UNIVERSITY OF CAMBRIDGE | Aviation Impact Accelerator

Searching for blue skies: Policy roadmap for navigational contrail avoidance

Policymaker summary

The Aviation Impact Accelerator
The Aviation Impact Accelerator is the global systems change initiative in aviation, based in the University of Cambridge. Combining data modelling and expertise across industry, governments and academia, we drive the transition to climate-neutral aviation.

The AIA's work draws upon the University of Cambridge's academic expertise and research rigour, together with the engineering capabilities of the Whittle Laboratory and the sustainability and policy expertise of the Cambridge Institute for Sustainability Leadership (CISL).

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1 Introduction

This report proposes a policy pathway designed to reduce aviation's non-CO_2 climate impacts – specifically, warming created by persistent aircraft contrails – in UK airspace and, subsequently, further afield. Building on technical work undertaken by the Aviation Impact Accelerator (AIA) at the University of Cambridge, and aligned with upcoming UK government-funded trials, this report sets out a phased approach for the implementation of targeted contrail avoidance with the aim of securing increasingly significant reductions in climate impact by 2040.

The opportunity should not be understated: the warming effect of non-CO_2 impacts from aviation, predominantly persistent contrail cirrus clouds, is comparable in scale to all of aviation's carbon dioxide emissions combined. If we can effectively avoid the formation of these persistent contrails, we can, in theory, almost halve the climate impact of aviation. Between 2 and 5 per cent of flights create 80–90 per cent of the warming impact, meaning intervention can be targeted at a small proportion of flights. The required intervention is small, involving an altitude change of ±2,000 ft in most instances, well within the envelope of normal flight operations to avoid weather and turbulence. Where these in-flight deviations cause additional fuel burn (~0.1 per cent averaged across an airline's fleet) the climate impact of the extra fuel is around 100 times smaller than the benefit of avoiding the contrail, and at least 15 times smaller even in the worst case. Unlike other climate solutions for aviation – a hard-to-abate sector – navigational contrail avoidance can be implemented in the short to medium term, with sustained efforts to scale avoidance before 2035 likely to be several times more effective than if action is delayed. Finally, the cost of contrail avoidance is very small, under US$25 per tonne of CO_2 equivalent warming, making it one of the most cost-effective climate solutions available today.

The UK Government should act now to establish the foundations for navigational contrail avoidance: improving access to reliable contrail forecasting data; ensuring flight-planning systems can identify viable avoidance routes; and developing incentives for airlines to avoid high-impact contrails where practicable. Government should also establish clear ownership for implementation and use UK trials to build the evidence and capability needed for wider international deployment.

This policymaker summary outlines a roadmap that could help realise this climate opportunity, focused initially on scaling avoidance in the UK through three policy building blocks ahead of wider international deployment through a phased roadmap. While this document summarises the proposals at a high level, the technical detail and developed policy roadmap can be found in two accompanying documents:

- → **Technical guardrails for contrails policy development**, explaining the scientific basis for navigational contrail avoidance, including guardrails delineating the implications for policymaking of operating in an evolving space. These are summarised in Section 3.
- → **Searching for blue skies: Policy roadmap for navigational contrail avoidance**, the white paper, which includes more detail on the policy proposals, the mechanisms for their operation, the modelling used to develop them and operational considerations, among other details.

2 An opportunity for UK leadership

The UK is almost uniquely well placed to lead on contrail avoidance due to its geographical positioning and control over North Atlantic airspace, world-leading academic and industry capability and respected public institutions. The UK government has recognised this position by providing £2.65 million to support the Operation Blue Skies large-scale trials over the 2026–28 period. Other jurisdictions are starting to move: the European Commission proposed a contrail-readiness incentive as part of its Emissions Trading System review in summer 2026. The window for UK leadership is open, the opportunity significant and the reward substantial.

A key national asset is the UK's control of air traffic over the eastern half of the busy North Atlantic air corridor, where atmospheric conditions also create a key contrail-forming region and therefore an ideal location for implementing avoidance. The Shanwick oceanic airspace west of Ireland (Figure 1) covers 700,000 square miles, and due to its strategic positioning will play host to the Operation Blue Skies trials overnight during winter (when the most contrail warming occurs) 2026–27 and 2027–28.

Several of the world's leading contrail researchers are based in the UK at Imperial, Cambridge, Reading and other universities. We host technology clusters with direct relevance for contrail prediction including space and remote sensing leaders like Airbus. The Aerospace Technology Institute provides billions of pounds of dedicated innovation funding to support low carbon innovation in the sector. The Met Office is one of only two International Civil Aviation Organization (ICAO) World Area Forecast Centres providing meteorological data to aviation stakeholders across the world. Finally, UK airspace is controlled by a single regulated Air Navigation Service Provider (ANSP), NATS, providing a structural advantage over the fragmented airspace of our European neighbours.

If implemented, the roadmap would make the UK the first country to avoid contrails as a matter of routine.

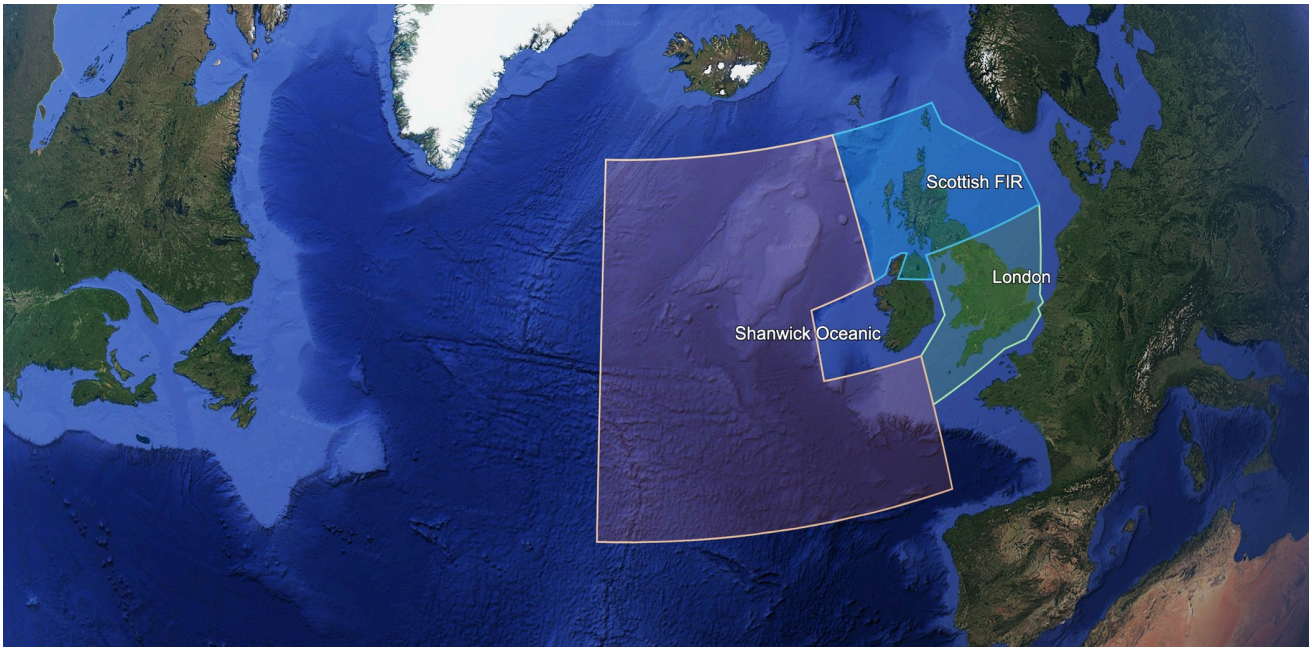


Figure 1: UK-administered airspace: the London and Scottish flight information regions and the Shanwick Oceanic Control Area.

3 Safe, effective, feasible: guardrails for contrail policy development

There are three tests that any aviation policy should pass:

→ Aviation is a safety-critical industry and **safety** considerations must come first at all times.

→ Any measure must be **effective** with sufficient coverage, compliance and climate benefit.

→ Any measure must be **feasible**, reflecting what science can tell us and operational systems can deliver, distinguishing temporary investment-related gaps from structural constraints that policy must be designed around.

Drawing on these principles and on the current science of contrail impact and avoidance, we have identified a set of technical guardrails to inform the design of any new contrail policy:

1. **Safety comes first.** Contrail avoidance must always remain subordinate to air traffic control instructions and operational safety, and flights unable to avoid for safety or capacity reasons should not be penalised.
2. **Lead with pre-tactical navigational avoidance.** Small changes of flight level, planned before departure, can be delivered with today's aircraft, flight-planning processes and air traffic management, making this the fastest and most deployable route to cutting contrail warming.
3. **Use portfolio-level monitoring and reporting.** Observation of contrail avoidance by individual flights is currently impossible at scale, while the complexities of atmospheric science lend a degree of uncertainty to climate impact modelling for any specific contrail. Consequently, evaluation of success or failure in contrail avoidance is best judged using statistical methods in the aggregate.
4. **Avoid reliance on SAF or future aircraft technologies in the near term.** The contrail benefit of SAF is not yet established, supply is far too limited, and the way SAF is traded cannot be tied to individual flights. New aircraft and engines will take decades to reach the fleet. Both are valuable in the long term, but cannot substitute for action now.
5. **Invest in infrastructure and weather data.** Better humidity observations, contrail forecasting and common flight-planning standards are the main gaps that investment can close, and should be funded as a priority.
6. **Do not conflate CO_2 and non-CO_2 effects.** Contrail and CO_2 warming are not interchangeable, and how to compare them remains contested. Keeping their policy instruments separate stops operators offsetting action on one with inaction on the other, even though individual flight plans must still weigh the two.
7. **Name a single co-ordinating owner.** No single actor controls the chain from forecast to flight: the Met Office, NATS, the Civil Aviation Authority and airlines each control one step. To avoid deadlock, a single co-ordinating owner, such as the Department for Transport or the Civil Aviation Authority, should hold the mandate for delivery.
8. **Adopt adaptive, ICAO-compatible regulation.** Contrail understanding and avoidance is a developing area, and while there is overwhelming evidence that avoidance will have a positive climate impact that

allows us to act, we should adapt to shape our action as our understanding improves. Measures should start as voluntary or incentive-based, tighten as capability matures and remain compatible with international rules set by ICAO.

9. **Apply to all operators equally, target by forecast.** Only a small share of flights (about 2 per cent globally and around 12 per cent over the North Atlantic) cause about 80 per cent of contrail warming. The most efficient approach covers all operators and lets forecasts and routing software select the high-impact flights, rather than drawing scope around particular routes or airspace.

More information can be found in our accompanying report, *Technical guardrails for contrails policy development*.

4 Three UK policy building blocks

Based on extensive engagement with stakeholders across the aviation ecosystem (including NATS, Met Office, CAA, academic experts, civil servants and industry representatives) we propose three building blocks for a contrail avoidance policy in the UK. Additional detail on these proposals and their development can be found in the accompanying white paper.

Building block 1: Data mandate

Aspect	Description
Problem	There is currently no single source of contrail intelligence available to all aviation stakeholders, leading to confusion, unclear climate impacts and accountability issues should an avoidance system be implemented under the current status quo.
Proposal	Require the Met Office to include forecasts of contrail-forming regions (ice-supersaturated regions) in the standard aeronautical meteorological data packet supplied to airlines, dispatchers, pilots and ANSPs. The mandated product is a baseline available to all, although operators may plan with any forecast that meets a published benchmark.

Table 1: Building block 1 (Data mandate): problem and proposal.

Building block 2: Capability standards

Aspect	Description
Problem	Most airlines do not have the tools within their flight-planning systems to avoid contrail-forming regions at present. Without the infrastructure in place airlines simply cannot plan avoidance.
Proposal	Set a minimum standard for flight-planning software requiring the ability to plan contrail-optimised routing, and oblige airlines to consider avoidance of contrail-forming regions in their planning.

Table 2: Building block 2 (Capability standards): problem and proposal.

Building block 3: Incentives to act

Aspect	Description
Problem	There is currently no regulatory or financial incentive for airlines to avoid contrail-forming regions. In some cases, they would face small additional fuel costs for performing a contrail-avoidance manoeuvre. Without a regulatory or price signal airlines are unlikely to plan contrail-avoiding routes.
Proposal	A fee and rebate attached to existing airspace charges, applying to warming modelled to have occurred in UK-administered airspace, could incentivise action. Alongside this, a small service charge on every flight in UK-administered airspace covers the rest of the running cost and the extra fuel burned on accepted avoidance plans, which is repaid in full to 2035 and on a falling scale to zero in 2040.

Table 3: Building block 3 (Incentives to act): problem and proposal.

Building block 3 outlines an incentive mechanism that could help scale adoption of contrail avoidance by airlines using the infrastructure developed in building blocks 1 and 2. In this system, flights confirmed to have avoided a contrail-forming region would receive a rebate funded by a fee levied on flights that were forecast to cross such a region and kept their route through it, with the scheme designed to cover its own costs. How the fee and rebate attach to a flight is shown in Figure 2.

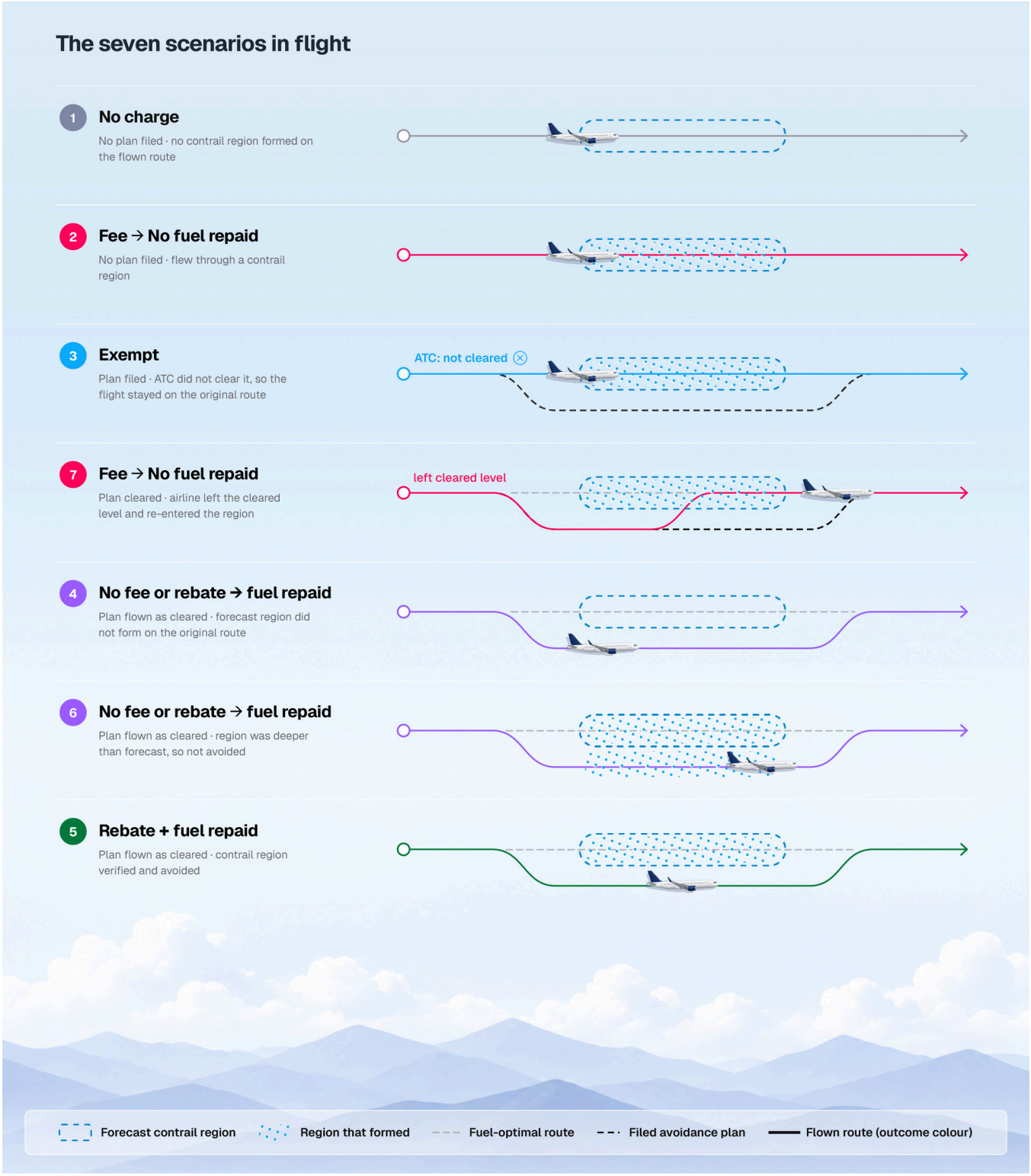


Figure 2: The seven scenarios as flight paths, showing what was planned, what was flown and what each flight pays or receives.

The decision process an operator would follow as part of this system is described in Figure 3, covering the period from a forecast flagging a planned flight as high-risk through planned avoidance to the aircraft flying a contrail-avoiding route and the outcome for the operator.

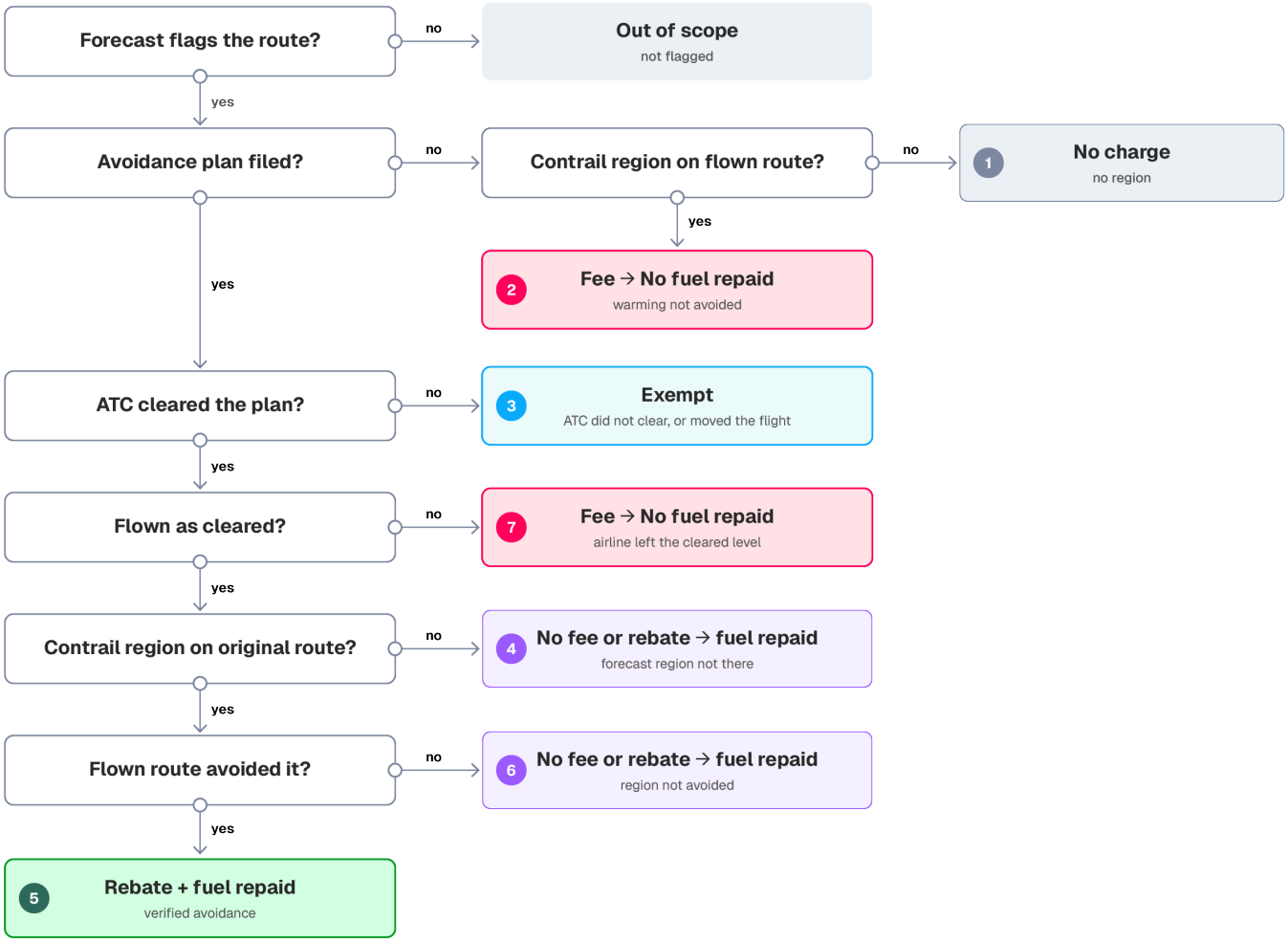


Figure 3: Seven scenarios as a decision sequence.

5 Implementation roadmap

Given the UK's geographical advantage and national assets described in Section 2, the implementation roadmap logically focuses first on building an avoidance system in UK airspace before expanding the scope to neighbouring partners over time ahead of an envisaged global avoidance system that is potentially achievable by 2040. Figure 4 shows this geographical expansion alongside the deployment of the policy building blocks in Section 4 over time. While some measures will naturally come sooner and others later, the importance of scaling contrail avoidance in the near term is critical to maximising positive climate impact, as described in Section 1.

Timeline	Geographic focus	Objective	What needs to happen
Phase 1 – Foundations (2026–28)	United Kingdom	Establish the essential technical, operational and policy building blocks on which everything else depends	Develop and validate contrail forecasting and measurement capabilities; implement Met Office data mandate
Phase 2 – Voluntary demonstrations (2028–30)	United Kingdom (+ Atlantic partners)	Generate operational evidence and demonstrate feasibility in UK flight information regions	Run pilot programmes with airlines and ANSPs; test operational procedures; evaluate climate benefit and airspace impact
Phase 3 – Feebate incentives (2030~2035)	UK, Atlantic partners and EU	Create economic incentives for airlines' participation, making avoidance the rational default	Introduce feebate from 2030. Gather evidence on responses and system effectiveness to refine the price signal
International expansion			
Phase 4 – New markets (~2030 onwards)	UK, EU and transatlantic partners	Scale beyond initial focus region to markets of greatest potential impact	Expand participation among airlines, ANSPs and states. Develop international governance framework for a global avoidance system
Phase 5 – A global system (2030~2040, parallel to Phase 3)	Global	Deliver a global and operationally embedded contrail avoidance framework	Leverage existing multilateral channels such as ICAO to share evidence, build consensus and develop an international mechanism

Table 4: The five phases of the implementation roadmap.

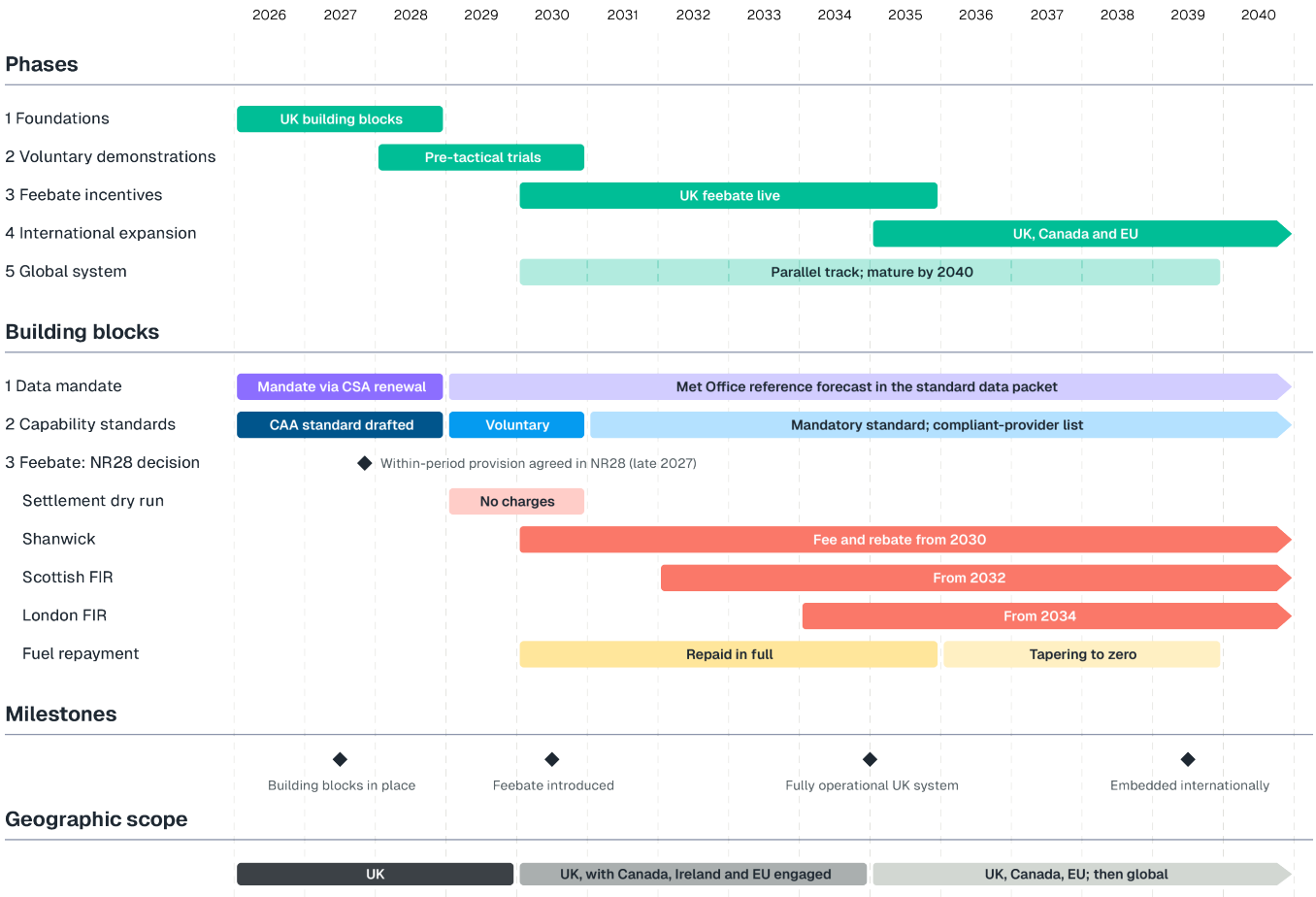


Figure 4: Contrail avoidance roadmap showing phases, policy building blocks, milestones and geographic scope (2026–2040).

6 A vision for global contrail avoidance

Navigational contrail avoidance is probably the only viable pathway to significantly reducing aviation's climate impact in the short to medium term; it is certainly the cheapest, implementable with existing aircraft and infrastructure and requiring only minor adjustments to current operational norms that passengers (and their wallets) are unlikely to notice. The policy roadmap outlined in this document moves the conversation from a place of experimentation, trials and knowledge building to demonstrating a maturity of knowledge that calls for operational implementation on an ambitious timescale that will deliver the greatest positive climate impact.

Unlike with other aviation climate solutions, the primary ask here is not for vast amounts of investment (although a modest amount will be needed); rather, it is mobilising the machinery of government to prioritise building the foundational systems that will underpin an avoidance system well into the future. Key UK institutions like the Met Office, NATS, the Civil Aviation Authority and Department for Transport are all working on contrails to varying extents, trying to understand the implications for their future roles. Through the consultations carried out to develop this work during 2026, a willingness to engage and take action was never a barrier; a lack of clear direction setting or a 'mandate' from the government to allocate a higher priority to this topic emerged as a critical next step in progressing the UK's leadership on both climate and aerospace innovation.

Hence, there is a clear ask to the UK government: demonstrate a clear commitment to addressing the climate impacts of aviation by prioritising navigational contrail avoidance as the cheapest, fastest and most easily implemented climate solution available for the sector today through the policy measures outlined here. In particular, we recommend seven actions for 2027–28:

→ Name a single owner (the Department for Transport or the Civil Aviation Authority)

→ Put contrail forecasts in the Met Office's standard aviation data

→ Keep a charging option open in the next NATS price control, which is settled in late 2027

→ Commission a legal opinion on the charging basis

→ Start a voluntary standard for contrail-aware flight-planning software

→ Fund humidity observations and the evaluation of Operation Blue Skies

→ Open talks with Ireland, Canada and the EU. None of these commits government to a feebate, and together they keep a 2030 start possible.

The urgency of taking action now rather than delaying is clear: recent research has shown the significant contribution contrail avoidance can make to reaching temperature targets under the Paris Agreement (up to 9 per cent if avoidance is phased in worldwide between 2035 and 2045; reducing to ~2 per cent if action is delayed by ten years). This opportunity is increasingly being recognised in other jurisdictions, notably the European Union, where the first attempt to introduce legislation targeting contrail impacts was proposed in 2026.

As demand for air travel continues to grow, we must look for ways to reconcile this trend with the increasingly apparent and threatening effects of climate change. Perhaps part of the solution has been in

front (or above) us all along – in eliminating contrails and delivering blue skies, we can buy ourselves time to build the longer-term solutions that will deliver a sustainable aviation system in the latter half of this century and beyond.

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