



Towards governance of climate cooling approaches

Scenarios and policy planning tool

centre
for future
generations

Funded by
Advanced
Research
+ Invention
Agency

ARIA



Australian
National
University

Towards governance of climate cooling approaches

Scenarios and policy planning tool

Author:

Dr. Trish Lavery
Centre for Future Generations
and Australian National University

Centre for Future Generations

Norrskén House
Rue du Commerce 72
1040 Bruxelles
E-mail: info@cfg.eu

Copyright © 2026 by the Centre for Future Generations.

Table of Contents

Executive summary	4
Scenario development	5
Six observations across the four scenarios	5
How to use the report	5
Acknowledgements	6
1. Introduction	8
Report context and scope	9
2. The landscape shaping SAI governance	10
2.1 Commercial and private sector interest	11
2.2 The governance and geopolitical landscape	13
2.3 The climate-policy context	16
2.4 The information environment	16
3. From landscapes to scenarios	19
3.1 Scenario summaries	21
4. Cross scenario insights for policymakers	23
Policy planning tool	26
Context	27
Contents of the planning tool	27
What this tool is not	28
Reading the scenarios	28
2036 SAI governance scenarios	29
A values-based prohibition	29
Silver Bullet	32
Hard Landing	36
Arms Race	40
Using the scenarios	43
Technique 1: futures wheel	44
Technique 2: robustness testing	45
Technique 3: backcasting	46
Translating workshop outputs into policy action	48
Endnotes	51

Executive summary

Stratospheric aerosol injection (SAI) is a form of solar radiation modification (SRM) that would reflect a portion of sunlight back into space to reduce global temperatures. It is not a solution to climate change. It would not reduce atmospheric carbon concentrations, or reverse ocean acidification, but it could lower global temperatures within months while mitigation and carbon removal take effect over decades. Its consequences would be global, imperfect, and unevenly distributed. Decisions about SAI research, deployment, and governance are contested.

Existing analysis of SAI has been scientifically sophisticated but politically simplistic. Real-world decisions will be taken under social, economic, and geopolitical conditions that formal climate models do not represent. This report changes that: it offers four 2036 scenarios outlining the plausible conditions under which SAI decisions may need to be taken, along with a facilitation tool that policymakers can use to test how governance arrangements might hold up, or fail, under each.

1. Values-based prohibition A Global Solar Geoengineering Restraint Agreement is adopted at UNEA but stalls at ratification. African, Latin American and Pacific leadership builds a precautionary majority; states with SAI programmes refuse to be bound. Central tension: does a normative position without infrastructure deter deployment, or does it concede capability, and choice, to others?	2. Silver bullet A private large-scale outdoor test is days from launch, backed by powerful states. SAI has been rebranded as cheap economic relief, protecting against climate-driven migration and insurance failure. Mitigation continues with weakened political backing. Central tension: can public institutions put guardrails on a privately-led cooling agenda once it takes a life of its own – and can cooling coexist with mitigation?
3. Hard landing An Arctic research alliance built on radical transparency, Indigenous inclusion and regional self-defence loses legitimacy after a drone lands outside its test zone. Flight data is selectively quoted online as evidence of covert activity. Neighbouring states move toward research bans. Central tension: can good-faith transparency sustain legitimacy in an information environment shaped by hostile actors?	4. Arms race A rival is accused of preparing for SAI deployment. Contested evidence drives escalation toward great-power competition. Research programmes are classified; middle powers debate developing atmospheric capabilities to balance against escalation. Central tension: once SAI is framed as weather sovereignty, will climate considerations still hold influence?

Scenario development

The scenarios were developed through a dual-track foresight process involving over 250 policymakers, scientists, civil society representatives and citizens across multiple regions globally, alongside a structured assessment by twenty-two experts. They assume a 2036 reached on an emissions trajectory not far off the current one, leaving SAI a live policy question rather than a technology choice overtaken by rapid decarbonisation.

Six observations across the four scenarios

Read together, the scenarios generate observations that hold across all four:

- **Politics, not climate science, may drive SAI decisions.** Values coalitions, cost-of-living politics, self-defence or rivalry shape outcomes more than scientific ideal-cases.
- **Owning research capacity is itself a governance choice.** States that lack technical expertise may be negotiating from a weaker position, whether their intent is to deter or enable deployment.
- **Public deliberation capacities are key.** Trust is earned slowly and lost quickly. Early engagement and transparency support a factual information ecosystem; late engagement leaves the field for others.
- **Independent monitoring and attribution is position-neutral infrastructure.** The capacity to know who is doing what in the atmosphere is useful regardless of what position countries take on SAI itself.
- **The climate and security policy communities are having different conversations about SAI, and neither is hearing the other.** If those who hold moral hazard, equity, and intergenerational concerns do not engage in defence and commercial spaces, the framings that will prevail will be brought by the actors that are in the room.
- **Defensible SAI deployment presupposes accelerated mitigation and a credible off-ramp.** The expert analysis found that defensible SAI deployment scenarios were consistently paired with accelerated mitigation efforts; deployment without such acceleration was not judged to be plausible.

How to use the report

The scenarios are the first half of a tool designed for structured policy planning. The second half is a facilitation guide offering three techniques for using the scenarios in workshop settings: the futures wheel (exploratory), robustness testing (evaluative), and backcasting (temporal). Each supports different workshop purposes, and together they help policymakers test how governance arrangements might hold up, or fail, under a range of plausible scenarios.

Acknowledgements

This report is one of the outputs of the SAFEGEOGOV project, funded by the Advanced Research and Invention Agency (ARIA) under its Exploring Climate Cooling opportunity space. The project brought together the Centre for Future Generations (CFG, Brussels), the Australian National University Futures Hub, the Organisation for Economic Co-operation and Development (OECD), and the University of Leeds. Dr Trish Lavery designed the scenarios project, led the expert engagement and stakeholder contribution, and drafted the report.

The SAFEGEOGOV project was led by the Centre for Future Generations climate cooling team:

Matthias Honegger, Cynthia Scharf, Giulia Neri, Camilla Taddei, Christine Nagy, and Roxane Cordier. Their coordination, analytical input, and sustained engagement across the life of the project made this report possible.

Earlier drafts of the report benefited significantly from comments from Danielle Young (University of Leeds), Dexter Docherty (OECD), Giulia Neri (Centre for Future Generations), Andrew Lockley (University of Texas at Austin) and Merle Read (Read Edit), whose critical reviews improved the quality and clarity of the final text.

The scenarios in this report are the product of a much larger collaborative effort. A structured expert engagement process brought together 22 contributors from institutions and organisations across multiple regions, whose analytical work directly shaped the scenarios. Alongside this, over 250 policymakers, scientists, civil society representatives, and interested citizens shared their perspectives through interviews and workshops over the course of the project. What is presented in this report reflects the middle ground of their many voices, and the author is grateful to all who contributed their time, expertise, and honest engagement with the complexities of the SAI governance debate.

The expert contributors were:

Clara Botto (Alliance for Just Deliberation on Solar Geoengineering), Chloé Colomer (University College London), Jared Farley (Cornell University), Tyler Felgenhauer (Duke University), Julia Guivant (Federal University of Santa Catarina, Brazil), Ellen Haaslahti (Operaatio Arktis, Finland), Matthias Honegger (Centre for Future Generations), Joshua Horton (independent consultant on climate policy and research), Sofia Kabbej (French Institute for International and Strategic Affairs, IRIS), Jeffrey Nielsen (personal capacity), Ernest Ofori (Emerging Climate Frontiers / Green Africa Youth Organizations, Ghana), Jesse Reynolds (The Degrees Initiative), Lorena Sabino (University of the Philippines Los Baños), Cynthia Scharf (Centre for Future Generations), Manish Kumar Shrivastava (The Energy and Resources Institute, TERI, India), Rhythm Singh (Indian Institute of Technology Roorkee), Hassaan Sipra (Alliance for Just Deliberation on Solar Geoengineering), Patrick

Taylor Smith (Stockdale Center for Ethical Leadership, United States Naval Academy), Julie Vinders (personal capacity), Hugo Wagner (Reflective), Albert van Wijngaarden (Scott Polar Research Institute, University of Cambridge), and Danielle Young (University of Leeds).

The consultation of over 250 policymakers, scientists, and civil society representatives is woven throughout the analysis even where individual contributions are not named. In addition to these formal engagements, countless people were willing to engage in informal discussions about the scenarios as they developed, offering reactions, challenges, and stories that sharpened the analysis in ways that are impossible to trace precisely but that shaped the report throughout. The author is deeply grateful for the generosity with which all these voices, formal and informal, shared their views.

Responsibility for the interpretations and analytical positions presented in this report rests with the author. The affiliations listed above are provided for identification only and do not indicate institutional endorsement of the report or its findings.

1. Introduction

Stratospheric aerosol injection (SAI) is a contested proposal that has been researched as a climate intervention to counter anthropogenic warming. It involves injecting stratospheric aerosols to reflect a portion of sunlight back into space, cooling the planet.¹ Research, technology development, and use are different acts, and this report treats them as such. SAI is not a solution to climate change. It does not directly reduce atmospheric carbon concentrations, nor reverse ocean acidification. What it could do is reduce global warming while mitigation and carbon dioxide removal efforts take effect. The consequences of SAI cannot be localised, so decisions about SAI governance, research or deployment are global in effect and thus inherently controversial.

This work presents diverse, plausible 2036 scenarios to aid policymakers' preparedness for possible future decisions on SAI. The scenarios were co-created with policymakers to support anticipatory planning of robust, ethical, and proactive responses to various future SAI research and deployment challenges. The scenarios are diverse and plausible to aid consideration of a broad range of possible futures. Each outlines a situation in which a policymaker is required to consider SAI's efficacy, legitimacy, and desirability, and its economic and geopolitical implications.

The scenarios were co-created with a dual-track methodological foresight approach involving over 250 policymakers, scientists, civil society representatives and interested citizens. Morphological scenario generation was carried out iteratively by drawing upon over 100 interviews with people from diverse fields and expertise, and from workshops attended by a further 130 participants. In a simultaneous, separate methodological track 22 experts from diverse fields progressed through a structured, software-supported approach to identify key influence factors, analyse their interdependencies and create mathematically plausible models of the future. Full details of the methodological approaches are provided elsewhere.²

These scenarios are diverse and plausible 2036 snapshots. They can help policymakers stress-test the social and geopolitical implications of SAI through proactive planning.

The scenarios are:

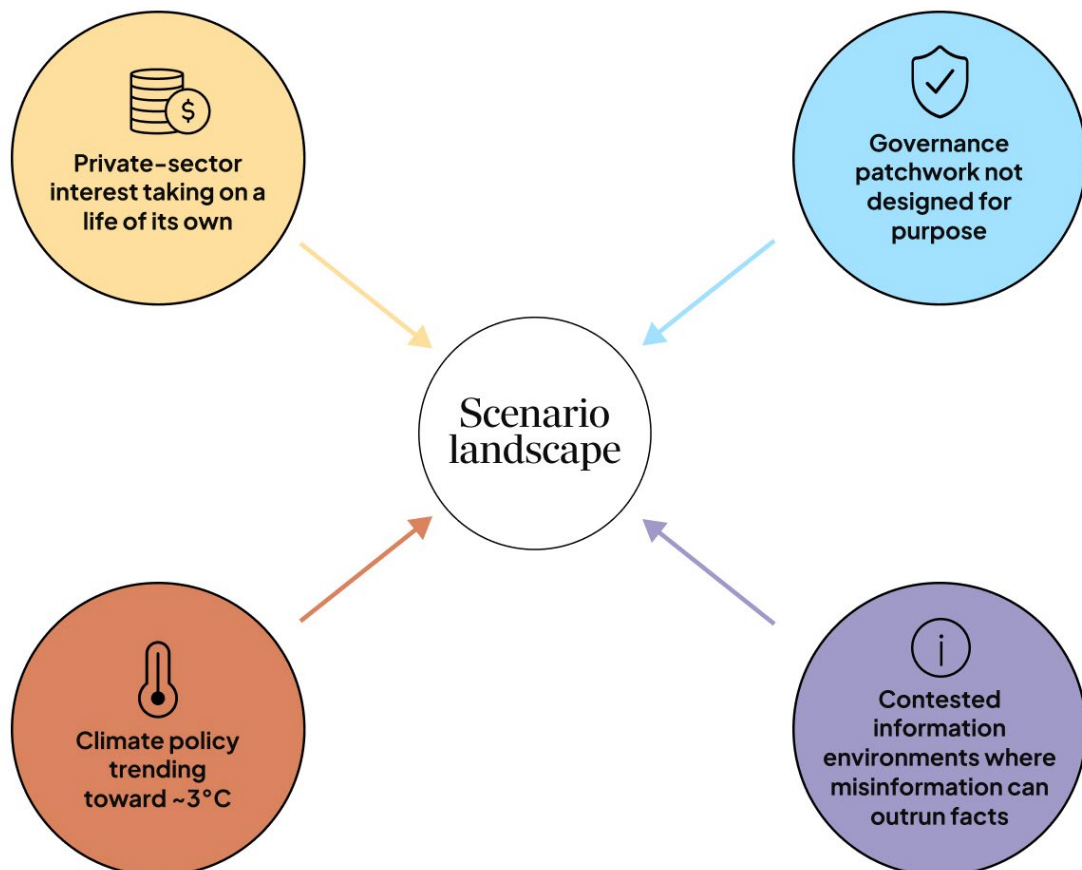
- **A values-based prohibition:**
A global agreement on solar geoengineering meets the limits of universal consent.
- **Silver bullet:**
SAI rebranded as an economic driver and a protector of border integrity.
- **Hard landing:**
Radical transparency meets a contested information environment.
- **Arms race:**
Geopolitical rivalry turns atmospheric intervention into a national security posture.

Report context and scope

SAI may currently be transitioning from a fringe idea to a focal point of global climate and security policy. SAI is one of several proposed approaches to solar radiation modification (SRM), the broader category that also includes marine cloud brightening, cirrus cloud thinning, space-based reflectors, and surface albedo enhancement. Of these, SAI is the most studied and the most widely considered plausible at scale, and it is the focus of this report. For nearly three decades SAI has occupied a contested and marginal space in climate policy. This may be changing, driven by accelerating climate impacts, the erosion of confidence in some communities in mitigation policy and the entry of commercial and security actors into a field previously dominated by scientists.

The following analysis, and the scenarios it inspires, rest on a single underlying assumption about the climate trajectory. Each of the four scenarios in this report imagines a 2036 in which the emissions curve is either still rising or falling marginally, leaving SAI as a policy-relevant issue for controlling future warming and addressing historical warming. That assumption is consistent with current trajectories but it is not the only possibility. If the political economy or technological trajectory of climate action were to shift in a meaningful way, SAI could fade from policy relevance entirely. This report was designed to explore scenarios in which policymakers may need to make decisions about SAI, so futures in which such decisions never become necessary are not considered here. The four scenarios that follow imagine futures in 2036 in which unforeseen technological or policy leaps to rapidly address climate change have not come to pass.

2. The landscape shaping SAI governance



This section maps the forces shaping SAI governance discussions; it is not directionally predictive. The four scenarios reflect plausible ways those forces – constraining and enabling, convergent and contradictory – could interact. None is inevitable, but each is designed to be instructive for policy planning.

Four areas of uncertainty that may influence SAI development are examined:

the commercial dynamics of SAI, the governance and geopolitical landscape, the climate policy context, and the information environment shaping public understanding and political legitimacy. Each subsection sets out current dynamics, the directions they might take, and the uncertainties that may shape which direction prevails.

2.1 Commercial and private sector interest

Private actors are entering the SRM market faster than governance frameworks can adjust, and SAI is where most of the capital is concentrated. Commercial investment in SRM has grown rapidly from effectively zero in 2023³ to over US\$115 million committed across nine startups in 2025.⁴ The largest capital investment has been to the US-Israeli SAI startup Stardust, attracting \$75 million in venture capital since establishment in 2023. Despite being many orders of magnitude less than investment in technologies such as AI, the technological readiness of SAI is much lower and so comparatively modest investments may significantly accelerate development.

Two distinct commercial models are emerging, reflecting different assumptions about how SAI could be financed and under what conditions. Stardust assumes a government contractor model of commercialisation. It is developing proprietary technologies (with associated intellectual property), lobbying Washington to shape a regulatory environment relevant to its operations, and aiming to be deployment-ready by 2030 at a proposed cost of more than a billion dollars a year to government clients. The company states it will not act without government authorisation, so its investors are explicitly betting that governments will eventually need the technology as temperatures rise and political action to cut emissions remains ineffective. In contrast, the retail model of US startup Make Sunsets has attracted over \$1 million in venture capital. The firm releases sulphur dioxide balloons, direct-selling cooling credits to retail buyers outside any recognised regulatory framework.⁵ While Make Sunsets relies on direct radiative effects from SAI, an alternative commercialisation model involves deploying SAI for its carbon cycle impacts⁶ and selling carbon credits on established carbon trading markets. Presently, there is no standards ecosystem for such credits.⁷

Accelerating commercial interest in SAI is moving the governance challenge beyond the environmental fora that have typically considered it. SAI companies (if selling to government clients) commercialise the prediction that the physical impacts of climate change (see Box 1) will intensify to a point where demand for atmospheric cooling becomes politically unavoidable. Their emerging infrastructure sits in a regulatory space that environmental governance was not designed to reach. If SAI begins to be seen as a prestige technology or a tool of geopolitical leverage, then considering SAI as a climate intervention no longer captures the full governance challenge.

BOX1 | The consequences of continued global warming are severe.

	Increased heat-related fatalities.	Heat-related mortality around the world has risen 63% since the 1990s and reached 546,000 deaths annually on average (2012–21). In 2024, the average person was exposed to 16 days of dangerous heat that would not have occurred without climate change. ⁸
	Decreased yields of staple crops (e.g., maize and wheat), particularly in low-latitude regions. ⁹	In the absence of effective adaptation, global crop yields could decline by up to 30% by mid-century ¹⁰ and 3°C of warming above pre-industrial levels could cause 20–48% of current crop production to shift outside its climatic niche ¹¹ . Falling crop yields could push an estimated 43 million people in Africa alone into poverty by 2030. ¹²
	Increased water scarcity.	Up to 50% of the global population is already experiencing water scarcity ¹³ and this figure is projected to increase because of climate warming. ¹⁴ Populations facing water stress have more than doubled between 1980 and 2010 and this figure is expected to increase by between 50% to 100% by 2100. ¹⁵ By 2050 approximately 60% of the world's population is projected to face water stress for at least one month per year by 2050. ¹⁶
	Loss of water availability due to glacial loss. ¹⁷	Globally over 30% of glacier mass has been lost since 1970, and many mountain ranges will lose glaciers completely within the coming decades. ¹⁸ Himalayan glaciers are disappearing 65% faster since 2010. ¹⁹ Scientists project these glaciers could lose up to 75% of their volume by 2100, affecting water availability for up to 2 billion people. ²⁰
	Changes in ocean circulation. ²¹	The Atlantic Meridional Overturning Circulation (AMOC) may already be slowing, ^{22,23} and is considered at moderate risk of collapse even in low-emission scenarios. ²⁴ Such an event could shift tropical rainfall patterns, reduce European winter temperatures by up to 20°C, and raise sea levels by an additional 50cm. Iceland recently designated AMOC collapse as a national security and existential risk and initiated coordinated government planning. ²⁵ A scientific assessment on AMOC stability is being undertaken at the EU level; ²⁶ Norway, Ireland and the UK have all increased AMOC research investment; ²⁷ and an international AMOC preparedness taskforce is being established. ²⁸
	Sea level rise, flooding and inundation. ²¹	Pacific island nations including Tuvalu and Kiribati face at least 15cm of sea level rise in the next 30 years regardless of emissions trajectories. ²⁹ The Western Pacific could become the first region to experience the complete loss of a sovereign state due to climate change, with sea level rise projected to cost the Marshall Islands its status as a nation. ³⁰
	Economic costs of weather-related damages and macroeconomic disruption.	Damages from extreme weather events from 2000 to 2019 were estimated to average US\$143 billion per year. ³¹ Projections of economic losses due to future warming vary widely depending on assumptions about the level of adaptation and the steepness of the climate damage curve, with one study estimating that global gross domestic product could contract by between 9 and 36% by 2100. ³²

2.2 The governance and geopolitical landscape

A patchwork of legal regimes is relevant to SAI, but none were designed for deliberate planetary-scale climate intervention. Customary laws relevant to SAI include the obligation of states to prevent local activities from causing significant transboundary harm.³³ Relevant treaties include the Convention on Biological Diversity,³⁴ London Convention³⁵ and its Protocol (LC/LP),³⁶ the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD),³⁷ the Convention on Long-Range Transboundary Air Pollution,³⁸ the UN Convention on the Law of the Sea (UNCLOS),³⁹ the Vienna Convention for the Protection of the Ozone Layer,⁴⁰ and the Montreal Protocol.⁴¹ Because SAI was not taken into consideration when these regimes were designed, they produce uneven applicability. Further, there is scope for selective interpretation, regulatory arbitrage, and the deliberate positioning of activities to fall within or outside specific regimes.⁴²

The Convention on Biological Diversity and London Protocol are the most relevant instruments to SAI. The Convention on Biological Diversity's non-binding Decision X/33 recommends a precautionary approach to geoengineering activities that may affect biodiversity, permitting small-scale scientific research conducted in controlled settings, and encouraging transdisciplinary research to address key uncertainties. Subsequent CBD decisions have sustained a political expectation of restraint without offering a treaty-level prohibition. The US is not a party to. Similarly, an amendment to the London Protocol covering marine geoengineering signals regulatory intent but has not entered into force given the lack of sufficient ratifications by the parties.

The primary gap in SAI research governance is not a lack of principles but their operationalisation and international coordination. Major scientific and policy reviews – by the Royal Society, the US National Academies, UNEP, and the European Commission's Scientific Advice Mechanism – converge on the features of responsible SAI governance: transparent disclosure and registries, independent impact assessment, monitoring and reporting, meaningful public and stakeholder participation, international information sharing, and adaptive periodic review as knowledge evolves. The Oxford Principles, Asilomar recommendations, a Code of Conduct for Responsible Geoengineering Research, and the American Geophysical Union's Ethical Framework point in similar directions. What is missing is translation into domestic regulatory systems and the mechanisms of internal coordination.⁴³

The distinctions between research and deployment set out in Box 2 are widely recognised as essential to governance, but remain under-specified in practice. There is no shared international taxonomy that formally distinguishes research activity from deployment-adjacent activity, or scientific research from technology development, and no international body currently has authority to enforce such distinctions. Research suggests that establishing this distinction in practice will be contested,⁴⁴ creating a grey zone that complicates oversight and amplifies controversy. This matters more as commercial and security-linked actors enter the field; pre-deployment signalling and notification norms apply even more loosely to private actors than to states.

BOX 2 | Distinguishing SAI activity types

Discussions of SAI governance benefit from distinguishing three broad activity types. These distinctions are not formally recognised in international law, and their boundaries are contested in practice, but they are analytically useful for policymakers considering what different kinds of activity require by way of governance.

- **Research activity.**

Research activities are designed for producing knowledge: reducing uncertainties and studying risks of SAI; they can involve laboratory work, atmospheric modelling, social, ethical, and legal scholarship, and small, brief outdoor process studies that test instruments or measure atmospheric properties. The primary purpose is to generate evidence about SAI's risks, uncertainties, and possible consequences. The activity is designed to produce no detectable climate effect.

- **Deployment-adjacent activity.**

Outdoor activity conducted at a size and duration sufficient to produce a detectable radiative or regional climate effect. The purpose is to demonstrate operational feasibility, test deployment readiness, or produce regional or even global cooling. This category sits closest to deployment itself and raises the strongest governance questions, particularly where transboundary effects are possible.

- **Technology development.**

Activity aimed primarily at building hardware, delivery systems, intellectual property, or deployment-ready programmes rather than at generating knowledge about risks or uncertainties. Such activity, even where it does not itself produce climate effects, is oriented toward capability rather than understanding, and sits outside of scientific research. Examples in the current commercial market include much of Stardust's engineering work and Make Sunsets' balloon releases.

The scenarios in this report engage with these categories differently. The values-based prohibition and arms race scenarios turn largely on technology development and deployment-adjacent activity by state and commercial actors. The silver bullet scenario shows how commercial technology development can proceed at speed while formal deployment authorisation is still being negotiated. The hard landing scenario turns on how ambiguity between activity types can be exploited in a contested information environment.

For over two decades, the dominant political and academic response to the governance gap has been principled restraint rather than active engagement. In 2022 a group of academics launched a formal call for an international non-use agreement on solar geoengineering; over 600 academics from 67 countries have since signed the accompanying open letter calling for an international non-use agreement and related restrictions on public research funding.⁴⁵ Their academic case rests on the argument that SAI risks are poorly understood and that outdoor research creates a slippery slope towards deployment. Further they advance a structural claim that planetary-scale technologies cannot be governed equitably and will inevitably favour powerful states over vulnerable ones.

Political leadership has focused primarily on preventing SAI deployment rather than restricting research. The African Ministerial Conference on the Environment (AMCEN) has called for a global governance mechanism for the non-use of solar radiation management (2023 Decision 19/5), and at its 2025 meeting issued an unequivocal rejection of SAI as a climate solution. The African Group led negotiations at the sixth session of the United Nations Environment Assembly (UNEA-6) in February 2024, with Djibouti playing a prominent coordinating role, and was joined by Colombia, Fiji, Mexico, Pakistan, and Vanuatu. Pacific Island nations, led by Vanuatu, have made parallel calls in UN settings for states to prohibit the development and use of these technologies.

The wider geopolitical conditions under which SAI governance must now develop may no longer be those of consensus-based multilateralism. Several interacting forces may shape what governance is possible.⁴⁶ The first is great power competition. The US and China are the powers most capable of unilateral large-scale deployment due to their economic and technological might to enact a programme and geopolitical power to facilitate it.^{47,48} A Chinese geoengineering scholar has been quoted as saying that geoengineering may be used (by other countries) as a tool to ‘maintain their hegemony’,⁴⁹ and recent US framing of SAI as a matter of weather sovereignty⁵⁰ has sharpened the security dimension, raising the prospect that atmospheric governance is absorbed into strategic rivalry. The second is the Global Majority, and African states in particular, which is now the most organised force advocating restraint. There are emerging indicators of a mismatch between governments and publics in these regions: public surveys show Global South publics are more favourable to SAI research than publics elsewhere⁵¹ leaving open whether the anti-SAI governance assertiveness continues, or instead shifts in response to public demand for equitable access to SAI policy influence in a free-driver policy environment.⁵² The third is the role of middle powers and issue-specific minilateral coalitions, which could prove decisive if they can hold a cooperative centre in the event that consensus-based institutions weaken; middle powers such as India, Brazil, Germany and Canada benefit from their geographical dispersal and relative lack of unified strategic opponents. Cutting across all three, the diffusion of capability to non-state actors may outpace state-led governance altogether if financial support exists from broad-based publics, corporations, or philanthropic donors.

2.3 The climate–policy context

Decarbonisation of each joule of energy used is happening but not fast enough to offset energy growth and thus to avoid significant warming. Renewable energy costs have fallen faster than anticipated, the International Energy Agency has revised its renewables forecasts upward multiple times, and global clean energy investment now substantially exceeds investment in fossil fuels. Even so, current emission reduction pledges put the world on a path to up to roughly 3°C of warming above pre-industrial levels by 2100, and this multi-degree warming is expected to persist for centuries.^{53,54} Without SAI, returning temperatures to less than a 1.5°C increase after overshoot would require not only rapid decarbonisation but carbon dioxide removal at a scale many experts consider neither technically nor economically feasible in the near term.^{55,56,57}

As the physical impacts of climate change intensify the appeal of SAI may lie in its rapid and inexpensive impact. While carbon removal will take decades to materially alter surface temperatures, SAI could cool the planet within months of deployment at scale. For communities facing repeated or existential climate threats, the difference between months and decades may prove politically decisive.

While interest in SAI might grow as climate change intensifies, so might arguments portraying SAI as a distraction from mitigation. SAI can only ever be a complement to decarbonisation. It addresses the symptoms of warming without fixing carbon concentrations. If deployment were ever stopped while greenhouse gas levels remained high, temperatures could rebound rapidly. This phenomenon, called termination shock, would be disastrous for biological systems that are not tolerant of such rapid changes. This means SAI is only coherent as a policy option in a world that is also seriously pursuing emissions reductions.

2.4 The information environment

The information environment is not merely a communication challenge, but is a structural background that will shape whether legitimate public deliberation about SAI is possible at all. Perceptions matter enormously in SAI discussions. The technology's legitimacy, its political feasibility, and the conditions under which it might be governed may all be determined as much by what publics believe, as by what scientists can demonstrate. Any future governance framework will need to establish and maintain legitimacy within a contested information space where scientific findings are actively disputed, public trust in institutions is uneven and fragile, and the actors shaping public understanding have widely divergent interests (see Box 3). Disinformation about SAI could trigger diplomatic tensions or civil unrest, regardless of the accuracy of the underlying claims.

BOX 3 | Chemtrail conspiracy theories.

Chemtrails conspiracy theories assert that the condensation trails behind commercial aircraft are evidence that deliberate atmospheric manipulation is already occurring. These theories emerged in the late 1990s and have grown into a substantial transnational community with established narratives, dedicated media, and significant political reach.

These beliefs are widespread and growing. A 2010 survey across the US, Canada, and the UK found that over 16% of respondents believed it was completely true or partly true that the government uses aircraft to release harmful chemicals into the air.⁵⁸ A 2016 US survey found up to 29% of respondents

indicated it was at least somewhat true that geoengineering was already occurring, with no apparent variation by political affiliation.⁵⁹ A 2023 study of tweets specifically about SAI found 32% were conspiracy related.⁶⁰

Chemtrails communities have spent more than two decades insisting SAI is already happening. If SAI moves from concept to research to deployment, this community has a ready-made framework for interpreting it and a substantial audience already primed to receive that interpretation. Multiple US states have already proposed or passed bans on solar geoengineering motivated primarily by chemtrails concerns rather than evidence-based policy debate.⁶¹

SAI is unusually vulnerable to perception-driven politics, both because of its fundamental nature and because of the conspiracy infrastructure already established for it. Its effects are largely invisible. It is technically complex. Its governance is contested; its potential for transboundary harm is real, and the chemtrails community provides a substantial pre-existing epistemological framework – albeit false and often self-contradicting – for interpreting any actual SAI activity through a conspiratorial lens. These conditions combine with a broader shift towards climate scepticism, away from disputing the underlying science and towards attacking the legitimacy of proposed responses, casting climate policy action as elite imposition or government overreach.⁶²

SAI may be particularly vulnerable to strategic disinformation by malicious actors, which poses a different governance challenge than organic public conspiracy theories. State-sponsored actors have demonstrated sophisticated capacity to inflame public divisions, including around environmental and climate policy in Western democracies; researchers have documented explicit targeting of climate debates as a tool of hybrid warfare.⁶³ SAI offers attractive properties for such campaigns: invisibility, complexity, contested governance, and a pre-existing conspiracy infrastructure to amplify fabricated claims. A disinformation campaign does not need to persuade large numbers of people of anything

specific. It needs only to generate sufficient uncertainty, anxiety, and distrust to make evidence-based governance impossible. In a recent event, public anger over perceived atmospheric manipulation in India spread rapidly, despite the absence of any SAI activity;⁶⁴ this illustrates how quickly perceptions can outrun facts, and how limited or irrelevant activities may trigger a political response.

Designing governance may require treating the information environment as a primary constraint rather than a communications afterthought. Legitimate concerns about SAI – equity, unintended consequences, and the concentration of power – are real and deserve serious engagement. These concerns provide raw material for conspiratorial narratives, and the boundary between legitimate concerns and disinformation is readily blurred in a contested information environment. Research on how publics navigate complex, contested information suggests that the solution is not only fact-checking but rather what some researchers describe as ‘friction-checking’⁶⁵ – that is, treating misinformation as an emotional and structural phenomenon and addressing the underlying grievances that make false narratives resonate, rather than only correcting claims after they spread.⁶⁶ Information environment design challenges are sharpened by the rise of authoritarian governance models; these treat transparency as a vulnerability rather than a virtue, making the information conditions for legitimate global SAI governance challenging.

3. From landscapes to scenarios

The forces described above interact to affect SAI governance, shaping what governance is possible. Commercial actors are creating a regulatory space environmental governance is not equipped to reach, as they bet on a climate trajectory that is the subject of contested policy. The governance architectures inherited from the past are being asked to manage technologies, actors, and political conditions for which they were not designed. This takes place in an information environment where perception may shape policy more decisively than does evidence.

The following four scenarios explore how these interactions could play out. Each scenario takes a different position on the central uncertainties identified, and traces what 2036 futures might result. They imagine:

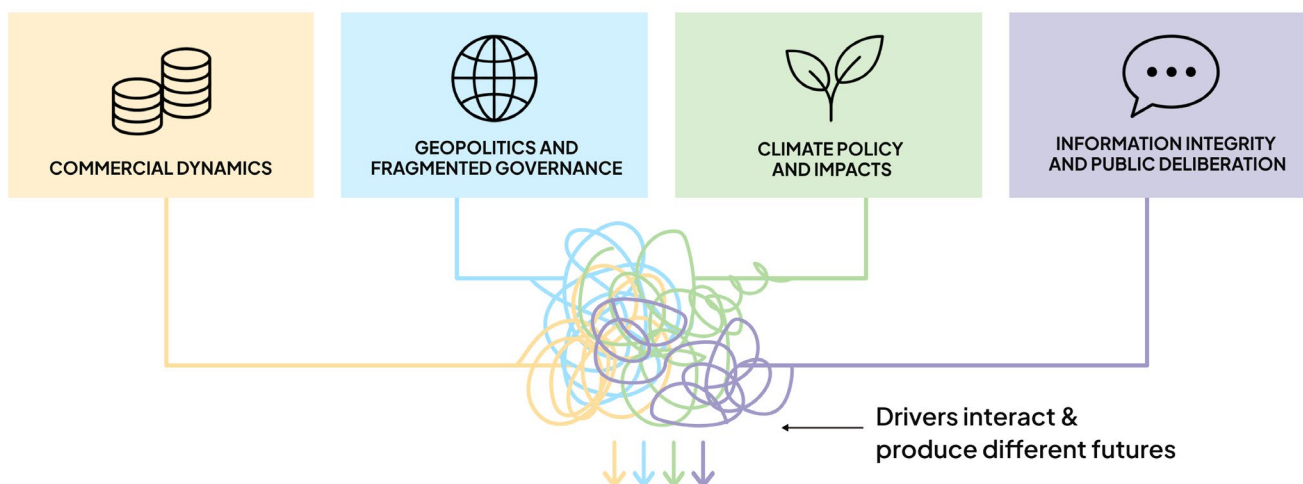
- a values-based prohibition that has passed at UNEA but stalls at ratification
- a commercially driven test conducted with the backing of states that have come to see cooling as more politically tractable than mitigation
- a research coalition acting to protect regional ecosystems whose carefully designed transparency cannot survive a single incident
- an arms race triggered by an accusation that may or may not reflect what actually happened.

The scenarios are neither forecasts nor mutually exclusive. They are a tool for exploring the policy implications of plausible futures and for testing whether the present governance arrangements are suitable for the future.

Towards governance of climate cooling approaches: Scenarios and policy-planning tool

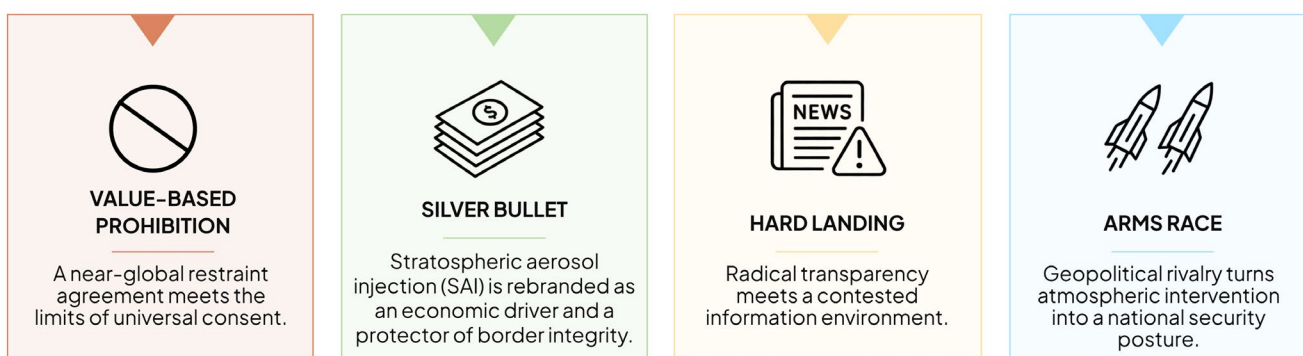
Key drivers of the scenario landscape

Identify 4 main areas of uncertainty and map how shifts across these areas could interact over time and shape what governance is possible for Stratospheric aerosol injection (SAI).



4 plausible scenarios in 2036

These scenarios explore how these interactions could potentially play out. They are not forecasts or mutually exclusive. They are a policy-planning tool.



Relevance for policymakers

Policymakers can use the scenarios to explore the implications of different futures and test governance options. The facilitation guide at the end of the report supports their use in workshops and strategic planning sessions.

3.1 Scenario summaries The full-length scenarios are available on pages 29–42

	Values-based prohibition:  A global agreement on solar geoengineering meets the limits of universal consent	Silver bullet:  SAI is rebranded as an economic driver and a protector of border integrity	Hard landing:  Radical transparency meets a contested information environment	Arms race:  Geopolitical rivalry turns atmospheric intervention into a national security posture
Scenario brief	A Global Solar Geoengineering Restraint Agreement has been adopted at UNEA. This commits parties to ensure that no deployment takes place until restrictive conditions are met and that any outdoor research is limited to small-scale experiments and subject to prior environmental assessment. The vote passed despite several abstentions, and the Agreement now enters a ratification phase. Several states with the most active SAI programmes have indicated they will not ratify. Policymakers face a choice between committing to self-restraint they cannot enforce on others, or watching the Agreement become a normative statement rather than binding international law.	In 2036 the first large-scale outdoor SAI test is days from launch; it is led by a large company with the backing of the states hosting its operations. The trial marks the accelerating shift in focus from emissions to cooling. Governments that would once have dismissed a focus on cooling are finding this politically difficult to sustain; proponents argue that SAI is more certain, speedy and cost-effective than emissions-based restrictions – and that constraining warming would suppress the weather extremes driving insurance costs and climate-related migration. Critics argue that the veneer of SAI innovation is protecting legacy fossil industries and draining global support for mitigation. Policymakers are left to decide how to regulate a growing private cooling sector, and whether near-term cooling can coexist with momentum for mitigation.	In 2036, an Arctic research alliance that has spent three years conducting outdoor SAI tests faces a crisis it had not prepared for. After a research drone suffered engine failure and landed outside the research zone, photographs of the plane were posted online and circulated within hours as evidence of a foreign spy plane. The coalition's transparent flight data, designed as its founding source of legitimacy, was selectively quoted to argue the opposite of what it actually showed. Two weeks on, the geopolitical fallout is still expanding: one coalition member is considering withdrawal, and nearby countries are accelerating domestic bans on SAI research in response to public concern. Policymakers are being asked to consider whether the right of vulnerable regions to act in self-defence is legitimate, and what governance looks like when perception outruns verification.	In 2036 the atmosphere has become a theatre of great power competition. The shift began in 2033, when a major power claimed that a rival was developing SAI deployment technology. The accused state denied any such intent and pointed to the accuser's own classified atmospheric research as the more credible threat. Independent verification of either claim has not been possible; the same evidence could support either a state preparing to deploy or a state preparing to accuse a rival of doing so. In response, both powers accelerated their classified SAI programmes and several other states moved to develop their own. A coalition of middle powers meets to consider whether to develop a standby SAI capability as a balancing instrument, in case of unstable or single-hemisphere deployment. Policymakers are left to decide whether to commit to atmospheric capabilities of their own, or to remain as voiceless outsiders of a politically charged SAI governance system.
Trigger	Sustained regional leadership by the African Union, Latin American states, and some Pacific Island nations builds enough international momentum by 2030 to force adoption at UNEA, despite opposition from some states.	Outdoor SAI trials led by private actors in the late 2020s capture public and political attention; the messaging sells cooling as a cheap, low-risk alternative to expensive and slow mitigation.	A research drone lands outside its designated test zone. It is immediately photographed by members of the public and rapidly reframed online as evidence of covert foreign intelligence-gathering or military operations.	A contested accusation with evidence that supports alternative interpretations, surfacing in 2033 against a backdrop of weather-sovereignty framing as a facet of great power competition. This precipitates expansion of classified SAI research among major powers.

Driving force	A precautionary norm advanced through coalition-building rather than universal consensus. The Agreement's authority rests on values shared by a majority of states, not the participation of all of them.	Commercial reframing of SAI as primarily for economic relief and border protection rather than climate change. This framing resonates in a political environment shaped by cost-of-living pressure, insurance costs, and contracted state capacity.	A coalition acting to protect the Arctic operates under conditions where information is weaponised faster than transparency can respond. Legitimacy designed for a coherent public sphere collides with a fragmented and contested one, where facts are reinterpreted and amplified by both careless misinformation and actively engineered disinformation.	A securitised concept of atmospheric intervention treats SAI as a national security asset rather than a climate intervention. This is amplified by a contested information environment where perceptions of capability drive the same dynamics as actual capability.
Governance posture	Active restraint backed by international legal architecture, with significant exceptions for the most active SAI-developing states. The grey zone of 'small-scale' research is left to ratifying states to interpret.	A growing private cooling sector operating ahead of regulatory frameworks. Governments are responding to populist demand for economic relief rather than leading the policy conversation. Mitigation continues but with weakened political backing, primarily driven by economic opposition.	A research alliance was built on principles of radical transparency, community inclusion, and consent-based legitimacy among affected populations. However, it was operating without universal international consent and with limited capacity to defend its work in a contested and hostile information environment.	Classified national programmes erode transparency; the absence of any international architecture capable of verifying claims, attributing activity, or coordinating responses to unilateral deployment worsens perception in a low-trust international environment. Climate governance has been displaced by strategic intelligence frameworks.
Central tension	Whether a normative agreement adopted under conditions short of universal consent can shape the behaviour of actors who chose not to participate, or whether restraint by some becomes capability concession to others.	Whether public institutions can introduce guardrails on a privately led cooling agenda once that agenda has acquired its own momentum and political constituency, and whether mitigation and cooling can coexist as policy commitments or whether one will displace the other.	Whether procedural openness, community inclusion, and good-faith design can sustain legitimacy in an information environment shaped by hostile actors and disinformation providers. What governance frameworks are required when perceptions outrun the facts available and malign actors weaponise ignorance, fear and confusion?	Whether the transition of SAI from a climate intervention into a tool of geopolitical leverage can be managed, or whether once the framing shifts, the technology becomes captured by strategic dynamics that make climate-driven governance impossible. What might middle powers have to consider if they have to choose between developing atmospheric capabilities to manage deployment risks or remaining voiceless in the resulting system?

4. Cross scenario insights for policymakers

The four scenarios explore different outcomes of the same underlying drivers of change in SAI governance. They are not exhaustive, nor mutually exclusive. They are the result of a co-creation process with over 250 people from different regions across the globe; other plausible 2036 futures could also be constructed from the same drivers of change. The scenarios are not neatly segregated from one another; conditions in one scenario could shift rapidly into those of another, and elements of more than one could be present simultaneously. For example, a research coalition operating under the conditions of the ‘hard landing’ scenario could find itself drawn into the dynamics of the ‘arms race’ if a geopolitical fallout escalated. An agreement of the kind described in the ‘values-based prohibition’ could be undone by the commercial momentum of the ‘silver bullet’, the security framings of the ‘arms race’, or both. Read together, the scenarios have generated a set of observations from the stakeholders engaged in this project that may be illustrative for others to consider.

Decisions about SAI may be shaped more by politics than by climate science, and any governance design may need to reflect that. Each scenario shows decisions about SAI being driven by something other than the climate: values and consensus politics in the ‘values-based prohibition’; economic and migration framings in the ‘silver bullet’; regional self-defence against climate change in the ‘hard landing’; and by strategic rivalry in the ‘arms race’. None of these futures is a climate response in any straightforward sense. Each is the product of political conditions that pure climate models do not represent.

The standard sources of scientific guidance on SAI may not be well suited to guiding the political decisions that will actually determine its use. Integrated assessment models and idealised deployment scenarios are built on the assumption that governments will respond rationally to climate evidence, but the scenarios in this report were co-created to be plausible rather than optimised, and the gap between them and the political assumptions built into the models is itself one of the findings. Governance design that proceeds from modelled assumptions about rational climate responses risks being unprepared for the conditions under which decisions may actually be taken. Policymakers may need to build enough independent research capability, and enough influence over research agendas, to ensure that scientific enquiry serves the political questions they will actually have to answer.

Decisions about who leads research and development are governance decisions in their own right. Research does not make deployment inevitable, but it can build knowledge, equipment, and expert networks that make some future choices easier than others. If infrastructure and expertise sit with a small number of private actors, public institutions may end up negotiating with those who already control the capability. The same may be true between countries who control capabilities and those that do not. Building independent public knowledge does not mean supporting deployment. Technical capacity can enable development, but it can also

make restraint more credible. Public funding brings transparency and oversight, and allows governments to interpret the science for themselves rather than relying on others' knowledge.

The political conditions for SAI decisions may depend on the extent to which informed public deliberation about them is possible. The 'hard landing' scenario illustrates how quickly a coalition acting in good faith can lose perceived legitimacy when public perception is shaped by actors hostile to its work. The 'silver bullet' shows how a commercial reframing can build a populist constituency for cooling that public institutions then struggle to regulate. In both cases the problem is not the public opinion in itself it is that publics have been engaged late, on terms set by others who have motivations not aligned to evidence-based deliberation. Citizen engagement and evidence-based communication are not afterthoughts to a technical programme. They are first-order governance conditions, and the scenarios suggest that any governance arrangement that does not bring publics along early and substantively may struggle to hold up under pressure.

Independent monitoring and attribution capacity is a concrete governance investment that many see as position-neutral. Regardless of what position a country takes on SAI itself, they may find it imperative to have trusted sources of data to know who is doing what in the atmosphere, and to understand the impacts of any testing or deployment on their own region. When attribution is contested and independent verification is unavailable, the same evidence can support multiple interpretations. Political consequences can then flow from whichever framing prevails rather than from what actually occurred. Investing in independent monitoring and attribution capacity, and in the international arrangements needed to make its findings authoritative, is a governance action that does not require a prior decision on whether or not SAI should ever be deployed.

The climate policy and security policy communities are having entirely different conversations about SAI, and neither is hearing the other. Interviews with climate scientists and environmental policymakers were often dominated by concerns about moral hazard, equity, and the risks of foreclosing future generations' choices. These are substantive concerns, taken seriously in the communities where they are raised, and for many they are strong enough to justify declining to engage with SAI conversations at all. However, during interviews with those in defence, security, and commercial circles, where SAI is increasingly being discussed as a strategic capability, these concerns rarely came up. Moral hazard is not part of the vocabulary. Equity is a background consideration at best. Future generations are not the frame within which decisions are being weighed. If the concerns of the climate community are to influence decisions about SAI, it may require someone to voice them in the rooms where those decisions are being taken. These voices should, perhaps especially, include those who believe SAI should never be pursued at all. Declining to participate on principle does not stop the conversation. It leaves the conversation to others.

The choice of frame, whether SAI is understood primarily as a climate intervention or as a security capability, may be the most consequential governance decision still open. Until recently, debate on SAI has sat largely within climate policy. A security framing is now gaining ground. If SAI comes to be viewed primarily through a security lens, the international cooperation any workable governance regime depends on becomes harder to construct, and existing climate

intervention conspiracy narratives are amplified. The framing choice determines who funds the research, which institutions are responsible for it, and what drives its development, pulling all three away from environmental metrics and public deliberation and toward strategic advantage.

Whichever framing prevails, what future generations inherit will depend on decisions

being taken now. Some of those interviewed noted any deployment of SAI risks locking future generations into a technological commitment they did not choose, with all the costs of maintenance and the risks of termination shock falling on people who had no say in the decision. Another view was that the future climate damages younger generations will inherit may be so severe that withholding SAI (including the research needed to evaluate it), is its own form of intergenerational harm. The scenarios presented here cannot resolve this debate. What they do suggest is that whatever position one takes on SAI engagement, the world that future generations inherit, and the extent to which they are able to make fully formed decisions, is a question worth engaging with now.

Across the analytical work conducted for this project, plausible SAI deployment scenarios were consistently paired with accelerated mitigation efforts, and deployment in the absence of mitigation acceleration rarely appeared as a plausible outcome.

This suggests defensible SAI scenarios were judged by experts to depend on accelerated mitigation and a credible off-ramp for deployment. Without accelerated mitigation, SAI risks becoming a substitute for the underlying climate action, not a complement to it. Without a credible off-ramp, SAI risks becoming a commitment future generations inherit rather than a choice they retain the capacity to make. The scenarios in this report explore many possible futures for SAI governance, but none of them changes this underlying condition. The work of accelerating mitigation and building the technical, political, and institutional capacity for a credible off-ramp is required now, and the climate-focused voices arguing for it have to be present in every conversation where SAI is being considered if the requirement is to hold.

Policy planning tool:

designing effective governance for Solar Radiation Modification (SRM)

This tool supports policymakers, advisers, and analysts to structure conversations about the governance of solar radiation modification (SRM), and particularly its most studied form, stratospheric aerosol injection (SAI). It provides four scenarios describing plausible SAI futures for 2036, alongside a facilitation guide for using them in workshops and strategic planning sessions.

The tool is designed for use inside government departments, ministries, intergovernmental bodies, research funders, and civil society organisations that are, or expect to be, engaged with SRM governance decisions. It is equally useful for those working directly on climate and environmental policy, and for those in adjacent domains, including foreign affairs, defence, development, science governance, and communications, whose work will shape, and be shaped by, how SRM governance develops.

Context

Discussions about SRM governance are taking place now, in an environment where formal international frameworks remain fragmented, where private sector investment is accelerating faster than regulatory capacity, and where the political framings that will guide decisions are contested. Policymakers considering SRM face a challenge common to many emerging governance questions: they must design or defend positions under conditions where the technology is developing rapidly, the political landscape is unstable, and the range of plausible futures is unusually broad.

Standard forms of scientific and policy analysis, including integrated assessment models and idealised deployment scenarios, are valuable for understanding the physical and technical aspects of SRM. They are less well suited to the political conditions under which decisions will actually be made. Scenario-based foresight offers a way to complement those analyses. Rather than predicting what will happen, it invites policymakers to consider a broad range of plausible futures and trace what those futures would mean for their work, their institutions, and the communities they serve.

Contents of the planning tool

The tool has three components, which appear in the sections that follow. The first is a set of four scenarios describing distinct plausible futures for SRM governance in 2036. Each scenario explores a different story about how governance conditions might develop, driven by different combinations of political, commercial, and geopolitical pressures. The scenarios were developed through a dual-track process combining expert analytical work with a consultation involving over 250 policymakers, scientists, civil society representatives, and other stakeholders across multiple regions. They are designed to be plausible rather than optimised, and to surface the political and geopolitical dynamics that formal modelling does not usually capture. A separate methodology paper describes the scenario development process in detail; familiarity with the methodology is not required to use the tool effectively.

The second is a facilitation guide offering three foresight techniques for using the scenarios in structured workshop settings. Each technique serves a different purpose: the futures wheel is useful for exploring second and third-order consequences, robustness testing can be used to evaluate different policy options, and backcasting helps identify leading indicators and near-term decisions by tracing what would need to have happened for a scenario to come about. The guide sets out when to use each technique, what it produces, and how to run it. A single team can use any one of the techniques as a standalone exercise, or combine them across a series of sessions.

The third is a set of critical uncertainties that emerged from the scenario development process. These can be used as prompts within workshops or as starting points for follow-on analysis. They surface the questions that policymakers will need to grapple with regardless of which future comes to pass.

The scenarios are not mutually exclusive. Conditions in one scenario could shift rapidly into those of another, and elements of more than one could be present simultaneously. Users of this tool are encouraged to think about the boundaries between scenarios as porous, and to consider what governance arrangements would remain useful across scenarios, not only within them.

What this tool is not

This tool is not a prediction. The scenarios are illustrative and exploratory; they do not aim to forecast the most plausible future. The value of the scenarios comes from the discussion they prompt rather than from any claim about which is most likely to occur. The tool does not set out policy recommendations. Rather, it provides material for structured conversation; the policy conclusions that follow from those conversations depend on the country, institution, and mandate of the users.

It is not a substitute for country-specific or institution-specific analysis. Users will typically need to combine the outputs of scenario workshops with their own analytical work to translate insights into actionable planning.

Reading the scenarios

The four scenarios follow. Each is presented in the same format: a scenario in brief, followed by four fields describing the trigger, driving forces, governance posture, and central tension, and closing with questions that are raised by the scenario. They can be read in sequence or dipped into individually, and no scenario depends on the others for context.

BOX P1 | Distinguishing SAI activity types

Discussions about SAI governance often collapse different kinds of activity into a single category. The scenarios that follow are easier to work with if three broad activity types are held distinct:

- **Research activity** generates evidence about SAI's risks, uncertainties, and possible consequences. It includes laboratory work, atmospheric modelling, scholarship, and small outdoor process studies designed to test instruments or measure atmospheric properties. It is designed to produce no detectable climate effect.
- **Deployment-adjacent activity** is outdoor activity conducted at a size and duration sufficient to produce a detectable radiative or regional climate effect. Its purpose is demonstrating operational feasibility, testing deployment readiness, or producing cooling for a specific region.
- **Technology development is activity** aimed primarily at building hardware, delivery systems, intellectual property, or deployment-ready programmes. It is oriented toward capability rather than understanding, and sits outside conventional definitions of scientific research.

These distinctions are contested in practice, and no shared international taxonomy formally enforces them. However, workshops using the scenarios in this tool benefit from holding the distinctions consciously. Each scenario engages with these categories differently.



2036 SAI GOVERNANCE SCENARIOS

A values-based prohibition

A global agreement on SAI meets the limitations of universal consent

Scenario narrative

A 2036 Global Solar Geoengineering Restraint Agreement is adopted at UNEA, committing parties to prevent deployment in the absence of a science-based, precautionary, global and transparent regulatory mechanism until there is adequate scientific justification for SAI activities considering environmental, transboundary, social, economic and cultural risks. Small-scale outdoor research is permitted, subject to restrictive environmental assessment. The vote passed, despite several abstentions; the Agreement now enters a ratification phase.

Proponents of the Agreement argue that it protects global climate action integrity, removing a technological fix that could displace mitigation. They consider the stratosphere as a global commons that cannot be equitably governed without consensus, and see the precautionary principle as appropriate for interventions whose transboundary risks remain poorly understood.

The Agreement's design has critics. The conditions for lifting the ban are restrictive and undefined, with no international body designated to assess compliance – leading to allegations that the process is designed to prevent progress. The small-scale research exception is undefined,

How we got there

and it is not clear whether it distinguishes research activity (designed to generate evidence without producing climate effects) from deployment-adjacent testing that happens to be small in scale but is orientated toward operational readiness. Several states with active SAI programmes have refused ratification, raising the prospect that the Agreement will be performative but ineffective – binding only those willing to be bound. Policymakers are being asked to commit to restraint they cannot externally enforce, and to do so in the context of accelerating climate impacts.

UNEA adoption support started regionally. In the late 2020s, the African Union had moved beyond AMCEN's earlier rejections of geoengineering to negotiate a regional protocol restricting African SAI. The first-of-a-kind protocol signalled African opposition, legally enacted.

Global North critics argued AMCEN reflected civil society lobbyist capture, not independent ministerial judgement; this argument did not land as intended. African states and their supporters read it as a refusal to take the AU's environment ministries seriously, a portrayal which hardened the environment ministers' commitment to leading the Agreement.

Latin American states joined the coalition through 2028 and 2029. A Pacific Island bloc made a supporting parallel declaration. By 2030 at least some nations from all three regions of the Global Majority had committed to restraint, and the concept that governance required major powers became tenuous. The question for the Global North and others was whether to align with Global Majority opposition from climate-vulnerable nations or be visibly out of step with it.

By the UNEA vote the Agreement had majority support despite a small but powerful coalition of opponents. Some framed the Agreement as an act of generational neglect, arguing that with mitigation falling short, research restraint amounted to obstructing future generations' knowledge of alternative climate responses. They pointed to growing climate impacts on human and non-human health, the economy and the environment as evidence of urgency; this argument was strongest when made by youth but weakened when echoed by states with active commercial SAI or SAI research programmes, where the line between principled critique and self-interest was blurred.

The vote passed. The Agreement is now at the ratification stage, where the question is no longer whether the principle of restraint commands majority support, but whether the states most active in SAI development will accept being bound by it.

Emerging evidence of change

- **African political leadership against geoengineering:** In July 2025 AMCEN reaffirmed its total rejection of SAI technologies and requested that African countries advance a non-use agreement in other international negotiations.⁶⁷ The African Group led negotiations at UNEA-6 in February 2024, with Djibouti playing a prominent coordinating role, and was joined by Colombia, Fiji, Mexico, Pakistan, and Vanuatu. Pacific Island nations, led by Vanuatu, have made parallel calls in UN settings for states to prohibit the development and use of these technologies.
- **European reactions to geoengineering:** The EU supported a precautionary approach to SRM in the UNEA-6 negotiations⁶⁸ and in a recent Joint Communication stated support for international efforts to assess the risks and uncertainties of climate interventions.⁶⁹ The German Federal Environment Agency (Umweltbundesamt) formally rejected SRM deployment as both an emergency option and a transitional technology due to its potential to create unpredictable climate risks.⁷⁰
- **Academic calls for geoengineering non-use:** More than 600 academics from 67 countries signed an open letter calling for an international non-use agreement on solar geoengineering.⁷¹
- **Repeated cancellation of SRM field experiments:** SRM field experiments, such as Harvard University's SCoPEX⁷², Cambridge University's SPICE and University of Washington's Marine Cloud Brightening outdoor test, were cancelled in part due to public backlash and activist opposition.

Key questions raised by the scenario⁷³

How can a non-unanimous international agreement function if the states most active in SAI development choose not to ratify?

States disagree on definitions of key terms. Box P1 sets out three broad activity categories: research, deployment-adjacent activity, and technology development, but this agreement leaves terms to national interpretation. Which institution, if any, should hold the authority to define these thresholds?



2036 SAI GOVERNANCE SCENARIOS

Silver bullet

SAI is rebranded as an economic driver
and a protector of border integrity

Scenario narrative

In 2036 the first large-scale outdoor SAI test is days from launch. The test is deployment-adjacent activity (see Box P1), at a scale intended to produce detectable climate effects, and it follows a decade of technology development by private actors. The trial is led by a large company, backed by the states hosting its airbases. The climatic and geopolitical consequences are both uncertain. The test marks the point at which a steady shift in climate action framing from emissions to cooling becomes difficult to reverse. Charismatic individuals have promoted SAI to publics as a cost-effective way to stabilise temperatures and shield the economy from structural upheaval. Several commercial actors are now developing SAI with various funding models being explored.

Governments that would once have dismissed a focus on cooling over carbon mitigation are finding it politically difficult to do so. Private actors have used tech platforms to promote SAI as the only short-term solution to climate change effects that are unambiguously accelerating. Further, SAI has been framed as more cost-effective than emissions-based restrictions in the medium term. Society fears severe destabilisation ahead; climate cooling is a way to reduce the severe weather events that are making insurance unaffordable, increasing cost of living, and causing climate-driven migration.

How we got there

Critics argue that the veneer of climate change innovation is being used as a front to protect legacy industries and is draining global support for deep emissions cuts. Policymakers struggle to justify the need for long-term commitment to mitigation among voters for whom more immediate concerns around border integrity and cost-of-living pressures are defining issues.

Outdoor SAI trials led by private actors in the late 2020s captured public and political attention. Most of what these actors were doing was technology development in the sense set out in Box P1: building hardware, delivery systems, and operational readiness rather than generating knowledge about SAI's risks or uncertainties. The activity was often described publicly as research, but its purpose was demonstrating commercial capability. Commercial messaging released by the company conducting the trials sold SAI to publics as a cheap, low-risk way to stabilise global temperatures; it landed in a receptive political environment. State finances across major economies were already stretched by a decade of emergency climate adaptation spending, pandemic debt, economic stagnation, and rising defence investment. The cost of living had become a dominant political concern for citizens, with insurance costs linked to extreme weather adding to household pressure.

As the global balance of power continued to shift away from Western dominance with the rise of Global South and Asian economies, state capacity in Western economies contracted. Non-state actors expanded their reach in response. Technology companies, private infrastructure funds, and multinational corporations gradually took on functions that states struggled to reliably provide, from digital communications to energy systems management. Powerful private companies increasingly shaped government policy, democratic processes, and national security.

Charismatic individuals used technology platforms to drive a shift in focus from carbon to cooling. They rebranded SAI as a shield against the economic cost of climate change and the political fallout of expensive climate action; the framing was deliberate and effective. Rather than asking voters to accept economic pain in the short term in exchange for protecting future generations, proponents offered immediate fiscal relief and quick-acting temperature management. It was a far easier proposition to sell.

Various models to fund SAI are being explored. A group of philanthropists has publicly expressed their intent to investigate funding SAI deployment. A proposal to allow carbon credits derived from climate cooling to be traded within existing carbon markets has attracted interest, potentially turning the planetary thermostat into a tradable commodity. Governments are coming under pressure from their citizens to accelerate SAI development to address cost-of-living pressures.

Emerging evidence of change

Critics warn that SAI development by private actors creates a dangerous technological lock-in, where the global economy becomes structurally dependent on a privately owned and operated planetary shield. There is an acute concern that this market-led pivot prioritises short-term industrial growth over the essential, difficult work of reducing greenhouse gas emissions; it binds future generations to an engineered atmosphere without a plan for reducing atmospheric carbon concentrations.

SAI is increasingly viewed as a working-class victory and a defence against elitist net-zero mandates that many deemed impossible to meet. A cooler climate is viewed as the answer to the environmental pressures driving mass migration and the solution for weather extremes making insurance prohibitively expensive. The result is a populist mandate that casts traditional mitigation as both elitist and outdated.

- **A conservative US think tank has suggested SAI could be used as an alternative to expensive fossil fuel transition policies to protect the economy:** Its report indicated SAI could reduce the costs associated with the fossil fuel transition, and protect energy companies and the economy.⁷⁴
- **A for-profit SAI sector is emerging that is structurally incentivised to manufacture demand for deployment:** In 2025 more than \$115 million was committed to nine SAI-related startups by over 50 investors.⁷⁵ Stardust, the best capitalised, aims to be deployment-ready by the end of the decade, anticipating government contracts for sunlight reflection.⁷⁶
- **A consumer-facing model of SAI commercialisation has emerged:** US startup Make Sunsets sells 'cooling credits' directly to private buyers and has been granted a patent for its SAI system.⁷⁷ It has raised over US\$1 million from investors to release stratospheric sulphur dioxide balloons and sold over \$100,000 in 'cooling credits' to private buyers.⁷⁸
- **Other models for funding SAI are plausible:** SAI could indirectly stimulate carbon drawdown by reducing soil respiration, promoting ocean carbon drawdown and enhancing photosynthesis.^{79,80,81,82} Trading SAI-derived carbon credits on existing offset markets has been envisaged as a possible method of commercialisation.⁸³ Philanthropic funding of SAI has also been explored as a possible emergency response, albeit one potentially lacking legitimacy and justifiability.⁸⁴
- **Economic concerns could distract from climate action:** While support for renewable energy and the energy transition remains high,⁸⁵ some findings suggest that the prioritisation of climate has decreased relative to immediate economic concerns.⁸⁶ A survey of 24,000 people found that global support for climate protection has declined, with the world's most advanced economies showing the strongest declines.

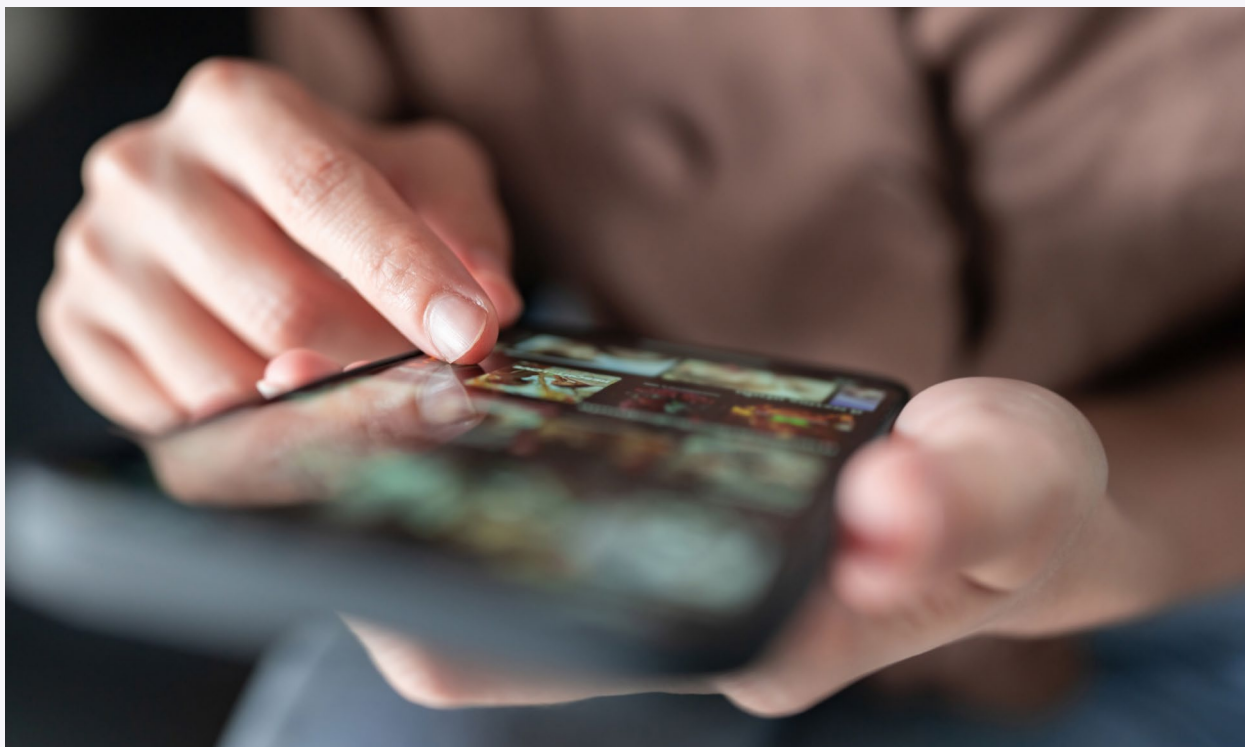
**Key
questions
raised
by the
scenario**

Many respondents expressed concern that the economic impacts of the green transition could threaten their financial security.⁸⁷

- **Social media narratives link climate action to government overreach:** Research reveals a transition from traditional climate denial to a 'new denial' on digital platforms, which focuses on attacking the efficacy of climate solutions and their supporters rather than the climate science itself. These narratives, often amplified by algorithmic recommendation systems, increasingly link climate action to government overreach and threats to national security.⁸⁸
- **Securitisation of climate migration:** Current security discourse in the Global North is increasingly recognising the climate security nexus and anticipating the risk of climate-driven displacement as a threat to national stability and security.⁸⁹

Are there effective mechanisms for introducing guardrails to manage private sector interest in climate cooling?

How should governance frameworks respond when commercial actors describe their activity publicly as research while conducting technology development oriented toward deployment readiness?



2036 SAI GOVERNANCE SCENARIOS

Hard landing

Radical transparency meets a contested information environment.

Scenario narrative

In 2036 the future of an Arctic research alliance hangs in the balance. For three years a coalition of Arctic states and their research partners has conducted a research programme designed to build the evidence base needed to evaluate whether SAI could safely be used to slow warming in a region whose ice loss threatens the cultures, economies, and in some cases the very existence of its inhabitants. The programme is research (see Box P1): the outdoor process studies are small in scale and designed to produce no detectable climate effect. The coalition has been consistent that the programme is not, and is not intended to be, deployment. They built their legitimacy through radical transparency, genuine inclusion of Indigenous and affected communities, and a positive framing that offered hope to a generation worn down by climate anxiety.

That changed in late 2034, when a research drone carrying atmospheric instrumentation suffered engine failure and was forced to land on farmland outside the research zone. Members of the public who found the aircraft photographed it and posted the images online. Within hours, the images were circulating as evidence of a foreign spy plane. Within days, the story had moved from conspiracy sites to political commentary, and from commentary

How we got there

into diplomatic exchanges. The coalition's transparent flight data, available in real time on its public dashboard, was being selectively quoted to argue the opposite of what it actually showed.

Two weeks on, the social and geopolitical fallout is still expanding. A neighbouring state has announced a full investigation in response to public demands. One research coalition member is reportedly considering withdrawal to protect diplomatic relations with a neighbouring major power. Several nearby countries are now considering domestic SAI research bans, citing public pressure rather than compelling evidence. The coalition's founding principle, that transparency would sustain legitimacy, is being tested in an information environment it cannot control, where bad-faith actors are willingly manipulating the facts. Policymakers are now being asked to consider whether the right of communities in vulnerable regions to pursue SAI research designed to defend them against climate change is legitimate, and what governance looks like when perception outruns verification.

The coalition's founding logic was building the knowledge base needed to survive a changing climate. Rather than pursuing planetary-scale climate action, its member states were responding to national priorities: the loss of Arctic ice and the mounting risk of an AMOC shutdown. Their focus was on building the evidence base for possible future regional stabilisation and on retaining the option of pursuing it if the science justified it. They argued that lives and livelihoods depended on generating knowledge that Arctic communities could act on, rather than waiting for evidence to be produced elsewhere.

The coalition pledged to radical transparency – committing to real-time, open-access monitoring of all its trials – aiming to demonstrate that its focus remained on regional ecosystems. Local community members were involved in experimental design and implementation, securing strong local buy-in. This arrangement represented a polycentric governance experiment operating across multiple scales including Arctic states, regional authorities, Indigenous governments, and scientific networks. Those with the most to lose claimed the right to act in self-defence in the absence of universal consent. The coalition's legitimacy derived not from traditional multilateral consensus but from this web of overlapping authorities and affected stakeholders.

Central to the coalition's public case was a deliberate reframing of what SAI represents. Rather than presenting the trials as a technological fix, coalition states argued that humanity had been altering the atmosphere as a side effect for over a century through fossil fuel emissions. What the coalition was proposing was categorically different: careful, transparent research to understand whether mindful, monitored stewardship of the cryosphere might one day be possible. That framing resonated more broadly than many

had anticipated. For a significant portion of the global public, exhausted by decades of climate anxiety and political paralysis, the coalition's work generated genuine hope that a demonstrated mechanism existed to address warming on a meaningful timescale.

Surrounding states had adopted a posture of non-obstruction. Russia's earlier confidence in the benefits of Arctic warming had already wobbled as permafrost thaw damaged extractive infrastructure, and Moscow had quietly accepted that the coalition's focus on cryosphere stabilisation was not entirely contrary to its interests. The EU had declined to formally endorse the trials while refraining from any action to obstruct them. That equilibrium held until the drone's unscheduled landing.

Emerging evidence of change

- **European Commission calls for SAI research:** The European Commission Scientific Advice Mechanism on Solar Radiation Modification recommended research on SRM be conducted responsibly and in keeping with EU ethical principles of research but called for an EU-wide moratorium on SRM deployment for offsetting climate warming.⁹⁰
- **Reframing moral hazard:** Emerging research has suggested that the 'moral hazard' of SRM can be reframed; for some, it represents a source of hope, rather than merely a distraction from cutting emissions.⁹¹
- **Disinformation and environmental entanglement:** Environmental politics is increasingly entangled with strategic competition, with climate security concerns now explicitly linked to disinformation campaigns.⁹² Russian disinformation strategies have explicitly targeted environmental politics to inflame divisions in Western democracies⁹³ and may apply similar tactics to geoengineering research.⁹⁴
- **Spill over into conspiracy theories:** Public concerns about solar geoengineering research reveal significant concerns about governance, equity and unintended consequences and these concerns often spillover into conspiracy theories⁹⁵ further complicating the prospect of transparent governance. Indeed, much recent US state legislation relevant to SRM has been inspired or motivated by conspiracy theory concerns about fictitious chemtrails.
- **Youth-led calls for new climate strategies:** The Finnish youth movement, Operaatio Arktis, argues that climate strategies from the 1990s are failing to protect polar ice. They advocate for an integrated approach that combines emissions reductions with solar radiation reflection and carbon sequestration.⁹⁶ Similarly, a guide co-created with young people calls for deeper public dialogue, particularly with young people, to understand the social and environmental impacts of geoengineering proposals.⁹⁷

**Key
questions
raised
by the
scenario**

- **Iceland designated AMOC collapse as a national security and existential risk:** This designation signals the start of coordinated government planning.⁹⁸ A scientific assessment on AMOC stability is being undertaken at the EU level;⁹⁹ Norway, Ireland and the UK have all increased AMOC research investment;¹⁰⁰ and an international AMOC preparedness taskforce is being established.¹⁰¹

Who holds the authority to decide on the legitimacy of climate cooling research when it is being conducted by climate-vulnerable states in their own defence?

The coalition maintained a clear distinction between research and deployment-adjacent activity, and communicated that distinction consistently. The public conversation failed to hold the distinction. What governance arrangements would help such distinctions survive contact with contested information environments, and who, if anyone, is responsible for maintaining them?



2036 SAI GOVERNANCE SCENARIOS

Arms race

Geopolitical rivalry turns atmospheric intervention into a national security posture

Scenario narrative

In 2036 the atmosphere has become a theatre of great power competition. The shift began two years earlier, when a major power claimed that a rival power was developing SAI aircraft. The accusation asserted that the aircraft design indicated technology development orientated toward deployment (see Box P1). The accused state denied any such intent, attributing the technology development to research, and pointed to the accuser's own classified atmospheric research as the more credible and immediate threat. Independent verification, where possible, is inconclusive. Analysts have noted that both countries have manufacturing capabilities but this doesn't necessarily indicate the intention to deploy SAI.

In the months that followed the accusation, both powers are believed to have accelerated their classified SAI programmes. Several other nations have moved to develop capabilities of their own. Other nations are now scrambling to undertake research designed to understand the regional impacts of a possible SAI deployment. Knowledge is constrained by the lack of understanding on whether a potential deployment might be unilateral or collaborative, or hemispherically uneven or not.

How we got there

A coalition of middle powers has met to consider whether to develop a standby SAI capability, not as a deterrent but as a balancing instrument. Proponents argue that the capability may be needed if uncoordinated deployments by rival powers create a hemispheric imbalance requiring correction, or if a deployment is abruptly halted and termination shock follows. Critics argue that building such a capability will further deepen the securitisation of the atmosphere and accelerate the very dynamic the coalition is trying to manage. Policymakers are left to decide whether to commit to SAI capabilities of their own, or to remain outside a system in which they have no voice in decisions that could shape their own climate.

By the mid-2020s, weather sovereignty had become the operative frame in several major-power governments. SAI research in environmental directorates was transferred to national security and defence ministries, where they became substantial, operationally focused, and classified.

Governments framed the work as defensive capability, guarding against the possibility of unilateral foreign atmospheric intervention. The major powers expanded outdoor testing through this period at scales individually defensible as research. In practice, each state's expansion of its own programme became the strongest evidence its rivals cited for expanding theirs.

Private aerospace and defence contractors lobbied for funding by positioning SAI as a dual-use technology offering both climate stabilisation and defensive capabilities. The commercial SAI sector, already attracting significant venture capital, found a new and better-resourced class of potential customer as SAI research was carried out under defence and intelligence budgets that dwarfed anything previously seen when it was treated strictly as climate research.

The trigger came in 2033, when intelligence leaks and analyst reports surfaced what the accusing state described as evidence of heavy investment in planes able to deliver significant payload to the stratosphere. The accusation was contested by the accused state. The planes were real, but their purpose was ambiguous. The timing of the disclosure raised questions about who benefited from the framing. Some analysts questioned whether the disclosure was a false flag narrative, engineered to justify the accusing state's own programme expansion, or whether the accused state deliberately positioned the planes to appear deployment-relevant in order to provoke escalation.

Whether the events were what they appeared, what they were claimed to be, or something else entirely, the policy consequences were the same. SAI shifted, almost overnight, from a climate policy question to a matter of strategic posture. The migration of SAI research into classified programmes produced a cycle of suspicion. Research hidden behind intelligence firewalls

was a target for espionage, which generated further secrecy. Rival nations interpreted each other's research not as a legitimate climate response but as a mechanism of geopolitical leverage. The question was no longer whether SAI should be researched, but what activity was actually happening behind the classification, who was doing it, and what they intended to do with the capability. In a classified environment, the distinctions between research, technology development, and deployment-adjacent activity became almost impossible to verify from outside.

Emerging evidence of change

- **SRM has been portrayed as an emerging strategic domain that requires US leadership to avoid ceding advantage to China:** A 2026 report by the American Council for Capital Formation Center for Policy Research argues that US leadership is required to prevent 'adversaries [acting] unilaterally to deploy or potentially weaponize SRM technologies'.¹⁰²
- **SAI has been framed as a tool to protect 'US weather sovereignty':** A US conservative think tank argued in early 2026 that America should develop global atmospheric modification capabilities to ensure its weather sovereignty and to eliminate threats from foreign interventions.¹⁰³
- **Commercial actors are building SAI deployment capabilities in anticipation of government demand:** In October 2025, Stardust raised \$60 million – the largest ever SAI funding round – from investors, bringing its total capital to \$75 million.¹⁰⁴ Investors openly acknowledge they are betting on climate and political failure, and Stardust aims to be deployment-ready by 2030. Overall SRM startup funding increased to more than \$115 million committed across nine companies.¹⁰⁵
- **China's opaque stratospheric ambitions:** While China's public statements suggest a lack of interest in SAI deployment, a recent report by the French Ministry of Armed Forces suggests this is unlikely to be true.¹⁰⁶

Key questions raised by the scenario

What international monitoring and detection systems might be required to distinguish research from technology development and deployment-adjacent activity in the stratosphere, and who is best placed to operate them?

When activity is classified and its claimed category cannot be independently verified, what governance arrangements can hold up under adversarial conditions?

Using the scenarios: foresight techniques for policymakers

Choosing a technique

Three techniques are provided for using the scenarios in workshop settings. Each has a different purpose and produces a different type of output. The right choice depends on what you want the workshop to achieve.

- The futures wheel is exploratory. It helps participants explore a scenario and understand some of the implications for their work, their organisation, and the communities they serve. It surfaces implications, blind spots, and second-order consequences. This technique is suitable for when participants are new to SRM, when the goal is shared understanding of a plausible future, or when the workshop purpose is an initial exploration of policy questions.
- Robustness testing is evaluative. It helps participants test a specific policy option, governance arrangement, or institutional design against multiple scenarios. It surfaces which choices hold up across futures, which are vulnerable to particular conditions, and which need to be redesigned to work under uncertainty. This technique is useful when participants have a specific policy question in mind, when the goal is to compare options, or when the workshop is directly informing a decision.
- Backcasting is temporal. It helps participants identify what would need to have happened for a scenario to come about, and when. It surfaces leading indicators, near-term decisions, and the choices that would push a scenario toward or away from a particular future. It can be used when participants have responsibility for near-term decisions, when the goal is to identify what to watch for and what to influence now, or when the workshop is intended to feed into planning cycles.

The three techniques are complementary. A team with time and appetite can use all three across a series of sessions: the futures wheel to build shared understanding, robustness testing to evaluate specific options, and backcasting to identify near-term actions. The sections that follow describe each technique in more detail.

Before any workshop

Regardless of which technique is chosen, a few preparation steps apply.

- Familiarise yourself with all four 2036 SAI scenarios before the session. Even if the workshop focuses on one, participants may raise the others in discussion.
- Assign one facilitator and one notetaker per breakout group where possible. The facilitator runs the conversation, keeps track of time, and pushes the group across domains. The notetaker captures outputs and is responsible for photographs or screenshots at the end.
- Establish ground rules at the start of any session. Chatham House rule (comments not attributed to specific individuals) can be used to support open discussion, particularly

where participants come from different institutional backgrounds. Remind participants that foresight thrives on diverse contributions, including hunches, anecdotes, and personal observations. The risk in the room is silence, not a bad answer.

- Introduce SAI briefly if the group is not familiar with it. A two-minute summary covering what SAI is, why it is debated, and why governance matters is enough. Avoid getting drawn into a technical debate. Refer participants to the scenarios themselves for further context.

Technique 1: Futures wheel

The futures wheel is a cascade-thinking exercise. The scenario sits in the centre of concentric rings. The first ring captures direct implications for the participant's workstream or organisation. The second ring captures what follows from those direct implications. The third ring captures cascading effects further out in time or further across the system.

When to use it

When participants are new to foresight, when the goal is to build shared understanding around one plausible future, when the workshop needs to broaden participants' sense of what is at stake, and when time allows for a divergent conversation before any convergent thinking.

What it produces

A visual map of first-, second-, and third-order implications for a specific scenario, from the perspective of the participant group. The wheel is typically photographed or exported and distributed after the session as a shared reference.

What you need

One facilitator and one notetaker per breakout group of up to twelve participants. For in-person sessions: a flip chart sheet with three concentric circles or a printed template at A1 or A2, Post-it notes in three colours, and marker pens. For online sessions: a shared whiteboard with one futures wheel template per breakout group and the central scenario summary preloaded. Allow 90 minutes for a single scenario, or 180 minutes for a comparative session across two scenarios.

Suggested agenda (single scenario, 90 minutes)

- Plenary introduction and scenario briefing (15 minutes)
- Anchor the scenario, silent read (5 minutes)
- First ring, direct implications (15 minutes)
- Second ring, knock-on consequences (20 minutes)
- Third ring, cascading effects (20 minutes)
- Synthesis and close (15 minutes)

Facilitation notes

Start each ring with a round-robin so every participant contributes. When moving to the second and third rings, take each previous Post-it in turn and ask “what follows from this”. Push participants toward domains they have not yet covered. Watch for over-clustering in one area; the PESTLEV checklist (political, economic, social, technological, legal, environmental, values) can prompt breadth.

Encourage participants to contribute from personal as well as professional perspectives. The first thought to surface is often a personal one, and these contributions add useful texture to the wheel. For a comparative session across two scenarios (180 minutes), repeat the wheel exercise with a second scenario after a 10-minute break, then reserve 15 minutes at the end for cross-scenario report-back in plenary.

Further reading

UK Government Office for Science. 2024. The Futures Toolkit, 2nd edition. Futures Wheels chapter. Available at [gov.uk](https://www.gov.uk).

European Commission Knowledge4Policy platform. Futures Wheel workshop: A step-by-step guide to run a foresight workshop. Available at knowledge4policy.ec.europa.eu/strategic-foresight/topic/futures-wheel-workshop_en.

Technique 2: Robustness testing

Robustness testing takes a specific policy option, governance arrangement, or institutional design and evaluates it against each scenario in turn. Participants ask, for each scenario, whether the option remains effective, becomes counterproductive, or requires modification. Outputs are typically captured in a matrix with the option or options on one axis and the scenarios on the other.

When to use it

When participants have a specific policy question, option, or draft position they are trying to test. When the goal is to compare options against uncertainty rather than to explore uncertainty in the abstract. When the workshop is directly informing a decision or a planning cycle.

What it produces

A matrix showing how one or more options perform across the four scenarios, with narrative notes on the conditions under which each option succeeds, fails, or needs to be adapted. The matrix supports comparison and can be included in decision memos or strategy documents.

What you need

One facilitator and one notetaker per group of up to fifteen participants. A matrix template on a flip chart or shared whiteboard, with scenarios on one axis and either specific options or evaluation criteria on the other. Copies of all four scenario summaries. Allow 120 minutes for a session testing two or three options across the four scenarios.

Suggested agenda (120 minutes)

- Plenary introduction and scenario briefing (15 minutes)
- Frame the options: group agrees on the option or options to be tested (15 minutes)
- Test option against scenario one (15 minutes)
- Test option against scenario two (15 minutes)
- Test option against scenario three (15 minutes)
- Test option against scenario four (15 minutes)
- Cross-scenario synthesis: which options hold up, which fail, which need modification (20 minutes)
- Close and next steps (10 minutes)

Facilitation notes

Before starting, agree on evaluation criteria. Feasibility, legitimacy, effectiveness, and risk of unintended consequences are a reasonable default set but can be adapted to the specific policy question.

Push participants to be concrete: what specifically would happen to this option under this scenario? Watch for confirmation bias, in which participants judge options they favour as robust across all scenarios; asking “under what conditions would this option fail” is a useful counterweight.

The synthesis stage is the most valuable part of the workshop and deserves protected time. Do not let earlier discussion overrun.

Further reading

UK Government Office for Science. 2024. The Futures Toolkit, 2nd edition. Policy Stress-testing chapter. Available at gov.uk.

European Commission Joint Research Centre. 2022. Stress-testing of policy options using foresight scenarios: a pilot case. Available at publications.jrc.ec.europa.eu.

Technique 3: Backcasting

Backcasting works backwards from the scenario to the present. Given a scenario, participants trace what would need to have been true earlier, in five-, three- and one-year increments, for that scenario to have come about. The output is a timeline of leading indicators and near-term decisions that would push the scenario toward or away from reality.

When to use it

When participants have responsibility for near-term decisions and want to identify what to watch for. When the goal is to turn scenario planning into actionable early warning and near-term action. When the workshop is intended to feed into monitoring frameworks, planning cycles, or decision points that will occur before 2036.

What it produces

A timeline showing what would need to have happened at 2030, 2032, and 2034 for the scenario to have arrived. Alongside the timeline, a set of near-term indicators to monitor and near-term decisions to influence. Outputs are useful for early warning, strategic monitoring, and identifying where to invest attention now.

What you need

One facilitator and one notetaker per group of up to twelve participants. A large timeline template with markers for 2036, 2032, 2030, and the present. Post-it notes in two colours: one for events or conditions along the timeline, another for indicators or decisions to be captured at the present-day end. Copies of the scenario briefing. Allow 120 minutes.

Suggested agenda (120 minutes)

- Plenary introduction and scenario briefing (10 minutes)
- Anchor the scenario: group agrees on the specific features of the 2036 state to be backcast (15 minutes)
- Work backwards to 2032: what would need to have happened between 2032 and 2036 (25 minutes)
- Work backwards to 2030: what would need to have happened between 2030 and 2032 (20 minutes)
- Break (5 mins)
- Work backwards to the present: what leading indicators are visible now and what near-term decisions would influence the trajectory (25 minutes)
- Synthesis: name the three to five indicators to watch and the three to five near-term decisions that matter most (20 minutes)

Facilitation notes

Backcasting is harder for participants than the futures wheel. The intuition of tracing forwards is more natural than tracing backwards. Expect the group to slip into forwards thinking and gently redirect.

Prompts that help: “what would already have had to be true by 2032 for this scenario to arrive in 2036?” and “what evidence would we already be seeing today if this scenario were unfolding?” The near-term end of the timeline is the most valuable output. Ensure the synthesis stage draws out specific indicators and decisions rather than general observations.

Further reading

UK Government Office for Science. 2024. The Futures Toolkit, 2nd edition. Backcasting chapter. Available at gov.uk.

United Nations Development Programme. 2024. Backcasting for Partnership Design, chapter in the Foresight CPD Toolkit. Available at undp.org/future-development/foresight-cpd-toolkit.

Adapting prompts to your audience

The prompts below can be substituted into the third-ring section of the futures wheel, into the evaluation criteria of robustness testing, or into the discussion of near-term decisions in backcasting, depending on the composition of the group.

Climate negotiators and climate-adjacent teams

How would this scenario reshape the politics of mitigation ambition? What does it mean for climate finance flows? How might it affect the legitimacy of the Paris Agreement? Where would loss and damage debates land in this future?

Foreign affairs and defence teams

How might this scenario reshape alliance structures? What new attribution and verification challenges does it create? Where would intelligence priorities shift? What posture would you expect from major powers and what does that mean for your country's position?

Research funders and science governance bodies

What does this scenario mean for the social licence of climate research? How does it change the risk profile of funding decisions? What new oversight functions would be needed and who would control them? How would the line between research and deployment be policed?

Development and humanitarian organisations

Who in your portfolio is most exposed in this scenario? What changes in donor priorities would you anticipate? How would this affect your relationships with partner governments? What new humanitarian risks emerge and where?

Communications and strategic communications teams

What disinformation pathways open up? Which existing narratives become more or less credible in this future? Where would you need to invest in audience research now to be ready? What does prebunking look like in this scenario?

Translating workshop outputs into policy action

Workshops using this tool will generate material of different kinds: implications maps from futures wheels, evaluation matrices from robustness testing, timelines and indicator lists from backcasting. The value of that material depends on what happens next.

Immediate synthesis

Before participants leave the room, ensure the raw outputs are captured and shared. Photograph flip charts, export shared whiteboards, and circulate the material to participants within a few days. Memory of the workshop fades quickly, and participants who cannot access the outputs afterwards will not act on them.

Where possible, identify a small group responsible for taking the outputs forward. Foresight material without an owner tends to sit in shared drives unread.

Looking across scenarios

The most useful policy insights often come from patterns visible across scenarios rather than from any single scenario. Ask which conditions, decisions, or capabilities appear as necessary or valuable in more than one scenario. These are candidates for near-term investment because they pay off across futures rather than only in one.

Conversely, ask which conditions or decisions appear valuable in one scenario and counterproductive in another. These are candidates for careful sequencing or conditional planning: they should be pursued only when it becomes clearer which scenario is unfolding.

Identifying indicators to watch

Scenario workshops surface not only what different futures would mean but what current signals suggest which future is unfolding. Compile a list of the indicators identified across the workshops and assign responsibility for tracking them. Review the list at regular intervals to see whether particular scenarios are gathering evidence over time.

Feeding into strategy and decision processes

Workshop outputs are most useful when they feed into existing strategy or decision processes rather than becoming standalone reports. Identify the specific processes the outputs should inform (planning cycles, decision memos, strategy refreshes, budget submissions) and prepare short syntheses tailored to each.

Where workshop outputs surface disagreement within the team, treat that as valuable information rather than as a problem to resolve. Disagreement often points to the assumptions and value judgments underlying a policy question, and those are worth surfacing explicitly in any subsequent decision.

Repeating the exercise

The scenarios are stable but the conditions surrounding them change. Repeat the exercise at intervals appropriate to the pace of change in your policy area. For SRM governance, an annual or biennial refresh is likely to be useful. Between refreshes, use lighter-touch check-ins to review indicators and revisit any options that have moved.

Surfacing critical uncertainties

A key goal of foresight processes is to surface critical uncertainties.

Some prompting questions to uncover these might include:

- How might commercial interest and investment in SAI change the forums within which SAI governance negotiations progress?
- Who has the legitimate authority to make decisions about the global atmosphere – and through what process?
- The distinction between research and deployment matters enormously for governance, but there is no shared international taxonomy defining what constitutes small-scale research versus large-scale research or deployment-relevant activity. How should this grey zone be managed, and by whom?
- How can the international community manage free-driver actions by small states or private actors?
- How might accelerating and increasingly extreme impacts of climate change affect public and political attitudes towards SAI?
- How can governments and scientific institutions communicate complex risk and uncertainty to publics?
- What governance design choices, including transparency, registries, and participatory deliberation, become more or less workable in a contested information environment?

Endnotes

- ¹ Royal Society. 2025. Solar Radiation Modification. Policy Briefing. <https://royalsociety.org/news-resources/projects/solar-radiation-modification/>
- ² T.J. Lavery. 2026. Methodology of scenario development: Dual-track approach to stratospheric aerosol injection governance scenarios for 2036. <https://cfg.eu/governing-climate-cooling-technologies/>
- ³ SRM360. 2025. SRM funding overview. <https://srm360.org/article/srm-funding-overview/>.
- ⁴ C. Hiar. 2025. 'Betting on climate failure, these investors could earn billions', POLITICO, 23 December. <https://www.eenews.net/articles/betting-on-climate-failure-these-investors-could-earn-billions/>.
- ⁵ B. Crumley. 2024 'Startup Make Sunsets wants to fight global warming by making aerosol clouds', Inc., 16 October.
- ⁶ Mechanisms of increased carbon drawdown as a result of SAI outlined in: SAPEA. 2024. **Solar Radiation Modification**. Berlin: SAPEA. DOI 10.5281/zenodo.14283096
- ⁷ A. Lockley. 2016. 'Licence to chill: Building a legitimate authorisation process for commercial SRM operations'. Environmental Law Review 18(1), 25–40.
- ⁸ M. Romanello, M. Walawender, S. Hsu et al. 2025. 'The 2025 report of the Lancet Countdown on health and climate change: Climate change action offers a lifeline'. The Lancet 406, 2804–57.
- ⁹ C. Mbow, C. Rosenzweig, L.G. Barioni et al. 2019. 'Food Security'. In: P.R. Shukla, J. Skea, E. Calvo Buendia et al. (eds.), Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. Cambridge University Press, 437–550. <https://www.ipcc.ch/srccl/chapter/chapter-5/>
- ¹⁰ UN Foundation. 2020. Climate change and the future of food. <https://unfoundation.org/blog/post/climate-change-and-the-future-of-food/>
- ¹¹ S. Heikonen, M. Heino, M. Jalava et al. 2025. 'Climate change threatens crop diversity at low latitudes'. Nature Food 6, 331–42. <https://doi.org/10.1038/s43016-025-01135-w>
- ¹² World Bank. 2022. 'What you need to know about food security and climate change'. Feature story, 17 October. Available at: <https://www.worldbank.org/en/news/feature/2022/10/17/what-you-need-to-know-about-food-security-and-climate-change>.
- ¹³ H.A. Munia, J.H.A. Guillaume, Y. Wada et al. 2020. 'Future transboundary water stress and its drivers under climate change: a global study'. Earth's Future 8, e2019EF001321. <https://doi.org/10.1029/2019EF001321>
- ¹⁴ IPCC. 2019. 'Summary for policymakers'. In: P.R. Shukla, J. Skea, E. Calvo Buendia et al. (eds.), Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. Cambridge University Press. <https://doi.org/10.1017/9781009157988.001>
- ¹⁵ H.A. Munia, J.H.A. Guillaume, Y. Wada et al. 2020. 'Future transboundary water stress and its drivers under climate change: a global study'. Earth's Future 8, e2019EF001321. <https://doi.org/10.1029/2019EF001321>
- ¹⁶ S. Kuzma, L. Saccoccia and M. Chertock. 2023. '25 countries, housing one-quarter of the population, face extremely high water stress'. World Resources Institute, 16 August. <https://www.wri.org/insights/highest-water-stressed-countries>
- ¹⁷ K. Madani. 2026. 'Water bankruptcy: The formal definition'. Water Resources Management 40, 78. <https://doi.org/10.1007/s11269-025-04484-0>.

- ¹⁸ UNU-INWEH. 2026. 'World enters "era of global water bankruptcy": UN scientists formally define new post-crisis reality for billions'. United Nations University Institute for Water, Environment and Health, 20 January. <https://unu.edu/inweh/news/world-enters-era-of-global-water-bankruptcy>
- ¹⁹ Al Jazeera. 2023. 'Himalayan glaciers may lose 75 percent of ice by 2100: report'. Al Jazeera, 20 June. <https://www.aljazeera.com/news/2023/6/20/himalayan-glaciers-may-lose-75-percent-of-ice-by-2100-report>
- ²⁰ Al Jazeera. 2023. 'Himalayan glaciers may lose 75 percent of ice by 2100: report'. Al Jazeera, 20 June. <https://www.aljazeera.com/news/2023/6/20/himalayan-glaciers-may-lose-75-percent-of-ice-by-2100-report>
- ²¹ University of New South Wales. 2024. 'Meltwater from Greenland and the Arctic is weakening ocean circulation, speeding up warming down south'. UNSW Newsroom, 19 November. <https://www.unsw.edu.au/newsroom/news/2024/11/meltwater-greenland-arctic-weakening-ocean-circulation>
- ²² G.M. Pontes and L. Meniel. 2024. 'Weakening of the Atlantic Meridional Overturning Circulation driven by subarctic freshening since the mid-twentieth century'. Nature Geoscience 17, 1291–98. <https://doi.org/10.1038/s41561-024-01568-1>
- ²³ Q. Xing, S. Elipot, W.E. Johns et al. 2026. 'Meridionally consistent decline in the observed western boundary contribution to the Atlantic Meridional Overturning Circulation'. Science Advances 12, eadz7738. <https://doi.org/10.1126/sciadv.adz7738>
- ²⁴ S. Drijfhout, J.R. Angevaere, J. Mecking et al. 2025. 'Shutdown of northern Atlantic overturning after 2100 following deep mixing collapse in CMIP6 projections'. Environmental Research Letters 20, 094062. <https://doi.org/10.1088/1748-9326/adfa3b>
- ²⁵ Energy News. 2025. 'Iceland's view of the Atlantic Ocean current collapse as a security and existential risk'. Energy News, 12 November. <https://energynews.oedigital.com/climate-change/2025/11/12/icelands-view-of-the-atlantic-ocean-current-collapse-as-a-security-and-existential-risk>
- ²⁶ JPI Oceans. n.d. 'Atlantic Meridional Overturning Circulation'. JPI Oceans. Accessed 18 September 2026. <https://www.jpi-oceans.eu/en/atlantic-meridional-overturning-circulation>
- ²⁷ Global Climate Risks. 2025. 'Iceland flags AMOC a national security threat'. Global Climate Risks (GCRP), 28 November. <https://globalclimaterisks.org/insights/blog/iceland-amoc-national-security-threat/>
- ²⁸ P. Barnard. n.d. 'Preparedness: risk foresight planning'. Phoebe Barnard & Associates. Accessed 18 September 2026. <https://www.phoebebarnard.com/preparednessplanning>
- ²⁹ R. Lindsey. 2023. 'Climate change: global sea level'. NOAA Climate.gov, 22 August. <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>
- ³⁰ UN News. 2024. 'UN expert calls for action as Marshall Islands faces dual displacement crisis'. UN News, 31 October. <https://news.un.org/en/story/2024/10/1156346>
- ³¹ OECD. 2025. 'OECD global long-run economic scenarios: 2025 update'. OECD Economic Policy Papers, No. 36. OECD Publishing, Paris. <https://doi.org/10.1787/00353678-en>
- ³² OECD. 2025. 'OECD global long-run economic scenarios: 2025 update'. OECD Economic Policy Papers, No. 36. OECD Publishing, Paris. <https://doi.org/10.1787/00353678-en>
- ³³ OECD. (In prep). Review of existing frameworks for management of solar radiation modification. OECD Publishing, Paris.
- ³⁴ Convention on Biological Diversity: Convention on Biological Diversity (CBD). Rio de Janeiro, 5 June 1992. Entered into force 29 December 1993. 1760 UNTS 79.
- ³⁵ London Convention: Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention). London, 29 December 1972. Entered into force 30 August 1975. 1046 UNTS 120.

- ³⁶ London Protocol: 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol). London, 7 November 1996. Entered into force 24 March 2006. 36 ILM1 (1997).
- ³⁷ ENMOD: Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD). Adopted by UN General Assembly resolution 31/72, 10 December 1976; opened for signature, Geneva, 18 May 1977. Entered into force 5 October 1978. 1108 UNTS 151.
- ³⁸ CLRTAP: Convention on Long-Range Transboundary Air Pollution. Geneva, 13 November 1979. Entered into force 16 March 1983. 1302 UNTS 217.
- ³⁹ UNCLOS: United Nations Convention on the Law of the Sea. Montego Bay, 10 December 1982. Entered into force 16 November 1994. 1833 UNTS 3.
- ⁴⁰ Vienna Convention: Vienna Convention for the Protection of the Ozone Layer. Vienna, 22 March 1985. Entered into force 22 September 1988. 1513 UNTS 293.
- ⁴¹ Montreal Protocol: Montreal Protocol on Substances that Deplete the Ozone Layer. Montreal, 16 September 1987. Entered into force 1 January 1989. 1522 UNTS 3.
- ⁴² OECD. (In prep). Review of existing frameworks for management of solar radiation modification. OECD Publishing, Paris.
- ⁴³ OECD. (In prep). Review of existing frameworks for management of solar radiation modification. OECD Publishing, Paris.
- ⁴⁴ Young, D., et al. Negotiating solar radiation modification governance: Evidence from non-ideal simulations. <http://cfg.eu/negotiating-solar-radiation-modification-governance/>
- ⁴⁵ F. Biermann, J. Oomen, A. Gupta et al. 2022. 'Solar geoengineering: the case for an international non-use agreement'. WIREs Climate Change 13(3), e754. <https://doi.org/10.1002/wcc.754>.
- ⁴⁶ Young, D., et al. Negotiating solar radiation modification governance: Evidence from non-ideal simulations. <http://cfg.eu/negotiating-solar-radiation-modification-governance/>
- ⁴⁷ A planetary large-scale SAI deployment would require both the availability of aircrafts that have a high payload capacity and engines capable of flying at high altitudes, and access to airbases in both hemispheres in the tropics or subtropics (Horton, Smith and Keith, 2025). While a number of states have the aerospace infrastructure capabilities that could feasibly support a planetary large-scale deployment, only a limited subset of states have this and secure access to airbases in both hemispheres.
- ⁴⁸ J. Nielsen. 2025. 'The big green button: stratospheric aerosol injection as a geopolitical dilemma during strategic competition between the United States and China, and implications for expanding aerosol injection near-term research'. Oxford Open Climate Change 5(1), kgaf009. <https://doi.org/10.1093/oxfclm/kgaf009>
- ⁴⁹ S. Moore and E. Freymann. 2023. 'China doesn't want a geoengineering disaster'. Foreign Policy, 21 February. <https://foreignpolicy.com/2023/02/21/china-geoengineering-rules-climate-change/>
- ⁵⁰ The Joseph Rainey Center for Public Policy and SilverLining. 2026. Protecting American weather sovereignty: strategies for a safe and secure atmosphere for America. March. <https://www.raineycenter.org/policy-brief/protecting-american-weather-sovereignty>
- ⁵¹ C.M. Baum, L. Fritz, S. Low and B.K. Sovacool. 2024. 'Public perceptions and support of climate intervention technologies across the Global North and Global South'. Nature Communications 15, 2060. <https://doi.org/10.1038/s41467-024-46341-5>
- ⁵² M.L. Weitzman. 2015. 'A voting architecture for the governance of free-driver externalities, with application to geoengineering'. The Scandinavian Journal of Economics 117(4), 1049–68. <https://doi.org/10.1111/sjoe.12120>
- ⁵³ UNEP. 2025. Emissions Gap Report 2025: off target. United Nations Environment Programme, Nairobi. <https://doi.org/10.5917/20.500.11822/48854>

- ⁵⁴ IPCC. 2021. 'Summary for policymakers'. In: V. Masson-Delmotte, P. Zhai, A. Pirani et al. (eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, 3–32.
- ⁵⁵ C.-F. Schleussner, G. Ganti, Q. Lejeune et al. 2024. 'Overconfidence in climate overshoot'. *Nature* 634(8033), 366–73. <https://doi.org/10.1038/s41586-024-08020-9>
- ⁵⁶ A. Deprez, P. Leadley, K. Dooley et al. 2024. 'Sustainability limits needed for CO₂ removal'. *Science* 383(6682), 484–86. <https://doi.org/10.1126/science.adj6171>
- ⁵⁷ S.M. Smith, O. Geden, M.J. Gidden et al. (eds.) 2024. *The State of Carbon Dioxide Removal 2024* (2nd edn). <https://doi.org/10.17605/OSF.IO/F85QJ>
- ⁵⁸ A.M. Mercer, D.W. Keith and J.D. Sharp. 2011. 'Public understanding of solar radiation management'. *Environmental Research Letters* 6(4), 044006. <https://doi.org/10.1088/1748-9326/6/4/044006>
- ⁵⁹ D. Tingley and G. Wagner. 2017. 'Solar geoengineering and the chemtrails conspiracy on social media'. *Palgrave Communications* 3, 12. <https://doi.org/10.1057/s41599-017-0014-3>
- ⁶⁰ F. Müller-Hansen, T. Repke, C.M. Baum et al. 2023. 'Attention, sentiments and emotions towards emerging climate technologies on Twitter'. *Global Environmental Change* 83, 102765. <https://doi.org/10.1016/j.gloenvcha.2023.102765>
- ⁶¹ Lavery, T. (2025) 'Solar geoengineering: protecting democratic deliberations in a contested information environment', *Defence Strategic Communications*, 16, pp. 61–107.
- ⁶² Center for Countering Digital Hate. 2024. *The new climate denial: how social media platforms and content producers profit by spreading new forms of climate denial*. London and Washington, DC: CCDH. <https://counterhate.com/research/new-climate-denial/>
- ⁶³ European External Action Service. 2025. 3rd EEAS Report on Foreign Information Manipulation and Interference Threats: exposing the architecture of FIMI operations. March. Brussels: EEAS. <https://www.eeas.europa.eu/sites/default/files/documents/2025/EEAS-3rd-ThreatReport-March-2025-05-Digital-HD.pdf> | T. Lavery. 2025. 'Solar geoengineering: protecting democratic deliberations in a contested information environment'. *Defence Strategic Communications* 16, 61–107. <https://doi.org/10.30966/2018.RIGA.16.3>
- ⁶⁴ S. Kumar. 2026. 'Is Delhi rain fake? What is solar geoengineering as viral claims link sudden weather change to Bill Gates' experiments'. *The Sunday Guardian*, 20 March. <https://sundayguardianlive.com/trending/is-delhi-rain-fake-what-is-solar-geoengineering-as-viral-claims-link-sudden-weather-change-to-bill-gates-experiments-177752/>
- ⁶⁵ V. Bélair-Gagnon. 2025. 'From fact-checking to friction-checking'. *Nieman Journalism Lab*, December. <https://www.niemanlab.org/2025/12/from-fact-checking-to-friction-checking/>
- ⁶⁶ J. Angwin. 2024. *The future of trustworthy information: learning from online content creators*. Discussion paper, Shorenstein Center on Media, Politics and Public Policy, Harvard Kennedy School, 9 December. <https://shorensteincenter.org/resource/future-trustworthy-information-learning-online-content-creators/>
- ⁶⁷ African Ministerial Conference on the Environment. 2025. Decision AMCEN/20/Dec.9: Africa's engagement at the seventh session of the United Nations Environment Assembly [unedited version]. Nairobi: AMCEN/UNEP. <https://wedocs.unep.org/items/d0cab887-5dbc-4901-99d1-e96ec482a057>
- ⁶⁸ D. McLaren and O. Corry. 2024. 'Countries failed to agree first steps on solar geoengineering at the UN. What went wrong?'. *Legal Planet*, 7 March. <https://legal-planet.org/2024/03/07/countries-failed-to-agree-first-steps-on-geoengineering-what-went-wrong/>
- ⁶⁹ European Commission and High Representative of the Union for Foreign Affairs and Security Policy. 2023. *Joint communication to the European Parliament and the Council: a new outlook on the climate and security nexus – addressing the impact of climate change and environmental degradation on peace, security and defence*. JOIN(2023) 19 final. Brussels, 28 June. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52023JC0019>

- ⁷⁰ Umweltbundesamt (UBA). 2026. Geoengineering. German Environment Agency. Last updated 4 August 2026, accessed 18 September 2026. <https://www.umweltbundesamt.de/en/topics/climate-energy/geoengineering>
- ⁷¹ Solar Geoengineering Non-Use Agreement Initiative. 2022. Open letter: we call for an international non-use agreement on solar geoengineering. Accessed 18 September 2026. <https://www.solargeoeng.org/non-use-agreement/open-letter/>
- ⁷² J. Tollefson. 2024. 'Divisive Sun-dimming study at Harvard cancelled: what's next?'. Nature, 27 March. <https://doi.org/10.1038/d41586-024-00876-1>
- ⁷³ For further discussion of policy relevant questions see D. Young. Negotiating solar radiation modification governance: Evidence from non-ideal simulations. <http://cfg.eu/negotiating-solar-radiation-modification-governance/>
- ⁷⁴ Texas Conservative Coalition Research Institute. 2026. Clearing the air: an analysis of weather modification, old and new. TCCRI white paper, by T. Wolfe, 24 March. <https://www.txccri.org/single-post/clearing-the-air-an-analysis-of-weather-modification-old-and-new>
- ⁷⁵ Politico (E&E News). 2025. 'Betting on climate failure, these investors could earn billions'. 26 December. <https://www.politico.com/news/2025/12/26/betting-on-climate-failure-investors-could-earn-billions-00677281>
- ⁷⁶ 'The strange and totally real plan to blot out the sun and reverse global warming'. 2025. Politico Magazine, 21 November. <https://www.politico.com/news/magazine/2025/11/21/stardust-geoengineering-janos-pasztor-regulations-00646414>
- ⁷⁷ Make Sunsets. 2025. Baby's first patent. Make Sunsets blog, 3 December. <https://makesunsets.com/blogs/news/our-first-patent>
- ⁷⁸ W.C.G. Burns and S. Talati. 2025. The solar geoengineering ecosystem: key actors across the landscape of the field. Alliance for Just Deliberation on Solar Geoengineering and Forum on Climate Engineering Assessment. <https://doi.org/10.2139/ssrn.5129664>
- ⁷⁹ L. Gu, D.D. Baldocchi, S.C. Wofsy et al. 2003. 'Response of a deciduous forest to the Mount Pinatubo eruption: enhanced photosynthesis'. Science 299(5615), 2035–38. <https://doi.org/10.1126/science.1078366>
- ⁸⁰ L. Mercado, N. Bellouin, S. Sitch et al. 2009. 'Impact of changes in diffuse radiation on the global land carbon sink'. Nature 458(7241), 1014–17. <https://doi.org/10.1038/nature07949>
- ⁸¹ Royal Society. 2025. Solar radiation modification: summary briefing. London: Royal Society. <https://royalsociety.org/news-resources/projects/solar-radiation-modification/summary-briefing/>
- ⁸² SAPEA (Science Advice for Policy by European Academies). 2024. Solar radiation modification: evidence review report. Berlin: SAPEA
- ⁸³ A. Lockley. 2016. 'Licence to chill: building a legitimate authorisation process for commercial SRM operations'. Environmental Law Review 18(1), 25–40. <https://doi.org/10.1177/1461452916630082>
- ⁸⁴ A. Lockley, I. Mundra and P.T. Smith. 2023. 'Legitimacy and justifiability of non-state geoengineering'. Futures 152, 103210. <https://doi.org/10.1016/j.futures.2023.103210>
- ⁸⁵ E. Giordano. 2026. 'Europeans want more renewables, even if it increases energy bills'. Politico Europe, 9 April. <https://www.politico.eu/article/poll-europeans-back-renewables-despite-higher-energy-costs/>
- ⁸⁶ European Commission. 2025. Climate change. Special Eurobarometer. Fieldwork February–March 2025, published June 2025.
- ⁸⁷ Ipsos. 2025. Global perceptions amid earth's temperature breaching the 1.5 degrees tipping point. Ipsos, 17 April. <https://www.ipsos.com/en/people-and-climate-change>
- ⁸⁸ Center for Countering Digital Hate. 2024. The new climate denial: how social media platforms and content producers profit by spreading new forms of climate denial. London and Washington, DC: CCDH. <https://counterhate.com/research/new-climate-denial/>

- ⁸⁹ European Commission and High Representative of the Union for Foreign Affairs and Security Policy. 2023. Joint communication to the European Parliament and the Council: a new outlook on the climate and security nexus – addressing the impact of climate change and environmental degradation on peace, security and defence. JOIN(2023) 19 final. Brussels, 28 June. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52023JC0019>
- ⁹⁰ European Commission, Group of Chief Scientific Advisors and Directorate-General for Research and Innovation. 2024. Solar radiation modification. Luxembourg: Publications Office of the European Union. <https://doi.org/10.2777/391614>
- ⁹¹ S. Low, L. Fritz, C.M. Baum and B.K. Sovacool. 2024. 'Public perceptions on solar geoengineering from focus groups in 22 countries'. *Communications Earth & Environment* 5, 352. <https://doi.org/10.1038/s43247-024-01518-0>
- ⁹² T. Ellison and B. Hugh. 2024. Climate security and misinformation: a baseline. Council on Strategic Risks (Center for Climate and Security), 23 April. <https://councilonstrategicrisks.org/2024/04/23/climate-security-and-misinformation-a-baseline/>
- ⁹³ C. Hirsch. 2024. 'The grand Russian disinformation strategy in environmental politics'. Central European University, Department of International Relations research blog. https://ir.ceu.edu/ohpa/research_blog/articles/rusdisinformation
- ⁹⁴ T. Lavery. 2025. 'Solar geoengineering: protecting democratic deliberations in a contested information environment'. *Defence Strategic Communications* 16, 61–107. <https://doi.org/10.30966/2018.RIGA.16.3>
- ⁹⁵ University of Cambridge. 2023. 'Social media posts around solar geoengineering "spill over" into conspiracy theories'. University of Cambridge research news, 28 February. <https://www.cam.ac.uk/research/news/social-media-posts-around-solar-geoengineering-spill-over-into-conspiracy-theories> | R. Debnath, D.M. Reiner, B.K. Sovacool et al. 2023. 'Conspiracy spillovers and geoengineering'. *iScience* 26(3), 106166. <https://doi.org/10.1016/j.isci.2023.106166>
- ⁹⁶ Operaatio Arktis. n.d. Operaatio Arktis [website]. Accessed 18 September 2026. <https://www.operaatioarktis.fi/>
- ⁹⁷ L. Dunlop, E. Rushton, L. Atkinson et al. 2022. 'Youth co-authorship as public engagement with geoengineering'. *International Journal of Science Education, Part B* 12(1), 60–74.
- ⁹⁸ Energy News. 2025. 'Iceland's view of the Atlantic Ocean current collapse as a security and existential risk'. Energy News, 12 November. <https://energynews.oedigital.com/climate-change/2025/11/12/icelands-view-of-the-atlantic-ocean-current-collapse-as-a-security-and-existential-risk>
- ⁹⁹ JPI Oceans. n.d. 'Atlantic Meridional Overturning Circulation'. JPI Oceans. Accessed 18 September 2026. <https://www.jpi-oceans.eu/en/atlantic-meridional-overturning-circulation>
- ¹⁰⁰ Global Climate Risks. 2025. 'Iceland flags AMOC a national security threat'. Global Climate Risks (GCRP), 28 November. <https://globalclimaterisks.org/insights/blog/iceland-amoc-national-security-threat/>
- ¹⁰¹ P. Barnard. n.d. 'Preparedness: risk foresight planning'. Phoebe Barnard & Associates. Accessed 18 September 2026. <https://www.phoebebarnard.com/preparednessplanning>
- ¹⁰² E. Sikorsky and S. Talati. 2026. 'Reframing the conversation on climate intervention and security'. Council on Strategic Risks, 5 May. <https://councilonstrategicrisks.org/2026/05/05/reframing-the-conversation-on-climate-intervention-and-security/>
- ¹⁰³ The Joseph Rainey Center for Public Policy and SilverLining. 2026. Protecting American weather sovereignty: strategies for a safe and secure atmosphere for America. March. <https://www.raineycenter.org/policy-brief/protecting-american-weather-sovereignty>
- ¹⁰⁴ C. Hiar and K. Mathiesen. 2025. 'Global cooling startup raises \$60M to test sun-reflecting technology'. Politico, 24 October. <https://www.politico.com/news/2025/10/24/global-cooling-startup-raises-60-million-dollars-to-test-sun-reflecting-technology-00620340>
- ¹⁰⁵ Politico (E&E News). 2025. 'Betting on climate failure, these investors could earn billions'. 26 December. <https://www.politico.com/news/2025/12/26/betting-on-climate-failure-investors-could-earn-billions-00677281>
- ¹⁰⁶ M. de Guglielmo Weber, S. Kabbej and L. Hebbel Boutang. 2023. 'Géo-ingénierie solaire: enjeux géostratégiques et de défense'. IRIS, Observatoire Défense et Climat, 29 November. <https://www.iris-france.org/180425-geo-ingenierie-solaire-enjeux-geostrategiques-et-de-defense/>