuels production and use is provided by the award of certificates for qualifying biofuels through the RFS and other Federal mechanisms including the biodiesel blending credit. Biodiesel benefits form an additional 1 USD/gallon blending credit, while ethanol does not have any direct federal financial incentives. These are supplemented by additional financial incentives provided by some US states. The levels have been sufficient to stimulate investment in biofuel production capacity and biofuel use.
- The value of the support from the RFS has a value of between 10 and 15 USD/GJ, depending on fuel type. Additional state level support increases this value significantly. For example, the Californian LCFS provides support which amounts to around 200 USD/TCO2e reduction.

Sustainability Governance

- The RFS has clear hurdles for GHG savings and incentivise to improve GHG performance, as do state-level support systems such as California's LCFS. The GHG calculation procedure includes the life cycle of biofuel production and use and provisions for emissions associated with land use change.

Support for innovation

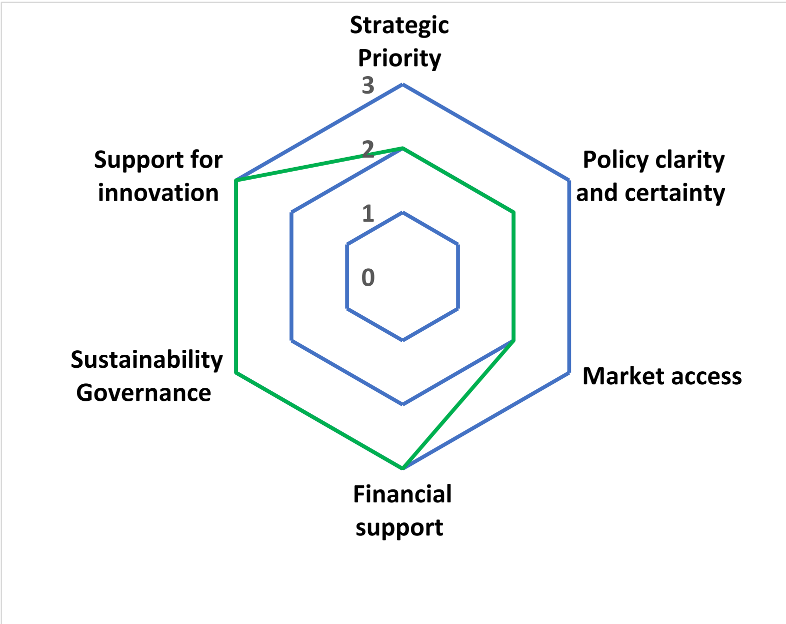
- There is a very significant R&D effort aimed at developing new biofuels and reducing costs, sponsored by the US DoE. Commercialisation of new fuels is encouraged by the banding rules within the RFS and by state initiatives such as the LCFS.

The review of policy is summarised in Table S1 Figure S1 below.

Table S1: Key Indicators

Bioenergy in energy supply %	5.3
Biofuels in transport %	5.0
PII %	12%
Jobs/PJ	345
GHG Savings kTCO2e/PJ	47
Policy support USD/GJ	2 - 10
Policy support USD/TCO2e	55 - 188

Figure S1 Summary of Policy Analysis - USA



1. INTRODUCTION

This report is part of the work carried out as part of the Biofuture Platform Policy Blueprint project. It should be read in conjunction with the other reports prepared under the project including similar project profiles for the Netherlands and Brazil, the methodology statement and the summary report, which will be made available via the Biofuture Platform website.

The profile discusses the national energy context in the USA and then discusses the trends in biofuels use in the transport sector along with the main relevant policies. It then reviews this data by calculating a number of quantitative indicators and reviews the policy portfolio against a number if qualitative benchmarks, as described in the Policy Blueprint methodology document.

2. NATIONAL CONTEXT

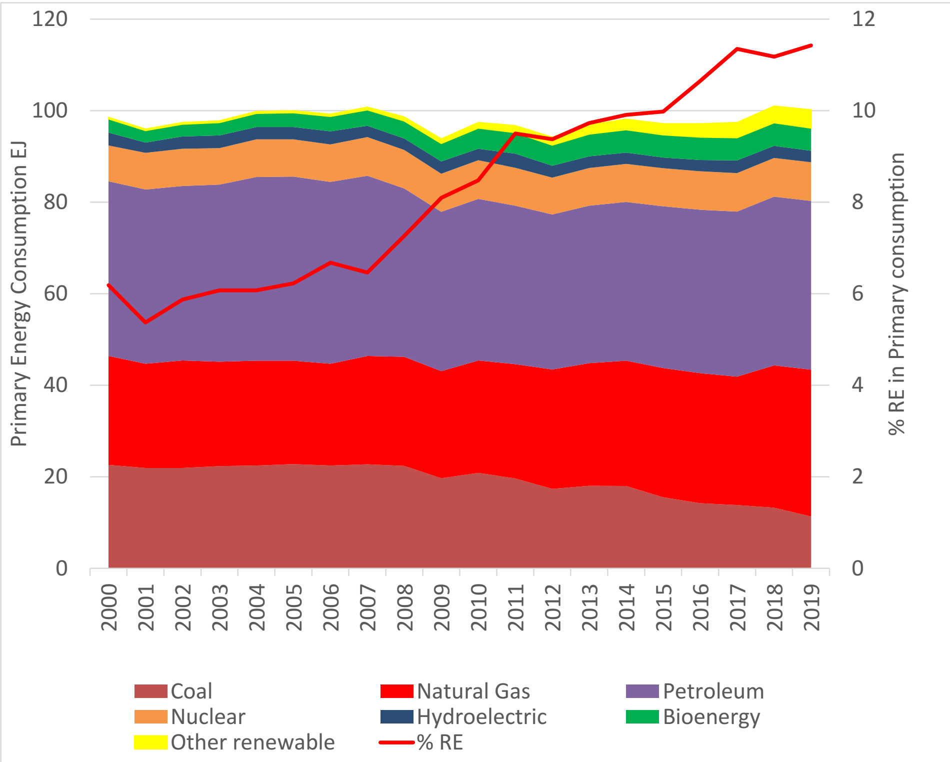
OVERALL ENERGY TRENDS

Overall energy demand in United States has been stable since 2000, rising by only 1.6% since then (Figure 1). Coal utilisation has been falling while natural gas use has grown significantly, with the development of resources within the US. During this period, the USA has become a significant exporter of petroleum products and of gas.

Renewable energy has grown during this period, from 6.4% of primary energy consumption in 2000 to 11.4% in 2019. Bioenergy is the most significant source, with its contribution rising from 3.0% in 2000 to 5.0% in 2019. Hydro has provided just over 2% during this period, with wind and solar rising from very low levels in 2000 to 2.7% and 1.7% respectively.

Renewables play an increasing role in power generation, providing some 17.5% of generation (up from 9.4% in 2000). Bioenergy has provided a stable proportion of generation since 2000 (ca. 1.5%) while wind and solar shares have been growing significantly and made up 7.4% and 1.7% of net generation respectively in 2019. Renewables – principally bioenergy - supply nearly 10% of the energy used in industry, and 5% of energy used in the residential and commercial sectors.

Figure 1 • United States – Trends in Primary Energy Supply

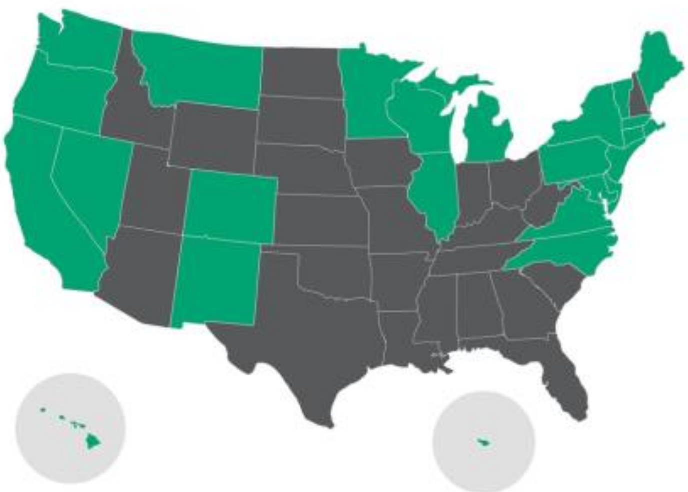


Source: US Energy Information Administration[1]

ENERGY POLICY

Priorities in the US energy policy have been shifting in recent years. Energy security was the main policy driver for many years when the country relied heavily on imported fuels. The strong growth in domestic production of oil and natural gas has made the country a net energy exporter, and policy priorities are now related to ensuring energy security based on indigenous fuels by reinforcing energy infrastructure. Current US government policy also centres on the concept of “energy dominance”, which reflects a strategy to maximise energy production, benefit from larger energy exports, be a global leader in energy technologies, keep consumer energy bills in check, and placing a heavy emphasis on innovation.[2] Following the US announcement to withdraw from the Paris Agreement in 2017 it subsequently withdrew a number of measures intended to reduce GHG emissions. These included the Clean Power Plan to cut carbon dioxide (CO2) emissions from the power sector. The US does not currently have federal GHG reduction targets. However, 24 US States (plus the territory of Puerto Rico) have adopted state level GHG targets and policies aimed at reaching them (Figure 2).[3] The US has now announced it will re-join the Paris Agreement and future energy policy is now expected to prioritise measures addressing climate change.

Figure 2 • States (in green) that have adopted state-level GHG targets



Source: IEA Bioenergy: Implementation Agendas: Comparison and Contrast in Transport Biofuels Policies, 2018-2019 Update [3]

Changes in the US energy mix – notably the switch from coal to gas for power generation – are leading to a significant decline in US GHG emissions. In fact, since mid-2000s, the U.S. has been on a downtrend of total GHG emissions.

ROLE OF BIOENERGY IN USA

- The contribution of bioenergy in USA final energy consumption has risen from 3.2% in 2000 to 5.1% in 2018 (principally due to the rise in transport biofuels prompted by the RFS) and to 5.3% in 2019 (Figure 3).

- This included:
    - 1.4% of electricity generation (0.2 EJ)
    - 9.3% of industrial heat requirements (2.6 EJ)
    - 3.2 % of residential and commercial energy needs (0.7 EJ)
    - 5.0 % of transport energy needs (1.5 EJ) mostly from bioethanol and biodiesel.

Figure 3 • Bioenergy in USA final energy consumption

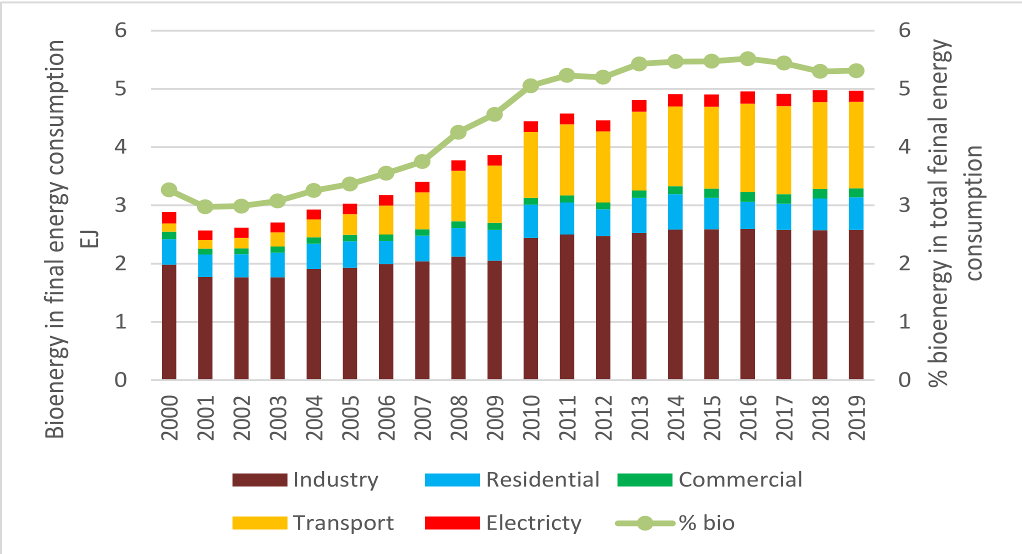
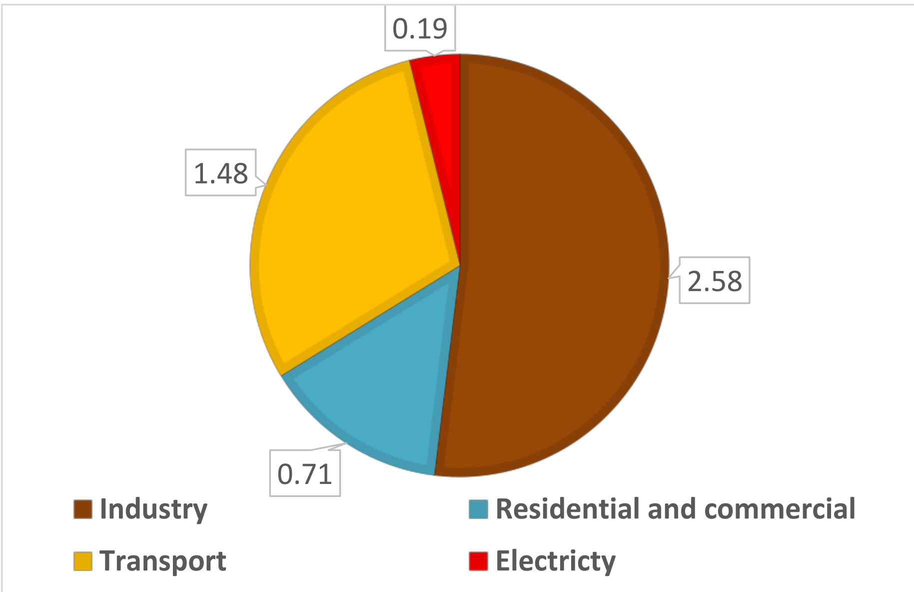


Figure 4 • Bioenergy in USA Final Energy Consumption (EJ) - 2019



3. BIOFUELS FOR TRANSPORT IN USA

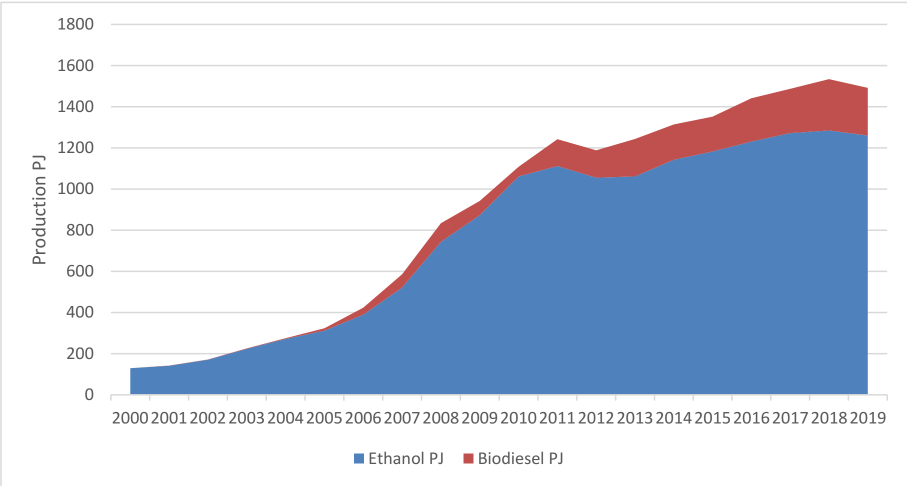
PRODUCTION OF BIOFUELS

The US is the world's largest producer of bioethanol, responsible for 50% of global production. Bioethanol production has increased 10-fold since 2000 to around 1.3 EJ (but production fell back slightly in 2019 due to policy and market factors (Figure 5).[4] Production is mostly based on corn. Ethanol is both imported and exported from USA depending on international market conditions. In 2019, there was a net export equivalent to 8% of domestic production.

The US is also one of the world's largest producers of biodiesel responsible for 14% of global production in 2019, principally from soy. Biodiesel production has also grown from a low level in 2000 reaching 0.25 EJ in 2018 (before also falling in 2019). The shares of biodiesel imported and exported to the USA market fluctuate significantly depending on market conditions and tariff levels. In 2019 net imports were equivalent to 3% of production.

Production of HVO (renewable diesel) has been growing rapidly and reached 67 PJ in 2019.[5] Plants with a capacity for a further 4 billion litres a year are reportedly under construction, some of which will be co-processed in petroleum refineries.[6] There has also been rapid growth in production of biomethane produced from municipal, agricultural and industrial wastes for transport use, estimated at 33 PJ in 2019.[7]

Figure 5 • Trends in biofuels production in USA 2010-2019

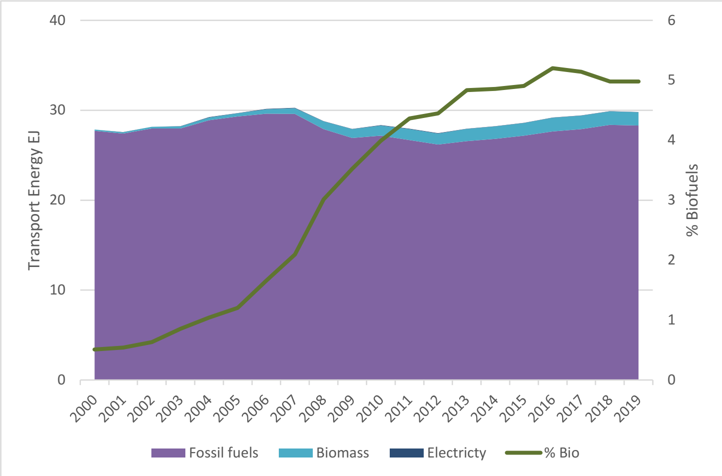


Source: Based on US EIA data

Use of transport biofuels

Overall transport energy demand in USA has grown only slowly in recent years. Gasoline is the most used fuel (53% of total in 2019) followed by diesel (22%), jet fuel (13%) and natural gas (4%, most of which is for pipeline operations). Electricity makes up only a small proportion of transport energy needs (0.1%) (Figure 6).

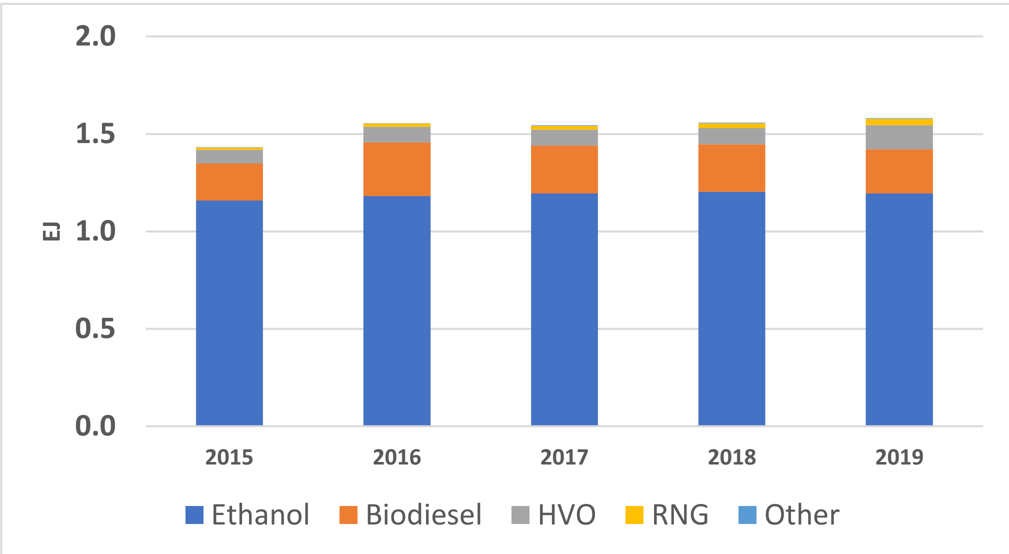
Figure 6 • Trends in transport energy use – 2000-2019



Source: Based on data in EIA Monthly Trends Table.6a

Biofuels contributed 5.0% to transport energy demand (in energy terms) in 2019. Bioethanol use rose sharply between 2000 and 2017, but then declined slightly in 2019, when it provided 1.2 EJ (Figure 7). Biodiesel use has grown by 76% since 2010, to 0.2 EJ in 2019. HVO provided some 124 PJ in 2019 and biomethane 33 PJ. Other advanced biofuels, including cellulosic ethanol, provided 4PJ.

Figure 7 • Biofuel use in USA 2015 -19



Source: Based on analysis of EPA RFS RIN data

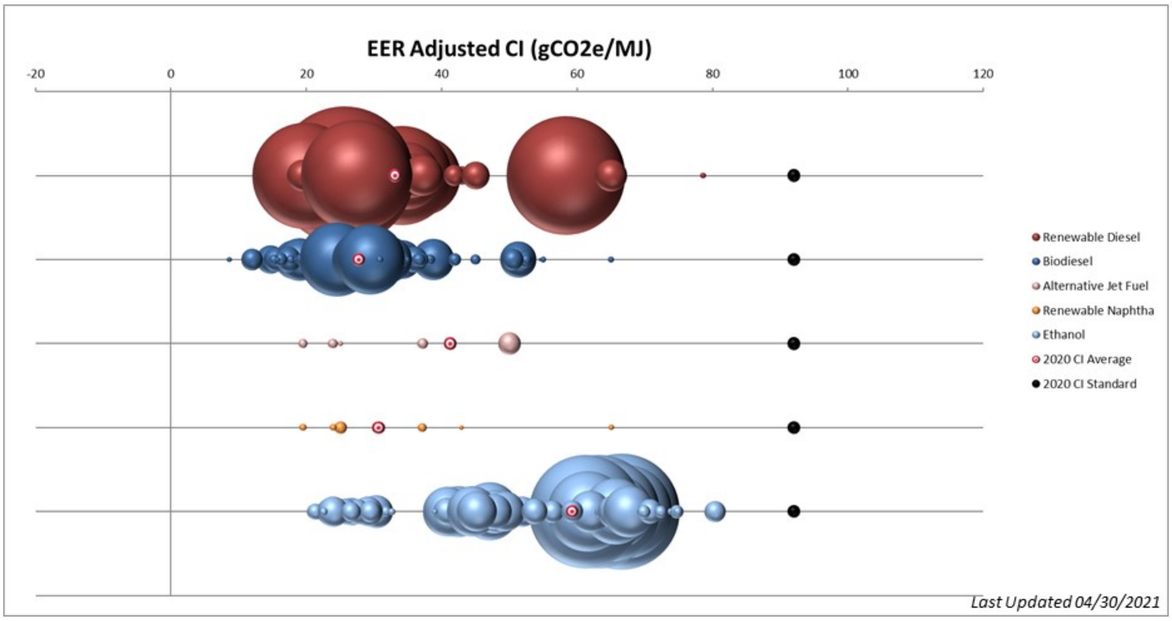
GHG reductions

There is no official overall estimate of the GHG savings produced by the use of biofuels in the USA. The EPA published a LCA analysis of the biofuels pathways during the RFS rule making, which qualified GHG reductions of biofuel production pathways for meeting RFS GHG reduction thresholds.[7] Since then, EPA added new pathways. Since the RFS is volumetric based regulation with GHG reduction thresholds, it GHG reductions by different pathways were not directly relevant to RFS.

Available data from the LCFS show a wide range of different emissions associated with the different pathways depending on feedstock and process conditions (see Figures 8 and 9). [8]

Figure 8 • GHG intensities of certified biofuel pathways in California Low Carbon Fuel Standard – Liquid Fuels (EER-energy economy ratio)

2020 Volume-weighted Average Carbon Intensity by Fuel Type for Liquid Fuels

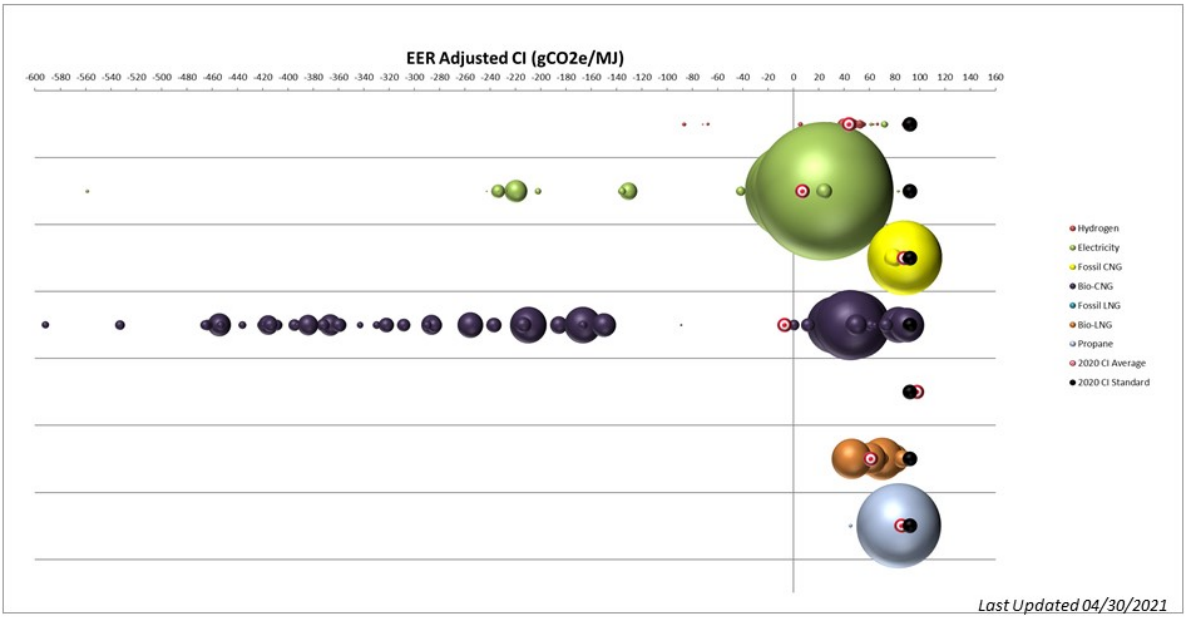


This figure provides perspective on the performance of actual quantities of fuel consumed in California.
Each sphere represents a certified fuel pathway; the size of the sphere represents the reported volume of the fuel in 2020, while its position on the horizontal axis indicates the carbon intensity of that fuel.

The alternative fuel's CI value is divided by its Energy Economy Ratio (EER) in order to obtain the EER-adjusted CI value, representing the emissions which occur from the alternative fuel per MJ of conventional fuel displaced.

Figure 9 • GHG intensities of certified biofuel pathways in California Low Carbon Fuel Standard – Non-Liquid Fuels (EER-energy economy ratio)

2020 Volume-weighted Average Carbon Intensity by Fuel Type for Non-Liquid Fuels



This figure provides perspective on the performance of actual quantities of fuel consumed in California.
Each sphere represents a certified fuel pathway; the size of the sphere represents the reported volume of the fuel in 2020, while its position on the horizontal axis indicates the carbon intensity of that fuel.

The alternative fuel's CI value is divided by its Energy Economy Ratio (EER) in order to obtain the EER-adjusted CI value, representing the emissions which occur from the alternative fuel per MJ of conventional fuel displaced.

The USDA has published a review of the overall GHG performance of US ethanol production.[9] This provides an updated calculation of the GHG performance based on a detailed LCA analysis which includes revised information in the ILUC effects associated with ethanol production and on emissions associated with feedstock production and processing. The report provides an assessment of the emissions associated with the current mix of production facilities and estimates that the average GHG emissions are some 56.65 gCO2e/MJ of fuel produced. This compares to 93.08 gCO2e/MJ for gasoline used in the US, so use of ethanol reduces emissions by some 40%.

The EPA estimates of emissions savings for the other principal biofuels used in transport in the USA include:

- 34.8 gCO_2e/MJ for FAME biodiesel
- 61.6 gCO_2e/MJ HVO,
- 80.8 gCO_2e/MJ biomethane.

On the other hand, the LCFS is based on GHG intensities of individual fuel pathways. The LCFS data has shown a clear downtrend of GHG intensity of corn ethanol between 2011 and 2019 (Rosenfeld et al., 2020). Most recently, Argonne National Laboratory has done retrospective analysis of GHG emissions of US corn ethanol between 2005 and 2019 and showed downtrend of corn ethanol GHG emissions during the period (Lee et al. 2021). This new study concluded that in 2019, with land use change emissions included, corn ethanol reduces GHG emissions by around 45% relative to petroleum gasoline. In addition, as shown in LCFS database, soy-based biodiesel results in around 65% GHG reduction relative to petroleum diesel.

These data allow calculation of a ballpark estimate of emissions savings for 2019, of around 75 $MTCO_2e$. This is equivalent to some 47$kTCO_2e/PJ$ of energy used.

Jobs

The production of biofuels is estimated to support 350,000 jobs associated with bioethanol in the USA in 2019, with a further 64,000 jobs associated with biodiesel. [10] This is therefore equivalent to 345 jobs/PJ of biofuels used.

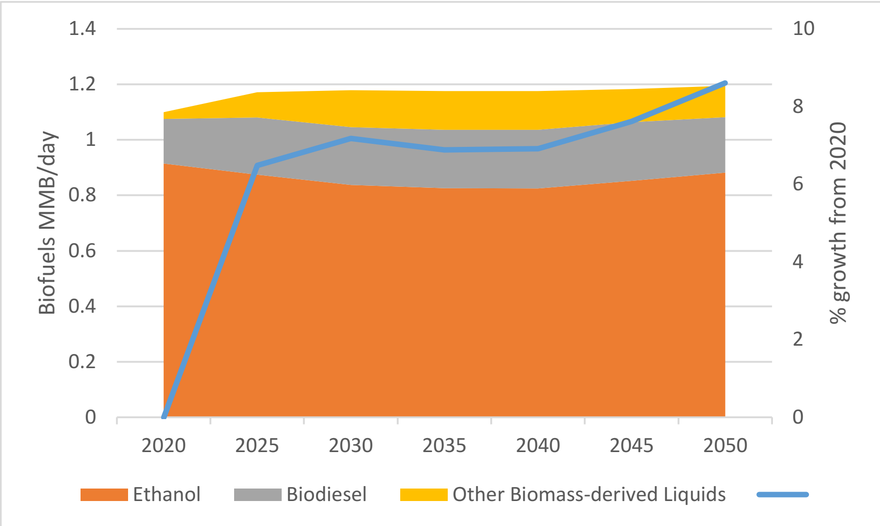
4. PRINCIPAL POLICY MEASURES

Targets and Projections

There is currently no federal greenhouse gas reduction target or strategy for increasing the contribution of biofuels to transport energy needs. future policies are expected to give higher priority to this sector.

The US EIA reference scenario indicates that the use of biofuels for transport is not expected to grow significantly between now and 2050. It shows biofuels use growing by some 7% by 2022 but then remaining substantially stable throughout the period, growing by 8% by 2050 (Figure 9).[11] Ethanol use reduces by 8% by 2030 and 3% by 2050 compared to 2020, while biodiesel grows by 29% by 2030 and 23% by 2050. Other biofuels increase by a factor of around five by 2030 and 2050. At present, there are significant activities in the U.S. to pursue RD&D of sustainable aviation fuels (SAFs) based on biomass feedstocks. SAFs may experience significant growth in the next ten years in the U.S.

Figure 10 • Growth of biofuels to 2050 – US EIA Annual Outlook, 2020, Reference case



Source: Based on data from US EIA Annual Energy Outlook, 2020, Table 11

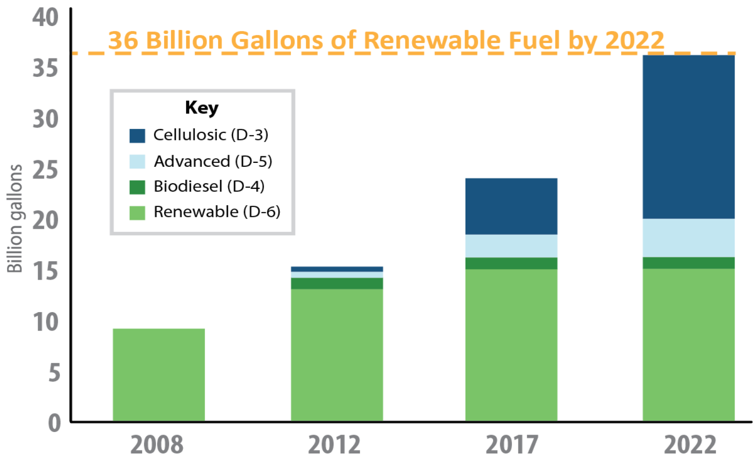
RENEWABLE FUEL STANDARD

Blending quota

The Renewable Fuel Standard (RFS) is the most significant policy measure used to drive the use of biofuels in the USA. The RFS establishes biofuel volume requirements, resulting in financial benefits of selling biofuels through the creation of tradeable certificates.

Originally introduced under the Energy Policy Act of 2005, it was subsequently amended in 2007 under the Energy Independence and Security Act, with more ambitious targets. This established an overall target of 36 billion gallons/year (136 billion litres) by 2022, with separate indicative tranches for different biofuels including cellulosic biofuels, biodiesel, advanced biofuels and renewable fuels – which includes corn-based ethanol. Each of the four biofuel categories has annual volumetric requirement. The level of renewable fuels was capped at 15 billion gallons, and the volume for the cellulosic biofuel category assumed a rapid growth in cellulosic biofuels – which was then expected to come principally from the production of ethanol and other fuels from feedstocks such as corn stover via cellulosic hydrolysis and fermentation (Figure 11).

Figure 11 • Congressional Volume Targets under the RFS



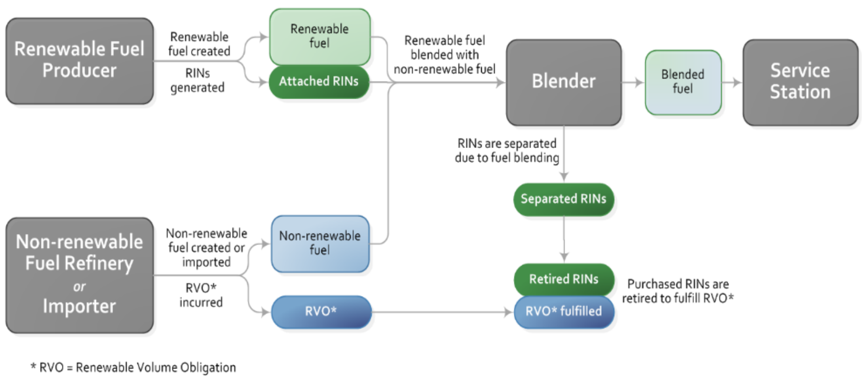
Fuels in each of these categories must be associated with specific biofuel feedstocks and must meet specific minimum GHG savings criteria (Table 1).

Table 1 • RFs Fuel Categories and GHG Criteria

Fuel Category		Process/Fuel	GHG criterion
Cellulosic biofuel	D3	Cellulosic ethanol RNG (biomethane)	≥60% compared to fossil gasoline
	D7	Cellulosic diesel	
Biomass diesel	D4	FAME biodiesel and Renewable diesel (HVO/HEFA)	≥50% compared to fossil diesel
Advanced biofuel	D5	Non-corn starch ethanol and other fuels meeting GHG criteria	≥50% compared to fossil gasoline
Renewable fuel	D6	Corn based ethanol and other qualifying renewable fuels	For plants built after 2007 ≥20% compared to fossil gasoline

Fuel distributors must achieve a mandated level of biofuels each year (the Renewable Volume Obligation) based on their market share. To demonstrate compliance, they must obtain the requisite number of Renewable Identification Numbers (RINs), generated when a biofuel producer sells a gallon of fuel through an approved pathway. These can be traded among obligated parties, as illustrated in Figure 12.

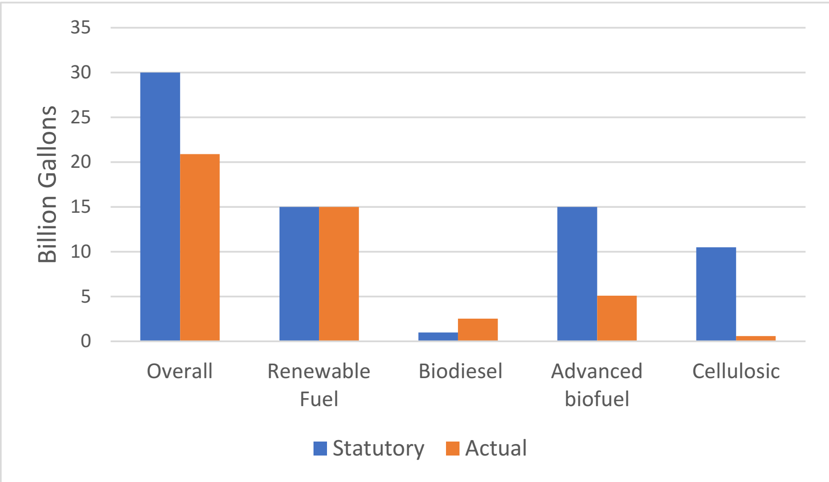
Figure 12 • Lifecycle of a RIN



The EPA has the authority to revise the "statutory" volumes annually. Figure 12 shows the official levels for 2020 compared to the statutory levels in the original act. The overall level for 2020 is much lower than originally intended, at 20.9 billion gallons compared to the originally indicated 30 billion gallons. This is principally because production capacity for cellulosic ethanol and other advanced biofuels has lagged behind expectations. Most of the fuel qualifying under this category is biomethane (renewable natural gas). The scope for biodiesel (including both FAME and Renewable Diesel) had been increased while the level for corn ethanol has been maintained. Scope for further increase is limited by the RFS law.

The impact of the RFS can also be reduced by the award of "waivers" which allow some fuel suppliers (notably smaller oil refiners) to avoid meeting their share of the RFS obligation.

Figure 13 • RFS - Comparison of Statutory and Actual Volume Requirements, 2020



The value of the RINS awarded under the RFS provide support for biofuels production and use. The value of the RINS depends on the fuel category and on the balance between supply and demand, as shown in Figures 14 and 15.

Figure 14 • Weekly RIN prices by fuel category under the RFS, 2015 - 2019

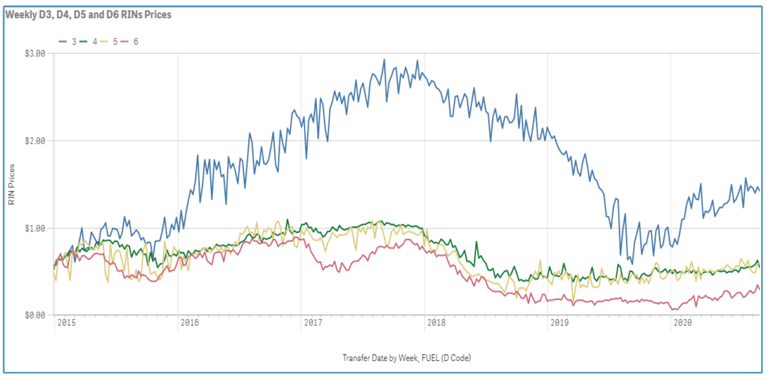
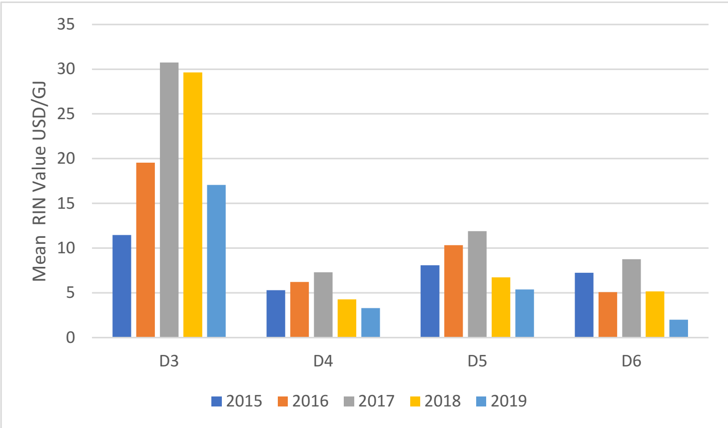


Figure 15 • Average RIN Prices per biofuel category 2015 – 2019, USD/GJ



RIN values vary significantly between the fuel categories, with an average of 5.6 USD/GJ for D6 (corn-based ethanol) for 2015 -2019 and 2.0 USD/GJ in 2019. For D4 (FAME) fuels the equivalent numbers are 5.4 SD/GJ and 3 USD/GJ. These rise to 21.7 USD/GJ and 17.7 for D3 fuels (principally biomethane).

Biodiesel producers also benefit from a tax credit equivalent to USD 1 for each gallon of biodiesel blended. This credit adds a further 7.3 USD/GJ to the RFS monetary values for these fuels. Average support levels for the main fuels in the market in 2019 were therefore 2.0 USD/GJ for ethanol and 10.3 for FAME biodiesel.

Complementary State Based Mechanisms

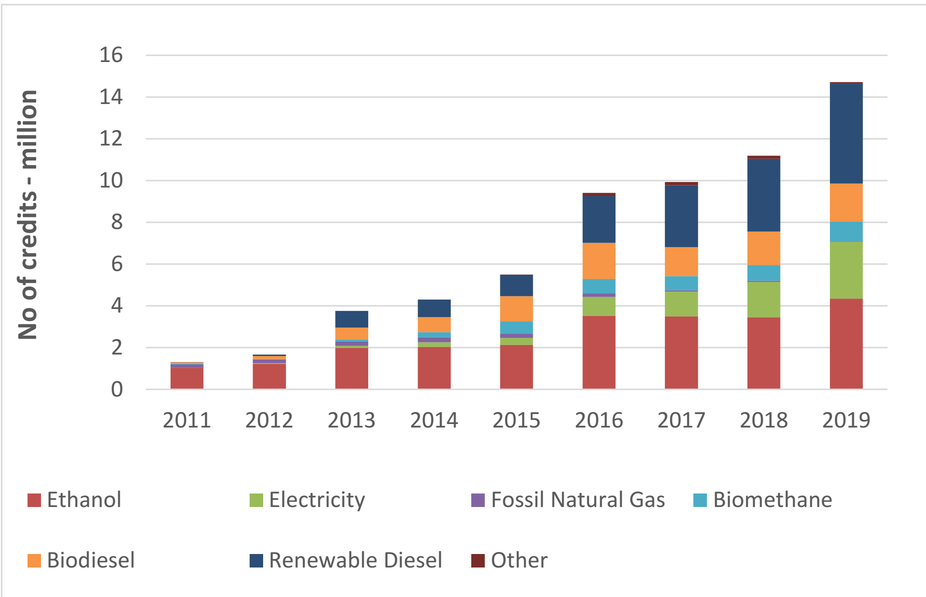
The RFS is complemented by a number of state-level specific programmes, notably the Low Carbon Fuel Standard Programme (LCFS) in California, which is also being adopted in Oregon.

The LCFS was initiated in 2007 and took effect in 2011. Its initial objective was to reduce emissions from transport by at least 10% by 2020 from the 2010 baseline, through the use of low carbon fuels including biofuels, but also LPG, CNG and electricity. The objective has been extended to a 20% reduction by 2030.

Under the LCFS, a target carbon intensity (CI, carbon emissions here actually include GHG emissions), established by life-cycle analysis for gasoline and diesel fuels, is determined for each year, which declines in line with the longer-term targets. Fuels which have a CI above this figure generate deficits while those with lower CI's generate credits. Regulated parties must balance deficits and credits in order to comply with the regulation.

In the early years, credits came mostly from the use of ethanol and fossil natural gas, but in 2019 renewable diesel was a significant source of credits (32%), while electricity (19%), biodiesel (13%) and biomethane (6%) also played important roles (Figure 16).[12]

Figure 16 • California LCFS – Credits by fuels type 2011 -2019



Source: analysis of data in Low Carbon Fuel Standard Reporting Tool Quarterly Summaries

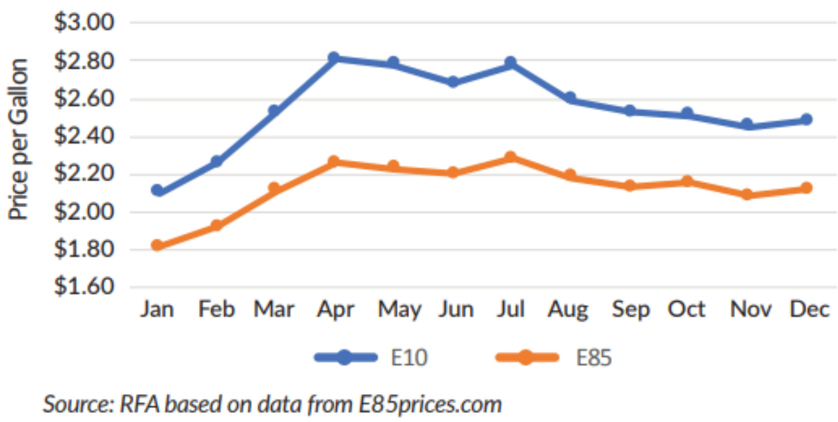
The value of the LCFS credits has been increasing as the targets tighten, with the average credit value of USD 192 ton of CO_2e reduced by fuels in 2019.[13]

Blending regulations

Biofuel blending levels must be authorised by the EPA. The standard ethanol blend in the USA was E10 until 2020. Recently, the EPA has authorised the year-round sale of E15, which can be used in an estimated 95% of gasoline fuelled vehicles. E15, which was previously only sold as a winter fuel, is available nationwide[14] E85, which is used in flex-fuel vehicles, is available in nearly 5000 service stations. In 2019, E85 sales amounted to 425 million gallons (1.6 billion litres). E85 are offered at a significant price discount compared to E10 gasoline (Figure 17).

Biodiesel can be blended at any level up to B100. B20 is the most commonly available blend. Renewable diesel (using HVO or HEFA fuels) can also be used at levels up to 100%.[15]

Figure 17 • National Average Retail Prices for E10 and E85



Source: RFA based in data from E85prices.com

Sustainability governance

The RFS sets minimum GHG reduction levels (compared to fossil gasoline and diesel fuels) of 20% for "renewable fuels" and 50 – 60% for other categories, so providing an incentive for improving GHG performance. The calculation procedure includes life cycle of a fuel and provision for emissions associated with land use change.

The LCFS provides a specific incentive for fuels which lead to higher GHG savings and an incentive to improve biofuel GHG performance.

Support for innovation

There is a very significant RD&D effort supported by the U.S. Department of Energy's Bioenergy Technologies Office (BETO) with an annual budget averaging around USD 250 million in recent years.[16] This programme works with key public and private stakeholders to develop technologies for producing cost-competitive advanced biofuels from non-food biomass resources, including cellulosic biomass, algae, and wastes (e.g., biosolids). It aims to promote national energy security by developing domestic sources of energy, grow a sustainable future with renewable biomass resources, generate green jobs by stimulating the U.S. bioenergy economy and to lead global technology innovation.[17]

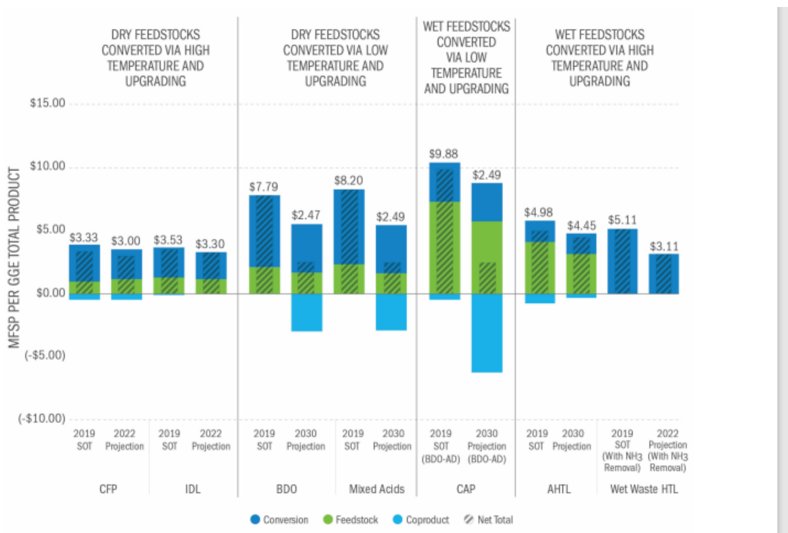
BETO funds research and development (R&D) on technologies necessary for the deployment and production of cost-competitive bioenergy, primarily biofuels. A recent State of Technology Report provides an update on the status of those R&D

efforts at the end of 2019, and assesses progress made towards BETO goals.[18] The report also discusses technical challenges and barriers facing the industry.

The report identifies a number of example development pathways and assesses progress toward achieving BETO goals (Figure 17). These include:

- By 2022, verify integrated systems research for hydrocarbon biofuel technologies that achieve a mature modelled minimum fuel selling price (MFSP) of $3/GGE with a minimum 60% reduction in GHG emissions relative to currently predominant fossil fuels.
- By 2030, verify integrated systems research for hydrocarbon biofuel technologies that achieve a mature modelled MFSP of $2.5/GGE with a minimum 60% reduction in GHG emissions relative to currently predominant fossil fuels.

Figure 18 • State of technology and goal year projection for illustrative pathways



In addition, US Department of Energy can provide financing to projects backed by loan guarantees to enable the financing and construction of large-scale plants involving innovative technologies, and in the past these have been used to finance new technologies such as cellulosic ethanol production.[19]The US Department of Agriculture (USDA) provides loan guarantees to assist in the development of advanced biofuels, renewable chemicals, and biobased products manufacturing facilities, through the Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (BAP), also known as the Section 9003

Program. This programme provides loan guarantees for up to 80% of the total eligible project costs up to $250 million.

The RFS and state-based initiatives such as the LCFS provide additional financial incentive for fuels with improved GHG performance. Advanced biofuel producers may also be eligible for financial support from USDA for each unit of biofuels produced, under the Advanced Biofuels Payment Program, or when they invest in plant designed to replace fossil fuels used to generate heat or power in eligible biorefinery plants under the Repowering Assistance Payments to Eligible Biorefineries programme.[20]

Policy development and review

The EPA keeps the RFS policy under review, adjusting the required fuel volumes in the RFS in line with the ability to supply and blend them.

5. USA POLICY REVIEW

DEPLOYMENT INDICATORS

Table 2 below shows the US situation in terms of the indicators identified above.

Table 2 • Deployment Indicators - US

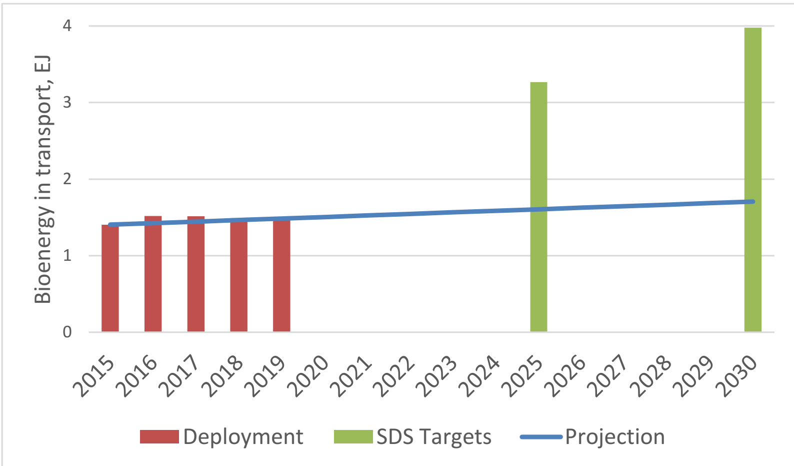
Current deployment	
% bioenergy in final energy consumption	5.3%
% bioenergy in transport:	5.0%
Growth of bioenergy in transport vs SDS projections for 2025 and 2030:	
Biofuels in transport 2019	1.5 EJ
Rate of growth 2015/2019	0.02 EJ/y
SDS Biofuels in transport 2030:	4.0 EJ
Rate of growth needed to 2030	0.17 EJ/y
PII 2030[iii]	12%
Jobs	
Jobs/PJ	345
GHG Savings kTCO2e/PJ	
Biofuels in Transport PJ	1582
GHG Savings 2019 $MTCO_2e$	75
GHG Savings $kTCO_2e/PJ$	Mean: 47 Ethanol: 42 FAME:63 HVO: 63 Biomethane: 81
Financial Support	
Financial Support 2019, USD/GJ	Corn based ethanol: 2.0 FAME biodiesel: 10.3
Financial support 2019, USD/TCO_2e	Corn based ethanol: 47 FAME biodiesel: 163
Additional support in California LCFS (2019) USD/TCO_2e	200

[iii] PII – Policy Impact Indicator. Compares the rate of increase of deployment between 2015 and 2019 with that needed to meet the level of bioenergy in transport in IEA's Sustainable Development Scenario (SDS).

While current policies, especially the RFS, have increased the contribution of biofuels to 5% of transport energy needs, deployment has now slowed. Deployment will have to accelerate dramatically (9-fold) to bring use of biofuels close to the levels within the SDS for 2025 or 2030 as shown in Figure 18. The Policy Impact Indicator (PII) is thus around 12%.

It is unlikely that future deployment will be in line with the IEA SDS projections unless some additional policy measures are taken at federal level.

Figure 19 • Trends in bioenergy deployment and SDS projections



POLICY ANALYSIS

Strategic Priority

There are no specific targets for biofuels for transport. In the US EIA Reference Scenario, biofuels do not grow significantly in future energy projections, increasing by some 7 % by 2025 and 2030, whereas they grow by a factor of two by 2025 and 2.6% by 2030 in the IEA SDS.[21] On the other hand, biofuels are actively promoted via the RFS and state-based initiatives such as the LCFS, and biofuels are a priority topic within US DOE's research programme.

Policy clarity and certainty

The RFS has provided long term policy certainty that has successfully stimulated investment in bioethanol and biodiesel production. There are uncertainties around future levels of the RFS and its future post 2022 which discourage further investment. Also, the smaller refiner exemption allowed under RFS has created uncertainty in volumetric requirements on the annual basis. State initiatives such as the LCFS are stimulating deployment of new technologies to reduce biofuel GHG intensities and new fuel pathways such as renewable diesel and RNG.

Market access

The RFS has promoted market access for ethanol and biodiesel and other fuels. The maximum level of corn ethanol has now been reached and other gasoline substitutes are not so far being produced in significant quantities. The RFS is therefore no longer a strong driver for higher levels of biofuels in transport.

The standard ethanol blend in the USA was E10 and recently, the EPA has authorised the sale of E15. B20 is the most commonly available biodiesel blend, although renewable diesel (using HVO or HEFA fuels) is also available in blends containing up to 100%.

Financial support or incentives

The RFS and other mechanisms including the biodiesel blending credit have successfully stimulated investment in biofuel production capacity and biofuel use.

Sustainability Governance

The RFS has clear thresholds for GHG savings and incentivise produce biofuels in the categories with high GHG reductions, as do state-level support systems such as California's LCFS. The GHG calculation procedure includes life cycle of biofuels and provisions for emissions associated with land use change.

There are no specific regulations relating to other economic or social sustainability impacts.

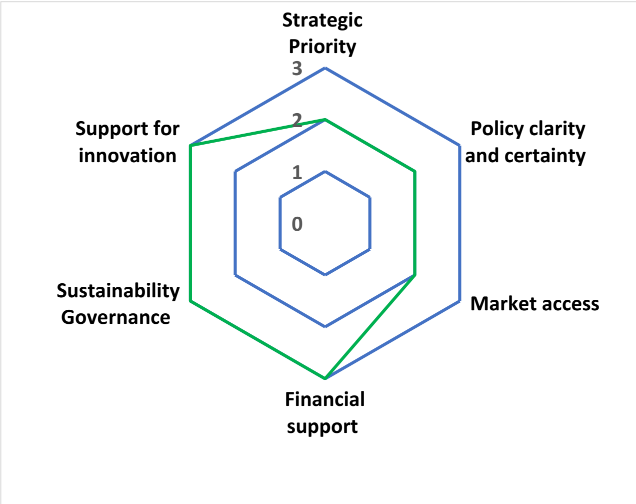
Support for innovation

There is a very significant R&D effort aimed at developing new biofuels and reducing costs, and commercialisation is encouraged by the RFS and by state initiatives such as the LCFS.

SUMMARY

This analysis is summarised in Figure 20.

Figure 20 • Summary of Policy Analysis - USA



REFERENCES

[1] US Energy Information Administration,
[2] IEA Energy Policies of IEA Countries: Unites States 2019 Review https://webstore.iea.org/energy-policies-of-iea-countries-united-states-2019-review
[3] IEA Bioenergy IEA Bioenergy: Implementation Agendas: Comparison and Contrast in Transport Biofuels Policies, 2018-2019 Update
[4] US Energy Information Administration
[5] Based on analysis of RIN data in EPA RINS Generated Transactions, https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rins-generated-transactions
[6] REN 21, Global Status Report 2020, https://www.ren21.net/gsr-2020/
[7] EPA, Lifecycle Greenhous Gas Results, Lifecycle Greenhouse Gas Results | Fuels Registration, Reporting, and Compliance Help | US EPA
[8] California Air Resources Board (CARB) Dashboard, (https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm)
[9] USDA Study Shows Significant Greenhouse Gas Benefits of Ethanol Compared with Gasoline | USDA
The greenhouse gas benefits of corn ethanol – assessing recent evidence (tandfonline.com)
[10] Renewable Fuels Association, Focussing on the Rural Economy, https://ethanolrfa.org/wp-content/uploads/2020/02/RFA_ruraleconomy.pdf ; Biodiesel, Production Statistics, https://www.biodiesel.org/production/production-statistics
[11] US Energy Information Administration, Annual Outlook 2020, Table 11, Petroleum and other Liquids, Supply and Disposition, Reference Case, https://www.eia.gov/outlooks/aeo/data/browser/#/?id=11-AEO2020&region=0-0&cases=ref2020&start=2020&end=2050&f=Q&linechart=ref2020-d112119a.3-11-AEO2020&map=ref2020-d112119a.63-2-AEO2020.1-0&sid=ref2020-d112119a.9-1-AEO2020~ref2020-d112119a.7-1-AEO2020~ref2020-d112119a.63-2-AEO2020.1-0&sourcekey=0 , viewed 22/10/20.

[12] CARB, Low carbon Low Carbon Fuel Standard Reporting Tool Quarterly Summaries, https://ww3.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm

[13] CARB, Monthly LCFS Transfer Activity Reports, September 2020 report, https://ww2.arb.ca.gov/sites/default/files/classic//fuels/lcfs/credit/September%202020%20-%20Monthly%20Credit%20Transfer%20Activity.pdf
[14] Renewable fuel Association, Focussing Beyond E10, https://ethanolrfa.org/wp-content/uploads/2020/02/RFA_beyondE10.pdf
[15] US EPA, Guidance for Biodiesel Producers and Biodiesel Blenders/Users, https://nepis.epa.gov/Exe/ZyPDF.cgi/P1001SRG.PDF?Dockey=P1001SRG.PDF
[16] Department of Energy Bioenergy Technologies Office, Key Activities. https://www.energy.gov/eere/bioenergy/key-activities
[17] Department of Energy Bioenergy Technologies Office, Key Activities. https://www.energy.gov/eere/bioenergy/key-activities

[18] US Department of Energy, Bioenergy Technologies Office, 2019 R&D, State of Technology, https://www.energy.gov/sites/prod/files/2020/07/f76/beto-2019-state-of-technology-july-2020-r1.pdf
[19] Department of Energy Loan Program Office, www.energy.gov/lpo/loan-programs-office
[20] USDA, Advanced Biofuel Payment Program Factsheet, www.rd.usda.gov/sites/default/files/fact-sheet/508_RD_RBS_AdvancedBioFuel.pdf

Electronic Code of Federal Regulations (eCFR)
[21] ES EIA Referece Scenario; IEA World Energy Outlook 2020; Annex A, US Balance