German Environment Agency

25. June 2018

The Research & Funding Landscape of Solar Radiation Modification (SRM)

Factsheet

1 Introduction

For many years, research into solar radiation modification (SRM)—also referred to as solar radiation management or solar geoengineering, within the broader field of climate geoengineering —received limited public funding. Private funding, primarily from philanthropic sources, was the source, albeit concentrated among a few key actors, mainly in the United States. Recently, there have been reports of growing interest from both the public and private sector, though concrete data on expanded funding flows is limited and the overall scale and direction of this investment remain unclear.

This factsheet seeks to trace the development of SRM project initiatives and financing, thus building on earlier efforts of this kind (Necheles et al., 2018; Surprise et al., 2022). The project table "**The Research Funding Landscape of Solar Radiation Modification (SRM)"** accompanying this document forms the core of the findings. In the following, the methodology used to collect the project data is outlined, followed by a presentation and discussion of key insights drawn from the table. Lastly, recent developments in the research landscape from the current year, which are not fully captured in the table, are discussed before a brief outlook on the implications of these findings for the ongoing debates surrounding SRM within the broader climate politics framework is provided.

2 Methods

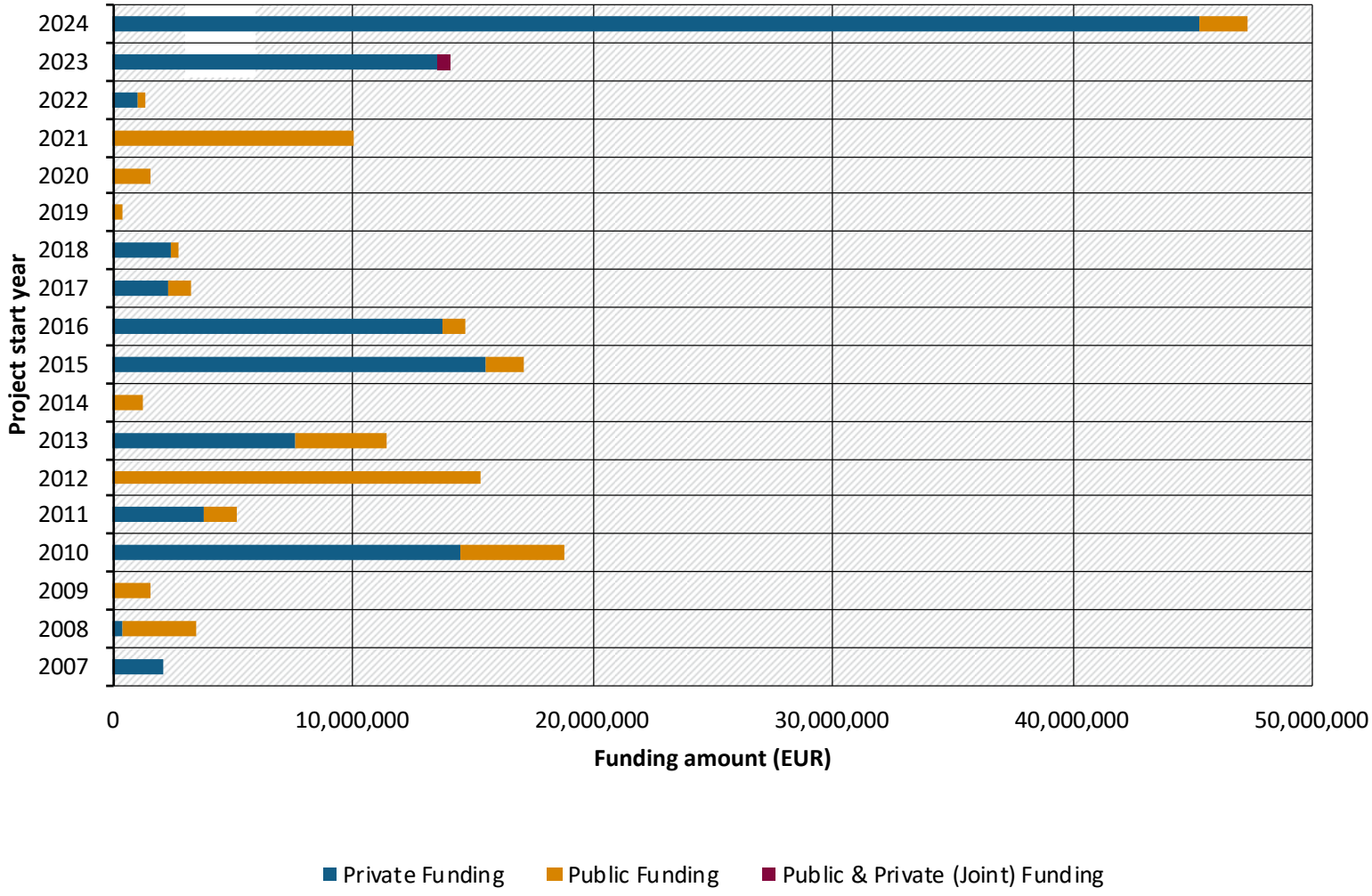
Data from previous research detailing SRM research projects and their funding, most notably the overview by Necheles and colleagues (2018) at Harvard University, formed a basis for the research and was comprehensively reviewed and updated wherever possible. A keyword search was carried out in the Grants Index of the Web of Science portal for the years 2000-2024 and a threshold of €100,000.00 in funding. The results were cross-checked with an extensive internet search. Lastly, the maps of the Geoengineering Monitor (a project of the Heinrich Böll Foundation & ETC Group, edited by Anja Chalmin) and a report by the French *The Defense and Climate Observatory* (2023) were consulted to find projects.

A total of 59 projects were identified that commenced between 2007 and August 2024 and had a clear connection to SRM, either in the project title or description. A minimum of €100,000.00 was set for projects to be registered in the list. In a few exceptions, projects without clear funding details were also considered if the scale or duration of the project strongly suggested to be above minimum funding amount. For comparability, all project funding amounts were converted to EUR, using the respective conversion rates as of September 2024.

The results are displayed in a table, detailing the project name, the funding type (private or public, or both), the funder(s), grantee(s), the discipline (natural or social sciences, interdisciplinary, or development), the funding origin (country), the main project location (country), the start and end year, the original and converted funding sums. References are added for each project, cells are left blank whenever (sufficient) information was not available on a category. A note on the accuracy of the information: The research has been conducted to the best of our knowledge and, in particular, information from third parties has been promptly verified. Nevertheless, the accuracy of the information cannot be guaranteed. In particular, with regard to funding amounts, there may be significant inaccuracies, as often only rough estimates or insufficient information is available. A conservative approach has been taken here, and the amount has generally been stated on the lower side. A special case involves potential double counting: since some actors receive funds for their own SRM projects while also financing other organizations, there is a possibility of double counting in a few instances. Overall, statements about funding flows should therefore be taken as estimates. Similarly, some projects address numerous topics and represent a comprehensive, often long-term research endeavour, others have a narrow thematic focus – a single, short-term university research project and a large-scale research consortium will always remain somewhat incommensurable, as do private enterprises and academic research projects. The decision was made to treat a research consortium with many smaller projects (e.g., the German SPP 1689 or the projects of the DEGREES Initiative) as a single entity rather than counting all sub-projects. While intended to avoid distortions, this should be taken into account when interpreting the results.

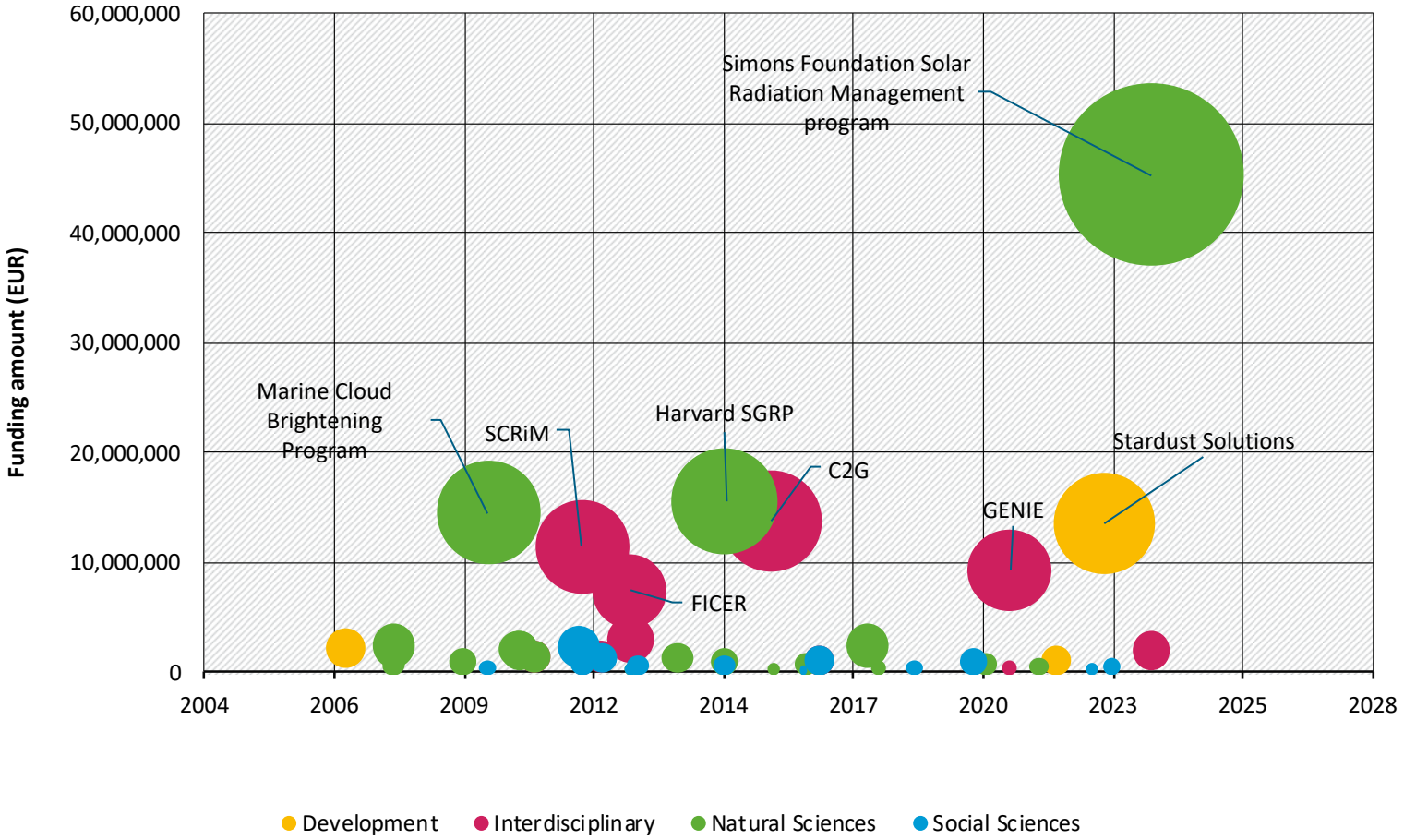
3 Results

Figure 1: Annual funding amount for SRM projects 2007 - 09/2024 per source of funding.



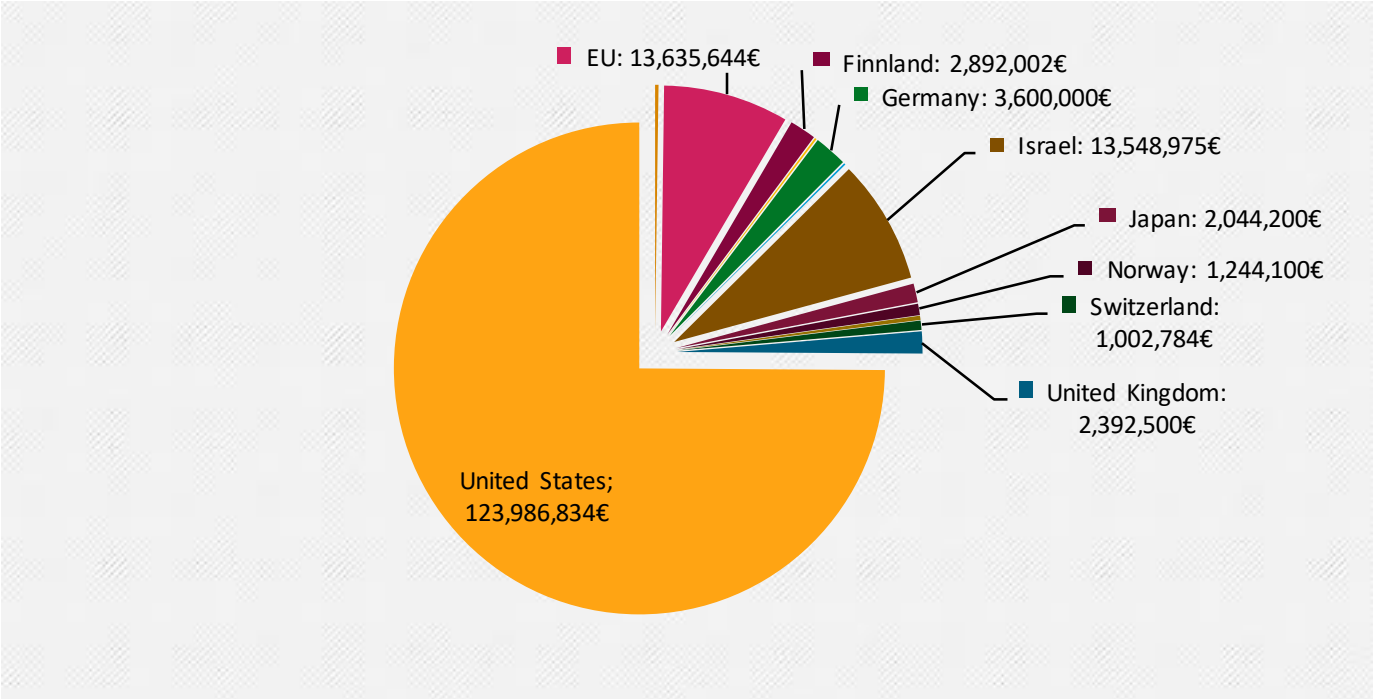
The y-axis shows the start year of the counted projects, while the x-axis shows the funding amount (converted to EUR for comparability). Source: Own figure

Figure 2: SRM project size in terms of funding, 2007-09/2024.



The y-axis shows the project funding size (in EUR), while the x-axis shows the start years. Bubble size varies with size of funding for better visibility. Colours are used for th eprojects' disciplines. Source: Own figure

Figure 3: Distribution of SRM funding per country origin, 2007- 09/2024.



3.1 The United States remain overwhelmingly dominant as funders of SRM research

Figure 3 illustrates the distribution of funding per country origin for SRM from our dataset. As described in chapter 2, the figures can only be regarded as an approximation. In addition, funding originating from more than one country and for which no exact breakdown was given was divided by the number and added equally to the respective country sums for this figure. A striking majority of the counted funding, totalling almost €123.99 million, has been provided by the United States, as represented by the largest segment of the chart. This underscores the central role the USA plays in driving financial support for SRM research, with other funding sources contributing only marginally in comparison. Amongst the remaining contributions, the European Union (ca. €13.64 million) and Israel (ca. €13.55 million) stand out. The fact that Israel and the EU are almost on a par here is striking, as Israel has so far only been represented by a single company (Stardust Solutions). Relative to their population size, the contributions from Norway (ca. €1.24 million), Finland (ca. €2.89 million), and Switzerland (ca. €1 million) are also noteworthy. It is not entirely

clear whether the funding for Stardust Solutions comes exclusively from Israeli sources – e.g., the venture capital fund Awz Ventures, which is investing in Stardust Solutions, is based in Canada and Israel.

While the USA continues to dominate in the funding of research projects, thus earlier work on the funding of SRM (Necheles et al., 2018; Surprise et al., 2022), this finding must increasingly be distinguished from the regional distribution of knowledge production. Both, the Geoengineering Map issued by the Geoengineering Monitor and the SRM-specific map by The Defense and Climate Observatory reveal numerous funding flows, particularly from the USA, but also from other Western states to countries in the so-called 'Global South'. In particular, the DEGREES Initiative, formerly SRM Governance Initiative (SRMGI) has had a major influence in proliferating research beyond the US American and European sphere. As such, while the funding of knowledge production remains highly asymmetrical, the distribution of sites of knowledge production are shifting.

3.2 Public and private funding for SRM projects – too close to call?

The project table gives insight into the distribution of research funding across private and public sources. Analysing the annual funding totals, which account for newly initiated projects each year (see Figure 1), no consistent dominance of either source emerges over the period under review, with the annual balance between the funding sources varying. Overall, however, the dominance of private funding is clear with approx. 71% of the total funding counted. Notably, a significant rise in private funding is already observable for 2024. Should this trend continue (refer to Chapter 3.4) and public funding fail to match this growth, private funding is likely to solidify its dominance for the near future. When comparing total funding amounts with the number of projects by funding source (s. table 1), it is noteworthy that publicly funded projects outnumber privately funded ones (37 publicly funded versus 20 private).

Table 1: Number of SRM projects per type of funding, 2007 – 09/2024

Type of Funding	Number of projects
Private	**20**
Public	**37**
Public-Private	**2**
Total	**57**

However, this discrepancy should be viewed in context. First, as explained above, the counting method used does not break down individual projects within larger initiatives (affecting both, research consortia such as often funded by the EU and e.g., funds by the DEGREES Initiative). Second, publicly funded projects often involve small-scale academic research, typically supported by national public research funding agencies (s.a. the National Science Foundation (NSF), UK Research and Innovation (UKRI) or the German Research Foundation (DFG)). Private, mostly philanthropic funding often flows into more long-time endeavours (s.a. the Harvard Solar Geoengineering Research Program (SGRP), the Marine Cloud Brightening Program, or C2G) and provides steady funding. It appears that foundations are sometimes even created around a single-purpose related to SRM (s.a. FICER or the Refreeze the Arctic Foundation). Surprise and colleagues (2022) provide additional insight into such stable financing flows, highlighting the dominance of the U.S. philanthropic sector.

3.3 SAI primacy lingers on

Stratospheric Aerosol Injection (SAI) continues to receive **the largest share of SRM funding** overall. However, the field seems to lean towards a more all-encompassing approach, with funded projects distributed as follows: Projects studying **various SRM methods account for 60.7%**, SAI for **23.2%**, Marine Cloud Brightening (MCB) for 10.7%, Surface Albedo Modification for 3.6%, and Cirrus Cloud Thinning (CCT) for 1.8%. If regarding only those projects with an explicit methodological focus, **SAI represents 52.6%** and thus remains predominant. Looking at individual projects not itemised in the table, such as the 14 awards granted by the Simons Foundation in 2024 or the DEGREES initiative, this picture is confirmed, with MCB in second place. Conversely, our table also shows that the vast majority of **social science and interdisciplinary projects** are not focused on a single technology, but rather take a **comprehensive perspective on SRM** (or even geoengineering) as a *set* of technologies.

3.4 Pivotal changes in 2024

As shown in figure 3, the evolving nature of the SRM research landscape means that funding from individual players, particularly from the private sector, can significantly reshape the overall R&D landscape.

2024 was a pivotal year for such a transformation. Several private funders entered the SRM field, resulting in an unexpected surge in funding:

- The Simons Foundation is supporting at least 14 SRM projects, with a budget exceeding €45.2 million —an amount unmatched throughout the entire 2007-2023 period.
- The Outlier Project, a new non-profit, is now backing both the Degrees Initiative and David Keith's newly launched Climate Systems Engineering initiative at the University of Chicago, with yet unclear sums.
- The Quadrature Climate Foundation, established in 2019 and funded through profits from Quadrature Capital, has announced plans to provide €36.9 million for SRM research. However, specific project details remain unavailable, leaving the full picture incomplete.
- Public institutions are also showing growing interest in SRM funding, as recently seen in the UK with a new €3.9 million grant: Modelling Environmental Responses to Solar Radiation Management.

4 Conclusion

After a long period in which SRM researchers lamented a paucity of both funding and knowledge on the potential of SRM methods, **the rapid increase in funding for SRM research in 2024**, particularly from private sources, marks a pivotal moment for the field. The dominance of private funding, now accounting for approximately 71% of total SRM research financing, is also a **cause for concern**, as private funders typically have a developmental bias. In some cases, their funding may be contingent on proof of concept for these technologies. As a result, **political and scientific pressures for SRM inclusion** in the climate regime may emerge in ways that are unwarranted and unwise. The analysis also found a continued focus on stratospheric aerosol injection (SAI) – although the majority of projects have a cross-technology focus. While the project landscape is **diversifying geographically in terms of sites of knowledge production**, the **financing flows remain highly concentrated** and mostly originate from the **USA**. This raises important questions about who controls the future of SRM technologies. This factsheet provides an overview of the – both stable and changing – realities of SRM research. In doing so, it provides a starting point for longer discussions and analyses of the rightful place of SRM research in the larger drama of climate politics.

5 References

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Imprint

Publisher

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Completion: October 2024

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