Drop the Crops

Why the UK's biofuels mandate needs reform

BY DILLON SMITH

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Executive summary

Every time a motorist refuels their vehicle, he or she is paying for the UK's biofuels mandate, the Renewable Transport Fuel Obligation (RTFO). As with fuel duty, this is buried in the per litre cost at the pump, and hence awareness among the general public tends to be low. But it amounts to a substantial sum: 6% of the total fuel bill at the pump in fact pays for biofuels blended into petrol (E10 grade) and diesel (B7 grade), as the result of a policy decision to lower carbon emissions.[1]

The RTFO has been in place for 15 years. But in its current form, it is an increasingly costly, outdated and counter-productive policy, which is in need of reform.

> **'British farmers were devoting c.35,800 hectares to biofuels as of 2020 according to the latest government estimates'**

When the UK introduced the RTFO, electric vehicles (EVs) were in their infancy. At that point, it was perfectly plausible that biofuels could be the key to decarbonising road transport. Why replace the whole vehicle when you can just replace the fuel?

But in the intervening 15 years, the technological landscape has shifted dramatically. EVs have come to dominate the zero-carbon vehicle market – to the point where the Government has committed to phase out the sale of new petrol and diesel cars and vans by 2030.[2] The only serious potential rival to EVs, at least for larger vehicles, is hydrogen – which also has zero emissions at the tailpipe.

At the same time, the drawbacks of the current biofuel mandate have become ever clearer. In the wake of the war in Ukraine and surge in inflation, there has been much discussion of the need for greater food security. Yet British farmers were devoting c.35,800 hectares to biofuels as of 2020 according to the latest government estimates.[3] The Green Alliance has calculated that 3.5 million people could be fed every year if the UK ceased to use crop-based biofuels.[4]

But there are bigger problems. Biofuels are assumed to have zero emissions when burned as an offset of the carbon absorbed during plant growth.[5] Yet they still emit CO_2 at the tailpipe like fossil fuels. For petrol vehicles, up to 10% of fuel at the pump

1 RAC, *'Petrol and diesel prices in the UK | Latest fuel price data from the RAC', retrieved 17 April 2023.* Link Note refers to unleaded petrol.

2 Department for Transport, Office for Low Emission Vehicles, Department for Business, Energy & Industrial Strategy, The Rt Hon Sir Alok Sharma KCMG MP, and The Rt Hon Grant Shapps MP, '*Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030', 18 November 2020.* Link

3 Note this figure refers to biofuels from UK grown crops sold into the UK road fuel market (and thus does not include exports), based on volumes reported under the RTFO and converted into equivalent crop areas. Department for Environment, Food & Rural Affairs, '*Area of crops grown for bioenergy in England and the UK: 2008-2020', December 2021.* Link (See Section 1: Biofuels, Table 1.1). Note 2020 figures are provisional

4 Note this refers to crops used to produce bioethanol in 2021 for the UK market, both cultivated domestically and globally. Green Alliance, *'Briefing: Food security and UK crop-based biofuel use', June 2022.* Link

5 Department for Transport, *'Renewable Transport Fuel Obligation: Compliance Guidance 2023', January 2023.* Link

is blended bioethanol, made up primarily of food crops such as corn and wheat. Their green credentials have been deeply undermined by the problem of indirect land use change. As mentioned above, crops also compete with food and feed production, a particular issue in the current era of global food insecurity. Incredibly, even amid the current crisis, Ukrainian farmers have been supplying corn to fuel British cars.[6]

The UK Government has tried to address some of these problems, by introducing a 'crop cap' which decreases over time, and additionally double-counts most biofuels sourced from wastes, to encourage their use instead. (Our biodiesel supply at this point is nearly all from waste and residues, primarily used cooking oil. Provided they are sourced sustainably, these can have much more substantial greenhouse gas savings relative to the fossil fuel they displace.)

'Even amid the current crisis, Ukrainian farmers have been supplying corn to fuel British cars'

But our Net Zero commitments, and the war in Ukraine, demand an even bolder response. Last summer, in the lead-up to the June G7 meeting, Boris Johnson committed to 'look at the UK's own demands on land and use of biofuel ahead of the G7 – globally, the use of grain for biofuel is contributing to reduced availability and increased costs for human consumption'.[7]

This paper argues that we should take advantage of our post-Brexit freedoms to phase food crops out of the RTFO entirely, as soon as possible. This would set an example for the world and put the UK in a strong position to work with our allies and partners on this issue to improve food security globally. We should also make judicious reforms to the rest of the biofuels regime to ensure wastes are sourced sustainably, while continuing to help more advanced fuels such as hydrogen to scale up.

- Chapter 1 is aimed at readers with little familiarity with biofuels and transport policy and will run through how the scheme works, where the feedstocks are sourced from and how biofuels fit in to the wider world of transport decarbonisation.

- Chapter 2 will take a more detailed look at crop-based biofuels and the host of issues that arise from their cultivation.

- Chapter 3 will look at biofuels from waste, focusing primarily on biodiesel, and discuss both the benefits of waste-based feedstocks and concerns around fraud and perverse incentives.

- Chapter 4 will discuss reforms to the RTFO as a whole, and the programme's future.

6 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', February 2023.* Link
Note 2022 data is provisional (based on data to 3 January 2023) and could change

7 Prime Minister's Office, 10 Downing Street and The Rt Hon Boris Johnson MP, *'PM pledges new support for countries on the food security frontline', 24 June 2022.* Link

Chapter 1: What is the RTFO?

The RTFO was first introduced in 2008, alongside a wave of similar policies across EU member states (formalised in the Renewable Energy Directive of 2009).[8] At the time, electric vehicles were still in their infancy, and the idea that such zero emissions vehicles would completely replace petrol and diesel for road transport was seen as a long way off.

Biofuels seemed a promising solution to the vexing issue of how to decarbonise road transport. As the thinking went, rather than replacing petrol and diesel vehicles, member states could simply substitute biofuels for fossil fuels in ever-increasing percentages.

> **'Biofuels initially seemed a promising solution to the vexing issue of how to decarbonise road transport'**

The theory was that because biofuels come from organic (usually plant) materials, the carbon absorbed by the plant while growing will offset the carbon burned at the exhaust pipe, making a significant (net) CO_2 saving. While the then current generation of vehicles could only take a certain percentage of biofuels blended in (referred to as the 'blend wall'), over time auto manufacturers would invest in appropriate engine technology, allowing the percentage of biofuels to increase and the percentage of fossil petrol/diesel to decrease.

In hindsight there were a number of issues with this narrative, even setting aside the rise of EVs. Subsequent chapters will discuss those issues in more depth, but first it is helpful to start with a refresher on how the RTFO works, and how it sits within wider transport decarbonisation policy.

How the RTFO works

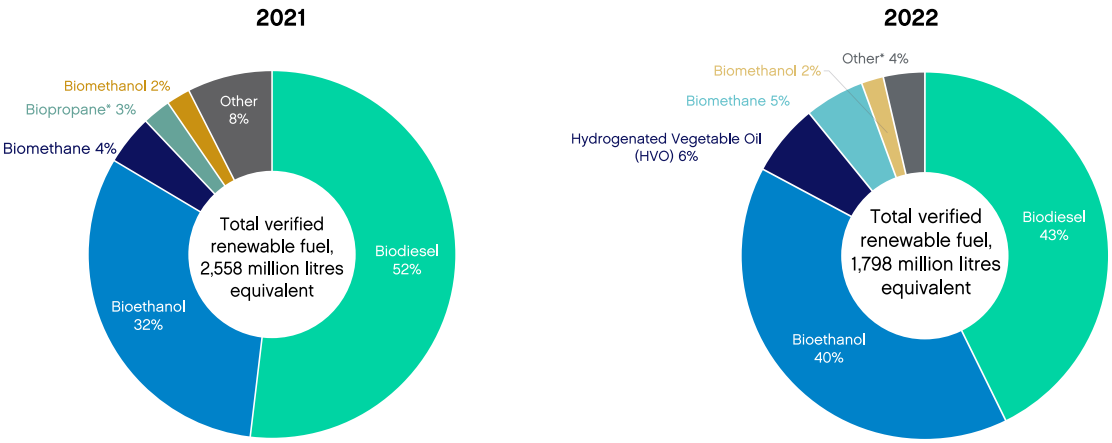
The RTFO today is set up as a mandate. Any significant supplier of transport fuel (or fuel for non-road mobile machinery) is obligated to supply a certain volume of renewable fuels, calculated as a percentage of the total fuel they supply.[9] In practice this is delivered by the redeeming of certificates for each litre (or equivalent) of renewable fuel supplied, known as Renewable Transport Fuel Certificates (RTFCs). RTFCs can be traded on an open market, and fuel suppliers have the alternative of paying a buy-out price equivalent to each litre of their obligation (currently 50p/litre), designed to set a hard ceiling on the price paid by consumers at the pump. In 2023 the obligation was set at 11.5% of total volume of fuel supplied to the UK market.

As can be seen below, biodiesel is currently the largest fuel supplied by volume, followed closely by bioethanol. The RTFO does cover a wide variety of sectors (including for example machinery used in manufacturing and construction) and individual renewable fuels, but the significant majority of the programme is still accounted for by bioethanol and biodiesel used in road transport.

8 The first Renewable Energy Directive (RED) in fact replaced the earlier 2003 EU Biofuels Directive, while prior to the RTFO the UK government used duty reductions to incentivise biofuels

9 In technical terms, any supplier of fuel for road and non-road mobile machinery (which includes manufacturing & construction machinery, rail, inland waterway vessels among others) that supplies 450,000 litres equivalent or more per year is obligated under the RTFO

Volume supplied to the RTFO by fuel type[10]

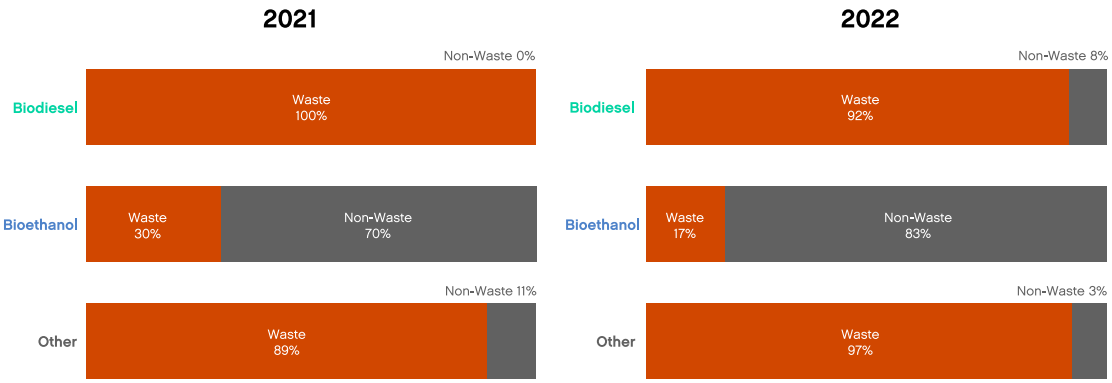


Source: Department for Transport (DfT)

Most biofuels supplied to the RTFO today come from either food crops such as wheat and corn or biological wastes such as used cooking oil. While Chapters 2 and 3 respectively will take a deep dive into the benefits and disadvantages of both types, the important thing to mention here is that the UK government has recognised the sub-optimal nature of crop-based biofuels and has put in place two counter-measures to account for this. The first is a 'crop cap' that sets a maximum level of RTFCs derived from crops that can be redeemed to meet RTFO obligations – currently c.3.5% of all fuel supplied, and set to reduce to 2% by 2032.[11] The second is the double counting of most waste-based fuels in the RTFC system, to increase the value of these feedstocks relative to crops.

This latter policy has clearly driven market behaviour – in 2021, of the 4,502 million RTFCs issued, 3,888 million were issued to double counted feedstocks.[12] As can be seen in the accompanying charts, the UK's supply of biodiesel is now almost entirely from wastes (a marked change from when the RTFO was first introduced), whereas with bioethanol the supply is still mostly from crops.

Proportion of waste vs non-waste feedstocks in the RTFO[13]



Source: DfT

10 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', and 'Renewable fuel statistics 2021: Final report', February 2023 & November 2022.* Link (2022) Link (2021). Note 2022 data is provisional (based on data to 3 January 2023) and could change

11 Note this excludes dedicated energy crops

12 Department for Transport, *'Renewable fuel statistics 2021: Final report', November 2022.* Link

13 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', and 'Renewable fuel statistics 2021: Final report', February 2023 & November 2022.* Link (2022) Link (2021). Note 2022 data is provisional (based on data to 3 January 2023) and could change

In recent years the Government has continually expanded the list of feedstocks (and fuels) eligible for RTFCs in order to boost nascent markets and technologies. While overall volumes supplied are relatively paltry compared to biodiesel and bioethanol, they may well increase over time as the markets for these products expand. The Government has also introduced a separate target for a specific set of 'development fuels', including aviation fuel (SAF), drop-in fuels (which can be blended up to 100%), substitute natural gas and hydrogen, all of which need to be produced from a subset of feedstocks to be eligible.[14] By granting them their own sub-scheme with a separate set of double-counted development RTFCs (dRTFCs) the Government hopes to further incentivise the production of these individual fuels as each of them has substantial decarbonisation potential (in the eyes of the Department for Transport). (Beyond the RTFO, the Government also has a further set of policies and strategies to incentivise the production of hydrogen and SAF.)

In 2021 the Government further increased the RTFO targets, covering the period 2022-2032. As can be seen in the table, while in 2023 the main RTFO target is set at 11.45% and the development target at 1.0%, by 2032 this is set to rise to 14.6% and 2.8% respectively. Because the scheme relies to a significant degree on double-counting of RTFCs (and dRTFCs, by definition double-counted), the actual volume of renewable fuel supplied will be significantly lower than these headline targets. And with the crop cap decreasing every year, suppliers will be forced to rely more and more on double-counted feedstocks.

RTFO obligation levels until 2032 (as a percentage of total fuel volume supplied)[15]

Year	Main obligation	Development fuels	Total obligation	Crop cap
2021	9.60%	0.50%	10.10%	3.83%
2022	11.10%	0.80%	11.90%	3.67%
2023	11.45%	1.00%	12.45%	3.50%
2024	11.80%	1.20%	13.00%	3.33%
2025	12.15%	1.40%	13.55%	3.17%
2026	12.50%	1.60%	14.10%	3.00%
2027	12.85%	1.80%	14.65%	2.83%
2028	13.20%	2.00%	15.20%	2.67%
2029	13.55%	2.20%	15.75%	2.50%
2030	13.90%	2.40%	16.30%	2.33%
2031	14.25%	2.60%	16.85%	2.17%
2032 onwards	14.60%	2.80%	17.40%	2.00%

The other main limitation is of course the blend wall ie the percentage of biofuels blended in that vehicle engines can take without causing issues. For petrol vehicles this is currently c.10% (hence E10 at the forecourt) and for diesel vehicles it is c.7% (B7).[16] Most vehicles can take these grades (as of 2011 all new cars sold in the UK were required to be E10 compatible), although in 2021, when E5 was switched to E10, the RAC that estimated up to 600,000 vehicles weren't compatible.[17]

On a technical level it is possible to blend at higher percentages (this is common in Brazil for example), but the cars have to be specially designed, with appropriate engine modifications. Some European countries have pressed ahead with this approach – in France E85 was available at c.25% of service stations as of early 2021, and automaker

14 Department for Transport, *'Renewable Transport Fuel Obligation: Compliance Guidance 2023', January 2023.* Link

15 Ibid.

16 RAC, *'What is the best fuel for my car? The definitive guide to different fuel types', 2 Mar 2022.* Link

17 RAC, *'What is E10 Fuel and how will it affect you?', August 2021.* Link

Ford has announced six new E85 compatible vehicles aimed at the French market.[18] But given the EV revolution and the anticipated phase-out of new petrol and diesel vehicles, most of the focus (and R&D budgets) of automakers has been on electric vehicles.[19] The same announcement noted that Ford offers 18 hybrid or fully electric vehicles in France, two of which are E85 compatible, and the company has pledged that it will only sell fully electric passenger vehicles in Europe by 2030.[20]

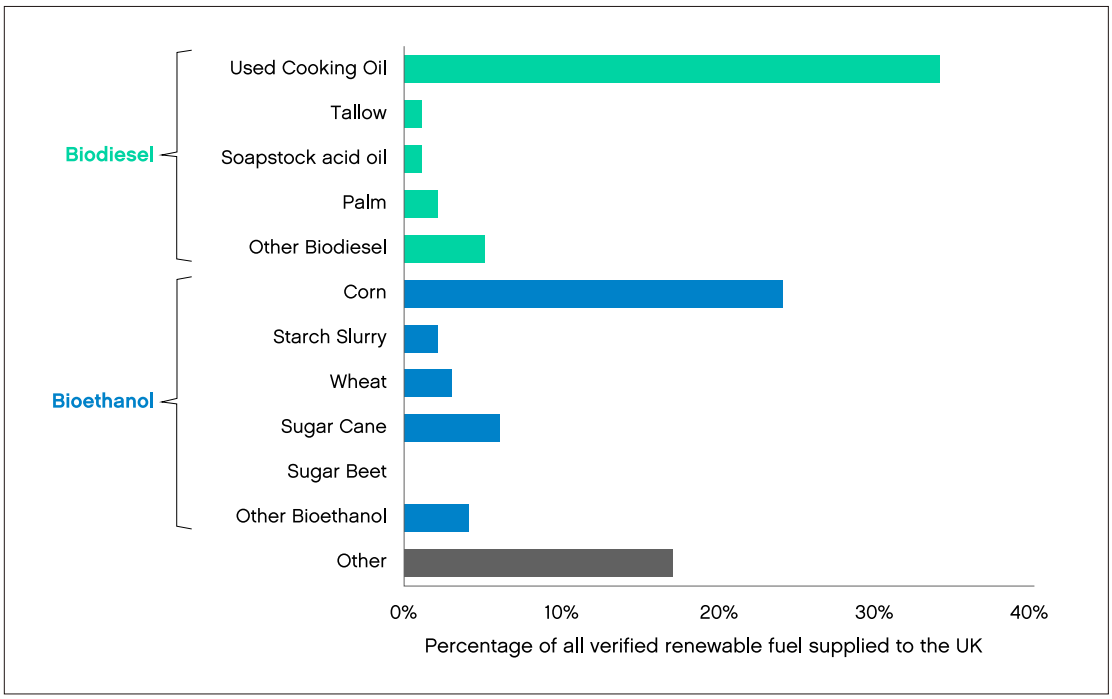
Feedstocks and sourcing

There are many potential feedstocks that can be converted into bioethanol or biodiesel. Which are selected depends on availability, cost, and of course government incentives.

For biodiesel by far the most common feedstock is Used Cooking Oil (UCO). Put simply, once the cooking and frying oil used in restaurants is finished with, it can be recycled via an industrial process into biodiesel. Similar processes occur for other waste-based biodiesel feedstocks such as soapstock acid oil contaminated with sulphur (a waste created by vegetable or animal oil processing).

The environmental logic presumes that these wastes would have been created anyway (ie fish and chip shops will always generate UCO). Hence rather than disposing of the waste, reusing it a second time is a win for sustainability. And by displacing fossil diesel that would have otherwise been burned, carbon emissions are reduced, given that the plant used to make the cooking oil absorbed carbon from the atmosphere when it grew.

Renewable fuel supply by feedstock (2022)[21]



Source: DfT

18 ePURE, *'E85 'superethanol' gets a boost in France and Finland', January 2021.* Link
Ford Motor Company, *'Ford annonce 6 nouveaux véhicules compatibles superéthanol-E85, dont 2 hybrides (English: Ford announces 6 new superethanol-E85 compatible vehicles, including 2 hybrids)', January 2021.* Link

19 BDO, *'Top 20 global carmakers spend another £71.7bn on R&D as electric vehicle rollout gathers pace', July 2021.* Link

20 Ford Motor Company, *'Ford annonce 6 nouveaux véhicules compatibles superéthanol-E85, dont 2 hybrides (English: Ford announces 6 new superethanol-E85 compatible vehicles, including 2 hybrids)', January 2021.* Link
Ford Motor Company, *'Electrification 2030', June 2021.* Link

21 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', February 2023.* Link
Note 2022 data is provisional (based on data to 3 January 2023) and could change

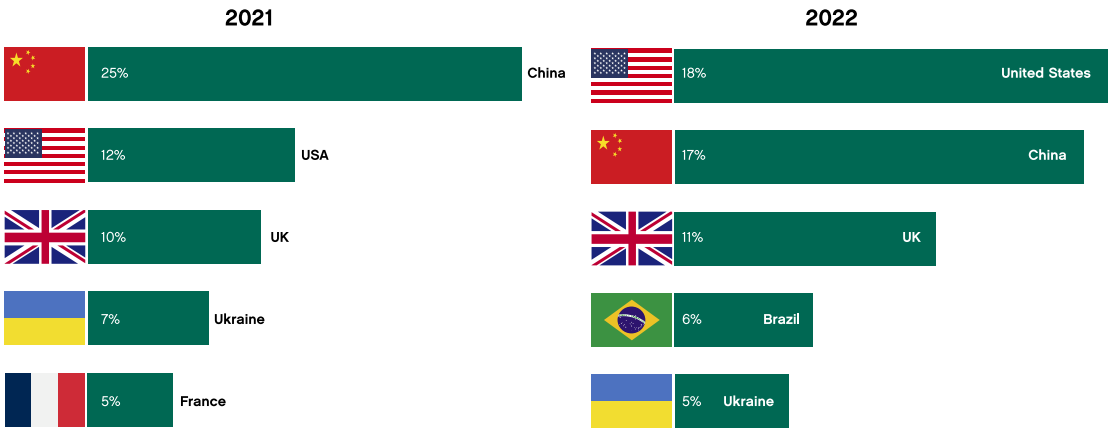
Yet while wastes are preferred, crops still play a substantial role in the RTFO. The majority of our bioethanol supply comes from food crops such as corn and wheat, while a small share of our biodiesel in 2022 came from palm trees.

The original environmental logic for crops was similar to that for wastes: as crops grow they absorb carbon from the atmosphere, and hence blending in crop-based biofuels will reduce carbon emissions by displacing fossil petrol or diesel. (As Chapter 2 will detail, this logic had some fatal flaws.) Crops are among the cheapest feedstocks to source to create bioethanol and crucially they are readily available in large quantities. While the cereal crops that are blended into ethanol are animal 'feed grade' rather than for human consumption ('milling grade'), feed wheat can be used as feedstock for flour production – Spain for example has started doing just this in response to the price rises intensified by Russia's invasion of Ukraine.[22]

One might reasonably assume that given the abundance of both farmland and fish and chip shops, the UK could provide an ample supply of both bioethanol and biodiesel feedstocks. Yet while that may have been the original intention, in 2022 a staggering 89% of feedstocks were imported from abroad (down from 90% in 2021).[23] The main source of feedstock for biodiesel is Asian countries such as China and Malaysia, while the United States and other agricultural nations supply corn and wheat for use in bioethanol. This of course includes Ukraine, which both in 2021 and 2022 was in the top five nations supplying feedstocks for the UK biofuels market – despite the country being invaded by Russia.

Although the UK does import some finished products (converted from feedstock into fuel elsewhere), the Government has worked to develop a domestic biofuels industry. Indeed, the UK now has a sizeable production capacity for both bioethanol and biodiesel, supporting thousands of UK jobs.[24]

Top 5 countries of origin for feedstocks used in the RTFO[25]



Source: DfT

22 Argus Media, *'Lack of milling wheat may turn millers to feed grade', 19 May 2022.* Link

23 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', and 'Renewable fuel statistics 2021: Final report', February 2023 & November 2022.* Link (2022) Link (2021). Note 2022 data is provisional (based on data to 3 January 2023) and could change

24 Department for Transport, *'Low carbon fuels strategy: call for ideas', February 2022.* Link, See page 44 Renewable Energy Association, *'Bioenergy strategy: Phase 1: Bioenergy in the UK – The state of play'*, October 2019. Link See page 19

25 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', and 'Renewable fuel statistics 2021: Final report', February 2023 & November 2022.* Link (2022) Link (2021). Note 2022 data is provisional (based on data to 3 January 2023) and could change

Cost to the motorist

Every time motorists pull up to the forecourt to fill up their vehicle, they are paying for the RTFO. Forecourt operators tack on the cost of the biofuels mandate as they do with fuel duty and VAT. At latest prices, biofuels make up 9.13 pence per litre of petrol and 9.86 pence per litre of diesel, c.6% of the fuel bill, as shown below.

Of course, even if the biofuels mandate was eliminated overnight, the existing bio-content would need to be replaced by additional petrol or diesel, meaning much of this cost would not be eliminated. However, biofuels have a lower energy density compared to their fossil fuel equivalents, delivering less energy (miles driven) for the same volume.[26] Coupled with higher wholesale prices for biofuels, motorists are paying a premium at the pump every time they fill up.[27] Indeed in 2021 the Government estimated that raising the main RTFO targets (by 5 percentage points) would result in an additional cost to motorists of 0.5 pence per litre (including VAT) in 2022, rising to 1.6 pence by 2032.[28] It is striking that in the discourse around the cost living crisis, the RTFO has barely had a mention. This is likely due to the fact that the cost is buried in the per litre price of petrol or diesel, and hence public awareness of the biofuels mandate is quite low.

Breakdown of petrol and diesel prices at the pump[29]

	Petrol (pence per litre)	%	Diesel (pence per litre)	%
Wholesale petrol / diesel	54.23	37%	48.24	30%
Biofuel content – E10 / B7	9.13	6%	9.86	6%
Delivery & oil company	1.70	1%	2.10	1%
Retailer margin	4.51	3%	21.34	13%
Fuel duty	52.95	36%	52.95	33%
VAT @ 20%	24.50	17%	26.90	17%
Retail price	**147.02**		**161.38**	

Source: RAC

The RTFO in context: the EV revolution

In the 15 years since the RTFO was introduced, electric vehicles have leapfrogged biofuels as the primary method of decarbonising road transport, at least for light vehicles such as cars and vans. They emit no CO_2 at the tailpipe, and over their lifecycle EVs are significantly lower emission than petrol or diesel vehicles, with or without biofuels.[30] As more renewable electricity generation capacity comes onstream and battery production technology improves, EVs will come ever closer to being truly 'zero-emission' over their lifecycle.[31]

26 Transport & Environment, *'Billions wasted on biofuels: Biofuels are a harmful and expensive distraction to road transport decarbonisation', June 2022.* Link

27 Note that other factors also play into the cost to motorists such as the cost of blending and taxation. For wholesale prices see RAC, *'Price of bio fuel v fossil fuel',* Link

28 Department for Transport, *'Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response: Annex A: Cost benefit analysis', June 2021.* Link

29 RAC, *'Petrol and diesel prices in the UK | Latest fuel price data from the RAC', retrieved 17 April 2023.* Link
Note refers to unleaded petrol.

30 International Council on Clean Transportation, *'European Union CO_2 standards for new passenger cars and vans: Life-cycle greenhouse gas emissions', July 2021.* Link
See also International Council on Clean Transportation, *'A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars', July 2021.* Link

31 Transport & Environment, *How clean are electric cars?', April 2020.* Link

While sticker prices for EVs are still higher than ICEs, overall running costs tend to be lower, and the upfront cost will likely continue to come down over time.[32] Analysis from BloombergNEF suggests that battery electric cars will reach cost parity with their traditional counterparts in every light vehicle segment across Europe by 2025-7.[33]

The commercialisation and roll-out of hybrids and battery EVs has proceeded at a remarkably quick pace. In 2016 the UK had only c.31,000 battery electric cars on its roads – just five years later the figure was nearly 400,000, and in 2022 c.664,000.[34] Add in the c.450,000 plug-in hybrids and there are more than one million plug-in cars on the UK's roads.[35] In 2022, some 23% of new car registrations were for fully electric or plug-in hybrid vehicles, up from c.11% in 2020.[36]

> **'In 2022, some 23% of new car registrations were for fully electric or plug-in hybrid vehicles, up from c.11% in 2020'**

This take-up has admittedly been greatly helped by generous government policies such as the plug-in car grant (now ended), low benefit-in-kind (BIK) rates for EVs compared to ICEs, and home charging schemes such as the EV chargepoint grant (formerly the Electric Vehicle Homecharge Scheme).[37] However, the target is for their market share to increase still further – by 2030, the sale of new petrol or diesel vehicles will be banned, which will be extended to hybrids in 2035. The Government is introducing a Zero Emissions Vehicle mandate in 2024 in order to further encourage this trend.[38]

There are of course limitations on increasing EV sales, not least the lack of public charging infrastructure. While many EV users charge at home overnight or at their workplace, for many urban users this is not an option – and of course during longer journeys public chargepoints are important.

Infrastructure has been rolling out – as of March 2023 there were c.40,000 individual chargepoints across c.24,000 charging locations UK-wide, up 35% from a year ago.[39] Workplace charging plays an underappreciated role as well, with a recent study concluding that the number of workplace sockets is comparable in magnitude to the public charging network.[40] While the current network is likely sufficient to support the number of EVs currently on the road, the number of chargers will need to increase substantially over the coming decade to support our uptake ambitions.[41] The Government's independent statutory advisor, the Climate Change Committee (CCC), has estimated that by 2030 around 280,000 chargepoints will be required in its Balanced Pathway – implying on average adding 35,000 per year, nearly double the UK's current endowment.[42] The Government's EV infrastructure

32 BuyACar, '*Cost of running an electric car', October 2022.* Link

33 BloombergNEF, '*Hitting the EV Inflection Point: Electric vehicle price parity and phasing out combustion vehicle sales in Europe', May 2021.* Link

34 Zap-Map, *'Electric vehicle market statistics 2023',* Link Chart: Cumulative number of battery-electric cars in the UK (2016 to date)

35 Ibid. Chart: Cumulative number of plug-in cars registered in the UK (2016 to date)

36 Ibid. Chart: Annual market share – plug-in market share of new car registrations (2016 to date). Note these figures exclude Mild Hybrid Electric Vehicles and Hybrid Electric Vehicles (those that have a battery but do not charge it externally). See Society of Motor Manufacturers and Traders data here

37 Office for Zero Emission Vehicles, '*Grant schemes for electric vehicle charging infrastructure', August 2022.* Link

38 Department for Transport, *'Policy design features for the car and van zero emission vehicle (ZEV) mandate', April 2022.* Link

39 Zap-Map, *'EV Charging Statistics 2023',* Link

40 Transport & Environment and Cenex, '*Project Report: A review of the UK's workplace EV charging sector', February 2022.* Link

41 Transport & Environment, '*Delivering a world-class charging network by 2030', June 2022.* Link

42 Climate Change Committee, *'Sixth Carbon Budget: Methodology Report', December 2020.* Link See Chapter 2, Table 2.3

strategy set a target of 300,000 public chargepoints by 2030 as a minimum, although it speculates that 'there could potentially be more than double that number'.[43] However Mike Hawes, chief executive of the Society of Motor Manufacturers and Traders, has warned that installation of public charge points is not increasing fast enough to hit this target, telling the BBC that 'the danger is the user experience gets worse before it gets better'.[44]

> **'The Government's EV infrastructure strategy set a target of 300,000 public chargepoints by 2030 as a minimum, although it speculates that 'there could potentially be more than double that number'**

There are also regional imbalances to consider. At the moment, London has the lion's share of public chargers, since the city's density and the high take-up rate of EVs make it an attractive market for chargepoint operators (CPOs).[45] In smaller towns and more rural areas, chargepoints are few and far between, making EV ownership a much more difficult proposition. The EV infrastructure strategy notes that 'the business case for commercial deployment can be challenging – this can be particularly true in areas of potentially low utilisation or high connection costs', leading to a chicken and egg problem between potential EV purchasers and CPOs.[46] Some still see a role for hydrogen fuel cells as an alternative to traditional combustion engines. But it is very clear that both the Government and the market see the decarbonisation of transport being driven by the steady abandonment of petrol and diesel fuels, not by their gradual replacement by biofuels.[47]

The RTFO in context: decarbonising transportation across the economy

Of course, the decarbonisation of transport is not just about cars. True, cars and vans make up more than 90% of the UK vehicle fleet, while HGVs and buses represent less than 2% as of September 2022.[48] However the latter made up close to a third of demand for diesel on the roads in 2021, in particular by HGVs.[49] The CPS has written previously about the potential of hydrogen power in heavier vehicles, in its report 'Driving Change', although electrification may well play a role as well.

In recognition of this more uncertain landscape, the UK has pledged that all new HGVs of 26 tonnes and under will need to be zero emission by 2035. For those over 26 tonnes it will be 2040.[50] Many in the industry see biofuels as an interim solution, both in higher blend percentages above the standard B7 and through the use of other fuels such as biomethane.[51] John Lewis for example has replaced many of its heavy diesel vehicles

43 HM Government, '*Taking charge: the electric vehicle infrastructure strategy' March 2022.* Link

44 BBC News, '*UK new car sales hit 30-year low but electric vehicle demand soars', 5 January 2023.* Link

45 Zap-Map, *'EV Charging Statistics 2023',* Link

46 HM Government, '*Taking charge: the electric vehicle infrastructure strategy' March 2022.* Link

47 It is worth mentioning that the European Union has recently agreed to add an exemption for e-fuels to their 2035 phase out of new petrol and diesel cars, at the behest of the bloc's auto industry. While e-fuels can play a valuable role in decarbonisation, it is unlikely they will ever be more than a niche market for cars - given their energy requirements and cost profile they are far better used in sectors like aviation where there are fewer alternatives.

48 Department for Transport and Driver and Vehicle Licensing Agency, '*Vehicle licensing statistics data tables: VEH0101: Vehicles at the end of the quarter by licence status and body type: Great Britain and United Kingdom',* Link

49 Department for Business, Energy & Industrial Strategy & National Statistics, *UK Energy in Brief 2022,* Link. Page 22

50 Department for Transport and The Rt Hon Grant Shapps MP, '*UK confirms pledge for zero-emission HGVs by 2040 and unveils new chargepoint design', 10 November 2021.* Link

51 Zemo Partnership, '*Market opportunities to decarbonise heavy duty vehicles using high blend renewable fuels', March 2021.* Link

with biomethane trucks, and has invested in a dedicated biomethane filling station at its head office.[52]

The same dynamic is also apparent in sectors such as aviation and maritime. While significant investment is going into redesigning aeroplanes to operate on electricity or hydrogen, neither of these technologies are yet at a commercial scale. Long-haul flying in particular is seen as challenging to decarbonise through new means of propulsion given range limitations, so Sustainable Aviation Fuel (SAF) will likely have a key role to play.[53]

'Wastes exist only in finite quantities, while biomass from crops is limited by land use considerations'

There are many potential ways to create SAF, some of which draw on the same feedstocks as biofuels, such as used cooking oil (UCO) and agricultural residues. Likely the best in class are e-fuels or power-to-liquid, synthesized using green hydrogen and carbon dioxide (ideally captured from the atmosphere). Yet these require significant amounts of clean energy and are relatively expensive today, which is why SAF from UCO has achieved the largest commercial scale to date.[54]

More broadly, one of the key limitations on biomass as a source of energy is scalability. Wastes exist only in finite quantities (some of which will reduce over time), while biomass from crops is limited by land use considerations, even more so given opportunity cost issues. Moreover, while the UK currently imports substantial quantities of biomass, as ever more countries commit to Net Zero the scope for imports will likely decrease (since the countries that currently export will presumably want to use the land and waste for their own decarbonisation goals). Given this fundamental issue of scalability, governments must be careful about which sectors these limited resources are used in.

As the Government's 2021 Biomass Policy Statement puts it, 'Recognising that sustainable biomass is a limited resource, it is important to ensure that biomass is prioritised within the economy where it offers the greatest opportunity to reduce greenhouse gas (GHG) emissions in 'hard to abate' sectors where there are fewer options to decarbonise through alternative low carbon technologies.'[55] To this end the Climate Change Committee and the Government have established 'priority use' frameworks to describe how biomass should be prioritised throughout the UK economy.[56] Within transport, for example, the CCC sees biofuels being phased out from cars and vans by 2040 and increasingly towards sectors like aviation.[57] This is quite sensible given that for light vehicles there is a clear path to zero emissions, whereas in aviation for example biomass-based SAF may well play a prominent role in the coming decades.

52 John Lewis Partnership, '*John Lewis Partnership steps up Net Zero carbon commitment with biomethane filling station', 18 June 2020.* Link

53 Energy Monitor, '*Aviation emissions: 'We can't wait for hydrogen or electric'', 11 October 2021.* Link
CNBC '*Hydrogen planes, electric propulsion and new regulations: Aviation is changing', 15 June 2021.* Link

54 Transport & Environment, '*FAQ: the what and how of e-kerosene', February 2021.* Link
Sustainable Aviation UK, *'Sustainable Aviation Fuels Road-Map', February 2020.* Link

55 Department for Business, Energy & Industrial Strategy, *Biomass Policy Statement, November 2021.* Link

56 Climate Change Committee, *'Sixth Carbon Budget', December 2020.* Link
Department for Business, Energy & Industrial Strategy, *'Biomass Policy Statement*', November 2021. Link

57 Ibid.

Chapter 2: The pitfalls of biofuels from food crops

When biofuels mandates like the RTFO were introduced, crops were originally their mainstay. They were readily available, relatively cheap and the environmental logic seemed sound. However, once put into practice, a whole host of issues began to crop up (sorry).

In particular, their emission-lowering bona fides have been seriously undermined by the problem of Indirect Land-Use Change (ILUC), outlined below, while the war in Ukraine and steep rises in global food prices have thrown into sharp relief the 'food vs fuel' issues stemming from crop-based biofuels. There are also a number of environmental issues not well captured by the GHG-reduction framework such as biodiversity and opportunity cost for land use. This chapter will examine each of these issues in turn.

The original environmental logic and the problem of ILUC

At the dawn of the biofuel era in Europe, crops such as corn, wheat and soybeans were the mainstay feedstocks. The environmental logic seemed relatively clear – when crops grow, they absorb CO_2 from the atmosphere as any plant does, and hence burning them only returns to the atmosphere that CO_2 which was captured. Even if the emissions at a car's tailpipe are similar to those of a pure fossil fuel tank, the vehicle's carbon intensity would be significantly reduced.

> **'As the US Energy Information Administration notes, 'In some parts of the world, large areas of natural vegetation and forests have been cleared or burned to grow soybeans and palm oil trees to make biodiesel'**

However, there is a fatal flaw in this story. Buried in the environmental logic of biofuels from crops is the implicit assumption that land is essentially limitless. In such a world, one could plant carbon-absorbing crops in ever increasing numbers, reducing the emissions intensity of transport and other sectors.

However in the real world land is scarce – there is very little vacant land simply sitting around waiting for someone to use it (particularly from an environmental perspective). Hence when governments throughout the world demanded that farmers grow crops to put into fuel tanks, the extra land needed to grow these crops (above what was required for food production) had to come from somewhere. In many cases, where that land tended to come from was areas of natural vegetation and forests – areas that can act as carbon stores and which desperately need protection. As the US Energy Information Administration notes, 'In some parts of the world, large areas of natural vegetation and forests have been cleared or burned to grow soybeans and palm oil trees to make biodiesel.'[58]

58 U.S. Energy Information Administration, '*Biofuels explained: Biofuels and the environment' April 2022.* Link

Not all, or even most, of this change was one-for-one – much of it was indirect. Let's say a UK farmer decided to dedicate a portion of his or her cropland to biofuels. That would lead to UK consumers needing to buy wheat from elsewhere. That rising demand for wheat would lead, somewhere far around the globe, to the clearing of land that was previously not used for agriculture. This issue became known as Indirect Land-Use Change (ILUC) – to reflect the indirect effects that biofuels mandates have on land use change around the world.

Sadly, repeated scientific studies have shown that ILUC due to increased biofuel production can significantly diminish (or even negate) the emissions benefits from the use of biofuels.[59] That is to say, the cure could be worse than the disease.

> **'Sadly, repeated scientific studies have shown that ILUC due to increased biofuel production can significantly diminish (or even negate) the emissions benefits from the use of biofuels'**

In particular, a plethora of researchers have attempted to estimate the full lifecycle greenhouse gas (GHG) emissions of various biofuels. The results of a meta-study published by the Royal Society are included in the charts below. For each biofuel, the Global Warming Potential (GWP) is shown across all the individual studies evaluated, as well as quartiles and averages, estimated against the reference fossil fuel (red line) and the required emissions savings (green lines).[60] (Note that the studies in the second chart include both direct and indirect land use change.)

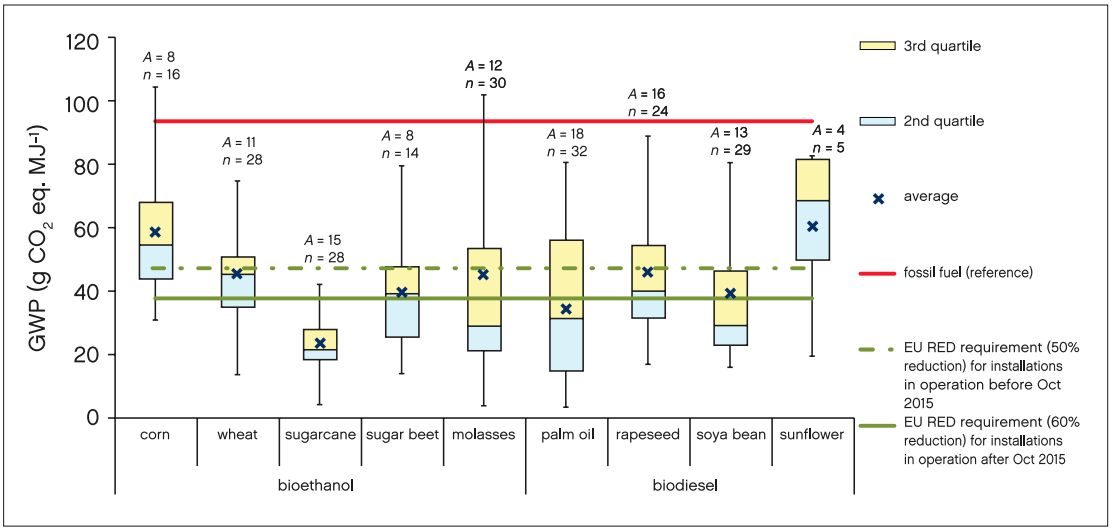
As the meta-study shows, and the quote from the US Energy Information Administration indicates, some of the worst offenders are soybeans and palm oil trees grown for biodiesel. When including land use change (primarily additional deforestation), such crop-based biodiesel can in fact be a far worse emitter of CO_2 than the fossil diesel it is meant to replace – compare the first chart, which excludes land use change, to the second one which includes it.

For bioethanol feedstocks, the trend is certainly better than for biodiesel, with sugar cane and sugar beet coming out ahead of wheat, corn and molasses. However, when including land use change, the emissions savings offered by the latter are paltry at best, while for the former they are more substantial but still not particularly robust relative to the required savings. (It is important to recognise here that there is considerable variability in individual academic estimates of carbon footprints, particularly when land use change is taken into account, which partly reflects differing crop locations, yields, and farming practices but also differences in analytical frameworks. It is also important to recognise that the ultimate emissions profile of any biofuel is not only determined by the relevant feedstock, but also by the production process, as well as any emissions from transporting the feedstock.)

59 Transport & Environment, *'What the Science Says (ILUC)'* Link

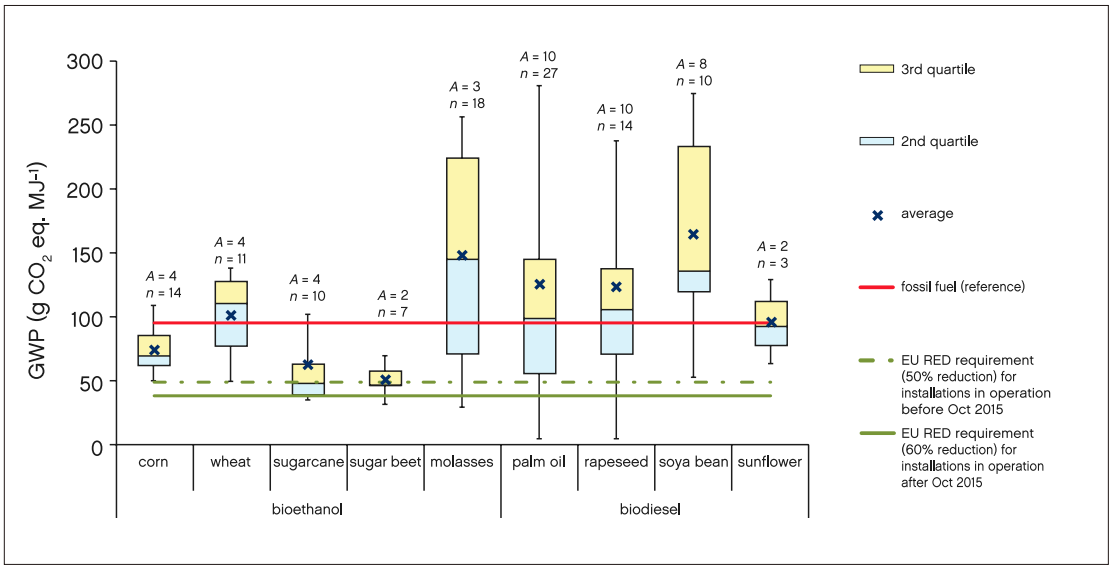
60 Note in the UK the relevant GHG savings are currently 55% for biofuels produced in plants operating before October 2015, and 65% for those opened thereafter

Carbon footprint of various crop-based biofuel feedstocks (excl. land use change)[61]



Source: Jeswani et al. (Royal Society)

Carbon footprint of various crop-based biofuel feedstocks (incl. land use change)[62]



Source: Jeswani et al. (Royal Society)

Given how contentious issues of land use are, and the variability exemplified in the above studies, the UK Government (and many others) opted for a risk-based approach via policies such as the crop cap and double counting. The aim was to reduce (but not eliminate) the use of crops, combined with as much transparency and protection as possible. To the credit of the RTFO team, biodiesel crops which have the highest land use change risks have been mostly (though not entirely) phased out of the RTFO.

61 Jeswani et al, '*Environmental sustainability of biofuels: a review*', *Proceedings of the Royal Society, November 2020.* Link

62 Ibid.

The UK was among the first countries to introduce carbon and sustainability reporting, and has an impressive amount of data related to the scheme that is made public. Any individual biofuel supplied must adhere to a minimum emissions-savings criteria on a full lifecycle basis, thus including cultivation, processing, transport & distribution and so on (but crucially excluding ILUC).[63] Additionally, to be eligible for RTFCs, any biofuel supplied to the RTFO cannot originate from certain categories of land with high biodiversity value or carbon stock (aiming to ensure for example that forests are not directly cleared or wetlands drained for the cultivation of biofuels).[64]

'The RTFO guidance itself admits that 'estimations of the effects of ILUC suggest that some crop-derived biofuels can lead to an increase rather than a decrease in carbon emissions'

While these standards are important, by definition they aim at direct land use change rather than indirect, and tracking the latter effectively is very difficult. Farmers will often point to these standards as evidence that ILUC is not an issue, and yet it is tough to believe the counterfactual that this implies – namely that in the absence of public biofuels subsidies, the amount of land needed for agriculture globally would remain the same. The RTFO guidance itself admits that 'estimations of the effects of ILUC derived from economic modelling – known as 'ILUC values' – suggest that some crop-derived biofuels can lead to an increase rather than a decrease in carbon emissions. When ILUC is included crop-derived biodiesel can increase carbon emissions compared to fossil fuels, whilst the GHG savings for crop-derived bioethanol are more modest than previously estimated.'[65]

The RTFO data reporting also includes a calculation of emissions savings both excluding and including ILUC. Yet this is only based on a weighted average value for groups of feedstocks (cereals vs sugars vs oil crops).[66] Of course this is not a particularly precise estimate, although it is certainly better than nothing. And across the entirety of the RTFO, the difference is small, leading to the headline statistic of only 6 percentage points differential as of 2022 (81% average CO_2 savings excl. ILUC vs 75% inc. ILUC).[67] Yet for individual feedstocks the difference can be significant – corn ethanol from the United States (the second-largest bioethanol feedstock in 2021 and by far the largest in 2022) had GHG savings including ILUC of only 41% in 2021 (2022: 47%), significantly below the required thresholds.[68] Indonesian palm (the largest source of biopropane in 2021 and a small component of biodiesel in 2022) had GHG savings including ILUC of only 4% in 2021 (2022: 6%).[69] Yet crucially these calculations are not included in the emissions savings threshold required to supply biofuels to the RTFO.[70]

As if this weren't enough of a problem, there is also the impact on biodiversity, beyond the protection in the sustainability standards for land with high biodiversity value. In recent decades, governments have become aware of the devastating impact that large

63 The relevant GHG savings are currently 55% for biofuels produced in plants operating before October 2015, and 65% for those opened thereafter.
Department for Transport, *'Renewable Transport Fuel Obligation: Compliance Guidance 2023', January 2023.* Link

64 Ibid.

65 Ibid, paragraph 7.19

66 Ibid, paragraph 7.23

67 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', February 2023.* Link (2022). Note 2022 data is provisional (based on data to 3 January 2023) and could change

68 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', and 'Renewable fuel statistics 2021: Final report', February 2023 & November 2022.* Link (2022) Link (2021). Note 2022 data is provisional (based on data to 3 January 2023) and could change. See RTFO data tables, tab RF__0105

69 Ibid.

70 Department for Transport, *'RTFO Compliance Guide 2023',* Link

scale single-crop agriculture can have on biodiversity, and the decline in plant and animal species as a result. Row crops such as wheat and maize are more economically efficient when grown in large monocultures, and yet are terrible for biodiversity.[71] Of course the same may well be true for such crops when grown for human consumption – but we need them far more. That is to say, biofuels from crops are a policy choice, and one that has quite negative effects for biodiversity. This is of course to say nothing of the biodiversity consequences from indirect changes in land use, for example loss of habitats due to deforestation.

The opportunity cost of land use

Another crucial flaw in the rationale for biofuels comes when you incorporate the concept of opportunity cost for land use, something studies such as those above do not capture well.

While all land of course has an economic value, you can also think of land having an opportunity cost to its alternate use. That is to say any land we are using for biofuels production is land we could be putting to other uses such as housing or food production, or (with our Net Zero hat on) solar farms or forests to act as a carbon sink. Thus beyond the emissions savings from biofuels, which as we have seen are not what they initially appear, the crucial question for crop-based biofuels remains – is this the best use of our land?

> **'Beyond the emissions savings from biofuels, which as we have seen are not what they initially appear, the crucial question remains – is this the best use of our land?'**

The amount of land in the UK used to grow biofuels for the domestic market is relatively small. As of 2020, the latest year available, they cover c.35,800 hectares, or 0.6% of UK arable land.[72] Crops such as wheat and sugar beet are most common – in 2020 wheat grown for bioethanol made up c.28,800 hectares, or 2% of UK wheat area.[73]

However, as outlined above, only a minority of crops supplied to the RTFO are actually grown in the UK. When including the land used abroad in countries such as the United States and Ukraine, the total amount to produce bioethanol is c.107,000 hectares as of 2021 (according to the Green Alliance), similar to the amount of land used to grow potatoes in the UK (140,000 hectares).[74] While the land used for biofuels is limited in scale relative to for example animal husbandry, nevertheless this land is still valuable and could be turned to other uses. (Note that while land use is of course not static, the same opportunity cost point still applies).

Food vs fuel: land use

One critical use of such land is of course for feeding people. The Green Alliance estimates that if the crops grown on those c.107,000 hectares of land were used for human consumption rather than biofuels, around 3.5 million people per year could be fed.[75] Transport and Environment has calculated that in Europe 10,000 tonnes of

71 Tudge, Sophie Jane; Purvis, Andy & De Palma, Adriana. *The impacts of biofuel crops on local biodiversity: a global synthesis. Biodiversity and Conservation, 30, 2863–2883 (2021).* Link

72 Note this figure refers to biofuels from UK grown crops sold into the UK road fuel market (and thus does not include exports), based on volumes reported under the RTFO and converted into equivalent crop areas. Department for Environment, Food & Rural Affairs, '*Area of crops grown for bioenergy in England and the UK: 2008-2020', December 2021.* Link (See Section 1: Biofuels, Table 1.1). Note 2020 data is provisional

73 Ibid, Figure 1.3.

74 Green Alliance, '*Briefing: Food security and UK crop-based biofuel use', June 2022* Link

75 Ibid.

wheat, the equivalent of 15 million loaves of bread, are turned into ethanol for use in cars every day.[76]

This issue has gained even greater resonance in the context of Russia's war in Ukraine. The reduction in wheat exports has reminded the world how vulnerable supply chains can be and the impact on the global poor. According to the UN, between 702 million and 828 million people suffered from hunger in 2021, and if including people who are food insecure (meaning they lack regular access to nutritious food) the number is a staggering 2.3 billion.[77] Depressingly, both of these figures are up from 2020, and there is significant concern that the 2022 figure will be even higher – driven partly by the impact of the war in Ukraine on both food prices and international supply chains.[78]

> **'Transport and Environment has calculated that in Europe 10,000 tonnes of wheat, the equivalent of 15 million loaves of bread, are turned into ethanol for use in cars every day'**

Turning to biofuels, while most feedstock has come from increasing crop production (with the associated land use change implications) rather than decreasing food supplies, the land used currently for biofuels is still scarce and could be used to feed people.[79] Globally the total amount of crops used annually for biofuels is equivalent to the calorie consumption of 1.9 billion people, according to data firm Gro Intelligence.[80] Transport and Environment has calculated that reducing the use of wheat in EU biofuels to zero would compensate for over 20% of the total wheat exports of Ukraine.[81] Notably some of the earliest ships to leave Ukraine's Black Sea ports (before the first UN-chartered shipment of food aid) were private ships loaded with corn for use in biofuels and animal feed, rather than wheat for human consumption.[82] This might have delivered much-needed hard currency to the Ukrainian government, but it seems bizarre that grain from war-torn Ukraine is being put in petrol tanks rather than being used to feed the global poor.

Of course, farmers, biofuels lobbyists and others push back on this narrative, not least in arguing that such crops cannot simply be diverted to human use. In particular, the difference between food wheat and feed wheat is often cited. But as discussed in Chapter 1, the distinctions are not quite so clear cut, with countries such as Spain blending 'feed wheat' into flour production. Indeed a study for the Overseas Development Institute examining this issue noted that 'While such [feed] wheat may not contain the ideal characteristics for milling, technically, it is usually fit for human consumption'.[83] Moreover the food wheat vs feed wheat argument implies that feed wheat would be produced in such vast quantities without public biofuels mandates – a highly dubious assertion.

76 Transport & Environment, '*Food not fuel: As global wheat prices soar, Europe burns the equivalent of 15 million loaves of bread every day to power our cars.', March 2022.* Link

77 Politico, '*Global hunger figures rose to 828m in 2021, UN says', 6 July 2022.* Link

78 Ibid.

79 Financial Times, '*Food vs fuel: Ukraine war sharpens debate on use of crops for energy', 12 June 2022.* Link

80 Menker, Sara, '*Gro's CEO Sara Menker at Societe Generale: Market Risk and the Agricultural Sector', Gro Intelligence, March 2022.* Link

81 Transport & Environment, '*Food not fuel: As global wheat prices soar, Europe burns the equivalent of 15 million loaves of bread every day to power our cars.', March 2022.* Link

82 Politico, *'U.N.-chartered ship to carry first wheat out of Ukraine', 11 August 2022.* Link

83 Locke et al., '*Diverting grain from animal feed and biofuels: can it protect the poor from high food prices?', Overseas Development Institute, April 2013.* Link

Another argument is that the production process of biofuels yields co-products, most commonly animal feed.[84] One example is distillers grains, often referred to as dried distillers grains with solubles (DDGS). This is certainly true (and beneficial) – but not a justification in itself for public biofuels mandates. After all, there would be more animal feed available if the biofuels weren't extracted first – grains can be fed to animals directly.[85] From a land use perspective, if crops were phased out of the RTFO, at least some of the land currently producing biofuels could potentially continue to be used for animal feed, rather than being released for other uses – which would likely still be a far more efficient allocation of our land than today.

Another co-product yielded by bioethanol producers is CO_2, for use in the food & beverage sector as well as other industrial applications. This too is beneficial to the UK economy, and the government considers this to bring environmental benefits in displacing fossil-derived CO_2.[86] Yet biogenic CO_2 does not require food crops as input - indeed CO_2 is increasingly captured as a by-product of the anaerobic digestion process (which creates biomethane), most of whose feedstocks (in the RTFO) are derived from waste products such as food waste and municipal solid waste.[87] More broadly of course the UK is not short of point sources of CO_2, the capture of which is expected to scale up rapidly this decade with the government's CCUS programme.

Food vs fuel: food prices

Another aspect to the food vs fuel debate is the impact on food prices of public biofuels mandates, which shot back to the top of agenda in 2022. Happily wheat prices have largely recovered from their previous highs, for now, but unfortunately the price spikes spilled into more general food inflation, currently running at c.18% as of February, according to the ONS.[88] In the UK and globally, higher prices hit the poor hardest, with 49% of British households on Universal Credit experiencing food insecurity in the past month (as of January), relative to 15% of households not on Universal Credit.[89] Experts warn that costs are likely to remain elevated in the near term given the impact of the ongoing war in Ukraine and weather events such as droughts.[90]

'In the UK and globally, higher prices hit the poor hardest, with 54% of British households on Universal Credit experiencing food insecurity, relative to 16% of households not on Universal Credit'

The extent to which biofuels policies have impacted food prices has, understandably, been the subject of intense debate over the last 15 years. The issue first gained salience during the food price crisis of 2006-8, when many blamed biofuels for price rises, with the UN food rights rapporteur famously describing them as a 'crime against humanity.'[91]

84 EurActiv, *'EU ethanol companies produced more animal feed than fuel last year', 22 June 2022.* Link

85 Transport & Environment, '*Food not fuel: Why biofuels are a risk to food security', March 2022.* Link

86 The RTFO emissions methodology gives credit for such displaced fossil emissions. However this methodology is somewhat questionable given both fossil and biogenic CO_2 streams (in these instances) are usually by-products which would otherwise be emitted, not the primary product. (The atmosphere of course does not care whether the CO_2 is derived from fossil or biogenic sources). Hence any net benefit from a 'displacement effect' is questionable. See RTFO compliance guidance, paragraph 8.60.

87 For an example see BioCarbonics Link

88 Trading Economics: Wheat prices Link
Office for National Statistics, '*Cost of living insights: Food', April 2023.* Link

89 The Food Foundation, *'Food Insecurity Tracking', January 2023, Round 12, Slide 7.* Link

90 Financial Times, '*War and adverse weather set to keep food prices high', 5 December 2022.* Link

91 BBC News, '*Biofuels 'crime against humanity', 27 October 2007.* Link

A host of academic studies have examined the issue and the general consensus seems to be that biofuels demand (in particular US maize ethanol consumption) did play a role, although quantifying exactly how large of a role and the relative contributions of other factors such as energy prices is difficult.[92] Regardless of what happened in the last crisis, the industry has argued that this time around it is not to blame for high prices – rather, according to James Cogan of Ethanol Europe, an industry lobby group, they reflect 'erratic trading conditions and high energy prices'.[93] Moreover, reducing biofuel production 'wouldn't materially ease the price crisis'.[94]

While it is certainly fair to argue that biofuels production likely has little to do with the current spike in food prices, it is more difficult to believe that the current global demand for biofuels has no effect on prices overall. On a global level c.10% of all grain grown is turned into biofuels, and in the US this rises to more than one third of all corn production.[95] Although some of the food security impact will be blunted by co-products such as DDGS, such a large additional source of demand above what is required for food and feed production cannot help but result in upward pressure on prices.

> **'In short, in the here and now land is still scarce, and biofuels do compete with food and feed crops for it'**

Another strand of argument often put forward accepts that price pressure does occur, but posits that this is positive rather than negative for food security by promoting additional investments in technology and infrastructure. Corn ethanol in the United States is often cited as example – as one study put it, 'local policies and fiscal incentives in support of corn ethanol resulted in attractive ethanol prices and not only provided a more secure income for rural communities, but also encouraged innovation and investment into farm infrastructure'.[96] In this perspective global land area is not the limiting factor on food (and bioenergy production), but rather yields and productive capacities. More broadly, by diversifying farmers' markets and incomes, the resilience of individual farmers is increased, which has a positive knock-on effect for food security.[97]

This is certainly a more nuanced perspective on the issue. Yet in this telling, the RTFO and other biofuels mandates are essentially acting as a price support mechanism for farmers' incomes, with the hope being that higher incomes will lead to increased agricultural productivity down the line. While this may be true, a far better way to accomplish this goal would be via direct R&D subsidies, of the kind that Defra already has in place in the UK.[98] This would also ensure that any such productivity gains did not come at the expense of the global poor, who feel the effects of higher food prices (which must eventually result from higher commodity prices) far more acutely.

In short, while productivity and yield improvements have certainly had a transformative impact on food production over the decades, that does not negate the fact that in the here and now land is still scarce, and that biofuels do compete with food and feed crops for it.

92 Malins, Chris, '*Thought for food: A review of the interaction between biofuel consumption and food markets', September 2017.* Link

93 Financial Times, '*Food vs fuel: Ukraine war sharpens debate on use of crops for energy', 12 June 2022.* Link

94 Ibid.

95 Ibid.
Boucher, Henry, '*Guest view: Global hunger fight means no biofuel', Reuters, 6 June 2022.* Link

96 Nogueria et al., '*Chapter 6: Sustainable Development and Innovation in Bioenergy & Sustainability: bridging the gaps', 2015.* Link Box 6.2, page 193, in SCOPE, *Bioenergy & Sustainability: bridging the gaps*

97 Royal Academy of Engineering, *'Sustainability of liquid biofuels', July 2017.* Link

98 Department for Environment, Food & Rural Affairs and UK Research and Innovation, '*Farming Innovation: find out about funding'.* Link

Other uses of biofuels land: nature recovery

If crops were removed from the RTFO tomorrow, both the moral and the environmental case for returning that land to food and feed crops for human consumption would be clear. For the substantial majority of crops used for blending that are grown outside the UK, this could well be the ultimate outcome, absent any policy changes from other governments. However, if we wanted to ensure that those 35,800 hectares of UK land were put to the best environmental use, would we really prioritise biofuels?

> **'Given the dire need for more land for a variety of purposes – including housing – it would be remiss not to discuss the land currently being used to grow biofuels as a potential alternative'**

Although any use of prime agricultural land for non-food purposes can run into ILUC concerns, studies suggest that from a purely environmental point of view, biofuels is unlikely to be the best use. The Institute for Energy and Environmental Research (IFEU) has calculated that the production of crops for biofuels consumed across Europe and the UK requires 9.6 million hectares of land, an area larger than the island of Ireland (and 5.3 million hectares if the production of co-products is taken into account).[99] Yet if this land were rewilded (allowing forests and other vegetation to grow), it could absorb c. 66 million tonnes of CO_2 from the atmosphere per year, twice the officially reported net CO_2 savings from the use of biofuels in displacing fossil fuels (c. 33 million tonnes). So the CO_2 opportunity cost of biofuels cultivation is significantly higher than the emissions reduction.

The read-across from all of Europe to the UK is certainly not perfect (for one thing, biodiesel crops still play a large role in some European programmes, whereas they have mostly been phased out of the RTFO). But the study is a useful datapoint.

Indeed, in England the Government has set itself the task of restoring much of our natural habitat through the new post-Brexit environmental land management (ELM) scheme. The broad aim of the scheme is to move away from automatic payments and towards a model of public goods for public money, paying farmers to use more sustainable methods and for projects such as planting trees and supporting woodland creation.[100] One of the three main pillars is the Landscape Recovery Scheme, working to restore pristine landscapes on a larger scale, aiming to restore nature, reduce flood risks and boost biodiversity.[101] The UK government has also set broader targets to increase tree canopy and woodland cover from 14.5% to 16.5% of total land area in England by 2050, and also to restore currently degraded peatland (35,000 hectares by 2025) – both very valuable for their potential as carbon sinks.[102]

These initiatives will require more land. The Climate Change Committee (CCC), in its 2022 Progress Report to Parliament, notes: 'Delivering deep emissions reduction

99 Transport & Environment, Oxfam and Institut für Energie und Umweltforschung, *'Biofuels: An obstacle to real climate solutions'*, March 2023. Link

100 Department for Environment, Food & Rural Affairs and Forestry Commission, *'England Woodland Creation Offer to transition into Local Nature Recovery scheme in 2025', August 2022.* Link

101 Department for Environment, Food & Rural Affairs, Natural England, Environment Agency, and The Rt Hon George Eustice MP, '*Projects of Landscape Recovery scheme announced: 22 projects receiving funding through the new scheme', September 2022.* Link

102 Committee on Climate Change, '*Progress in reducing emissions: 2022 Report to Parliament', June 2022.* Link
Department for Environment, Food & Rural Affairs, Environment Agency, Natural England, and The Rt Hon Thérèse Coffey MP, 'New legally binding environment targets set out', December 2022. Link

in the land sector will require a transformation in the way land is used. To achieve this as well as maintaining a strong food production sector will require some land to be released from its current use."[103] While the CCC goes on to mention productivity improvements, demand measures and agroecology as potential solutions, another must surely be to wind down crop-based biofuels, freeing up thousands of hectares of land for other uses.

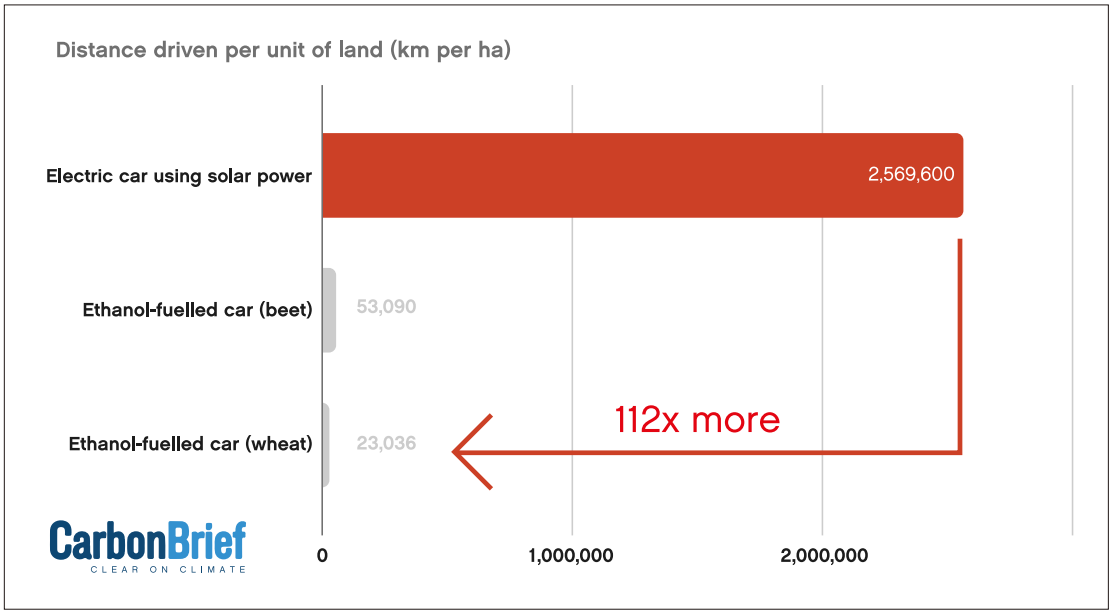
Obviously not all land is the same in terms of its potential for restoration measures, and of course what is suitable for any particular hectare will depend on a variety of factors. Indeed many have argued for a 'three compartment' model of land use, prioritising the most productive land for food production, while restoring habitat on the least productive hectares (with a mix on the rest).[104] The government's upcoming Land Use Framework will set out its views on these trade-offs. The broader point is that given the dire need for more land for a variety of purposes – including housing – it would be remiss not to discuss the land currently being used to grow biofuels as a potential alternative.

Other uses of biofuels land: energy conversion

Another potential use for the land currently used for biofuels is also a source of energy generation for transport, and a far more efficient one at that – namely solar farms.

At the most basic level, both crops and solar panels aim to convert rays of sunlight into energy. Crops of course rely on photosynthesis, which although a marvel of evolution is a technology that is 3.5 billion years old. Solar panels rely on photovoltaic cells, a modern technology that is significantly more efficient. Carbon Brief has done some excellent analysis on this issue, finding that a single hectare of land with solar panels delivers between 48 and 112 times more driving distance per year – if converted into electricity – than the same land if used to grow biofuel.[105]

Use of a hectare of land: solar panels vs crops[106]



Source: Carbon Brief

103 Committee on Climate Change, '*Progress in reducing emissions: 2022 Report to Parliament*', June 2022. Link

104 Green Alliance, '*Shaping UK land use: Priorities for food, nature and climate*', January 2023. Link

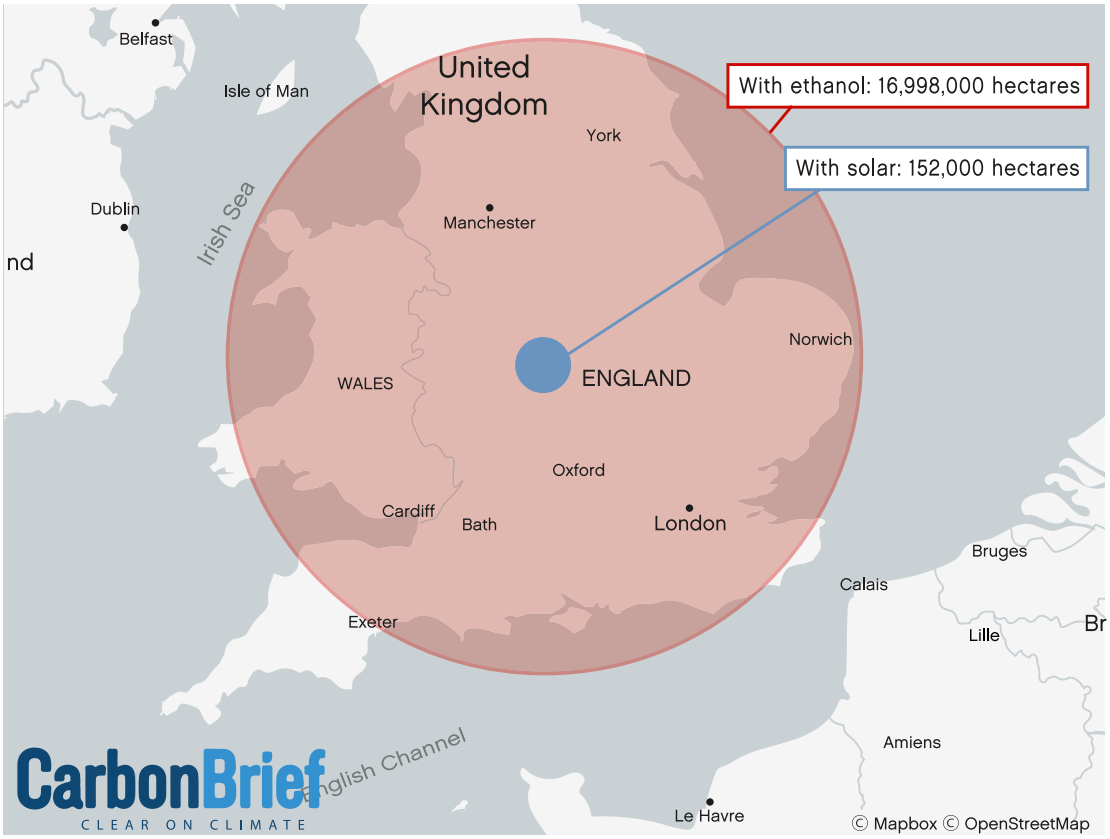
105 Carbon Brief, '*Factcheck: Is solar power a 'threat' to UK farmland?*', 25 August 2022. Link See calculations behind these numbers here

106 Ibid.

Put another way, you could get enough energy to fuel all of the UK's cars from either 152,000 hectares of solar farms (assuming all cars were EVs), or 17m hectares of wheat for biofuels (if all they were all petrol).

Of course the space efficiency of solar panels relative to crops delivers CO_2 benefits as well, given that the rest of that land can be turned over to other uses. Returning to the IFEU study mentioned above, only 2.5% of the land currently occupied by biofuels for European consumption would be needed for solar panels to produce the same amount of energy, leaving 97.5% available for rewilding (or food production). Assuming the former, using this amount of solar energy in cars (rather than fossil fuels) would further increase the overall emissions savings, from c. 66 million to c.107 million tonnes, more than three times the officially reported net CO_2 savings from biofuels.[107]

How much space would it take to fuel all the UK's cars for a year?[108]



Source: Carbon Brief

So even if the Government decided that the thousands of hectares of land currently being used for biofuels were indeed best used to provide energy for transport, rather for food production, nature restoration, housing or any other use, a better use of them would be for solar farms. From an energy conversion perspective, fuels from crops are an outmoded and inefficient use of land.

107 Transport & Environment, Oxfam and Institut für Energie und Umweltforschung, *'Biofuels: An obstacle to real climate solutions'*, March 2023. Link

108 Ibid. (See here) Analysis based on UK average mileage of 11,800km per year, average real-world fuel efficiency of European cars and a representative EV, relative energy density of ethanol and petrol, UK wheat ethanol yield data, data on the number of cars on the road, and assumptions on the land use (45MW/km2) and capacity factor (11%) of UK solar farms.

Policies to discourage crop use

As mentioned above, the UK Government (and its counterparts across Europe) does appreciate the negatives of biofuels from crops and is keen to shift biofuels mandates as much as possible towards waste. Hence to the double counting of RTFCs from waste feedstocks, as well as the development fuels programme (which excludes crops). Hence to the introduction of a crop cap in 2018, which seeks to limit the total volume of crop-based feedstocks that can be accepted into the RTFO from each supplier. Currently this is roughly 3.5%, but the cap is set to decrease regularly down to 2% by 2032.

But while the crop cap was a welcome step forward, it was always somewhat of a halfway house. It discouraged crops but didn't ban them outright, while setting somewhat arbitrary target levels. Moreover, by introducing E10 in 2021 the Government sent decidedly mixed signals, since the level of crop-based bioethanol has risen significantly to meet the higher blending level.[109]

'Last year many European governments responded to higher food and fuel prices caused by Russia's invasion of Ukraine by temporarily cutting their biofuels blending mandates'

Given the significantly changed context from when the crop cap was introduced in 2018 (Net Zero by 2050, a ban on new petrol or diesel vehicles by 2030, the war in Ukraine), the Government should look to be more ambitious. Once ILUC is taken into account, crop feedstocks deliver modest emissions savings at best, and at worse have higher emissions than the fossil fuels they replace. In addition, such crops have negative biodiversity impacts and are unlikely to be the best use of our land, whether for food and feed or emissions and environmental purposes. We therefore recommend that crops should be phased out of the RTFO entirely, as soon as practically possible. At a minimum this should include reducing the crop cap down to zero by 2030 and ideally sooner.

This would not make us an outlier: Germany's environment minister has just proposed withdrawing entirely from the use of crop-based biofuels by 2030.[110] The EU has, less ambitiously, pledged to phase out the use of palm oil by 2030.[111] Last year many European governments responded to higher food and fuel prices caused by Russia's invasion of Ukraine by temporarily cutting their biofuels blending mandates. Finland reduced its mandate by 7.5 percentage points for 2022-23, Sweden froze its 2023 mandate at 2022 levels, while Latvia temporarily suspended its blending obligations entirely through the remainder of 2022 and 2023.[112] The Czech Republic abolished its mandate completely on a permanent basis.[113] In March the European Commission blessed these plans, putting out a statement saying it 'supports Member States in using possibilities to reduce the blending proportion of biofuels which could lead to a reduction of EU agricultural land used for production of biofuel feedstocks, thus easing pressure on the markets for food and feed commodities."[114] While the UK appeared to be looking at a similar temporary mandate waiver in the leadup to the June 2022 G7

109 Department for Transport, *'Renewable fuel statistics 2022: Third provisional report', February 2023.* Link
Note 2022 data is provisional (based on data to 3 January 2023) and could change

110 Reuters, '*German minister to propose withdrawal from use of crop-based biofuels', 17 January 2023.* Link
Bloomberg, '*Germany Seeks to End Crop Biofuels By 2030 in Food-Fuel Standoff*', 25 January 2023. Link

111 EurActiv, '*After palm oil, activists aim at banning soy oil for use in biofuels', 14 November 2022.* Link

112 Argus Media, '*Latvian says plans to suspend biofuels targets: Correct', 13 May 2022.* Link

113 Aktuáln .cz, *'Vláda kvůli vysokým cenám benzinu zruší přimíchávání biopaliv. Odpustí i silniční daň (English: Due to high gasoline prices, the government will cancel the blending of biofuels. It will also waive the road tax)' 3 March 2022.* Link

114 European Commission, '*Safeguarding food security and reinforcing the resilience of food systems', March 2022.* Link

meeting (according to press reports), ultimately the Johnson government did not choose to follow suit.[115]

Phasing out crops would likely be unpalatable to the UK's bioethanol producers, as it would necessitate a change in their business model (although some domestic bioethanol production does go to markets beyond road transport).[116] The UK government should therefore work with them to help smooth the transition. Ideally they could convert their production processes to use waste feedstocks, either for bioethanol or for newer uses such as SAF. Alternatively, there may well be export opportunities for crop-based bioethanol that could make up some of the gap.

The main RTFO targets would also need to be re-examined to account for this change, discussed further in Chapter 4. This would likely cause a decrease in ethanol blending over the short term (representing something of a reversal on E10), and hence an increase in dependence on fossil fuels. While this would be unfortunate, ethanol blending in cars still only represents a small fraction of the vehicle's fuel. Moreover if paired with increased ambition for EV uptake (either via the ZEV mandate or through introducing electrification as detailed in Chapter 4), over the medium term this policy would decrease dependence on fossil fuels and of course aid our decarbonisation ambitions.

The Centre for Policy Studies is certainly not the only organisation in the sector calling for an end to crop-based biofuels. In the UK, leading green NGOs and think tanks such as the Green Alliance and Transport & Environment have made similar calls.[117] Last year nearly 40 leading European NGOs, including Oxfam, Greenpeace, WWF and BirdLife, called for the European Commission to end support for crop-based biofuels entirely to alleviate pressure on food supplies.[118]

Recommendation 1

> The Government should phase out crops entirely from the RTFO as soon as practically possible. At a minimum this should be by 2030, but ideally sooner.

Meanwhile, the UK should continue to work with our allies and partners to come to a common consensus on winding down crop-based biofuels. After all, to make a meaningful difference to global food prices the UK will need to coordinate its actions with the EU and the US. Given the power of biofuels lobbies (particularly in Washington DC), this will be difficult, but it is both morally and environmentally the right thing to do.

Recommendation 2

> The UK should work with our allies and partners to come to a common consensus on winding down crop-based biofuels to boost food security globally.

Finally, it is important to point out that while the preceding analysis applies primarily to food and feed crops such as wheat, maize and palm oil, not all crops are created equal. Dedicated energy crops such as miscanthus (currently excluded from the crop cap) can

115 Reuters, '*Exclusive: Britain, Germany push G7 for halt to biofuel mandates to tame food prices*', 23 June 2022. Link

116 Department for Environment, Food & Rural Affairs, '*Area of crops grown for bioenergy in England and the UK: 2008-2020*', *December 2021.* Link (See Section 1: Biofuels, Figure 1.7).

117 Green Alliance, '*Briefing: Food security and UK crop-based biofuel use*', *June 2022* Link
Transport and Environment, '*Targeting Net Zero – Next steps for the Renewable Transport Fuels Obligation*', *April 2021.* Link

118 Transport and Environment, '*NGOs call on the EU to choose food over fuel*', *May 2022.* Link

be grown on marginal land, avoiding competition with food production, although today these are primarily used for power generation rather than biofuels.

Another potential solution may be found in the use of cover crops, rather than primary cultivation. Oilseed crops such as camelina and carinata (promoted by Nuseed) can be planted in the winter and harvested before next season's planting, in an attempt to avoid competing with primary production.[119] Indeed Defra is encouraging the use of cover cropping through the Sustainable Farming Initiative, which provides a number of ecological and climate benefits.[120]

> **'Last year nearly 40 leading European NGOs, including Oxfam, Greenpeace, WWF and BirdLife, called for the European Commission to end support for crop-based biofuels entirely to alleviate pressure on food supplies'**

In order to assuage any concerns over ILUC, any cover crops used for biofuels must not displace any existing cover cropping practices which have an economic value, and must be careful not to disturb the primary growing season and thus decrease primary yields.[121] While biofuels from cover crops are a promising avenue for further development, caution and stringent standards are warranted.

119 See Nuseed's product page here

120 Department for Environment, Food & Rural Affairs, Rural Payments Agency, Natural England, Rural Development Programme for England Network, '*Sustainable Farming Incentive: Winter Cover Crops', 16 November 2022.* Link

121 O'Malley, Jane, '*Cover crops: a cover story for business-as-usual biofuels', The International Council on Clean Transportation (Blog), 9 June 2021.* Link

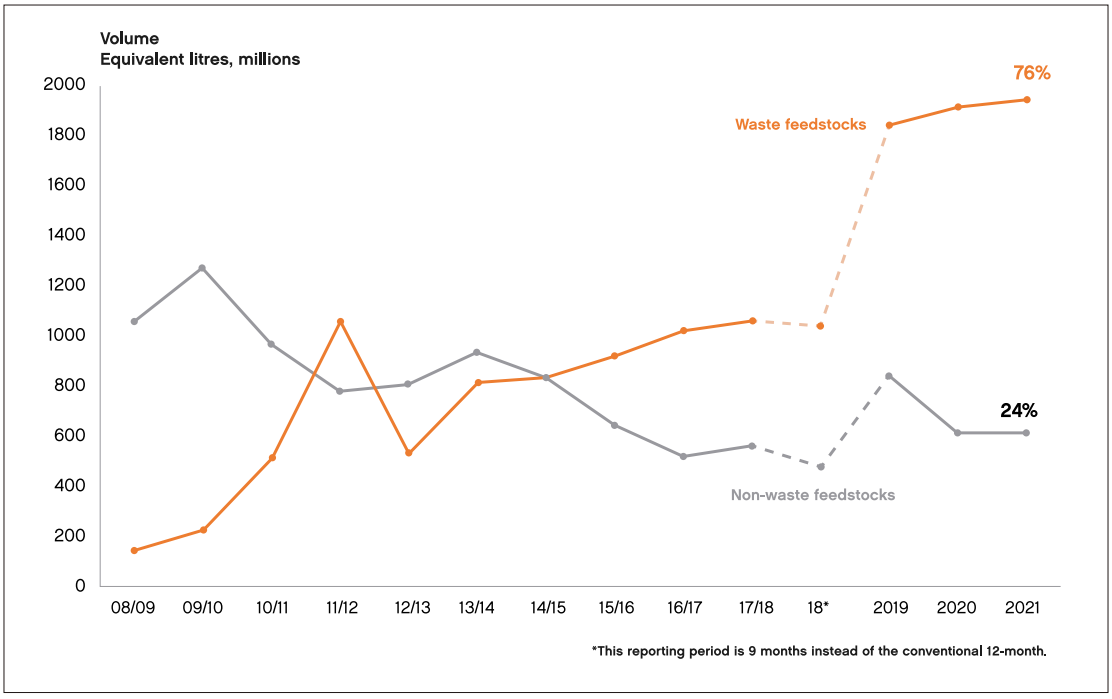
Chapter 3: The promises and peril of second-generation biofuels

While crops were originally the mainstay of biofuels mandates such as the RTFO, increasingly governments are transitioning to second-generation feedstocks (mostly from wastes) as the primary or exclusive source of biofuels. Indeed in 2021, roughly three quarters of renewable fuels in the RTFO were sourced from waste feedstocks, almost the inverse of when the programme began.

The Government deserves much credit here – the incentives put in place by DfT to double count most waste feedstocks and introduce a crop cap have clearly had their intended effect. Of the two main biofuels, biodiesel blended for B7 has become primarily waste-based in recent years, while bioethanol in E10 has a substantial waste component (30% in 2021).

For the sake of brevity this chapter will focus on these two, but of course other fuels in the RTFO such as biomethane come significantly from waste, and the Government's new development fuels sub-target is also based on a yet more limited set of waste feedstocks. However, while biofuels from waste can have far stronger environmental credentials, there are certainly concerns to be aware of related to the waste hierarchy, feedstock availability as well as outright fraud. This chapter will consider each of these issues in turn.

Waste vs non-waste feedstocks supplied to the RTFO over time[122]



Source: DfT

122 Department for Transport, *'Renewable fuel statistics 2021: Final report', November 2022.* Link

The environmental justification for waste-based biofuels

From an emissions perspective, the justification for biofuels from wastes and residues is similar to those from crops, with of course one crucial step added. Whereas biofuels from crops very quickly run into ILUC concerns, the environmental logic presumes the wastes and residues would have been created anyway. Thus waste-based biofuels are assumed to have zero emissions up to the point of their collection, and starting from a zero base can generate significant savings relative to fossil fuels.

To give an example involving Used Cooking Oil (UCO), once the cooking oil from a fish and chip shop has been used up, the primary options for disposal (other than use in biofuels) are either incineration or deep landfill. Relative to either of these, use in road transport as a biofuel is a chance to displace fossil diesel emissions and reduce the amount of waste sent to landfill.[123] So the emissions savings from waste-based feedstocks tend to be significantly more robust than those from crops.

> **'The emissions savings from waste-based feedstocks tend to be significantly more robust than those from crops'**

However, waste-based biofuels are not a panacea. For one, while substituting waste-based biofuels for fossil fuels is likely a positive trade from an environmental perspective, the process still involves combustion and releasing CO_2 to the atmosphere. Although the assumption of plant growth offsets still apply, obviously the best mode of transport from an environmental perspective would be zero emission vehicles which produce no tailpipe emissions.

Another set of issues stems from increasing the economic value of materials that are meant to be wastes. The most obvious problem is the potential for fraud, discussed in more detail below. But more subtle is the potential incentive for increased use of the original material from which the waste is derived, with potentially negative environmental implications.

The hierarchy of wastes (reduce, reuse, recycle) is a critical consideration in terms of the sustainability of many such fuels. For example food waste is better converted to fuel than disposed of. But it is far better for the planet to reduce the amount of food waste in the first place. As part of the United Nations' Sustainable Development Goals, the UK has committed to halving per capita food waste by 2030.[124] The UK has made admirable strides towards that goal – yet as our food waste declines, so too must the feedstock available for biofuels.

Finally, the question of what exactly counts as waste can be somewhat vexed. The RTFO attempts to carefully distinguish between 'products' which have economic value in their own right and thus are single-counted, and true wastes and residues which would generally otherwise be discarded.[125] These distinctions can occur even within the same plant – with sugar beet for example, both molasses and sugar beet pulp have economic value and are considered products, whereas the betaine residue and the plant's tops and tails are considered wastes.[126] Yet drawing these distinctions can sometimes be difficult and blurry. For example, sugar beet tops (leaves) can be used for animal feed or even as

123 NNFCC, *'Implications of Imported Used Cooking Oil (UCO) as a Biodiesel Feedstock', May 2019.* Link
124 House of Lords Library, *'Food waste in the UK', March 2021.* Link
125 Department for Transport, *'RTFO list of feedstocks including wastes and residues', September 2022.* Link
126 Ibid.

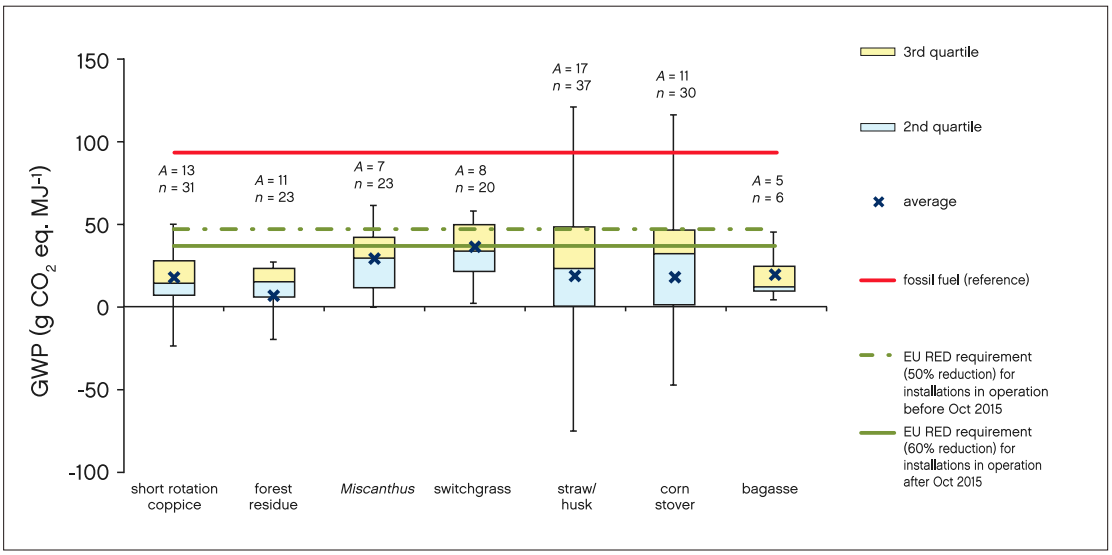
food for humans, either eaten directly or processed as vegan protein.[127] While these uses may not be widespread, by classifying the tops as a waste and making them eligible for double credits, the RTFO creates a strong disincentive for such uses. The RTFO team within government does review the status of various materials as new evidence becomes available, but these judgement calls are not always easy to make.

Second-generation bioethanol

As discussed in Chapter 1, in 2021 30% of bioethanol supplied to the RTFO was derived from waste feedstocks. The most common waste-based bioethanol feedstocks are agricultural wastes such as starch slurry and betaine residue, as well as food waste. Some dedicated 'energy crops' are also eligible for double credits, such as miscanthus (long grass that can grow almost anywhere) and short-rotation coppice, although in the UK these are primarily used for power generation.

As the chart below shows, academic studies suggest that the emissions savings of waste-based bioethanol can be substantial relative to petrol, although other environmental considerations apply as discussed above. The supply of wastes and residues has accordingly been increasing as a percentage of bioethanol supplied to the RTFO – up from only 12% in 2019 to 17% in 2022 (and 30% in 2021), as is clearly the Government's intention.[128] The UK relies heavily on imports for its stock of waste for bioethanol – while in 2021 betaine residue was sourced entirely domestically, starch slurry (by far the biggest waste feedstock) was sourced entirely from EU nations, as was food waste[129]

Carbon footprint of waste-based bioethanol feedstocks[130]



Source: Jeswani et al. (Royal Society)

127 EcoWatch, *'Sugar Beet Leaves Create Vegan Protein Alternative', 27 February 2015.* Link
Lofgren, Kristine, *'How to grow sugar beets for food and fodder', Gardener's Path, 16 August 2021.* Link

128 Department for Transport, *'Renewable Fuel Statistics 2019 Final Report', November 2020.* Link

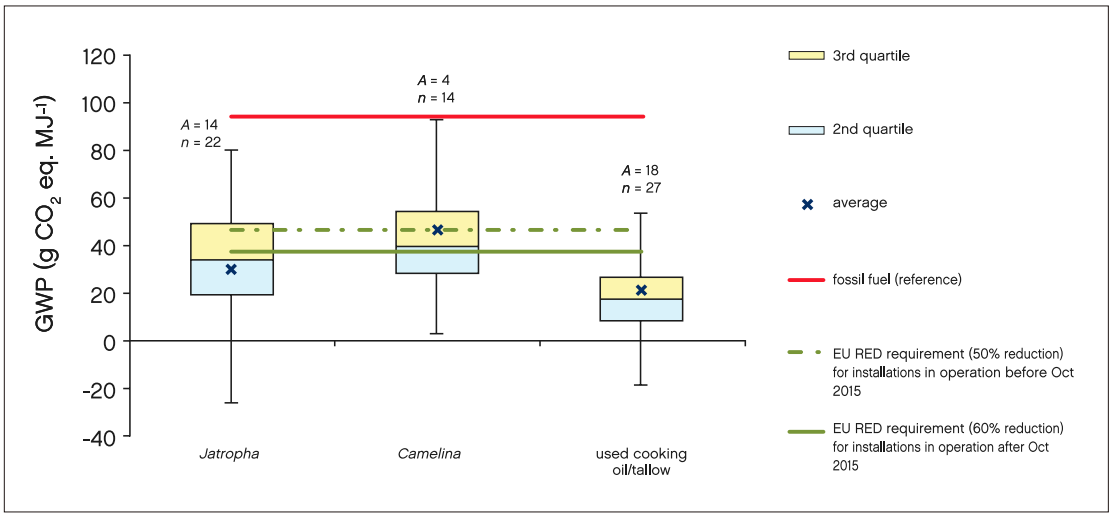
129 Department for Transport, *'Renewable fuel statistics 2021: Final report', November 2022.* Link (See table RF__0105a)

130 Jeswani et al, *'Environmental sustainability of biofuels: a review', Proceedings of the Royal Society, November 2020.* Link

Second-generation biodiesel

The vast majority of biodiesel blended into B7 at the pump is now sourced from wastes, a marked change from when the RTFO was first introduced. By far the largest feedstock is used cooking oil (UCO), although other sources of waste-based biodiesel include various types of tallow (animal fat), soapstock acid oil and waste pressings from the production of vegetable oils among others. Studies suggest the emissions savings from these feedstocks can be substantial relative to pure diesel, provided that the sustainability assumptions are met.

Figure 13: Carbon footprint of various waste-based biodiesel feedstocks[131]



Source: Jeswani et al. (Royal Society)

As demand for waste-based feedstocks such as UCO has soared, biodiesel producers have had to look far and wide for supplies. The result is that by 2021, only 5% of the UCO used in our biodiesel was sourced domestically – almost 50% came from China, with the rest sourced from the US, Russia, Malaysia and many others.

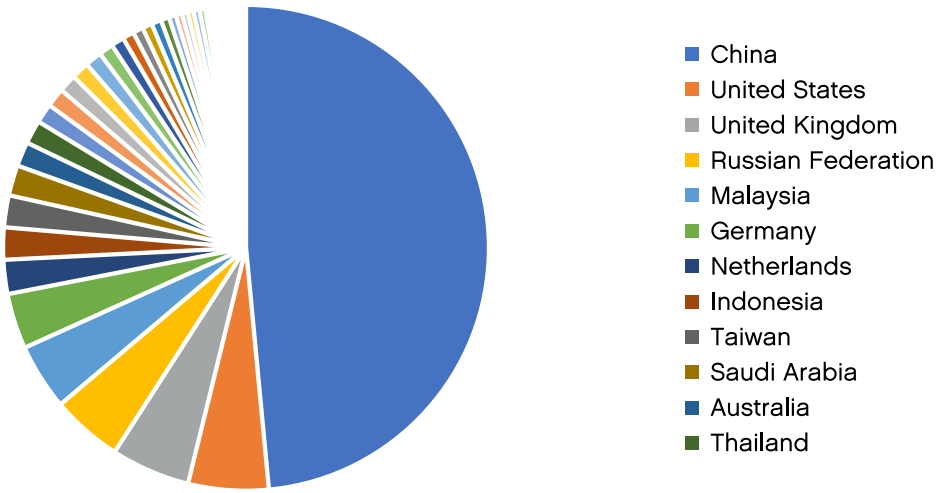
Yet by definition there is a finite stock of used cooking oil in the world, and biofuels mandates such as the RTFO have created intense demand for it. The International Energy Agency recently warned of a looming 'supply crunch' over the 2022-7 period on current trends, noting that 'demand is approaching the supply limits of the most-used wastes and residues'.[132] In their main forecast case, utilisation of used cooking oil and animal fats exhausts nearly 100% of estimated supplies over the period. Even when including a broader range of wastes, such as palm oil mill effluent, tall oil and other agribusiness waste oils, demand is still c.65% of supply.[133]

131 Jeswani et al, '*Environmental sustainability of biofuels: a review', Proceedings of the Royal Society, November 2020.* Link

132 IEA, '*Is the biofuel industry approaching a feedstock crunch?', December 2022.* Link

133 Ibid.

Country of origin for UCO feedstock used in biodiesel (2021, ME)[134]



Unfortunately, the combination of a tight market and the high value that double-counting bestows has attracted bad actors. Organised criminal gangs have started to get in on the business, whether by posing as legitimate recycling firms or outright stealing used oil from pubs. Police Scotland last year advised pubs and restaurants to check for identification when drivers attend to collect UCO, warning 'this is becoming a lucrative market for criminals due to increased legislation targeting carbon reduction and air quality and the move away from other fuel types, such as red diesel'.[135] There have also been instances of outright fraud – most famously in 2019 Dutch authorities announced a criminal investigation into producer Biodiesel Kampen, for falsely selling 'ordinary' biodiesel as more expensive sustainable biodiesel (from used kitchen grease) on a large scale.[136] Dutch authorities calculated that sales of this fraudulent biodiesel were equivalent to 32% in 2015 and 23% in 2016 of total sustainable biofuels used in the Netherlands, with nearly 60% of biodiesel sold by Kampen in 2015 wrongly certified as sustainable.[137] The UK Serious Fraud Office charged a trader at Greenergy with fraud and money laundering in connection with the scandal.[138]

Beyond well-publicised cases such as the Kampen scandal, establishing how widespread fraud truly is within the industry is difficult and of course quite contentious. In 2019 an unnamed industry source told EurActiv that one third of the UCO used in Europe's biofuels market was more than likely fraudulent, commenting: 'In a scenario where UCO attracts super premium pricing due to double-counting, where it is cheap and easy to adulterate virgin palm oil to seem like UCO, and where the regulation is not adequately designed to prevent fraud, it is self-evident that much of our UCO is fake'.[139] On the other hand, the industry association (EWABA) strongly rejected this claim, commenting that 'unsubstantiated allegations such as this one are scandalously slanderous and to the benefit of our competitors who are trying to smear our industry

134 Department for Transport, *'Renewable fuel statistics 2021: Final report', November 2022.* Link (See table RF_0105a)

135 Savva, Anna, '*Cooking oil 'biofuel crimewave' as crooks exploit Scots love of fried food', Scottish Daily Express, 26 August 2022.* Link

136 deStentor, '*Kamper Biodiesel-baas Cees B. moet 20 maanden de cel in (English: Kamper Biodiesel boss Cees B. has to go to jail for 20 months)' 22 August 2019.* Link
Inspectie Leefomgeving en Transport: Ministerie van Infrastructuur en Waterstaat *'Signaalrapportage: Fraude met certificering duurzame biodiesel (English: Signal Report: Fraud with sustainable biodiesel certification)', May 2019.* Link

137 Ibid.

138 Serious Fraud Office, '*Former biodiesel trader charged with fraud and money laundering concerning the sustainable fuel sector', 25 February 2021.* Link

139 EurActiv, '*Industry source: one third of used cooking oil in Europe is fraudulent', 26 June 2019.* Link

for their own advantage'.[140] There was no clear consensus among the industry experts consulted for this paper on the extent to which fraud concerns were justified.

There are certainly safeguards in place designed to prevent fraud, such as chain of custody reporting and the use of voluntary certification schemes such as the International Sustainability and Carbon Certification, (ISCC), which audit suppliers and producers. The ISCC has recently tightened its auditing regime, for example in 2021 introducing mandatory surveillance audits three to six months after first certification of any operator operating in a high-risk supply chain (such as wastes and residues eligible for double counting).[141] However, the supply chains can be complex and the process does have weak points, such as relying heavily on paperwork.

With regards to UCO collection, auditors generally only conduct spot checks, while the standard required by the RTFO is only a 'limited' assurance.[142] Moreover, while the ISCC does indeed suspend certification from non-compliant firms, this only applies to future volumes they sell, hence any volume they sold previously is still considered compliant.[143] While traders can also play a role, as a source at the ISCC told Argus Media: 'Given the ridiculous price premium, I guess the temptation to cheat is always there. If the trading community can be more vigilant, it will help a lot. [But that is] wishful thinking. More tempting to expect ISCC to do the policing.'[144]

> **'There was no clear consensus among the industry experts consulted for this paper on the extent to which fraud concerns were justified'**

The European Commission is sufficiently concerned that it is introducing a central database this year that would track biomass feedstocks through the supply chain, working with blockchain-based providers such as BioLedger as well as the ISCC.[145] Each market participant will have to register purchases of raw materials and sales of products (which can only occur between entities on the database), attempting to prevent fraudulent counting of sustainable feedstocks.[146] BioLedger promises to undertake location tracking of individual collectors as they pick up UCO from restaurants via an app.[147] While such a database would be unlikely to completely eliminate the risk of fraud, the move to a digital system would likely go a long way towards reducing this risk and deterring potential fraudsters.

Finally, moving beyond the direct risks of fraud, there are other potential concerns around the use of UCO. First is the indirect risk of increased usage of cooking oil in response to the economic incentive provided by UCO sourcing. As restaurants realise the value of their UCO, they may be tempted to use more cooking oil, for example refreshing their frying oil more regularly. In small instances this actually could have public health benefits and would be unlikely to cut into GHG savings, but on a larger scale it would cause further deforestation and damage the scheme's environmental credentials.[148]

140 Ibid.

141 International Sustainability & Carbon Certification, '*ISCC EU 203: Traceability and Chain of Custody', July 2021.* Link

142 International Sustainability & Carbon Certification, '*System updates: 1 October 2019',* Link
Department for Transport, '*RTFO Compliance Guide 2023',* Link (Paragraphs 12.5-12.12)

143 International Sustainability & Carbon Certification, *'Withdrawn Certificates', 2023.* Link

144 Argus Media, '*European UCO buyers wary of contaminated imports', 28 July 2020.* Link

145 See here for the ISCC's work, and here and here for Bioledger's work

146 Williams, Melanie, '*Is Europe's new biofuels' database a sign of things to come?', Melanie Williams Consulting, September 2022.* Link

147 See BioLedger's website here

148 For the health benefits see for example Bryant, Kelly '*The Scary Reason You Shouldn't Reuse Cooking Oil', Reader's Digest, 29 March 2021.* Link

There are also concerns that in many supplying countries, such as China, UCO is not entirely a waste, in that it has existing uses (for example in animal feed).[149] Thus exports to Europe for use in biofuels would need to be replaced in the domestic market, likely coming from cheap virgin oil such as palm. A study on UCO by bioeconomy consultants NNFCC noted that 'although correlation does not necessarily equate to causation, the available evidence indicates that palm oil imports to China are increasing, in line with their increased exports of UCO'.[150] If so, this could lead to ILUC and drive deforestation, undermining the original environmental rationale.[151]

Finally there is the question of opportunity cost here in the UK. Used cooking oil can be used in a variety of other settings, for example in power generation, or in soap-making.[152] In a similar vein to sugar beet tops, these uses may not necessarily be widespread, but providing such a strong financial incentive to send UCO to the RTFO makes it unlikely they will ever become so.

'Dutch authorities calculated that sales of fraudulent biodiesel were equivalent to 32% in 2015 and 23% in 2016 of total sustainable biofuels used in the Netherlands, with nearly 60% of biodiesel sold by Kampen in 2015 wrongly certified as sustainable'

The Department for Transport is certainly aware of these concerns. Its response to the 2021 consultation noted: 'We are aware of recent reports concerning used cooking oil derived biofuel, its potential links to indirect land use change and fraudulent supply. There is no evidence showing a causative link between UK policies to promote waste-derived biofuels and increased use of virgin oils in other parts of the world. Factors that influence consumption of virgin oils include changes in eating habits and policies relating to public and animal health.'[153] While proving a causative link may well be difficult given the indirect nature of many of these effects, there is still every reason to strengthen standards to lower the risks that our policies cause harm.

Policies for ensuring waste feedstocks are sustainable

Sustainably sourced waste biofuels can have an important role to play in the transition to zero-emissions infrastructure, and currently make up the majority of the RTFO. This chapter has considered only some of the largest examples, but of course there are many other waste-based feedstocks and fuels eligible for RTFCs. However, the risks of fraud demand vigilant policing mechanisms. The UK should therefore consider introducing more rigorous database tracking for waste-based feedstocks sold into the RTFO. Given how far advanced the European efforts are, one option could be to join the EU scheme once it is fully up and running. DfT could also work to develop its own bespoke scheme, although this would require significant time and effort. The UK should also continue to work with auditors and other third-party providers to strengthen the quality of audits. In short, the UK must ensure that fraudsters cannot take advantage of the RTFO for their own profit.

149 Transport & Environment, *'UK's imports of dubious 'used' cooking oil set to rise, fuelling deforestation', April 2021.* Link

150 NNFCC, *'Implications of Imported Used Cooking Oil (UCO) as a Biodiesel Feedstock', May 2019.* Link

151 BBC News, *'Climate change: Used cooking oil imports may fuel deforestation', 15 July 2019.* Link

152 Bioenergy Insight, *'UCO-to-power plant opens in UK', 3 February 2015.* Link
Mahoney Environmental, *'15 Creatives Uses of Used Cooking Oil You Never Knew About', 2022.* Link

153 Department for Transport, *'Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response', April 2021.* Link

Another (more drastic) option would be to revisit the double-counting mechanism, for example removing the double-counted status of UCO imported from countries outside Europe, as Transport & Environment have called for in the context of the EU.[154] This would reduce the incentive for fraud and the potential for a substitution effect in the relevant countries. Given that this change could be accomplished with the stroke of a pen, it would also be far quicker and easier to implement than a database scheme. However, this would also be highly disruptive for industry, potentially fall foul of World Trade Organisation rules, and could raise costs for consumers if supplies of UCO into the RTFO were replaced with more expensive feedstocks.

Finally, the Government should continue to be vigilant regarding opportunity costs of using wastes and residues, as well as principles such as the waste hierarchy. While reusing is good, reducing is better and in the case of food waste for example this must remain paramount.

Recommendation 3

The UK must ensure robust verification and monitoring of waste-based feedstocks (in particular Used Cooking Oil) and should consider rigorous database tracking but potentially also the removal of double counting in certain instances.

154 Transport & Environment, *'REDII national implementation: How member states can deliver sustainable advanced transport fuels', January 2020.* Link

Chapter 4: Reforming the RTFO

While the previous two chapters looked at biofuels from crops and waste respectively, and proposed policy reforms specific to each, this chapter will look more broadly at the RTFO as a whole.

Should the Government seek to wind down the use of crops as we suggest, the main target levels will likely need to be re-examined, as crops still make up the majority of bioethanol feedstocks. However, changing course on the main target levels so soon after increasing them may be difficult, in which case electrification could be a promising option to make up the gap. Making this change could help to rapidly scale-up public charging infrastructure and thus boost EV take-up, although if introduced it should be accompanied by stringent safeguards to ensure additionality.

'In 2021 the UK Government increased the main RTFO target by 5 percentage points, to eventually reach 14.6% in 2032'

Finally, looking to the future of the RTFO, we argue that in the short term the Government should continue to scale up advanced fuels, while helping over the medium term to manage the transition of feedstocks from road fuels to other sectors such as aviation.

RTFO main target levels

In 2021 the UK Government increased the main RTFO target by 5 percentage points, to eventually reach 14.6% in 2032. The principal aim seemed to be avoiding any reduction in biodiesel supplies given the introduction of the higher blend wall of E10 (up from E5).[155] The biofuels industry lobbied heavily for this change (and indeed wanted even higher levels), concerned that without increased targets, overall volumes of biofuels supplied would decrease as EV uptake continues.[156]

Yet by increasing the target levels, the Government has likely only pushed back 'peak biofuel' by a few years. Indeed, DfT modelling published alongside the consultation response shows that the Government expects this change to push up peak biofuels volumes from roughly 3 billion litres in 2022 (previously) to 3.5bn litres in 2025, after which volumes will gradually begin to decline.[157]

155 Transport and Environment, *'Targeting Net Zero – Next steps for the Renewable Transport Fuels Obligation', April 2021.* Link

156 Renewable Transport Fuel Association, '*RTFA Feedstock Availability Summary Report', April 2021.* Link

157 Note this refers to the 'High EV' scenario which includes the government's commitment for new vehicles to be zero emission by 2035 (as opposed to the EEP scenario which does not), comparing the Baseline – Do Nothing scenario to the chosen Option 3 (5 percentage point increase to the main RTFO target). Department for Transport, '*Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response: Annex A: Cost benefit analysis', June 2021.* Link

In the Government's projections most of these higher volumes in 2022-2025 result from greater use of crop-based bioethanol, with the volume of biodiesel and waste-based bioethanol relatively unchanged (until later this decade, when the crop cap is reached).

Lower volumes of biofuels for road transport are likely unavoidable. But while some legacy petrol and diesel cars will be on the road into the 2040s, biofuels will be needed in other sectors long before then. Indeed, the consultation proclaims the future of the biofuel market to be 'a transition from road biofuels' and discusses particularly the transition of bioethanol and biodiesel producers to aviation fuel.[158]

But if our recommendation to phase crops out of the RTFO is accepted, those targets will need to be revisited. While waste-based bioethanol volumes have been increasing in recent years (alongside other more advanced biofuels), it is unlikely that these would be able to make up the gap from eliminating crops entirely. Moreover, given crop-based bioethanol has historically been the cheapest fuel used to meet the RTFO obligation, were the main targets not revisited the net result could be even higher costs for consumers.[159]

Exactly where the new targets would be set would depend on how quickly crops were phased out, and assumptions around availability of other feedstocks. However, revising the main RTFO targets would likely be the simplest and most straightforward way to account for the phase-down of crops.

Recommendation 4

The UK should revisit the main RTFO targets in light of our proposed phase-down of crop-based biofuels.

Should electric vehicles be included?

The Government may find it politically difficult to revisit the main RTFO targets so soon after they have been increased. There may also be concern that absent any other changes, doing so would create a gap in the UK's carbon budgets. If so, a potential solution to achieve the higher targets without crops is to introduce electrification to the RTFO and RTFC regime, as several other European countries have done. While this would provide a welcome boost to the public charging network and hopefully help drive EV take-up, this is also a sub-optimal policy outcome in several respects.

Electrification could be accomplished by allowing chargepoint operators (CPOs) to claim RTFCs for the electricity they supply to EVs at public chargepoints. The logic for this change is that in the same way a fuel supplier is helping to decarbonise road transport by blending a certain percentage of biofuels into petrol or diesel, a CPO is doing the same by supplying renewable electricity to an EV. Generating RTFO credits would bolster the business case for new charging infrastructure, working in complement to existing government initiatives but using a market-based mechanism to do so. Because the pass-through mechanism would remain the same (motorists filling up at the pump), this change would boost the roll-out of public charging infrastructure without requiring new pots of funding from the Treasury. The UK already had such a system which ran in parallel to the RTFO, where suppliers of electricity for transport could claim credits (although volumes were low).[160]

158 Department for Transport, '*Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response', April 2021.* Link

159 Department for Transport, '*Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response: Annex A: Cost benefit analysis', June 2021.* Link

160 Referring to the GHG Regulations. Department for Transport, *'Renewable fuel statistics 2019: Final report data tables: RF_02 (GHG tables)', 2019.* Link

Other countries and territories have made this switch to their own RTFO-type instruments. The Netherlands was one of the first to do so, allowing CPOs to generate renewable energy units (HBEs) based on the amount of electricity supplied to EVs (using the grid average share of renewables, as well as a multiplier of four to account for EV efficiency).[161] Within Europe, Germany, Austria and France now have some form of electric crediting programmes.[162] California's Low Carbon Fuel Standard policy also credits renewable electricity supplied in transport to the obligation on fuel suppliers, including both public chargepoints and private charging.[163]

However, including electricity will likely result in a sub-optimal policy outcome, in several respects. Firstly, introducing other elements to the RTFO adds more complexity in what is already a complex policy instrument, creating the risk of yet further unintended consequences. Electricity and liquid fuels are fundamentally different markets that will not necessarily behave in the same way. Care must be taken not to flood the market with cheap credits that crowd out all other compliance options (and of course private capital from the chargepoint market). In a similar vein, this change must help fund new infrastructure that would not otherwise be viable, rather than simply adding to the margin of CPOs. Thus appropriate safeguards would have to be put in place to avoid the risk of over-subsidization, given the existing government initiatives in place – at a minimum, this should include only granting RTFCs to new infrastructure rather than existing charge points. The system could also be geographically tailored, so that chargers could only be eligible for RTFCs in areas where the infrastructure was currently patchy, or potentially time-limited as well.

Overall electrification could be a promising option for the RTFO's future, with the key advantage that it could help boost the UK's charging infrastructure without requiring increased taxpayer funding. However, while countries that have introduced this change, such as the Netherlands and Germany, have undoubtedly found success with it, the implicit background for this change is the mandatory targets in the EU's Renewable Energy Directive. Post-Brexit the UK is no longer bound by these targets and can chart its own path. Electrification should therefore be considered only if decreasing the main RTFO targets is not possible, and if included should be subject to strict safeguards.

Recommendation 5

If the main target levels are unable to be changed, electrification may be a promising solution, helping to boost the UK's charging infrastructure and increase EV take-up without requiring new taxpayer funding. However this is a sub-optimal policy in several respects and if introduced should be subject to strict safeguards to ensure additionality.

161 Dutch Emissions Authority, '*Renewable Energy for Transport 2022-2030: Registering delivery of electricity', 2023.* Link

162 Clean Energy Wire,'CO_2 *reduction and biofuels in Germany's transport sector – implementing the RED II directive', 21 May 2021* Link
Bloomberg, '*EV Chargers, Biofuel Makers Square Off in Billion-Dollar Tussle*', 18 January 2023. Link

163 California Air Resources Board, '*LCFS Electricity and Hydrogen Provisions', 2023.* Link

Looking ahead

This report has focused primarily on the largest feedstocks for bioethanol and biodiesel, which represent the lion's share of the RTFO. However, the RTFO also allows for the supply of a vast array of other renewable fuels and encompasses sectors beyond road transport. In 'Driving Change', the CPS called for increased support for hydrogen via the RTFO (among other measures), and we were pleased to see the expanded eligibility announced in the 2021 consultation, for example in fuel-cell powered trains.[164] DfT has also continually worked to expand the list of eligible fuels under the RTFO, most recently for Recycled Carbon Fuels (RCFs) made from fossil-derived wastes such as non-recyclable plastic waste (which DfT believes to be a key potential source of SAF).[165] More broadly, helping to scale up newer, more advanced biofuels, e-fuels and hydrogen should remain a priority, particularly given the potential to decarbonise sectors such as aviation and heavy transport.

> **'Helping to scale up newer, more advanced biofuels, e-fuels and hydrogen should remain a priority, particularly given the potential to decarbonise sectors such as aviation and heavy transport'**

Indeed, while the primary use of biofuels and other advanced fuels today is in road transport, over the next two decades this will shift into heavier vehicles as well as other sectors such as aviation and maritime. This will naturally require the evolution of business models within the industry as well as the policy support mechanisms such as the RTFO (and others). Within aviation, for example, DfT has committed to introducing a SAF mandate (with a goal that it represents 10% of total fuel used by the aviation sector by 2030), and has committed that once the mandate is introduced in 2025, aviation fuels will no longer be eligible for support under the RTFO.[166] The upcoming Low Carbon Fuels Strategy will publish a range of scenarios to forecast demand for low carbon fuels across different transport modes, while the upcoming Biomass Strategy will review the use of biomass across the economy more widely and how this should best be utilised.[167]

Both of these will help the industry prepare for the change in its business models, although the government should continue to keep the RTFO under review as the contours of this transition become clearer. For example, given cars will make the transition to zero-emissions vehicles more quickly than buses and HGVs, the Government might consider splitting out the RTFO by mode of transport, rather than having the same targets across all modes.

Whatever mechanism is chosen, the Government should seek to ensure that over the coming two decades, the limited of stock of biofuels is allocated to the sectors and transport modes where they are most needed, with minimum environmental damage and maximum environmental benefits.

164 Department for Transport, '*Targeting Net Zero – next steps for the Renewable Transport Fuels Obligation: Government response', April 2021.* Link

165 Department for Transport, '*Supporting Recycled Carbon Fuels through the Renewable Transport Fuel Obligation', July 2022.* Link

166 Department for Transport, '*Sustainable aviation fuels mandate: Summary of consultation responses and government response', July 2022.* Link

167 Department for Transport, '*Low carbon fuels strategy: call for ideas', February 2022.* Link

Conclusion

The RTFO has helped build a domestic biofuels industry and supported our transport decarbonisation goals. The scheme has been well-administered: our data reporting is genuinely world-leading, and the RTFO has constantly been expanded to include new feedstocks, fuels and even new sectors as needs have evolved.

Yet as this report has shown, after 15 years the UK's biofuels mandate is in need of a post-Brexit, post-Ukraine refresh. Biofuels from food crops should be wound down as soon as possible, while the UK should continue to work with our allies on this issue to make a difference to global food security. Waste-based biofuels, on the other hand, can deliver much more solid emissions reductions relative to the fossil fuels they displace – even though the potential for fraud highlights the need to ensure robust verification and monitoring.

Going forward the RTFO will need to evolve if it is to stay relevant. Re-examining the main target levels is likely the best way to incorporate our proposed phase-down of crops, ensuring this change does not hit consumers at the pump. However, should this prove difficult, electrification may be a promising alternative to hit these higher targets – again subject to strict safeguards to ensure additionality and avoid the risks of double subsidization.

Recommendations

1.	The Government should phase out crops entirely from the RTFO as soon as practically possible. At a minimum this should be by 2030, but ideally sooner.
2.	The UK should work with our allies and partners to come to a common consensus on winding down crop-based biofuels to boost food security globally.
3.	The UK must ensure robust verification and monitoring of waste-based feedstocks (in particular Used Cooking Oil) and should consider rigorous database tracking but potentially also the removal of double counting in certain instances.
4.	The UK should revisit the main RTFO targets in light of our proposed phase-down of crop-based biofuels.
5.	If the main target levels are unable to be changed, electrification may be a promising solution, helping to boost the UK's charging infrastructure and increase EV take-up without requiring new taxpayer funding. However, this is a sub-optimal policy in several respects and if introduced should be subject to strict safeguards to ensure additionality.

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