UK policy instruments for aviation decarbonisation: the sustainable aviation fuel mandate and policymaking approach underlying the future UK framework.

MAULET, N.

2024

UK Policy Instruments for Aviation Decarbonisation: The Sustainable Aviation Fuel Mandate and Policymaking Approach Underlying the Future UK Framework

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Abstract:
The UK's fuel decarbonisation toolbox is expanding to include more policy support for developing sustainable aviation fuel (SAF). This support framework will grow out of the UK experience with the Renewable Transport Fuel Obligation by including a sector-specific mandate. Westminster is also working on a future revenue certainty mechanism for SAF, that is yet to be legislated. In doing so, the UK government proposes to deliver a continued support to low-carbon fuel innovation. The government also intends to address the Climate Change Committee's persistent calls for a swifter decarbonisation across transport modes. This SAF policy should help speed up aviation decarbonisation by serving multiple purposes and targets, a policymaking approach typically associated with renewable energy support programmes. The SAF policy's consultations, government documentation, and expert opinions, help recognize several policy traits, coming out as critical design characteristics when structuring policy programmes supporting renewable energy sources. Such policy characteristics include providing certainty, clarity, continuity, and adaptability when structuring instruments and government interventions. Policy programmes should also prove capable of adapting to market and trade conditions. Instruments should equally factor in WTO rules and rulings on subsidies, renewable support schemes, sustainable fuels, or export markets, as and when applicable.

Keywords: Decarbonisation; UK; Policymaking; Mandate; Contracts for Difference; Transport; Aviation; Sustainable fuel.

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1. INTRODUCTION

Since 2008, the UK has been stimulating the supply and demand of low carbon fuels for transport through the Renewable Transport Fuel Obligation (RTFO). Environmental research and findings by the Climate Change Committee (CCC) have recently called for more government efforts to decarbonise the aviation sector by effectively progressing on investments needed to boost the supply of sustainable aviation fuel (SAF)[1]. European air traffic is set to rise by 2% per year beyond 2025 and government and aviation have since 2022 been further coordinating on policy solutions to deliver their Jet Zero Strategy and create a viable market for SAF.[2] In its doctrinal approach, this article will examine the UK's forthcoming aviation fuel policy instruments by concisely looking at the aviation blending mandate coming into force on January 1, 2025. The government's policy strategy on SAF also includes attracting investments for SAF production by introducing the revenue certainty mechanism it announced in July 2024 and that will rest on future legislation. In that respect, this article will discuss why a guaranteed strike price mechanism, reflecting the UK's experience with Contracts for Difference (CfD), would incentivise and provide a desired enhanced certainty to SAF investors. This article will also explore the UK policy support to innovation in SAF. In doing so, this discussion will seek to identify the critical policymaking characteristics underlying the Department for Transport's (DfT) announced SAF policy framework. This article therefore proposes to explore the UK's policymaking technique rather than dissecting the SAF framework in minute details. The SAF interventions will not rest on radically innovative instruments for growing a UK SAF industry. Yet, this article will seek to highlight, and confirm, how certain in-built policy characteristics, such as providing certainty, clarity, continuity, and adaptability, should be regarded as essential policy traits for structuring effective policy programmes aimed at supporting decarbonized energy solutions deployment.

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1. Climate Change Committee, *Progress in reducing emissions, 2024 Report to Parliament* (2024) Climate Change Committee, UK, 57.
2. Eurocontrol, 'EUROCONTROL Forecast 2024–2030' (September 2024) https://www.eurocontrol.int/publication/eurocontrol-forecast-2024-2030 01 September 2024; Department for Transport, 'Jet Zero Strategy' (HM Government, July 2022) https://www.gov.uk/government/publications/jet-zero-strategy-delivering-net-zero-aviation-by-2050 accessed 14 August 2024.

2. POLICY OUTCOMES – DEVELOPING A MARKET BY STIMULATING DEMAND. SUPPLY-SIDE SOLUTIONS AND INSTRUMENTS

2.1 From the RTFO to the mandate – Demand-pull instrument and the RTFO since 2008

Historically, the UK has gained considerable policy experience with renewable transport fuels by first requiring large hydrocarbon fuel suppliers to annually sell growing proportions of biofuel-blended transport fuels. To stimulate supply, the government chose to introduce in 2008 a cross-sector Renewable Transport Fuel Obligation (RTFO). This obligation now applies to road, non-road, maritime, and aviation fuel suppliers selling more than 450,000 litres by periods of reference. In 2022, 48 million litres equivalent of SAF were supplied to aviation in the UK. These are small volumes when put against the billion litres of kerosene sold each year to air transport. Thus, SAF only represented 0.4% of all jet fuels purchased over the same period[3].

Since 2008, the RTFO has been operating through three requirements. First, RTFO participants must supply a set percentage of renewable fuels within their annual total deliveries. The system encourages two types of renewable fuels; "generally eligible fuels", that fall under the scheme's general obligation, and "development fuels", eligible and supplied under the development fuel target. Each obligation requires that a defined percentage of transport fuel be sourced from eligible non-hydrocarbon, or low-carbon, fuel products. For 2024, the general obligation was set at 13.56% of hydrocarbon, or non-renewable, fuel supplies. For the development fuels target, the percentage was set at 1.37%of the volumes of reference. Each such regulatory percentage is designed to increase with, by 2032, the main obligation percentage reaching, subject to further revisions, 17.67%, and the development fuels obligation reaching 3.39% percent.[4] Suppliers are meant to meet these obligations through the physical supply of blended fuels. Yet, the DfT allows participants to buy out some of their RTFO volumes by paying a fixed amount per litre of fuel not supplied under the obligations.

The second RTFO requirement demands that suppliers report supplies through the RTFO Operating System. This obligation directly connects to the third RTFO requirement prescribing that suppliers hold Renewable Transport Fuel Certificates once all reported volumes have been independently verified.

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3. Department for Transport, 'Renewable fuel statistics 2022: Third provisional report' (Government Digital Service) https://www.gov.uk/government/statistics/renewable-fuel-statistics-2022-third-provisional-report accessed 22 August 2024.
4. Department for Transport, "Renewable Transport Fuel Obligation: Compliance Guidance 2024: 01/01/24 to 31/12/24" (January 2024) https://assets.publishing.service.gov.uk/media/6582e7fbed3c3400133bfc84/renewable-transport-fuel-obligation-compliance-2024. pdf accessed 12 September 2024.

Suppliers demonstrate their compliance with the RTFO obligations by redeeming their certificates to the DfT. RTFO certificates are tradable, thus enabling suppliers who cannot meet their RTFO obligations to buy missing certificates on the open markets that trade in RTFO certificates. The certificates' market price may therefore vary depending on offer and demand. But the DfT sets a minimum buy out price. These mechanisms combine to stimulate the UK blended fuel supply across all transport sectors.

Yet, the rise in commercial air traffic towards 2050, and the need for more government progress on decarbonizing transport generally, now call for more specific instruments to decarbonize aviation fuel. The industry should also grow to produce second and third generation SAF products (2g and 3g SAF) in the UK. National scientific and industrial capacity indicate that the country is well-placed for especially becoming a leader in 2g SAF derived from solid waste. Such prospects could give rise to investments in a leading Recycled Carbon Fuels (RCF) industry. Unlike first-generation SAF, RCF do not derive from fat, oil, or esters. The processing of industrial waste enables extracting RCF from solid unrecyclable plastics or industrial flue gas converted into ethanol. The produced ethanol is then turned into SAF.

These prospects require attracting investors and growing the industry's confidence in a robust demand for SAF. Thus, the government's forthcoming SAF toolbox includes a sector-specific mandate designed to offer greater market visibility and supply-side stimulation. Government interventions should also operate to enable a derisked environment with supplies supported by a mandate gradually requiring reaching 10% of SAF in jet fuels supplies by 2030.

This effort through a demand-pull mechanism should help structure a more sizeable SAF supply chain and trigger at least ten years of investments. Enabling a RCF industry will also support the UK's circular economy by notably recycling municipal solid waste into low carbon fuels. Government should therefore be considering introducing competitive market arrangements with local authorities for recycling solid waste and allow a steady stream of feedstock to RCF producers. The Energy Act passed in 2023 already comes with provisions allowing the Secretary of State to include RCF as part of RTFO-eligible UK fuels. However, once the new SAF mandate is in place, the RTFO will no longer regulate SAF suppliers. Participants will need to comply with the new SAF mandate which, based on the official timeline, is set to start on January 1, 2025.

2.2 The SAF mandate, R&D funding, and grant funding

The UK SAF programme is structured to be volume-driven and combines with a strategy to build a secure SAF demand. Stimulating the market through an RTFO-inspired mandate forms a central piece in the jet fuel market's transition.

With UK research and industry also progressing on more advanced RCF technology, the government had a case for rapidly introducing such a SAF-specific instrument. Ramping up the UK infrastructure for SAF production is also especially needed as, in 2024, the P66 Humber Refinery was the only SAF production site[5]. And outputs are currently minimal.

2.2.1 The mandate

The announced SAF mandate builds on several of the RTFO's features. It defines a main obligation resting on aviation fuels suppliers to blend increasing volumes of SAF in their annual jet fuel supplies. This blending obligation will start at 2% of the total UK jet fuel demand in 2025. This volume will increase year-on-year on a linear basis, to reach 10% in 2030 and 22% in 2040.[6] As of 2028 a specific obligation will also apply to "power-to-liquid SAF", i.e. SAF generated by using renewable or nuclear energy.

In addition, SAF suppliers will be entitled to claim certificates for the SAF volumes they deliver. Such certificates will serve as evidence of compliance and be tradeable. As such, certificates will provide additional revenue to SAF suppliers holding excess certificates by allowing to sell them to suppliers facing a shortfall. The SAF mandate will also come with a buy-out price mechanism to address compliance needs from suppliers struggling to meet their volume obligations.[7] The buy-out price for the main blending obligation will be at £4.70 per litre of fuel, and £5 per litre of fuel for power-to-liquid SAF.

When operating, the UK SAF supply obligation will be market-shaping. Similar SAF mandates are already operating in countries like Singapore, Norway, France, and Sweden. Statistics from the International Renewable Energy Agency also show how in 2016, 68 governments had already tested biofuel mandates, with blending obligations usually nearing 10%.[8] These policies reflect how governments elsewhere have, just like the UK, built trust in mandate obligations for delivering effective low-carbon transport fuel policies.[9]

By 2030, 10% of the UK aviation fuel mix should come from sustainable feedstock. By 2040, such volumes should reach 22%.[10] Speeding up on policy

5. Phillips 66 Company, 'Renewable Fuels' (Phillips 66 Company. 2024) https://www. phillips66.co.uk/emerging-energy/renewable-fuels/ accessed 01 September 2024.
6. Department for Transport, 'Supporting the transition to Jet Zero: Creating the UK SAF Mandate Government response to the second consultation on the SAF Mandate' (April 2024), 23 https://assets.publishing.service.gov.uk/media/66cf1f99a7256f1cd83a89c1/creating-the-UK-saf-mandate-consultation-response.pdf.
7. Ibid., 44.
8. IRENA, 'Advanced biofuels. What holds them back?' (IRENA, 2019), 40 https://www. irena.org/-/media/Files/IRENA/Agency/Publication/2019/Nov/IRENA_Advanced-biofuels_ 2019.pdf
9. Olivia Woolley, Renewable Energy Law (Hart, 2023), 228.
10. Ibid., 22.

delivery for emission reductions largely explains why SAF has become an urgent priority for Westminster. Acting fast on SAF forms part of the government's lead programmes mentioned in the King's Speech of July 2024.[11] The UK also wants to seize the SAF opportunity to modernize its infrastructure and create market conditions likely to turn the UK into a SAF powerhouse and supplier. SAF technology could also help transition aviation by promoting fuels requiring minimal technical changes to turbojet engines.[12] All these factors help to see the role of SAF innovation and explain why, next to demand-pull mechanisms, the UK's SAF strategy includes research-push mechanisms.

2.2.2 R&D funding and additional policies combining with the mandate

By 2028, five new plants should be delivering UK SAF at commercial scale.[13] This objective aligns with the recent UK re-industrialization and levelling-up programs. On innovation, policy interventions have been supporting research and development around SAF demonstration plants. Since 2014, the DfT has organized funding calls through its Advanced Biofuel Demonstration Competition (ABDC), the Future Fuels for Flight & Freight Competition (F4C), and the Green Funds, Green Skies (GFGS) competition. These competitions came, however, with a much lower funding capacity than the one attached to the Advanced Fuels Fund (AFF) introduced by the Secretary of State in 2022.[14] Coming with £135 million, the AFF provides support for infrastructure, feasibility, and development design studies. The DfT has already awarded competitive AFF grants in 2022 and 2023. Such grants support near-term results and demonstrate how government has entered a triple race against time. First, there is a national priority in supporting infrastructure by addressing investors' risk-aversion for building plants until the revenue certainty mechanism for SAF discussed below comes into play.

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11. Prime Minister's Office and His Majesty King Charles III, Oral statement to Parliament The King's Speech 2024' (Gov.UK, 17 July 2024) https://www.gov.uk/government/speeches/the-kings-speech-2024 accessed 03 August 2024.
12. Odi Fawwaz Alrebei and others, ' Aircraft performance of a novel SAF: Lower costs, lower environmental impact, and higher aircraft performance' (2024) 24 Energy Conversion and Management: X100739 <https://www.sciencedirect.com/science/article/pii/S2590174524002174. Airbus, ' Airbus A400M first test flight with SAF: One step forward to a more sustainable military aviation' (*Airbus*, 2022) accessed 21 November 2024.
13. Department for Transport, 'Pathway to net zero aviation: Developing the UK sustainable aviation fuel mandate' (March 2023) 7 https://assets.publishing.service.gov.uk/media/66cf1f76a7256f1cd83a89c0/pathway-to-net-zero-aviation-developing-the-uk-sustainable-aviation-fuel-mandate.pdf accessed 18 August 2024.
14. Ricardo, 'Advanced Fuels Fund' (*Ricardo*, 2024) https://www.ricardo.com/en/news-and-insights/campaigns/aff accessed 10 August 2024.

Second, the UK is running against time to become a world-leading producer in non-biological, waste and residue-based, advanced fuel technology. Winning this race could give the UK a competitive advantage by growing a 2g SAF capacity, including for export. If, in 2023, the UK's annual SAF supplies reached 97 million litres, investment in infrastructure for advanced technology remains very low.[15] This volume represented 0.28% of all jet fuels consumed in the UK in the said year.[16] Thirdly, the UK research strategy is prioritized to address the CCC's findings showing how government, and aviation, need to move faster on decarbonisation, given the sector's forecast and the UK's carbon budget for aviation.[17] Government interventions are therefore justified by a clear sense of national priority, also connected to insufficient progress and coordination on air quality.[18] This environment will probably justify that government keep supporting aviation fuel research beyond the AFF's 2022–2025 allocation rounds.

When analysed together, the above interventions seek to deliver on the policy priorities of pulling demand for SAF, providing a revenue certainty mechanism, through a competitive and adaptable framework for SAF. These policy priorities inform the UK policymaking for transport and aviation decarbonisation. Acknowledging such priorities also helps isolate several policy traits that transpire as essential ingredients for defining, and delivering, impactful policy outcomes in support of renewable fuels and technologies.

3. SPECIFIC POLICY TRAITS UNDERLYING INSTRUMENTS FOR A UK SAF INDUSTRY

Next to legislating on the mandate, the government has been consulting with jet fuel stakeholders on options for introducing a revenue certainty mechanism to stimulate and de-risk investment in SAF infrastructure. Such additional revenue certainty mechanism is still under discussion and would be subject to future legislation.

Yet, the government's technique for structuring a robust SAF framework, helps to highlight several policy traits coming out as essential characteristics for delivering an effective SAF market reflecting UK policy outcomes.

15. Department for Transport, 'Renewable Fuel statistics' (Gov.UK, 2024) https://www.gov.uk/government/collections/renewable-fuel-statistics accessed 18 August 2024.
16. SAF Investor, 'UK SAF usage jumps 188% in 2023' (Specialist Insight, 2024) https://www.safinvestor.com/news/144958/uk-saf-usage-jumps-188-in-2023/ accessed 18 August 2024.
17. Climate Change Committee (n1); Climate Change Committee, 'The Sixth Carbon Budget Aviation' (Climate Change Committee, 2020) https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf
18. House of Commons Committee of Public Accounts, Tackling local air quality breaches (HC 2022–23, 37), 3.

3.1 Providing certainty – Government plans for introducing a revenue certainty mechanism for SAF

The market economics, and core political narrative, structuring the policy-making for growing the UK's energy infrastructure primarily rely on the private sector to deliver energy investment.[19] For decades now, private investors have been delivering the bulk of the infrastructure and carrying energy project risks. Considering the role of debt, and other forms of structured facility in project finance, these investments require some very clear visibility on investment returns and revenue streams. Debt and structured finance also increase the projects' costs and exposure depending on the project's investment risk profile[20].

With this backdrop, research exploring interventions and frameworks supporting renewable investments has confirmed how providing revenue certainty and long-term visibility through government programmes works as an enabler of investor confidence.[21]

The UK's Energy Market Reform initiated in 2013 has sought to increase investor confidence in large-size renewable energy investments by especially addressing aspects of revenue volatility. The need to enhance revenue certainty also partly explains, beyond aspects of public cost, the UK's policy shift from interventions structured around the Renewables Obligation to the current CfDs for supporting large-size RES investment.[22]

Since 2013, the revenue stability coming with CfDs has helped grow the UK's world-leading offshore wind capacity. The fourth allocation round in 2021 awarded 12 GW of CfDs auctioned primarily to offshore wind projects. CfDs help de-risk investments by providing certainty through 15-year private law contracts. They include a guaranteed "strike price"

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19. Tim Rayner, Merethe Dotterud Leiren and Tor Håkon Jackson Inderberg, 'The United Kingdom: From market-led policy towards technology steering' in Comparative Renewables Policy (Routledge, 2020), 119.
20. Bjarne Steffen, 'Estimating the cost of capital for renewable energy projects' (2020) 88 Energy Econ 104783 https://www.sciencedirect.com/science/article/pii/S0140988320301237. IRENA, Unlocking Renewable Energy Investment: The Role of Risk Mitigation and Structured Finance, (IRENA, Abu Dhabi, 2016) 26.
21. Judith Lipp, 'Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom' (2007) 35(11) Energy Policy 5489 https://www-sciencedirect-com.ezproxy.rgu.ac.uk/science/article/pii/S0301421507002091; Sam Cross and others, 'Bioenergy development in the UK & Nordic countries: A comparison of effectiveness of support policies for sustainable development of the bioenergy sector' (2021) 144 Biomass Bioenergy 105887 https://www.sciencedirect.com/science/article/pii/S0961953420304219. Merethe Dotterud Leiren, Tor Håkon Jackson Inderberg and Tim Rayner, 'Policy styles, opportunity structures and proportionality: Comparing renewable electricity policies in the UK' (2021) 42(1) International Political Science Review 33.
22. Marijke Welisch and Rahmatallah Poudineh, 'Auctions for allocation of offshore wind contracts for difference in the UK' (2020) 147 Renewable Energy 1266 https://www. sciencedirect.com/science/article/pii/S0960148119314168.

providing a minimum revenue for the renewable power generated. Contracts are also indexed to inflation. Government awards CfDs through rounds of reverse auctions leading to award contracts to the lowest bidder. This approach encourages cost efficiency and innovation, thus promoting investments demonstrating value for money for energy consumers and taxpayers. This CfD intervention therefore shows how by providing certainty through a fixed minimum strike price for RES output, these contracts have successfully fostered a lower risk environment by helping to project minimum revenue forecasts and stabilization.[23]

Interest in CfDs for SAF has also grown from the business environment developing around 2g and 3g SAF. UK science and R&D in development fuels are available to deliver a world-leading SAF supply chain. Yet, this prospect remains subject to structuring an enabling business case around SAF. Recent government material and consultations show how policy options for introducing a SAF revenue certainty mechanism notably include possibly legislating on a new guaranteed strike price mechanism for SAF, similar to the CfDs supporting low carbon electricity generation.[24] The SAF industry's context however differs from earlier CfD models introduced to de-risk RES electricity production destined to serve a domestic market. With SAF, competition will be international, and governments nearby are developing SAF support programmes. Setting the future UK revenue certainty support for SAF will therefore call to consider how competing markets are also introducing revenue support mechanisms and how these may impact on the competitiveness of UK SAF products.[25] Providing certainty over UK SAF revenue would therefore mean avoiding the outcome that this support scheme becomes overly costly and uncompetitive. A new CfD scheme would require clearly framing the costs that can effectively be recovered and how these are likely to be supported when faced with changing cost drivers, especially during the investments' early phase. It also matters that the UK industrial strategy's general policy outcome whereby the UK should be a world leader in the

23. David Newbery, 'Designing efficient Renewable Electricity Support Schemes' (Energy Policy Research Group, University of Cambridge, 2021) 2 https://www.jstor.org/stable/resrep30313; Lena Heike Kitzing, and others, Contracts-for-Difference to support renewable energy technologies: Considerations for design and implementation (European University Institute, 2024) 5.
24. Department for Transport, 'Sustainable Aviation Fuels Revenue Certainty Mechanism' (2024) 22 https://assets.publishing.service.gov.uk/media/667c2dc5c7f64e234209007b/dft-saf-rcm-consultation.pdf accessed 17 November 2024; Lena Kitzing, and others, 'An evolving risk perspective for policy instrument choice in sustainability transitions' (2020) 35 Environmental Innovation and Societal Transitions 369 https://www. sciencedirect.com/science/article/pii/S2210422418301278.
25. Pierpaolo Cazzola, et al, 'Comparative Assessment of the EU and US Policy Frameworks to Promote Low-Carbon Fuels in Aviation and Shipping' (UC Davis, September 1, 2024) https://escholarship.org/uc/item/36f1f2zh accessed 17 November 2024.

"development, manufacture, and use of low carbon technologies that cost less than high carbon alternatives" keeps verifying.[26] Technologies capable of rapidly generating high volumes with economies of scale should thus be given the priority. Next to delivering a competitive market price, a future CfD for SAF would at least need to cover the cost of interests on borrowings during the early project stages.[27] It would therefore belong to the DfT, the aviation, the fuel industries, and the future CfD delivery partners, to design a SAF business model that would absorb funding costs and thus give rise to further revenue stability to investors.

3.2 Providing clarity – A robust business model with solid market forecasts for SAF

Success with the government's arrangement will also depend on its ability to enable 2g and 3g SAF deployment based on solid market forecasts. Clarity on market understanding appears even more critical than government is already acknowledging the UK's competitive advantage on non-hydrotreated esters and fatty acids (non-HEFA) SAF.[28] Priority outcomes also include rapidly attracting investments to build five UK SAF plants at commercial scale.[29]

In this context, clarity on targets and contract stability must verify for private investment to follow through. In that respect, introducing a CfD mechanism would provide investors with clarity over their contracts' minimum term which, typically, spans over 10 to 15-years. Another key aspect of this revenue certainty mechanism is how stakeholders understand this policy will be funded. Since the Energy Market Reform in 2013, CfDs supporting large-size RES investments have seen their financing socialized across electricity end consumers. Suppliers pass on electricity end users the cost of their Supplier Obligation, i.e. the specific levy the CfD administrator requires suppliers to pay to finance the CfD scheme.[30] UK electricity end users, including household consumers, pay a per-unit levy on their electricity

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26. HM Government, 'Industrial Strategy Building a Britain fit for the future Clean growth' (HM Government 2017) 42 https://assets.publishing.service.gov.uk/media/5a8224cbed915d74e3401f69/industrial-strategy-white-paper-web-ready-version.pdf. HM Government, Net Zero Strategy: Build Back Greener (HM Stationery Office 2021).
27. Timo Gerres, Pedro Linares, 'Carbon Contracts for Differences: their role in European industrial decarbonization (Climate Friendly Materials Platform, September 2020) 4 https://climatestrategies.org/wp-content/uploads/2021/03/Carbon-Contracts_CFMP-Policy-Brief-2020.pdf.
28. Department for Transport (n 6), 31.
29. Ibid., 7.
30. Department for Energy Security and Net Zero, 'Electricity Market Reform: CFD Supplier Obligation' (Department for Energy Security and Net Zero) https://www.gov.uk/government/collections/electricity-market-reform-cfd-supplier-obligation accessed 15 July 2024; Katherine Monahan and Marisa Beck, 'The United Kingdom's contracts for difference policy for renewable electricity generation' (Canadian Climate Institute, 14

bills. Success with a CfD for SAF would require the same clarity and understanding on how this intervention will achieve the effective cash collection required to finance the strike price committed to SAF investors. Building public trust around this revenue certainty mechanism therefore requires policymakers to clarify whether the public purse will support SAF CfDs, or whether the scheme should generate its own funding by exclusively sourcing its money through the aviation industry. The latter option is not just supported by financial models and efficiency studies, it is supported by policy groups defending that the cost of the SAF price certainty mechanism should be confined to the sector's market base without burdening the general UK taxpayers.[31] Financing should therefore clearly rest on the aviation industry, a position that would also match environmental doctrines defending the polluter pays principle.

3.3 Providing continuity – Long-term delivery and policy support

The strategic policymaking behind UK SAF confirms the central role of consultations for structuring industry-led government instruments aimed at decarbonising transport. This collaboration also evidences how government interventions for RES prove inevitable, including in a private sector-driven, liberalised, energy market.[32] As announced in the King's Speech of July 2024, the UK will not achieve a swift aviation transition without a SAF bill and support framework.[33] The SAF mandate and interventions should therefore lead to a clear product shift, stimulated by growing SAF supply and obligations. Triggering this fuel displacement, and investment in five SAF plants, shows how much this framework will need to appeal to the supply chain by helping to de-risk this environment. These ambitions represent even greater challenges in a context where the UK has lost almost 30% of its refinery capacity since 2010.[34]

February 2023) https://climateinstitute.ca/publications/uk-contracts-for-difference-policy-for-renewable-electricity-generation/#:~:text=In%20effect%2C%20the%20U.K.%20CfD, on%20the%20fluctuating%20power%20market. accessed 01 September 2024.

31. Philip New, Developing a UK Sustainable Aviation Fuel Industry, (2023) 21 https://assets.publishing.service.gov.uk/media/64afb9edc033c1000d80621c/developing-uk-sustainable-aviation-fuel-industry-independent.pdf accessed 16 June 2024.
32. Alkis Pitelis, Nicholas Vasilakos and Konstantinos Chalvatzis, 'Fostering innovation in renewable energy technologies: Choice of policy instruments and effectiveness' (2020) 151 Renewable Energy 1163 https://www.sciencedirect.com/science/article/pii/S0960148119317938 accessed 18July 2024.
33. Ibid. (n 11).
34. OEUK, 'Offshore Energies UK (OEUK): Why is the UK exporting gas when we are in short supply?' (OEUK News, 5 April 2022) https://oeuk.org.uk/offshore-energies-uk-oeuk-why-is-the-uk-exporting-gas-when-we-are-short-supply/ accessed September 1, 2024.

Government's progress on SAF requires understanding how its instruments can lead to continuity in structuring a steady SAF supply and demand, while generating a market lift off through solid investments and delivery partners. Focusing on the mandate will help include larger volumes of SAF across the supply chain. Yet, acting on the mandate alone would hinder the government's plan for long-term SAF investments that should reduce marginal costs and render UK SAF more competitive. These prospects therefore confirm how policies supporting innovative RES should rest on holistic models that can help shape markets, especially in the early years.[35]

Policy observers will recognize the market traction also achieved through combining a demand-pull instrument, the mandate, to a future revenue certainty mechanism. In practice, a mechanism like CfDs would help de-risk and provide long-term visibility to investors. This combination would not simply address the SAF investors' revenue stability concerns reflected in consultations.[36] Government interventions come as long-term, market stabilizing strategies, because of the continuity required to achieve aviation decarbonisation and deliver on the public priority to displace fossil fuels.

The SAF mandate and future revenue certainty mechanism therefore confirm how long-term institutional role and public engagement remain critical requirements for transforming attitudes across energy markets.[37] The central role of public intervention to achieve transformation is also reflected in the UK's history with market-shaping arrangements started more than twenty years ago. Without such interventions, the UK RES transformation would have failed to yield any significant sectorial benefits and remained uneconomical.[38]

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35. Andrea Masini and Emanuela Menichetti, 'Investment decisions in the renewable energy sector: An analysis of non-financial drivers' (2013) 80(3) Technological Forecasting and Social Change 510 https://www.sciencedirect.com/science/article/pii/S0040162512001850 accessed 22 July 2024. Robyn Owen, 'Lessons from government venture capital funds to enable transition to a low-carbon economy: The UK case' (2021) 70(3) IEEE Trans Eng Manage 1040, 1042.
36. Ibid. (n 6) 27. Ingmar Schlecht, Christoph Maurer and Lion Hirth, 'Financial contracts for differences: The problems with conventional CfDs in electricity markets and how forward contracts can help solve them' (2024) 186 Energy Policy 113981 https://www. sciencedirect.com/science/article/pii/S0301421524000016 accessed 28 June 2024.
37. Lizette De La Peña, and others, 'Accelerating the energy transition to achieve carbon neutrality' (2022) 177, Resour Conserv Recycling 105957, 105964 https://www. sciencedirect.com/science/article/pii/S0921344921005668 accessed 28 June 2024. Måns Nilsson and others, 'The missing link: Bringing institutions and politics into energy future studies' (2011) 43(10) Futures 1117, 1118 https://www.sciencedirect.com/science/article/pii/S0016328711001765 accessed 29 June 2024.
38. Catherine Mitchell and Peter Connor, 'Renewable energy policy in the UK 1990–2003' (2004) 32(17) Energy Policy 1935 https://www.sciencedirect.com/science/article/pii/S0301421504000710 accessed 29 June 2024.

3.4 Providing adaptability – A SAF framework capable of adjusting to market conditions

This policy investigation helps confirm how long-term clarity and continuity remain core requirements for building RES programmes altogether capable of triggering policy uptake, stakeholders' buyout, private investment, and a system and value chain transformation.[39] In the SAF model, the mandate pulls demand by meeting growing SAF supply obligations. Future legislation will further support investment in SAF production by introducing a mechanism offering certainty over investment revenue. Their impact should lead to bolster the SAF market share and, with growing SAF revenue, stimulate the sector's capacity to invest and further innovate.

Experience with instruments supporting large RES deployment reveals how policy frameworks also demonstrate effectiveness by their capacity to adapt to changing markets. Policy history shows how the Renewables Obligation's (RO) gradually required introducing a banding system, with revised targets and revenue adjustments, to drive more large RES investment. The RO model proved ultimately too expensive, and this framework was transformed to enable the CfD model with reverse auctions. Policy adaptability therefore helps towards outcomes and delivery, especially in markets with evolving technologies and their associated uncertainties.[40] With early-stage technologies, delivering on policy outcomes also requires accompanying investors in unstable environments, which include adapting to changing government budgets and circumstances.[41]

Policy models should anticipate that early RES supports must adapt to their competitive markets also stimulated by economies of scale. Changes may

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39. Rheinard Haas, and others, 'How to promote renewable energy systems successfully and effectively' (2004) 32(6) Energy Policy 833, 838. https://www.sciencedirect.com/science/article/pii/S0301421502003373 accessed 30 June 2024. Friedmann Polzin, and others, 'How do policies mobilize private finance for renewable energy? — A systematic review with an investor perspective' (2019) 236 Appl Energy 1249, 1250. https://www.sciencedirect.com/science/article/pii/S030626191831818X accessed 2 July 2024.
40. Ute Dubois, 'Adaptability of competitive electricity reforms a modular analysis' (2009) 37(4) Energy Policy 1213 https://www.sciencedirect.com/science/article/pii/S030142150800654X accessed 2 June 2024; Max Åhman, 'Government policy and the development of electric vehicles in Japan' (2006) 34(4) Energy Policy 433 https://www. sciencedirect.com/science/article/pii/S0301421504001855 accessed 4 July 2024.
41. Michael Pahle, and others, 'The crucial role of complementarity, transparency and adaptability for designing energy policies for sustainable development' (2021) 159 Energy Policy 112662 https://www.sciencedirect.com/science/article/pii/S0301421521005279 accessed 6 July 2024; Economidou, M. and others, 'Strategic energy and climate policy planning: Lessons learned from European energy efficiency policies' (2022) 171 Energy Policy 113225 https://www.sciencedirect.com/science/article/pii/S030142152200444X accessed 4 July 2024.

also affect the SAF investors themselves.[42] As indicated above, UK SAF will be exposed to international competition. An effective SAF policy will therefore require monitoring how the cost of a revenue certainty mechanism impacts on the flexible competitive pricing of UK products. Ideally, mandated supplies should lead to a natural demand for SAF, with production becoming rapidly more economical without policy support needs. A satisfactory policy outcome should be that UK SAFs become priority products by outperforming market forecasts, regardless of the demand-pull mechanism.

3.5 A flexible policy framework suited to international trade rules

Government interventions for SAF should be justified in so far as the above instruments are required to grow a commercial capacity steered by competitive prices. In doing so, this strategy should foster a level playing field with other SAF markets and not distort trade and competition. With SAF, competition will be regional if not global. As a critical market, the European Union (EU) will also be stimulating SAF supply and uptake by implementing the ReFuelEU Aviation regulation as of January 1, 2025.[43] The EU's instruments include an EU-wide minimum share blending obligations and a CfD mechanism partly financed by using carbon credits from the EU's Emissions Trading System (EU ETS).[44] The role of the UK Emissions Trading Scheme (UK ETS) in financing SAF will require clarification. At the time of writing, the industry would welcome seeing the UK SAF policy being supported by the UK ETS.[45]

Looking towards 2050, and as blending requirements keep rising, the SAF cross-border trade will grow supported by tighter decarbonisation requirements, growing air traffic and fuel suppliers' intake. This cross-border context could lead to question the impact on international trade of domestic subsidies for SAF production and investment, and their compliance under the WTO's Agreement on Subsidies and Countervailing Measures (the SCM rules). Regarding RES support schemes, the SCM rules have been tested

42. Jochen Markard, Marco Suter and Karin Ingold, 'Socio-technical transitions and policy change – Advocacy coalitions in Swiss energy policy' (2016) 18 Environmental Innovation and Societal Transitions 215 https://www.sciencedirect.com/science/article/pii/S2210422415000313 accessed 25 June 2024.
43. Council Regulation (EU) 2023/2405 of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation) OJ L, 2023/2405, 31.10.2023.
44. Liselotte Jensen, 'Aviation's contribution to European Union climate action' (European Parliament Research Service, Briefing June 2023) https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698882/EPRS_BRI (2022) 698882_EN.pdf accessed 2 July 2024.
45. Ibid. (n 6), 27.

against domestic feed-in tariffs stimulating renewable electricity production.[46] Cases resolved under WTO rules have however done little to clarify the SCM rules in detail. Yet, these cases have addressed whether certain domestic renewable energy programmes should be treated as subsidies actionable under the SCM rules. The recent cases introduced by Malaysia and Indonesia have led the WTO's dispute board to scrutinize whether specific national provisions did provide an "income support" to biofuel operators within the meaning of the SCM's article 1.1(a)(2). Although these claims failed, these two WTO cases have shown how two major biofuel producers have sought to challenge income support mechanisms by putting forward violations of the WTO's SCM rules and other GATT 1994 provisions.

Considering the sizeable international market for SAF, it appears meaningful to consider how domestic frameworks might be challenged as "subsidies", such as broadly construed in WTO language. Competitors could argue that the UK support mechanisms would make SAF exports possible by means of subsidies conferring a specific UK benefit causing adverse effects to non-domestic SAF operators. The UK support framework should also satisfy the standard for national treatment under WTO rules as a condition to UK SAF exports. Despite the WTO's limited caselaw and unclear legal solutions around renewable energy support schemes, this legal risk should invite government to introduce a SAF policy package compatible by design, and adaptable, to WTO doctrines. The rise of SAF markets will define cross-border trade flows closely aligned with existing JetA1 fuel markets. This product displacement will call for further interventions to maintain equal market conditions between jet fuel producers and suppliers. Policy instruments should therefore remain adaptable to allow a level playing field amongst operators, as interventions are likely to remain justified to further push SAF uptake, and speed up decarbonisation, considering the industry's forecasts of an annual 2%rise in European air traffic from 2024 to 2030.[47]

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46. WTO Secretariat, 'Dispute Settlement: European Union and its Member States—Certain Measures Relating to the Energy Sector' (WTO, 2018) https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds476_e.htm accessed 14 June 2024; WTO Secretariat, 'Canada-Certain Measures Affecting the Renewable Energy Generation Sector' (WTO, 2014) https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds412_e.htm accessed 15 June 2024; WTO, 'Agreement on Trade Related Investment Measures' (WTO, 2024) https://www.wto.org/english/tratop e/invest_e/ accessed 15 June 2024.
47. Eurocontrol, 'Forecast update 2024–2030' (Eurocontrol, 2024) https://www.eurocontrol.int/sites/default/files/2024-02/eurocontrol-seven-year-forecast-2024-2030-february-2024.pdf accessed 15 July 2024.

4. CONCLUSION

The SAF blending mandate announced for January 2025 has been designed to boost aviation decarbonisation while encouraging the UK to become a market leader in 2g/3g SAF production. These objectives arise in an environment where domestic decarbonisation is primarily achieved through private invest-ment, the industry's engagement and transformation.[48] In this article, it has been possible to isolate how the UK SAF mandate, and its future revenue certainty mechanism will likely combine to offer greater market stability and certainty to investors. The role of government interventions in policymaking shows that policy instruments are not just there to provide support to initial investment. They also play a role in addressing asymmetries when reaching the stage of project delivery and help towards market stabilization. This exploration has also confirmed how such instruments should prove flexible by design, and display an in-built capacity to adapt, serve multiple policy outcomes, and adjust to domestic and international requirements. Another important feature of the British technique in designing policy instruments is to consult with industries on policymaking. This expertise includes considering stakeholders' experience and gathering views to help design more purposeful, evidence-based, policy instruments. Thus, introducing a SAF policy capable of adapting to market conditions, and achieving a competitive pricing, will prove essential to make UK products successful, including on external markets. Transforming UK prospects on SAF could also mean creating more durable industrial opportunities by developing innovative decarbonised fuels for road transport. This additional outcome would signal how a policy support to fuel innovation, combined with industrial and supply-side mechanisms for aviation, can contribute to the wider transport sector's decarbonisation. Success with SAF could therefore percolate across the rest of UK transport, making the need to transform engine technology, or swap for electrical vehicles, less of a radical and expensive shift. This achievement would demonstrate how sectorial policy efforts on aviation fuels can enable a fairer transition across other transport modes, and private vehicles in particular, until the infrastructure for electric, low, or zero-emission transport solutions, expand substantially and become more affordable.

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48. Friedemann Polzin et al., 'How do policies mobilize private finance for renewable energy?A systematic review with an investor perspective' (2019) 236 Appl Energy 1249 https://www.sciencedirect.com/science/article/pii/S030626191831818X accessed 16 July 2024.