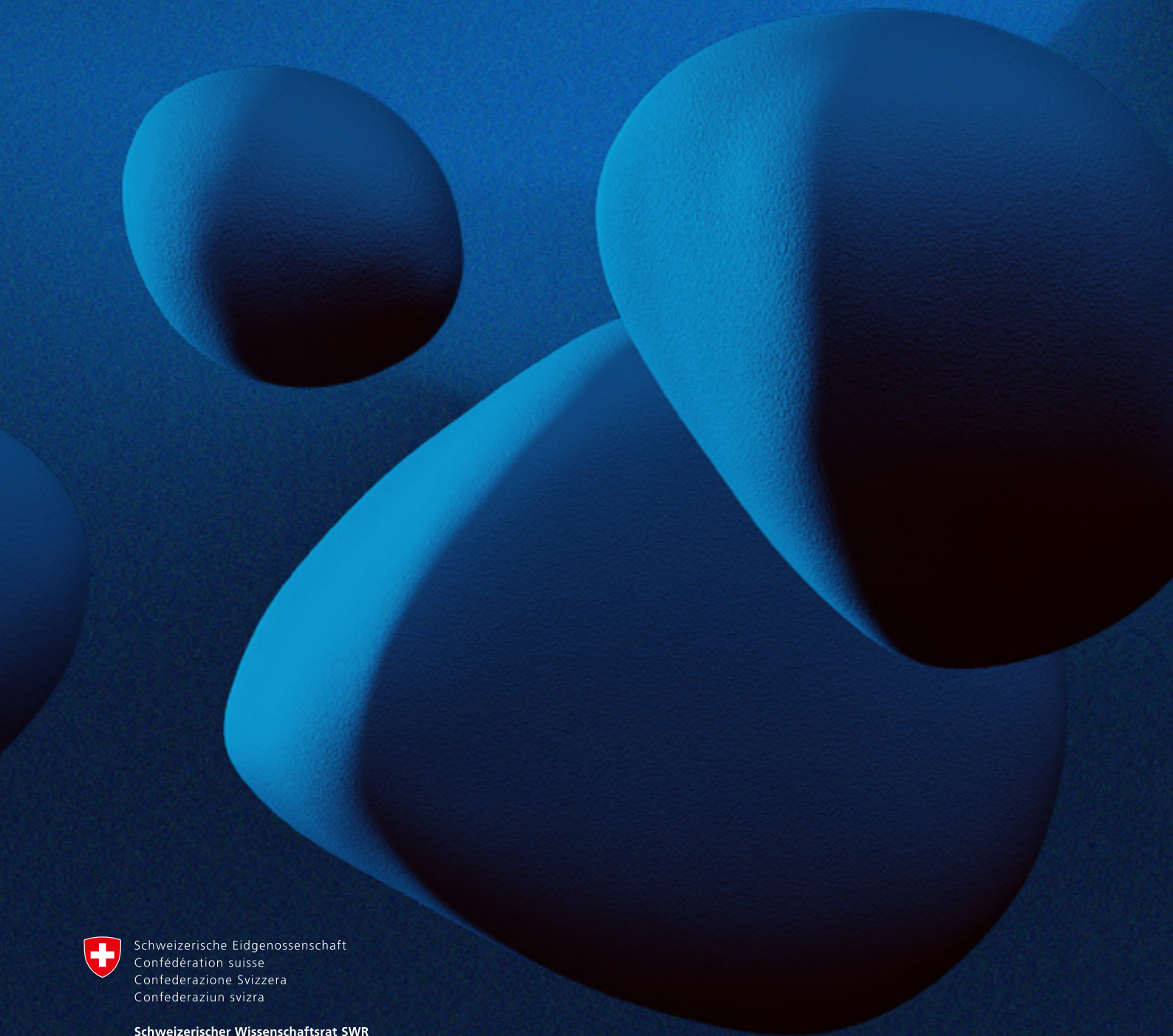
Swiss Science
Council SSC

SSC Report 1/2023
Mission-oriented Research and Innovation
in Switzerland

Mission-oriented Research and Innovation in Switzerland

Analysis and Recommendations
by the Swiss Science Council SSC



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Der Schweizerische Wissenschaftsrat

Der Schweizerische Wissenschaftsrat SWR berät den Bund in allen Fragen der Wissenschafts-, Hochschul-, Forschungs- und Innovationspolitik. Ziel seiner Arbeit ist die kontinuierliche Optimierung der Rahmenbedingungen für die gedeihliche Entwicklung der Schweizer Bildungs-, Forschungs- und Innovationslandschaft. Als unabhängiges Beratungsorgan des Bundesrates nimmt der SWR eine Langzeitperspektive auf das gesamte BFI-System ein.

Le Conseil suisse de la science

Le Conseil suisse de la science CSS est l'organe consultatif du Conseil fédéral pour les questions relevant de la politique de la science, des hautes écoles, de la recherche et de l'innovation. Le but de son travail est l'amélioration constante des conditions-cadre de l'espace suisse de la formation, de la recherche et de l'innovation en vue de son développement optimal. En tant qu'organe consultatif indépendant, le CSS prend position dans une perspective à long terme sur le système suisse de formation, de recherche et d'innovation.

Il Consiglio svizzero della scienza

Il Consiglio svizzero della scienza CSS è l'organo consultivo del Consiglio federale per le questioni riguardanti la politica in materia di scienza, scuole universitarie, ricerca e innovazione. L'obiettivo del suo lavoro è migliorare le condizioni quadro per lo spazio svizzero della formazione, della ricerca e dell'innovazione affinché possa svilupparsi in modo armonioso. In qualità di organo consultivo indipendente del Consiglio federale il CSS guarda al sistema svizzero della formazione, della ricerca e dell'innovazione in una prospettiva globale e a lungo termine.

The Swiss Science Council

The Swiss Science Council SSC is the advisory body to the Federal Council for issues related to science, higher education, research and innovation policy. The goal of the SSC, in conformity with its role as an independent consultative body, is to promote the framework for the successful development of the Swiss higher education, research and innovation system. As an independent advisory body to the Federal Council, the SSC pursues the Swiss higher education, research and innovation landscape from a long-term perspective.

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Zusammenfassung

Mit dem vorliegenden Bericht gibt der Schweizerische Wissenschaftsrat SWR erstmals einen Überblick über missionsorientierte Forschung und Innovation in der Schweiz. In den letzten Jahren hat dieses Thema an Bedeutung gewonnen. Der Klimawandel, die Covid-19-Pandemie und wachsende Spannungen in der Weltpolitik haben zu missionsorientierten Initiativen wie dem europäischen *Green Deal* oder dem *US Inflation Reduction Act* geführt. Im ersten Teil wird eine kurze Einführung in die Geschichte und die Trends der missionsorientierten F&I-Politik gegeben, mit einem Fokus auf die Europäische Union und die Niederlande.

Die Schweizer Forschungs- und Innovationspolitik ist traditionell stark auf Bottom-up-Prozesse ausgerichtet, was zu vielen bahnbrechenden Entwicklungen und Technologien geführt hat. Die hiesige Privatwirtschaft hat es immer wieder geschafft, auf herausfordernde Umbrüche mit eigenen Initiativen zu reagieren, wenn nötig mit Unterstützung durch den Staat. Trotzdem stellt sich die Frage nach einer stärkeren Missionsorientierung heute auch für die Schweiz. Neben den bereits erwähnten globalen Herausforderungen spielt dabei der beschränkte Zugang zu den europäischen Rahmenprogrammen für Forschung und Innovation eine wichtige Rolle.

Dies bedeutet nicht, dass es in der Schweiz nicht bereits missionsorientierte Instrumente gäbe. Der Bericht beschreibt in seinem zweiten Teil, dass Förderorganisationen wie der Schweizerische Nationalfonds (SNF), Innosuisse und auch der Bund selbst (über die Ressortforschung) verschiedene Förderinstrumente implementiert haben, mit denen vordefinierte Themen bearbeitet werden können. Die vom SWR durchgeführten Interviews mit verschiedenen Expertinnen und Experten zeigten jedoch Defizite in der Koordination auf. Dies führt zu Überschneidungen in der Projektförderung und zu einer ineffizienten Nutzung der Ressourcen. Der Rat empfiehlt daher, die Themensetzung und die Koordination missionsorientierter Aktivitäten durch Förderorganisationen, Ressortforschung und andere Akteure zu verbessern. In diesem Zusammenhang sollten die Rolle und das Engagement des Interdepartementalen Koordinationsausschusses für die Forschung des Bundes (KoorA-RF) gestärkt werden.

Der dritte Teil dieses Berichts konzentriert sich auf ein spezifisches Förderinstrument, das in der Schweiz bisher noch nicht eingeführt wurde: den ARPA-Ansatz. Dieses aus der US-amerikanischen Rüstungsforschung stammende Konzept verspricht bahnbrechende und missionsorientierte technologische Entwicklungen, die in kurzer Zeit realisiert werden können. Es ist daher nicht verwunderlich, dass verschiedene Länder versucht haben, eigene ARPA-Agenturen zu schaffen. Die erfolgreiche Umsetzung hängt jedoch massgeblich davon ab, dass hochqualifizierte Programmmanager gefunden werden. Sie müssen bereit sein, ihre Positionen in der Industrie oder in der akademischen Forschung für eine bestimmte Zeit aufzugeben, um für ein ARPA-Programm zu arbeiten. Darüber hinaus müssen sie angemessen entlohnt werden.

Neben den Gesprächen mit Expertinnen und Experten aus der Schweiz hatte der SWR auch die Gelegenheit, sich mit hochrangigen Vertretern zweier ARPA-Agenturen auszutauschen. Dazu gehören die Direktorin von ARPA-Energy, Evelyn N. Wang und die Präsidentin und CEO von Wellcome Leap, Regina E. Dugan (Letztere ist die vormalige Direktorin von DARPA). Auf der Grundlage dieses Austauschs sowie interner Diskussionen empfiehlt der SWR, ein ARPA-Pilotprojekt bei der Schweizer Innovationsagentur Innosuisse durchzuführen. Die Ausgestaltung würde in Zusammenarbeit mit dem SNF, der Ressortforschung, dem ETH-Bereich und den Hochschulen festgelegt. Potenzielle Kunden – z.B. staatliche Stellen mit dringenden technologischen Bedürfnissen – sollten ebenfalls einbezogen werden.

Der SWR ist überzeugt, dass das auf Exzellenz ausgerichtete und von unten geprägte Schweizer Erfolgsmodell beibehalten werden soll. Gleichzeitig ist der Rat der Meinung, dass die heutigen Herausforderungen Verbesserungen und neue Akzente für missionsorientierte Forschung und Innovation in der Schweiz erfordern.

Résumé

Avec ce rapport, le Conseil suisse de la science (CSS) fournit la première vue d'ensemble de la recherche et de l'innovation (R&I) orientées mission en Suisse. Au cours des dernières années, ce thème a gagné en importance. Le changement climatique, la pandémie de Covid-19 et les tensions croissantes dans la politique mondiale ont donné lieu à des initiatives orientées mission, telles que le *Green Deal européen* et l'*Inflation Reduction Act* des États-Unis. La première partie de ce rapport est une brève introduction à l'histoire et aux tendances des politiques de R&I orientées mission, mettant en évidence des exemples au niveau de l'Union européenne et des Pays-Bas.

Les politiques suisses de recherche et d'innovation ont traditionnellement été fortement orientées vers des processus *bottom-up,* ce qui a conduit à de nombreux développements et technologies disruptifs. Le secteur privé suisse a toujours été en mesure de faire face aux grandes transformations en lançant ses propres initiatives, parfois avec le soutien subsidiaire de l'État. Une plus forte orientation mission semble toutefois s'avérer de plus en plus nécessaire pour la Suisse. Outre les défis mondiaux déjà mentionnés, l'accès limité aux programmes-cadres européens de R&I doit désormais aussi être pris en compte.

Cela ne signifie pas pour autant qu'il n'existe pas encore d'instruments orientés mission en Suisse. Le rapport décrit en deuxième partie comment les organismes de financement tels que le Fonds national suisse de la recherche scientifique (FNS), Innosuisse et le gouvernement suisse lui-même (par le biais de la recherche de l'administration fédérale) ont mis en œuvre divers outils de financement qui peuvent être utilisés pour traiter certains thèmes. Toutefois, les entretiens menés par le CSS avec divers experts ont révélé des lacunes en matière de coordination. Celles-ci entraînent des chevauchements dans le financement des projets et une utilisation inefficace des ressources. Le Conseil recommande d'améliorer l'établissement de programmes et la coordination des activités orientées mission par les agences de financement, la recherche de l'administration fédérale et les autres parties prenantes. Dans ce contexte, il convient de renforcer le rôle et l'engagement du Comité interdépartemental de coordination de la recherche de l'administration fédérale (KoorA-RF).

La troisième partie de ce rapport se concentre sur un instrument particulier, qui n'a pas encore été introduit en Suisse jusqu'à présent : l'approche ARPA. Ce concept, qui trouve son origine dans la recherche états-unienne en matière de défense, permet un développement technologique révolutionnaire et orienté mission dans un court laps de temps. Il n'est donc pas surprenant que plusieurs pays aient tenté de créer leurs propres agences ARPA. Le succès de la mise en œuvre dépend toutefois de la capacité à trouver des directeurs de programme hautement qualifiés. Ceux-ci doivent être prêts à quitter leur poste dans l'industrie ou la recherche universitaire pendant un certain temps pour travailler dans le cadre d'un programme ARPA et doivent être rémunérés de manière appropriée.

Outre les entretiens avec les experts suisses, le CSS a également eu l'occasion d'échanger avec des représentants de haut niveau d'organes ARPA. Il s'agit notamment de la directrice de l'ARPA-Energy, Evelyn N. Wang, et de la présidente-directrice générale de Wellcome Leap, Regina E. Dugan (l'une des anciennes directrices de l'agence DARPA). Sur la base de ces échanges et de discussions internes, le CSS recommande de mettre en œuvre un projet pilote ARPA au sein de l'agence suisse pour l'innovation Innosuisse. Son champ d'application devrait être déterminé en collaboration avec le FNS, la recherche de l'administration fédérale, le domaine des EPF et les hautes écoles. Les clients potentiels – par exemple les départements fédéraux ayant des besoins technologiques urgents – devraient également être impliqués.

Le CSS est convaincu que le modèle de réussite suisse, axé sur l'excellence et façonné par le bas, doit être maintenu. En même temps, le Conseil est d'avis que les défis d'aujourd'hui nécessitent en outre d'améliorer et de renforcer la recherche et l'innovation orientées mission en Suisse.

Executive Summary

With this report the Swiss Science Council SSC provides the first overview on mission-oriented research and innovation in Switzerland. Over the last years, this theme has gained in importance. Climate change, the Covid-19 pandemic and growing tensions in global politics have led to mission-oriented initiatives such as the European Green Deal and the US Inflation Reduction Act. In the first part, a short introduction to the history and trends of mission-oriented R&I policies is provided, by highlighting the examples of the European Union and the Netherlands.

Swiss research and innovation policies have traditionally been strongly oriented towards bottom-up processes, which led to many disruptive developments and technologies. The Swiss private sector has repeatedly been able to respond to challenging transformations through its own initiatives, with subsidiary support by the state. However, today the question of a stronger mission-orientation is also increasingly arising for Switzerland. In addition to the global challenges already mentioned, the limited access to the European R&I Framework Programmes plays an important role.

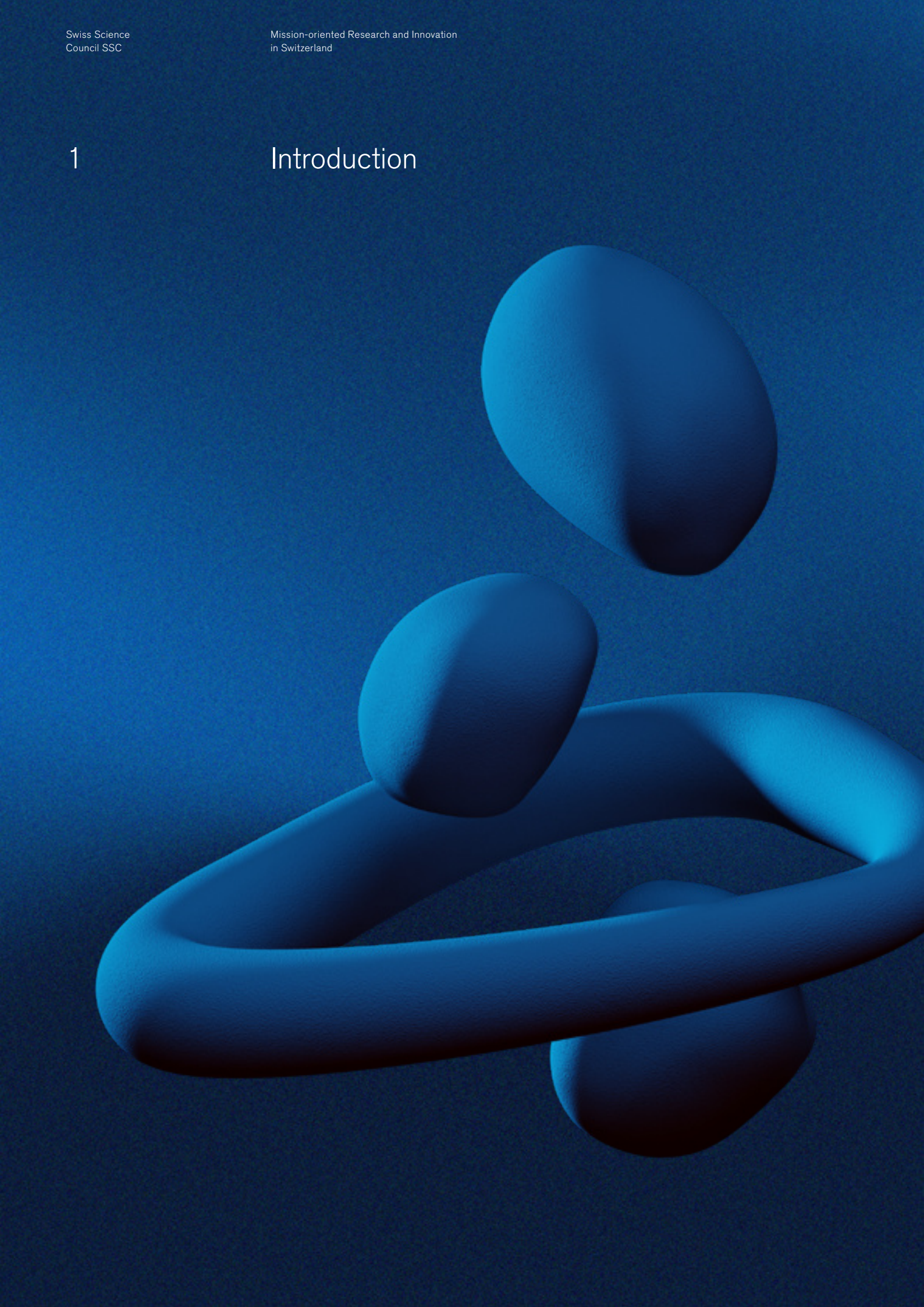
This does not mean that mission-oriented instruments do not exist at all. In its second part the report describes how funding bodies such as the Swiss National Science Foundation (SNSF), Innosuisse and also the Swiss government itself (through departmental research/Ressortforschung) have implemented various funding vehicles that can be used to address predefined topics. However, interviews conducted by the SSC with various experts revealed shortcomings in coordination. This leads to overlaps in project funding and to an inefficient use of resources. The Council thus recommends to improve the agenda setting and coordination of mission-oriented activities by funding agencies, departmental research and other stakeholders. In this context, the role of and commitment towards the Interdepartmental Coordination Committee for Federal Government Research (KoorA-RF) should be strengthened.

The third part of this report focuses on a specific instrument which has not been introduced to Switzerland so far: the ARPA approach. This concept, which originated in US defence research, promises ground-breaking and mission-oriented technological development within a short period of time. It is therefore not surprising that various countries have tried to create their own ARPA agencies. Successful implementation, however, depends on finding highly qualified programme managers. They must be willing to leave their positions in industry or academic research for a certain period of time to work for an ARPA programme and they have to be appropriately compensated.

Besides the interviews with experts from Switzerland, the SSC has also had the opportunity of exchange with high-ranking representatives of ARPA bodies. These include the director of ARPA-Energy, Evelyn N. Wang, and the President and CEO of Wellcome Leap, Regina E. Dugan (the latter having been a former DARPA director). Based on these exchanges as well as internal discussions, the SSC recommends to implement an ARPA pilot at the Swiss innovation agency Innosuisse. The scope would be determined in collaboration with the SNSF, departmental research, the ETH domain and universities. Potential customers – e.g., governmental departments with pressing technological needs – should also be involved.

The SSC is convinced that the Swiss success model, which is geared towards excellence and shaped from below, should be maintained. At the same time, the Council is of the opinion that today's challenges also call for improvements and new emphases for mission-oriented research and innovation in Switzerland.

1 Introduction



1 Introduction

Mission-oriented research and innovation has gained in importance, both in Switzerland and abroad. The SSC has repeatedly addressed aspects of mission-oriented research and innovation, for instance in its study on "Dealing with disruption",[1] and the evaluation of the Swiss National Science Foundation SNSF.[2] However, no broad discussion of the potential of mission-oriented R&I in Switzerland exists to date. In view of the upcoming ERI Dispatch 2025–2028, the Council decided to provide a first overview of this important topic as well as to develop dedicated recommendations.[3] The approach of the Advanced Research Projects Agency ARPA, which has so far not been implemented in the Swiss funding system, is given special attention.

The leading questions of this study are:

- Which mission-oriented policies and funding instruments do already exist in Switzerland and how are they implemented?
- What are the opportunities and risks of mission-oriented research and innovation for the Swiss R&I landscape, with special consideration of the ARPA approach?

These questions have been answered through a review of the existing literature and expert interviews with key stakeholders from funding agencies and governmental institutions, within Switzerland and abroad.[4] The Swiss Science Council thanks all the experts for their important contributions. The Council is particularly grateful for the valuable inputs by Regina E. Dugan, Director and CEO of Wellcome Leap and former Director of DARPA as well as by Evelyn N. Wang, Director of ARPA-E at the US Department of Energy.

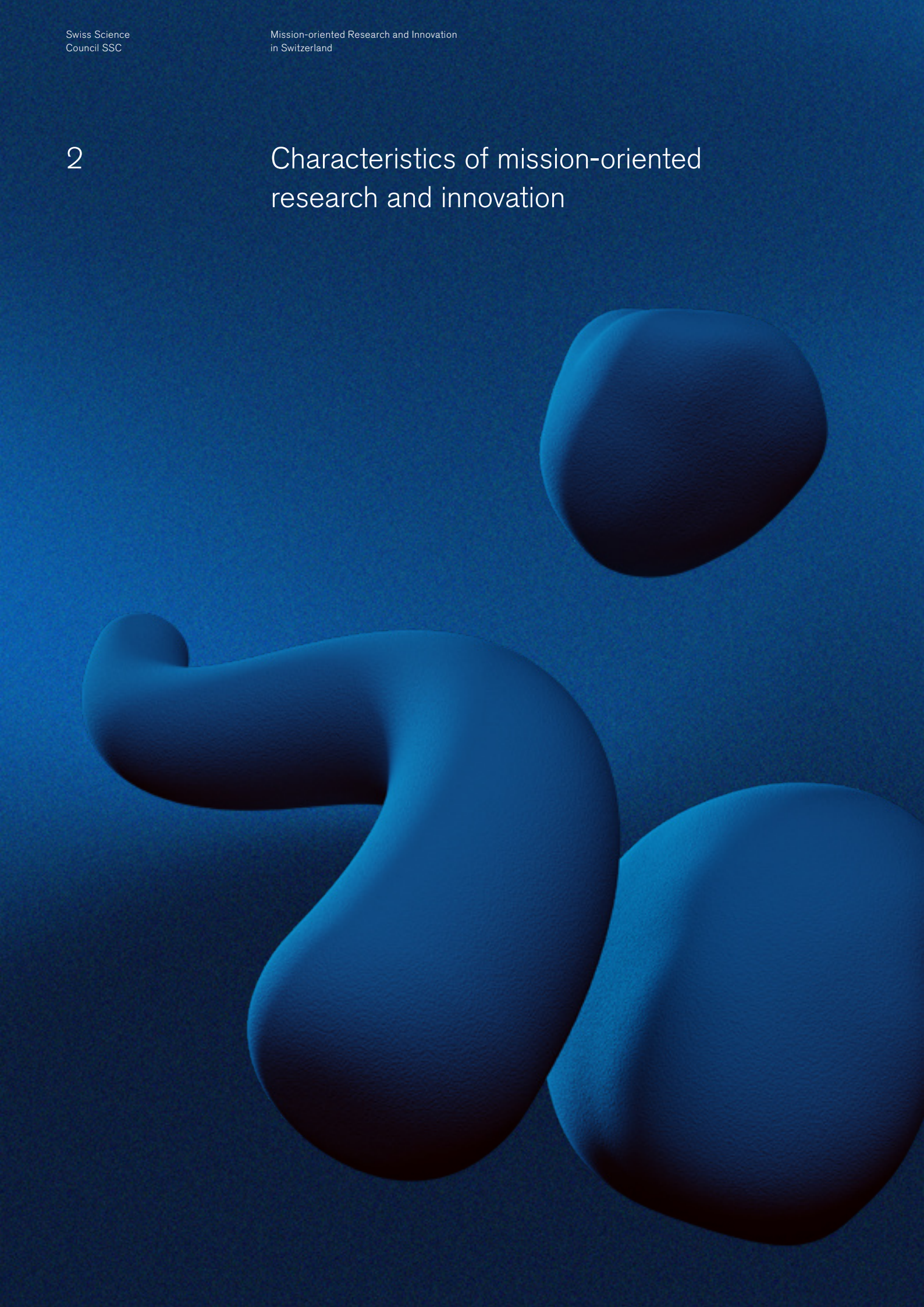
1 SSC 2019.

2 SSC 2022.

3 See also SSC 2023a.

4 An overview of the interviews is provided in the Annex of this report.

2 Characteristics of mission-oriented research and innovation



2 Characteristics of mission-oriented research and innovation

2.1 Definition and framework

In recent years, a broad discussion on mission-orientation in research and innovation has developed. In this context, it is important to differentiate between mission-oriented *policies* and mission-oriented *research and innovation*. The OECD defines Mission-oriented Innovation Policies (MOIP) as a "co-ordinated package of policy and regulatory measures tailored specifically to mobilise science, technology and innovation in order to address well-defined objectives related to a societal challenge, in a defined timeframe. These measures possibly span different stages of the innovation cycle from research to demonstration and market deployment, mix supply-push and demand-pull instruments, and cut across various policy fields, sectors and disciplines".[5]

Mission-oriented research and innovation and dedicated funding instruments help to *implement and operationalise* the policies described above. It is, however, also possible to have mission-oriented research and innovation in a system, that does not dispose of an overall policy, which is the case in Switzerland. Therefore, the SSC proposes the following working definition, which focuses on the research and innovation *activities*:[6]

"Mission-oriented research and innovation aims at achieving pre-defined societal and/or technological goals. It requires therefore special incentives and structures to influence the direction of research and innovation activities. The goals must be measurable, verifiable, and be implemented within a binding timeframe. Mission-oriented R&I is often transdisciplinary: it involves not only academic disciplines, but also the government, the public sector, the private sector, practitioners as well as society at large (citizens) to tackle societal, economic and ecological transformations."

Challenges of mission-oriented research and innovation

While mission-orientation has the ambition to steer research and innovation towards certain desired outcomes, such an approach also implies costs. This concerns, on the one side, governing and coordinating efforts, which are considerably higher than for bottom-up funding programmes (OECD 2021: 9; 12). The top-down characteristic of mission-oriented instruments can also lead to high "switching costs", as researchers may have to change the direction of their established field of interest towards a specific topic, which has been defined by someone else, typically a funding agency (Myers 2020).

Furthermore, the fundamental tension between "missions" and "innovation" has to be taken into account. Foray (2022) has pointed out that missions impose "a discipline, and centralised priorities and decisions", whereas innovation "requires decentralised entrepreneurial search and freedom to experiment." From this point of view, mission-oriented innovation would be an "oxymoron". (124) A possible solution to this problem could be the approach of an "incomplete plan", which combines "a planning logic and a self-discovery logic". (131)

These overall challenges regarding mission-oriented research and innovation cannot be discussed in depth in this report. However, they should be considered for further discussion.

In order to differentiate the different funding approaches for research and innovation in Switzerland, the present study refers to the framework introduced by Azoulay et al.[7] This framework consists of a quadrant, which groups funding approaches into four categories. This quadrant is of special interest for policy discussions in Switzerland, as it allows to distinguish two different logics (or *modi operandi*) for mission-oriented research and innovation.

5 OECD 2021: 8.

6 See also SERI 2020: 12; Fraunhofer ISI 2021: 7.

7 Azoulay et al. 2019.

		Idea generation	
		Investigator initiation	*Mission-inspired solicitation*
Project execution	*Investigator/innovator freedom*	Bottom-up research projects (SNSF projects)	Mission-inspired areas + freedom to explore (NRP, Innosuisse Flagships, SWEET)
	Empowered programme staff	Private Venture Capital	- [ARPA pilot]

Figure 1: Quadrant of Swiss funding instruments (adapted from Azoulay et al. 2019: 92)

The two boxes on the left refer to those instruments, where researchers may apply with their own project ideas (bottom-up approach). The two boxes on the right include mission-oriented instruments which are oriented towards a pre-defined societal and/or technological goal. In the case of the upper boxes, researchers are given a great deal of freedom in project implementation; in the case of the lower boxes, project managers are actively involved in shaping the project.

Switzerland is particularly strong in the funding of excellent and curiosity-driven research and innovation (box on the top left side), which includes the project funding of both the Swiss National Science Foundation (SNSF) and the Innovation agency Innosuisse. This has led, among other things, to disruptive developments and technologies. The bottom-left quadrant, where "researchers propose ideas, but programme staff are deeply involved in the execution of the project", is mostly of relevance for venture capital.[8] In both cases, researchers may apply with their own project ideas (bottom-up approach).

Of greater interest for the present study are the boxes on the right-hand side of the quadrant. They are both mission-oriented, but follow different implementation logics. In the case of the top right box, the agency predefines a priority area. Researchers and innovators are given a lot of freedom to design and implement their projects. Switzerland has several funding instruments in place which follow this logic. The implementation is relatively easy, but there is a certain risk of duplication, when several agencies identify the same priority area and launch dedicated calls. Moreover, instruments following this logic have a limited capacity when it comes to driving specific societal and/or technological transformations and solutions. The funding approach of the upper-right box is further discussed in chapter 3.

The bottom right box of the funding quadrant refers to ARPA-like instruments combining mission-orientation with active project management. This approach is more demanding for agencies than the funding logic discussed above (top right box). Empowered and proactive programme managers are deeply involved in the design and the execution of ARPA programmes which are targeted towards very specific and precisely defined goals. This logic allows specific technologies to be developed and particular problems to be solved. However, the increasing research directional adjustment costs – i.e., the cost for a scientist to adjust her research agenda to fit the mission – related to a decrease in freedom to experiment is a sharper issue than for the funding logic of the top right box. The ARPA approach is discussed in chapter 4.

The adapted Azoulay framework highlights that there are several mission-oriented initiatives in the Swiss funding system which can be associated to the logic of the top right box. In practice, the framework boxes are partially overlapping and some of the existing mission-oriented instruments do have aspects of the bottom right box. Yet, the general picture is clear: *a dedicated programme to operate under the ARPA logic is missing so far.* This report aims at assessing whether this is a problem and if so, how it should be addressed.

8 Azoulay et al. 2019: 93.

2.2 Mission-oriented R&I policies

2.2.1 History and trends of mission-oriented R&I policies

Mission-oriented research and innovation has its origins in the 1940s and 1950s, with military and space initiatives such as the "Manhattan" or "Apollo" programmes.[9] In the 1990s, innovation policy aimed at fixing "failures in national innovation systems and strengthen national innovation networks".[10] Since the beginning of the 21st century, a new mission-orientation has been gaining momentum in Europe, USA and Asia. It is shaped by major societal challenges like climate change as well as by events such as the Covid-19 pandemic.[11] Related initiatives are the European Green Deal, the US Inflation Reduction Act and the US CHIPS and Science Act.[12] An important point of reference for mission-oriented policies is the Agenda 2030 with the Sustainable Development Goals (SDGs), which have been adopted in 2015 by the United Nations.[13]

As this new mission-orientation goes beyond the development of specific technologies and aims at having a broad impact in society as a whole, it requires coordinated efforts from various funding agencies and stakeholders.[14] Within the European Union, the Research Framework Programme Horizon Europe (2021–2027) puts an emphasis on mission-oriented research and development.[15] In the USA, mission-oriented R&I is promoted through the Advanced Research Projects Agency (ARPA) approach.[16]

The OECD has identified four types of Mission-oriented Innovation Policies (MOIPs):

- Overarching mission-oriented strategic frameworks
- Challenge-based programmes and schemes
- Thematic mission-oriented programmes
- Ecosystem-based mission programmes

9 OECD 2021: 14.

10 Hekkert et al. 2020: 76.

11 Fraunhofer ISI 2021: 6; EFI 2023a.

12 Foray points out the implications of the shift from a *mission-oriented policy* to a *mission-oriented innovation policy*: "MOPs excelled at crossing certain technological frontiers, [but] they did not have the same objectives relating to societal transformation as missions do nowadays". Foray 2022: 126.

13 Mazzucato 2018: 10–11. As for the focus on SDGs, there are also critical voices. The International Science Council, for instance, indicated in its study on "Mission science for sustainability" that "the nature of the SDGs as articulated in Agenda 2030" has contributed to a siloed approach (ISC 2023: 12).

14 OECD 2021: 14; Hekkert et al. 2020: 77.

15 Mazzucato 2018; Mazzucato 2019.

16 Azoulay et al. 2019.

Type	Leadership	Missions	Examples
1. Overarching mission-oriented strategic frameworks	Centre of government High-level committee	Multiple missions or mission areas Pursuing ambitious challenges Long-term horizon	Horizon Europe's missions (EU) Mission-driven Top Sectors policy (Netherlands) High Tech Strategy 2023 (Germany) France 2030 Acceleration Strategies (France) Hydrogen Earthshot (United States) Moonshot R&D Programme (Japan)
2. Challenge-based programmes and schemes	Agency	Focused Seeking acceleration of innovation Mid- to long-term horizon ARPA-inspired[17]	Pilot-E (Norway) Industrial Strategy Challenge Fund (United Kingdom) Science Foundation Ireland's Innovative Prize (IE) SPRIND (Germany) DARPA (USA)
3. Thematic mission-oriented programmes	Ministry Agency Large research institutes	Building upon existing programmes to make them better targeted and coordinated Mix of societal and competitive challenges	Cross-ministerial Strategic Innovation Promotion Programme (Japan) CSIRO's missions (Australia) Flagship Programmes (Finland) NRC Challenge program (Canada) The Alchemist (Korea) Building of Tomorrow/Cities of the Future (Austria)
4. Ecosystem-based mission programmes	Ministry Agency	Innovation agenda developed by the innovation actors themselves, with neutral support from public authorities	Green missions (Denmark) Growth Engines (Finland) Strategic Innovation Areas (Wallonia, Belgium) Strategic Innovation Programmes (Sweden)

Table 1: Basic characteristics of the four main types of MOIPs (based on OECD 2021: 20 and Larrue 2022: 10)

The OECD considers that "there is no one size fits all, and all countries can find types of MOIPs that are more relevant to their own national agenda and capacity."[18] However, the Organisation for Economic Cooperation and Development is rather critical when it comes to the institutionalisation of missions in most of its member states.[19]

In what follows, we will introduce two examples of "overarching mission-oriented strategic frameworks", namely the European Framework Programmes for Research and Innovation and the Dutch Top Sector approach.

2.2.2 Mission-oriented R&I policy in the European Union

The research and innovation activities of the European Union are mainly implemented by dedicated Framework Programmes (FPs). The first FPs of the European Economic Community (which became the European Union in 1993) date back to the 1980s. Their aim was not only to promote research and innovation, but also to support member states economically and enhance their competitivity. From the very beginning, the EU FPs were oriented towards pre-defined thematic areas, such as agriculture and energy. After the 1993 Treaty of Maastricht, the FPs included more socio-economic aspects of R&I. They were no longer seen as an instrument to achieve technological breakthroughs, but rather as a measure to serve society as a whole.[20]

17 OECD 2021: 25.

18 OECD 2021: 13.

19 OECD 2023: 184.

20 EPRS 2017: 3–15.

In the year 2000, the concept of the European Research Area was implemented by the European Commission. FPs now "had become the financial tool used to implement EU policy on research and innovation."[21] The 8th FP Horizon 2020 (2014–2020) had a strong focus on the Sustainable Development Goals (SDG) and included, among others, a Green Deal Call, in order to "make Europe the first climate neutral continent by 2050".[22]

While the EU FPs always had a strong top-down approach and thematic orientation, the 9th FP Horizon Europe (2021–2027) for the first time explicitly referred to "missions" as a key concept.[23] The driving force behind Horizon Europe's missions was the economist Mariana Mazzucato. In 2017, she became special advisor to Carlos Moedas, the European Commissioner for Research, Science and Innovation and subsequently published two reports on European R&I that formed the base for the current implementation of missions under Horizon Europe.[24]

The starting point of Mazzucato's reports is the Apollo mission, which was launched by US president John F. Kennedy in 1961 and ultimately led to the first man on the moon. For Mazzucato, this is a good example of how to achieve an ambitious goal by investing in technological and organisational innovation. In the context of European R&I, however, missions should not simply solve technological problems, but rather help to "steer economic growth in ways that are more meaningful". While Mazzucato acknowledged the political importance of the SDGs – which have been a key reference point under Horizon 2020 – she argued that they were "too broad to be actionable". Individual projects, on the other hand, are actionable but limited in their impact. Missions might thus provide a link between broad global challenges such as SDGs and concrete R&I projects: they "should be broad enough to engage the public and attract cross-sectoral investment; and remain focused enough to involve industry and achieve measurable success."[25]

The European Commission started with the introduction of "missions" as a funding line under Horizon Europe in 2019. In the same year, the European Parliament and the EU Council agreed on the five thematic areas cancer, climate change, water management, cities and food. Subsequently, dedicated mission boards with experts were established in order to specify each of the missions. They presented their proposals to the European Commission and the wider public in 2020. In September 2021, the European Commission finally launched five concretised missions with a budget of nearly 2 billion Euro until 2023:[26]

- Adaptation to Climate Change: support at least 150 European regions and communities to become climate resilient by 2030
- Cancer: working with Europe's Beating Cancer Plan to improve the lives of more than 3 million people by 2030 through prevention, cure and solutions to live longer and better
- Restore our Ocean and Waters by 2030
- 100 Climate-Neutral and Smart Cities by 2030
- A Soil Deal for Europe: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030

The mission approach of the European Union has not only been received positively. Among others, there have been doubts whether the reference to the Apollo mission made by Mazzucato could indeed serve as an example of the "new" mission-approach. The later goes far beyond engineering challenges, as it tackles grand societal challenges and aims at changing the behaviour of the society as a whole.[27] While some stakeholders of the academic community welcomed the mission approach, others expressed also concerns regarding "general and vague mission targets", among other.[28] The involvement of the different regional and national governments in implementing the Horizon Europe mission approach has been proved to be quite difficult and business participation relatively weak.[29] The European Commission is currently carrying out an assessment of the missions.

21 EPRS 2017: 30.

22 EC 2020a.

23 The following paragraphs are based on the SSC secretariat blog article of 20 October 2021, SSC Secretariat 2022.

24 Mazzucato 2018; Mazzucato 2019; In this context it is also interesting to look at the restructuration of the European Commission's Directorate General for Research and Innovation (DG RTD) in 2019, which aimed at better coordinating R&I activities and breaking down silos. Science Business 2019.

25 Mazzucato 2018: 7; 10–11.

26 Science Business 2021.

27 Foray 2022: 126.

28 Science Business 2021. In her book "Mission Economy", Mariana Mazzucato herself expressed some doubts regarding the implementation of her ideas into Horizon Europe, especially regarding the Horizon Europe Mission Boards, whose members might have "little appetite to make choices as everyone defends their own corners". Mazzucato 2021: 117.

29 Science Business 2023.

2.2.3 Mission-oriented R&I policy in the Netherlands

In 2011, the Dutch government introduced the Top Sectors approach in order to enhance economic competitiveness. The Top Sectors consist of ten (originally: nine)[30] thematic clusters and involve stakeholders from science, the government as well as the private industry. As of 2018, the Top Sector initiative has an explicit mission-orientation and addresses four societal challenges with dedicated missions:

- Energy transition and sustainability (6 missions)
- Agriculture, water, food (6 missions)
- Health and healthcare (5 missions)
- Security (8 missions)

Every societal challenge has an "Knowledge and Innovation Agenda" (KIA), which is created and implemented by key stakeholders of the Top Sectors; so-called "Topteams". Knowledge and Innovation Agendas correspond to multi-year mission-driven innovation programmes (MMPIs). Those MMPIs define how mission goals should be achieved, including research and innovation activities, funding and policy instruments.[31] It is important to note that the idea of the Dutch approach was not so much to implement new mission-oriented funding instruments, but rather to coordinate existing mechanisms, e.g., calls of the Dutch Research Council NWO or the SME Innovation Stimulus for Regional and Top Sectors. A targeted instrument for mission-oriented R&I is the Mission-driven Research, Development and Innovation (MOOI) scheme, where academic researchers work together with SMEs, suppliers, and other stakeholders.[32]

According to the OECD, the Dutch new Top Sectors Policy approach "is one of the very first – and maybe still unique to date – attempt to formally link a sectoral/technological approach and a societal challenge approach".[33] Apart from breaking up administrative silos, this approach has also improved the collaboration between private and public R&I stakeholders and contributes to the "internationalization of the Dutch economy and research activities". Challenges of the Topic Sectors Policy approach include the relatively high number of missions (25), lack of interdepartmental coordination, as well as limited impact on instruments apart from the R&I support schemes (e.g., procurement and pricing).[34]

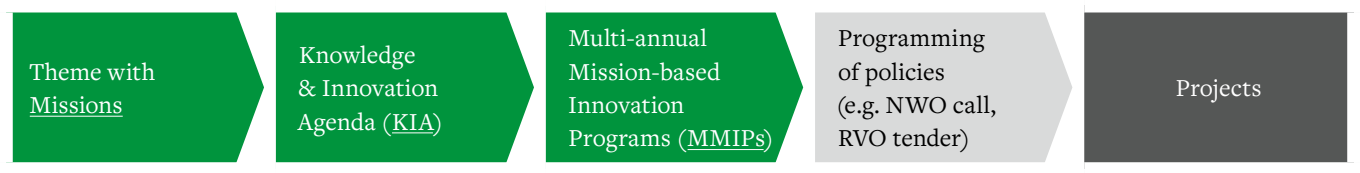


Figure 2: Chain from missions to research and innovation projects (Janssen 2020: 16)

30 Recently, the new top sector ICT has been introduced (Topsector ICT s.d.).

31 OECD 2021: 21; OECD s.d.; Janssen 2020: 13.

32 Janssen 2020: 28–29.

33 OECD s.d.

34 OECD s.d.

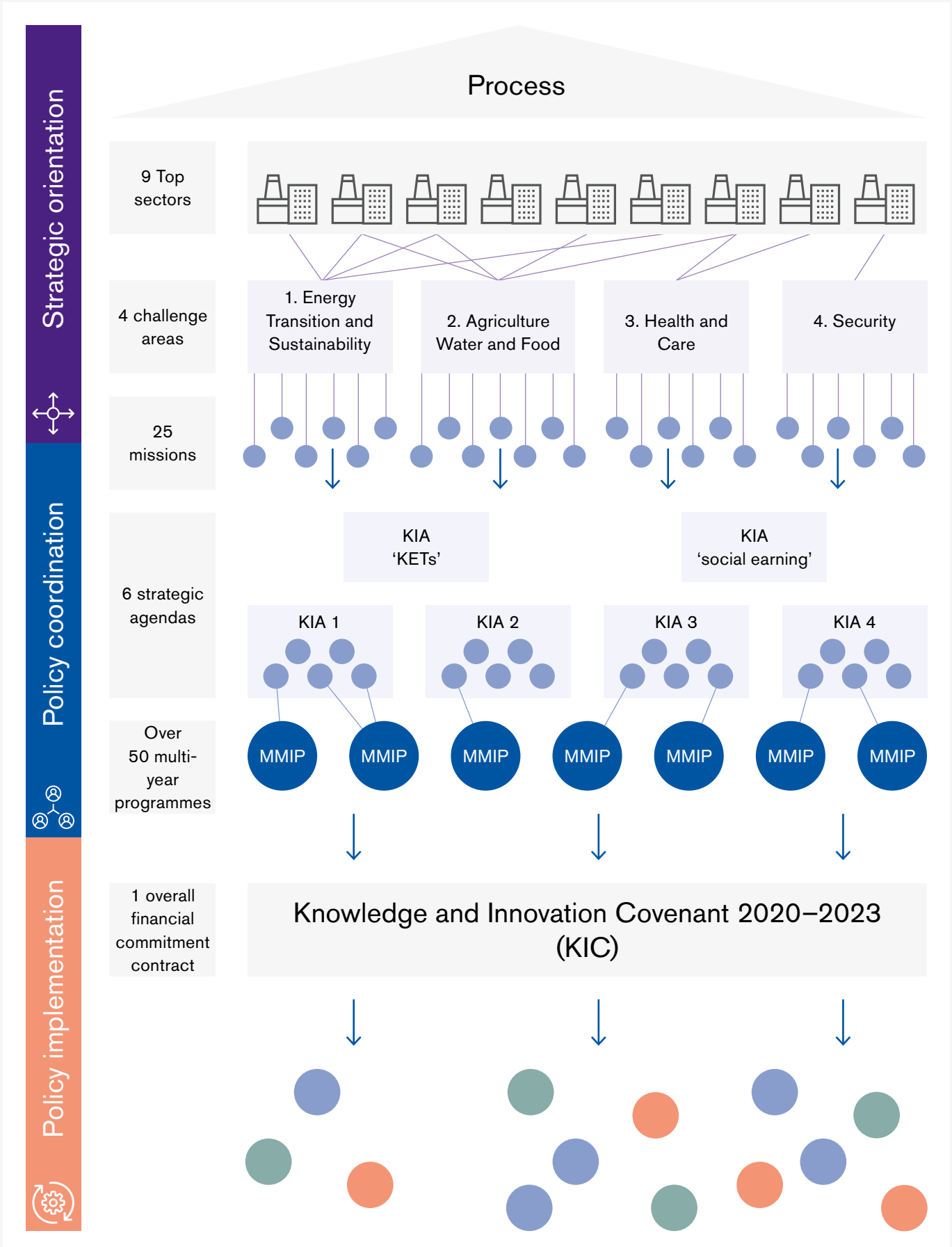


Figure 3: The Dutch Mission-driven Top Sectors and Innovation Policy process (OECD 2021: 22)

2.3 Preliminary conclusion

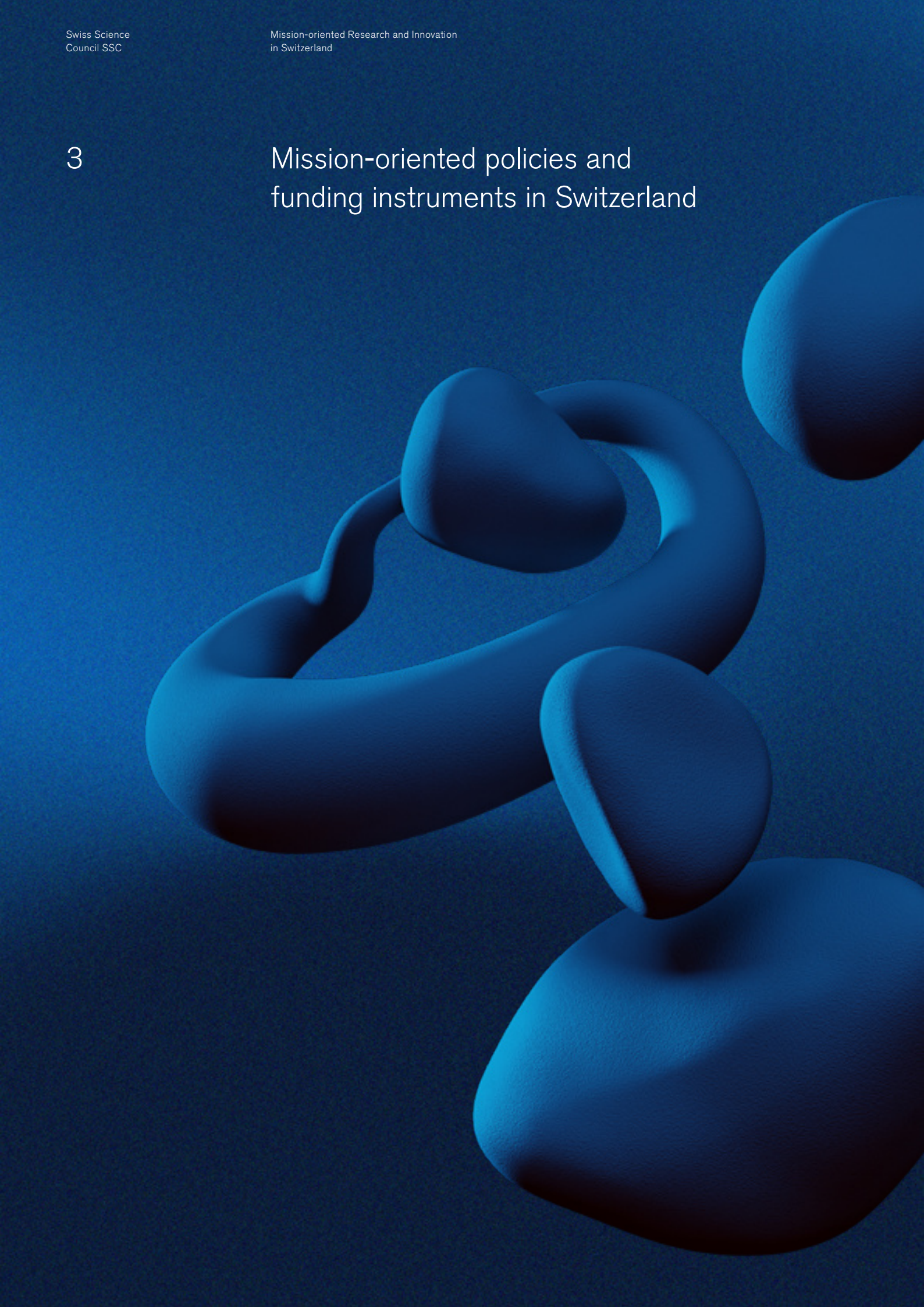
Mission-oriented research and innovation aims at achieving predefined societal and/or technological goals. This allows a targeted steering of research and innovation activities by an agency, the government or other stakeholders. In comparison to a bottom-up approach, additional costs may arise, for example with regard to coordination or the postponement of established research activities. Furthermore, the field of tension between "innovation" – which often requires freedom to experiment – and "mission-orientation" – which implies directionality – has to be taken into account.

According to Azoulay et al., two different logics of mission-oriented R&I can be distinguished:[35] In the first case, dedicated instruments pre-define a thematic area but leave a lot of freedom to the researchers when it comes to the specific design and implementation of the projects. In the second case, mission-orientation goes together with active project management by the funding agency. This logic corresponds to the ARPA approach. While Switzerland has several funding instruments of the first logic in place, this is not the case for the second (ARPA) logic.

As for mission-oriented R&I *policies*, various types can be distinguished. The Netherlands is often highlighted as a positive example for an overarching mission-oriented strategic framework. This framework is based on the so-called Top Sector approach and strongly relies on the exchange of the government, science and the industry. Another example for such an overarching policy approach is provided by the European Union with its 9th Framework Programme Horizon Europe. In both cases, coordination between the various stakeholders is one of the biggest challenges.

35 Azoulay et al. 2019.

3 Mission-oriented policies and funding instruments in Switzerland



3 Mission-oriented policies and funding instruments in Switzerland

3.1 Mission-oriented policies

In Switzerland aspects of a mission-oriented technology policy can be found until the 1960s, with large-scale R&I projects such as the development of a nuclear experimental reactor in Lucens. From the mid-1970s onwards, diffusion-oriented and key technology-focused policies prevailed and signalled a shift away from a centralised, state-led technology approach.[36] Swiss research and innovation have ever since been strongly oriented towards bottom-up processes. The Swiss private sector has repeatedly been able to respond to challenging transformations through its own initiatives, with subsidiary support by the state.[37]

Over the last years, however, calls for a more mission-oriented ERI policy have increased.[38] In 2021, a parliamentary postulate was submitted by National Councillor Valentine Python (Green Party), which called on the Federal Council to better coordinate the promotion of innovation. The postulate thereby referred to various characteristics of a mission-oriented R&I policy by stating that "in the face of the climate and environmental crisis", Switzerland needed "a real global strategy for transformative innovation (innovation to help address grand challenges such as decarbonisation) and coordination to address the problem of fragmentation in the Swiss research and innovation landscape."[39]

The main instrument for steering public education, research and innovation on a nation level, are the ERI Dispatches.[40] An ERI Dispatch covers four years and outlines the budget and the activities of education, research and innovation stakeholders such as universities and funding agencies (e.g., Innosuisse and the SNSF). Both the current (2021–2024) as well as the upcoming (2025–2028) ERI Dispatches do include transversal thematic areas such as the Agenda 2030 and the Strategy of Sustainable Development and identify five cross-political research topics.[41] Clearly defined missions and a dedicated strategy to meet them in a coordinated approach and within a defined time-frame are not part of the ERI Dispatches.

Even though an overarching mission-oriented policy does not exist in Switzerland to date, a wide range of mission-oriented activities are ongoing, as we will see further below.[42] The Swiss approach probably most closely aligns with type 3 of the OECD model of mission-oriented innovation policies, where missions "build upon existing programmes to make them better targeted and coordinated" and there is a "mix of societal and competitive challenges".[43]

Main results of the expert interviews regarding tendencies of mission-oriented R&I in Switzerland:[44]

International dimension

- There is a tendency towards a stronger mission-oriented industrial policy by global players such as the USA or the European Union. Linked to the challenging US – China relationship, the USA seem to privilege strategic industrial policies over traditional free trade policies. Switzerland cannot react by promoting only bottom-up R&I; both Innosuisse and the SNSF have to find a good mix between top-down and bottom-up, competitive funding. Switzerland should be proactive in the areas of AI and defence. It is key that the Swiss funding system remains competitive.

- International initiatives, such as the EU Green Deal or the US CHIPS and Science Act, are often not as big as they seem to be, as already existing funding is simply re-branded. In Switzerland, on the other hand, a seemingly small programme such as the Quantum Initiative with CHF 10m for 2023/2024 and CHF 80m for the ERI period 2025–2028[45] develops its impact in the context of other R&I activities: from 2021 to 2024, the Swiss Confederation will invest more than CHF 450m on Quantum R&I in the ETH domain. Further funding for this field comes from the cantonal universities or the National Centres of Competence in Research (NCCR).

36 Angermann 2021: 38; 50.

37 OECD 2006: 47.

38 Pasternack et al. 2015: 59–60; SATW 2021: 25. In 2020, the Swiss Academies made a proposition for six priority themes for "Swiss Sustainability Research", including Food for people and planet, Sustainability and spatial development, Net-zero greenhouse gas emissions society, Economic and financial systems for well-being, Synergies, trade-offs, and common threads, and Enabling sustainability research. Those thematic areas were identified together "with stakeholders from academia, government, NGOs, and the private sector" (Wuelser et al. 2020: 7) and are closely related to the Sustainable Development Goals (SDGs). While the initiative only marginally addressed the concept of mission-oriented research and innovation policy, it took up some important characteristics such as addressing societal challenges, transdisciplinarity, and mobilisation. The Swiss Academies of Arts and Sciences are currently preparing a report on "Lighthouse programmes in sustainability research", which also deals with aspects of mission-oriented research and innovation.

39 Python 2021; in its statement of 16.02.2022, the Federal Council asked Parliament to reject the postulate. The Federal Council stated that "in federal Switzerland, which successfully organises research and development in a decentralised, fundamentally open-topic manner and according to the bottom-up principle, such thematic top-down steering is not desirable, especially since challenges (e.g., decarbonisation) are also addressed by the actors without such a mechanism." Swiss Federal Council 2022.

40 Widmer et al. 2018: 42–44.

41 Sustainable behaviour; Sharing society; Data protection; Smart regions; Health and the environment. Swiss Federal Council 2020: 3727–3737; EAER 2023: 34–36; 112.

42 It is worth mentioning that Switzerland has a broad expertise in transdisciplinary methodologies, which are key for mission-oriented research and innovation. One important stakeholder is the Network of Transdisciplinary Research td-net, which is hosted at the Swiss Academies of Arts and Sciences. See also Schneider et al. 2019: 465.

43 OECD 2021: 20; 39.

44 The statements stem from the experts interviewed (see Annex), but are not assigned individually.

45 Based on the ERI planning subject to parliamentary decisions 2024.

- In general, Switzerland should try to be more strongly involved in international (e.g., Horizon Europe) or bilateral (e.g., Canada) mission-oriented programmes. The Dutch R&I policy is also of interest for Switzerland. Among other things, the Netherlands has been able to attract funding from the private sector for R&I activities in the quantum domain.

Top-down vs. bottom-up approach

- In Switzerland, it would be good to focus more on solving technological problems in specific areas, even though the main R&I funding approach should remain bottom-up. More strategic use of existing resources for targeted R&I could be achieved, with the government taking a lead.
- Mission-orientation is a matter of culture. In Switzerland, there is a very strong bottom-up mentality when it comes to R&I; this makes it difficult to implement major changes from above. On a policy level, there is no strong priority setting, e.g., by a national minister of research and innovation. This is also consistent with the Swiss system with autonomous (cantonal) universities.
- A prioritisation of research infrastructures and societal challenges might be helpful, based on discussion and consensus between the partners. Still, such a process might be difficult to implement as every sector/discipline has to be satisfied.

Coordination

- There is a lack of an overview on stakeholders and an understanding of the complex actor constellation. The Dutch Top Sector approach might be of interest here.
- There are right now a lot of redundancies, e.g., in the domain of energy, where funding is available from the SNSF, Innosuisse and the departmental research alike.

Instruments, programmes and institutions

- In Switzerland, there are mission-oriented institutions such as the PSI, but not much research programme money is available.
- There is a clear potential for the ETH Domain and in particular its four national research institutes to implement and deliver on potentially new mission-oriented R&I programmes.
- The Swiss Accelerator Research and Technology (CHART) programme is a good example of a mission-oriented programme. It aims at supporting the Future Circular Collider at CERN. In this case the receiver of the results is CERN. Such initiatives benefit both science and Switzerland.
- Big problems should be solved by the best researchers available. Switzerland does not have the adequate scale for this. The NCCRs could be more open for international partners. Initiatives like the Swiss Quantum Initiative are good but have limited impact. Switzerland should consider seriously about which thematic areas it should lead and/or protect.
- There are already several mission-oriented instruments in place, such as the NRPs, the Flagship Initiative and the PGB ("Projektgebundene Beiträge"). Coordination could be improved, though, at the level of the Federal Act on Funding and Coordination of the Swiss Higher Education Sector (HEdA) as well.
- The Swiss Conference of Higher Education (SHK) is the place where important stakeholders from both policy and the R&I domain meet. So far, the SHK has not been "revolutionary" in its decisions, but it has nevertheless become a place where important R&I focus areas are discussed and common strategies are aligned.

3.2 Departmental research

Within the public administration, mission-oriented R&I activities are mainly carried out by the departmental research, also known as Federal Government Research, Federal Policy Research or "Ressortforschung".[46] According to Art. 16 RIPA, departmental research provides results which enable the Federal Administration to fulfil its tasks. This includes providing scientific evidence in order to find solutions for problems of political relevance.[47] Departmental research "lies at the interface between scientific research and policy/real-world applications".[48] It has to be regularly evaluated by the Federal Office in charge, according to the guidelines provided by the Federal Department of Economic Affairs, Education and Research.[49] Since the total revision of the RIPA in 2012, the concepts of departmental research have to be aligned with the priorities of the universities, the SNSF and CTI/Innosuisse.[50]

46 So far no dedicated study on departmental research and innovation exists for Switzerland (Angermann 2021: 38; 50). Evaluations of the departmental research took place in 2006 (Landert Farago & Partner 2006) and 2009/2010 (SSTC 2009; SER 2010). The ARAMIs database provides an overview of all research, innovation and evaluation projects funded and/or implemented by the Federal Administration (Swiss Federal Council s.d.).

47 SERI 2023.

48 SDC 2020: 27.

49 EAER 2005.

50 Swiss Federal Council 2011: 8856.

Departmental research has a yearly budget of around CHF 350m and involves the following policy sectors:

Policy sector	Leading office	Project and programme examples[51]	Budget 2021–2024 in million CHF
1. Health	Federal Office of Public Health (FOPH)	Establishment of National Diagnostic Reference Values for Mammography	42
2. Social security	Federal Social Insurance Office (FSIO)	Study on "The economic situation of the working-age and retired population"	5,1
3. Environment	Federal Office for the Environment (FOEN)	Pilot programme «Adaptation to climate change"	56
4. Agriculture	Federal Office for Agriculture (FOAG)	R&I activities of Agroscope	614
5. Energy	Federal Office of Energy (SFOE)	SWEET programme	227
6. Sustainable spatial development and mobility	Federal Office for Spatial Development (ARE)	Study on «The costs of congestion of the transport infrastructure"	6
7. Development and cooperation	Swiss Agency for Development and Cooperation (SDC)	SOR4D programme (together with the SNSF)	201
8. Security and peace policy	Offices of the Federal Department of Defence and the Federal Department of Foreign Affairs (FDFA)	Verification of chlorine intoxication; Time synchronisation	136
9. Vocational skills development	State Secretariat for Education, Research and Innovation (SERI)	Swiss Leading House VPET-ECON (Research Center on the Economics of Education, Firm Behavior and Training Policies)	16
10. Sport and exercise	Federal Office of Sport (BASPO)	Study on "The mental health of top Swiss athletes"	7,7
11. Sustainable transport	Federal Office of Transport (FOT)	Research project on "Data Governance für Smart Mobility"	59
Other federal offices with departmental research	16 Federal Offices	Federal Food Safety and Veterinary Office: Projects on Covid-19 in domestic and wild animals	117
Total			**1'487**

Table 2: Budget of departmental research per policy sector (EAER 2023: 186)

51 SERI 2022.

In order to coordinate the activities of the different offices, the Federal Council has established a Steering Committee for Education, Research and Technology ("Steuerungsausschuss-BFT") in 1998. After the revision of the RIPA in 2012, this entity has been renamed Interdepartmental Coordination Committee for Federal Government Research KoorA-RF.[52]

One of the main tasks of KoorA-RF is the coordination of the multi-year programmes, which have to be developed by the responsible federal offices of the departmental research as well as the SNSF and Innosuisse. These multi-year programmes provide information on policy research, facilitate the "cooperation among research bodies and contain the information required for the periodic ERI Dispatch and the Confederation's financial planning".[53] KoorA-RF also provides guidelines for the quality assurance of departmental research and is involved in the selection process of National Research Programmes (NRPs) and National Centres of Competence in Research (NCCRs).

The following institutions are represented within KoorA-RF:[54]

- Directorates/executive boards of the federal offices
- Federal Financial Administration
- SNSF
- Innosuisse
- Swiss Federal Institutes of Technology (ETH Board)

KoorA-RF is chaired by a member of the Executive Board of the SERI. There are biannual meetings, which are prepared by a dedicated Working Group. The administrative office of KoorA-RF is located at SERI, with one dedicated Scientific Advisor in charge.

It is important to note that KoorA-RF has no competence when it comes to steering resources of departmental research. The Federal Council explicitly rejected this idea in its statement on a parliamentary report by the National Council Control Committee.[55] In its evaluation of departmental research in 2009, the Swiss Science Council (at the time called Swiss Science and Technology Council) suggested a stronger and centralised governance of the governmental research, as well as the implementation of a Chief Scientific Officer. This suggestion has, however, not been taken up.[56]

Despite its limited competences, KoorA-RF has made some successful efforts to consolidate departmental research. Among other things, the committee defined together with its stakeholders five thematic focus areas, which are based on the Federal Council's Strategy for Sustainable Development 2016–2019:

- Sustainable behaviour
- Sharing society
- Data protection
- Smart regions
- Health and the environment

These focus areas served as reference for the ERI Dispatch 2021–2024[57] and are also included in the Explanatory Report for the ERI Dispatch 2025–2028.[58] In addition, KoorA-RF has developed an overview of the different strategies and action plans which are of relevance for departmental research.

In the expert interviews, several stakeholders mentioned KoorA-RF as an important stakeholder for knowledge circulation. The interviews also indicate, however, that biannual meetings might not be sufficient to coordinate the research activities between the departmental research, the funding agencies and the ETH domain. Furthermore, resources for the administration of KoorA-RF are very limited.[59]

An interesting example of a research and innovation programme with different Federal Offices involved is the National Centre for Climate Services NCCS. It was founded in 2015 in "response to the call of the Global Framework for Climate Services (GFCS) of the World Meteorological Organization (WMO) to establish national coordination mechanisms". The main coordinator of NCCS is MeteoSwiss, which also hosts a dedicated secretariat. There are 6 other Federal Offices involved as well as the Swiss Federal Institute for Forest, Snow and Landscape Research WSL and ETH Zurich.[60]

With the programme "NCCS-Impact", which runs from 2022–2025 and includes six cross-sectoral projects, the NCCS aims at obtaining "an overview of impacts under future climate change in Switzerland" and "closing the gap identified between basic scientific research and climate mitigation and adaptation measures".[61]

52 SER 2010: 5.

53 RIPA 2012: Art. 42; 45.

54 SDC 2020: 28; O-RIPA 2012: Art. 57.

55 Swiss Federal Council 2006: 849.

56 SSTC 2009: 6; SER 2010: 12.

57 Swiss Federal Council 2020: 3849.

58 EAER 2023: 112.

59 According to the guidelines on quality assurances for departmental research (EAER 2005), the KoorA-RF secretariat at the SERI only disposes of 10 % of a full-time position.

60 NCCS 2023: 4.

61 NCCS 2023: 3.

Main results of the expert interviews on departmental research:

- Departmental research is key for mission-oriented R&I funding in Switzerland, as, for example, the SWEET programme, which is financially compensated in the ERI domain. In view of the very challenging financial situation of the Confederation, the extent to which these activities need to be compensated in the ERI domain is currently being discussed.
- The legal basis of departmental research is different from funding agencies such as the SNSF or Innosuisse. In general, mission-oriented initiatives are not sufficiently coordinated (e.g., in the energy or health area), which leads to duplications of funding streams and to potential oversaturation and inefficiency.
- Innosuisse informs the KoorA-RF about its mission-oriented funding areas. Innosuisse is also in contact with the Swiss Federal Office of Energy. Coordination between the different mission-oriented funding instruments and agencies could be improved.
- There is room for improvement regarding the different funding instruments at national level, including better coordination with the Departmental Research (Ressortforschung). The Interdepartmental Coordination Committee for Federal Government Research (KoorA-RF) has only two meetings per year, which limits its impact.
- The coordination of research activities in specific policy areas is primarily the task of the federal agencies in charge.
- Even though the coordination bodies CORE[62] and KoorA-RF facilitate knowledge circulation, there have been funding overlaps in the past, namely between SWEET and the Innosuisse Flagship Initiative in the area of "net zero carbon emission". This leads to inefficacy within the system. The fact that good ideas are scarce should be taken into account.

3.3 Mission-oriented funding instruments

3.3.1 Overview

Even though an overarching mission-oriented policy does not exist in Switzerland to date, a wide range of mission-oriented activities is ongoing.[63] The table below provides an overview of funding instruments including aspects of mission-orientation, e.g., regarding pre-defined societal and/or technological goals that have to be achieved and transdisciplinary cooperation between academic and other stakeholders.[64]

62 The Federal Energy Research Commission CORE is an advisory body of the Federal Council and the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

63 See also Schneider et al. 2019: 465.

64 This table does not include private funding initiatives, which may also support mission-oriented R&I, such as the Gebert Rüf Stiftung, the ISREC Foundation, the Leenhards Foundation and the Sandoz Foundation.

Name	Funding institutions	Mission-orientation
Advanced Manufacturing Technology Transfer Centers (AM-TTC)	Art. 15 RIPA (Federal Council)/ ETH Board/Third party funds	Establish advanced manufacturing technology transfer centres (AM-TTC) in Switzerland.
Belmont Forum	SNSF/Belmont Forum	Funding calls for proposals, also known as Collaborative Research Actions (CRAs), to promote international transdisciplinary research in the context of global environmental change.
Environmental technology promotion	Federal Office for the Environment	Development of technologies, installations, processes and products (goods and services) that can reduce environmental pollution in the public interest.[65]
ETH Strategic Areas	ETH Domain	The ETH Board identifies five Strategic Areas that aim to respond to the global challenges identified for the period up to 2028.
Flagship Initiative	Innosuisse	Stimulate innovation in areas relevant to a large part of the economy or society and to promote transdisciplinary project collaboration.
Nano-Tera.ch (2008–2016)	ETH/SERI/Partner institutions/ Third party funds	Developing key technologies that use micro- or nano-components with the aim of implementing a data network in the fields of security, the environment, medicine and health.
National Competence Centres of Research (NCCR)	SERI/SNSF/Higher education institutions/Third parties	Focused on a clearly designated and thematically defined field of research of Swiss national interest. Proposals for a new NCCR can be submitted on a bottom-up basis by all researchers active in Switzerland.
National Research Programmes (NRP)	SERI/SNSF	Generating scientific knowledge aimed at solving Switzerland›s most pressing problems. New NRPs can be proposed both bottom-up (e.g., by the research community) or top-down (e.g., by the Federal Council).
NTN Innobooster	Innosuisse	Foster science-based and sustainable radical innovation in thematically different Innovation Boosters.
Quantum Initiative	SERI/Academies	Consolidating Switzerland's excellent position in the field of quantum technology and strengthening its competitiveness at international level.

65 This programme is mostly bottom-up designed, but has the potential for a mission-oriented approach. See Interface et al. 2022: 22–23.

Solution oriented Research for Development (SOR4D) programme	SNSF/SDC	Proposals must explicitly aim at systemic solutions that simultaneously address several of the 17 Sustainable Development Goals of the 2030 Agenda, particularly where they relate to the four objectives of Switzerland's International Cooperation Strategy.
SWEET Outside-the-box Rethinking (SOUR)	SERI, managed by Swiss Federal Office for Energy	Complementary programme within the framework of SWEET to specifically promote the exploration of unconventional and alternative approaches for Switzerland's energy future and to identify potential game changers.
Swiss Competence Centers for Energy Research SCCER (2013–2020)	CTI/Innosuisse/Other competitive federal funds/Third party funds/Funds by research institutions	Developing and implementing solutions to pressing issues relating to the energy transition in Switzerland.
Swiss Energy research for the Energy Transition SWEET	SERI, managed by Swiss Federal Office for Energy	Accelerate innovations that are key to implementing Switzerland's Energy Strategy 2050 and achieving the country's climate goals.
Transforming Health and Care Systems (THCS)	THCS/SNSF/Innosuisse/BAG	Contribute to the transition towards more sustainable, efficient, resilient, inclusive, innovative and high-quality people-centred health and care systems equally accessible to all people.

Table 3: Mission-oriented public funding instruments in Switzerland

Three of these programmes are presented in more detail below, namely the SWEET programme, the Flagship Initiative and the National Research Programmes.

3.3.2 Swiss Federal Office of Energy: The SWEET programme

The Swiss Energy research for the Energy Transition (SWEET) programme is hosted by the Swiss Federal Office of Energy (SFOE). Its origins lie in the reactor accident at Fukushima in 2011, which caused the Swiss government and parliament to take action in order to transform the Swiss energy system by reducing energy consumption and increase efficiency as well as foster renewable energy sources. The Federal Council developed an Energy Strategy 2050 with a dedicated action plan, which was subsequently approved by parliament in 2013. This was the base for funding an R&I programme on energy research and innovation, including the Swiss Competence Centers for Energy Research (SCCER). This first energy programme had a budget of around CHF 725m and ran from 2014 to 2020. It was under the lead of Commission for Technology and Innovation CTI, which was transformed in 2019 into Innosuisse.[66]

In 2021 the Swiss Energy research for the Energy Transition (SWEET) programme was launched. Unlike the SCCER, SWEET is administered by the Swiss Federal Office of Energy (SFOE). The initial budget was CHF 136m until 2032.[67] The programme supports solution-oriented research by stakeholders from the academy, governmental institutions, the private sector and NGOs. Contrary to Innosuisse and the SNSF, SWEET may directly fund companies. The call areas are defined by the SFOE after consultation of the Federal Energy Research Commission CORE. Important points of reference are the Energy Strategy 2050 and the Long-term Climate Strategy to 2050.[68]

66 Innosuisse 2021: 13; 16.

67 It is planned to invest another CHF 135m until the year 2036: "At its meeting on 9 June 2023, the Federal Council opened the consultation on an additional commitment credit for the current research funding instrument SWEET (SWiss Energy research for the Energy Transition). The aim is to expand SWEET into SWEETER (SWiss research for the Energy Transition and Emissions Reduction). SWEETER will work on issues related to ensuring security of supply while simultaneously transforming the energy system to net-zero greenhouse gas emissions." Swiss Federal Council 2023b. Cf. the dedicated statement of the SSC within the consultation process (SSC 2023b).

68 SFOE 2023: 8.

Main results of the expert interviews on the SWEET programme:

- SWEET is a unique mission-oriented instrument in Switzerland, due to its focus on a specific policy (Energy Strategy 2050) [69], its transdisciplinarity and the relatively strong monitoring during the implementation process.
- Monitoring of SWEET projects is key in order to secure the impact of the programme. To date, the monitoring process is weakened by a lack of resources for the SWEET office.[70]
- A general challenge SWEET faces is the lack of coordination with other funding instruments, namely the Innosuisse Flagship Initiative, the NRP and the ETH Joint Initiatives. Even though the coordination bodies CORE and KoorA-RF facilitate the knowledge circulation, there have been funding overlaps in the past, namely with the Innosuisse Flagship Initiative in the area of "net zero carbon emission". This leads to inefficiency within the system. The fact that good ideas are scarce should also be taken into account.
- Different funding bodies could be complementary in their mission-oriented funding activities. For instance, the SNSF could launch an NRP on energy, which would then be taken up in a second phase by SWEET on a higher TRL and finally by an Innosuisse Flagship, which is closest to the market. This might increase the impact on the value chain.

3.3.3 Innosuisse: The Flagship Initiative

The Flagship Initiative

The Flagship Initiative was launched by Innosuisse in 2021. It has been inspired by the Swiss Competence Centers for Energy Research (SCCER). Similar to the SWEET programme, the Flagship lnitiative aims at supporting transdisciplinary collaboration, i.e., both academic and non-academic stakeholders are involved. The programme also explicitly targets "innovation in areas relevant to a large part of the economy or society" and attempts "re-solving social relevant challenges in the public interest"[71]. Former Flagship Initiative calls focused, among others, on the digital transformation triggered and accelerated by Covid-19 and disruptive solutions for the transition towards a net zero world.

Main results of the expert interviews on the Flagship Initiative:

- The Flagship Initiative is mainly influenced by the Innosuisse experts, the Innovation Council and the Board of Directors. The thematic fields of the Flagship Initiative are thus defined by a bottom-up process (see above) and do not follow a specific mission-policy from above.
- Coordination with similar instruments by other funding bodies is done via inter-departmental coordination meetings (including Innosuisse, the SNSF and federal offices). There are some overlaps between the different funding instruments. An increase of mission-oriented activities by the funding bodies would make coordination even more important and challenging.
- The added value of the Flagship Initiative in comparison with Innosuisse innovation projects lies in the systemic and transdisciplinary approach as well as on the focus on societal and economic challenges.
- Flagship Initiatives provide a broad thematic framework but leave room for bottom-up initiatives by researchers and other stakeholders. This instrument is less prescriptive than the SCCER/SWEET programme. The costs of shifting the research focus are thus limited.
- Flagship Initiatives cover the value chain from (elements of) basic research to piloting activities. There is no focus on the nascent S-curve ("the technology exists, is relatively unexplored, and has great potential for improvement"[72]).

69 Swiss Federal Office of Energy 2018.

70 See also SFOE 2023: 6.

71 Innosuisse s.d.

72 Azoulay et al. 2019.

3.3.4 Swiss National Science Foundation: National Research Programmes

The SNSF has several instruments with mission-oriented aspects, e.g., Solution-oriented Research for Development (SOR4D) and Implementation Networks. The main mission-oriented instrument is the National Research Programme (NRP). The first NRP has been launched in 1975, against the backdrop of the oil and economic crisis (SNSF 2002: 14). The main goal of this funding programme is to address societal challenges and supporting the policy making of the Federal Government.

Thematic areas of NRPs may come from interested stakeholders (bottom-up) or be initiated by the government (i.e., NRPs 78 and 80 on Covid-19). SERI is involved in the NRP "Prüfrunde". In particular, it is leading the first stage of identifying topics and drafting programme proposals. Once the Federal Council has approved an NRP, SERI mandates the SNSF to implement the programme. The role of the NRP Steering Committee is key. Its members are selected by the SNSF National Research Council. The Steering Committee develops the NRP calls, evaluates the proposals and coordinates the different projects within an NRP. It has to take strategic decisions, also regarding knowledge and technology transfer.[73] Call for proposals are focusing on the specific area of the NRP, yet leave much freedom to the applicants in the concrete project design.

Three NRPs (59, 60, 61) were evaluated a few years ago.[74] The instrument has been positively assessed on aspects such as prestige, academic output or organisation. As for the non-academic output, which is critical for mission-oriented programmes, the evaluation states that "impacts have been limited. Specifically, the transition from immediate outcomes and impacts among groups and organisations closely connected to each NRP, towards wider impacts of more significant societal scale, was less successful than most stakeholders had anticipated"[75]. The SNSF has subsequently taken measures to address these challenges.[76] Schneider et al. assessed NRP 61 on Sustainable Water Management as a model for a research funding programme aiming for societal transformation.[77] In its evaluation of the SNSF in 2022, the SSC has highlighted the potential of NRPs for mission-oriented research.[78]

Main results of the expert interviews on NRPs:

- Over the last years, NRPs have become more transdisciplinary. The stakeholder participation process has been improved, e.g., through dialogue platforms. In the future, NRPs may have to focus more strongly on aspects of the theory of change and systems knowledge, target knowledge, as well as transformation knowledge.[79] As for research in general, boundary conditions are limiting the mission-orientation of NRPs. Researchers are sometimes not so interested in impact beyond academia, as incentives are missing. Furthermore, NRP calls do normally not predefine (expected) outcomes. With a different mandate, there might be scope for developing NRPs into a "mission-oriented" funding instrument.

- There is room for improvement regarding the different funding instruments at national level, including better coordination with the Departmental Research (Ressortforschung). The Interdepartmental Coordination Committee for Federal Government Research (KoorA-RF) has only two meetings per year. The exchange with Departmental Research (Ressortforschung) is thus limited.

- Collaboration between the SNSF and Innosuisse is improving, not least due to the joint BRIDGE-programme. More and more Innosuisse experts are involved in NRPs, depending on the adequacy of the topic. The SNSF is also in contact with other European funding agencies, e.g., through the Science Europe network. When coordinating different funding instruments, it should be taken into account that research and innovation is not a linear process.

- NRP thematic areas seem to be strongly influenced by public administration. This approach might not be the best solution for mission-oriented R&I. It is important to have an overview of all stakeholders involved in mission-oriented R&I.

- NRPs are not focused on technology development, but the SNSF has adapted the programme over the last year in order to have more impact beyond academia.

73 SERI s.d.; Interview with Pierre Willa et al. 2023.

74 Technopolis 2018.

75 Technopolis 2018: 2.

76 SNSF 2018.

77 Schneider et al. 2019: 469.

78 SSC 2022: 12.

79 Cf. Pohl 2022.

3.3.5 ETH Domain

Unlike the cantonal universities, the ETH Domain falls directly under the authority of the Swiss Federation, namely the Federal Department of Economic Affairs, Education and Research (EAER). The ETH Domain includes the Federal Institutes of Technology (ETH Zurich and EPF Lausanne) as well as the following research institutes:

- Swiss Federal Institute of Aquatic Science and Technology (Eawag)
- Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)
- Empa (Swiss Federal Institute for Materials Testing and Research)
- PSI (Paul Scherrer Institute)

The ETH research institutes were originally created to do mission-oriented research, e.g., on nuclear energy, water treatment, forest maintenance and particle accelerators. Today, they also perform other functions ranging from curiosity-driven basic research to proton therapy for fee-paying patients. Furthermore, different national infrastructures are linked to the ETH Domain, including the Swiss National Supercomputing Centre (CSCS), the Swiss Data Science Center (SDSC) and the Centre Suisse d'Electronique et de Microtechnique (CSEM).

Within the Strategic Plan 2025–2028, the ETH Board has identified 5 Strategic Areas, which include urgent global challenges in domains where the ETH institutions may have a strong impact:[80]

- Human Health
- Energy, Climate and Environmental Sustainability
- Responsible Digital Transformation
- Advanced Materials and Key Technologies
- Engagement and Dialogue with Society

The Strategic Areas are implemented "through existing or new activities at the level of the individual institutions, and with Joint Initiatives at the level of the ETH Domain". The funding of the Strategic Areas amounts to 3–5 % of the overall ETH budget. Additional targeted funding come from the Joint Initiatives, where different institutions of the ETH Domain collaborate together.[81] The ETH Board has also discussed the option of creating top-down, interdisciplinary and mission-oriented research programmes within the ETH Domain, with participation from leading scientists in Swiss academia or industry.[82]

Main results of the expert interviews on the ETH Domain:

- There is a clear potential for the ETH Domain and in particular its four national research institutes to implement and deliver on potentially new mission-oriented R&I programmes.
- PSI has been created to do mission-oriented research, even though it has also other tasks (e.g., large scale research infrastructure, nuclear safety).
- PSI staff is able to do mission-oriented research, as it is not only judged on short-term academic output.

3.4 Preliminary conclusion

Switzerland has relatively few experience in mission-oriented R&I policies. Recently, however, the country has come under increasing pressure to intervene in a more steering manner in order to achieve societal, economical, and technological goals. Some of the interviewed experts explicitly ask for a dedicated strategy and a better overview and coordination of existing mission-oriented activities.

With the departmental research – also known as "Ressortforschung" – there exists an instrument which allows the government and the federal administration to fund mission-oriented R&I in a considerable number of policy areas. In this context, the role of the interdepartmental coordination committee KoorA-RF is crucial, as it links departmental research with the SNSF, Innosuisse and the ETH domain. However, the expert interviews indicated that this exchange between the different stakeholders should be further improved and there exists a lack of coordination, which leads to inefficiencies and funding duplications.[83]

An example of mission-oriented departmental research and innovation is the Swiss Energy research for the Energy Transition (SWEET) programme. The founding of SWEET is closely linked to the Fukushima reactor disaster and the subsequent realignment of Swiss energy policy. In comparison with other funding programmes, SWEET has a relatively strong top-down approach. Transdisciplinary and collaborative R&I is at the core of the programme. The monitoring process of the project implementation is limited, due to the lack of resources by the SWEET office.

80 ETH Board 2022: 15.

81 ETH Board 2022: 15–17; Interview with Christian Rüegg 2023.

82 Statement by Susan Gasser (30.08.2023), member of the Swiss Science Council SSC and the ETH Board.

83 See also IEA 2023: 88.

The Innosuisse Flagship Initiative was inspired by Swiss Competence Centers for Energy Research (SCCER), SWEET's predecessor programme. It thus also has a link to the energy transition policy of the 2010s. Flagship Initiatives provide a broad thematic framework but leave room for bottom-up initiatives by researchers and other stakeholders. Transdisciplinarity is a prerequisite for projects funded under this instrument. In the past, there have been some overlaps with the SWEET programme, due to a lack of coordination.

The National Research Programmes (NRPs) of the SNSF belong to the oldest mission-oriented research instruments of Switzerland. Societal and political challenges are at the forefront of the programme. While the important contributions of the NRPs to the Swiss science system are undisputed, they are primarily rooted in (basic) research and their impact beyond academia has been limited. It should be noted, however, that over the last years the SNSF has taken different measures to make the NRPs more transdisciplinary.

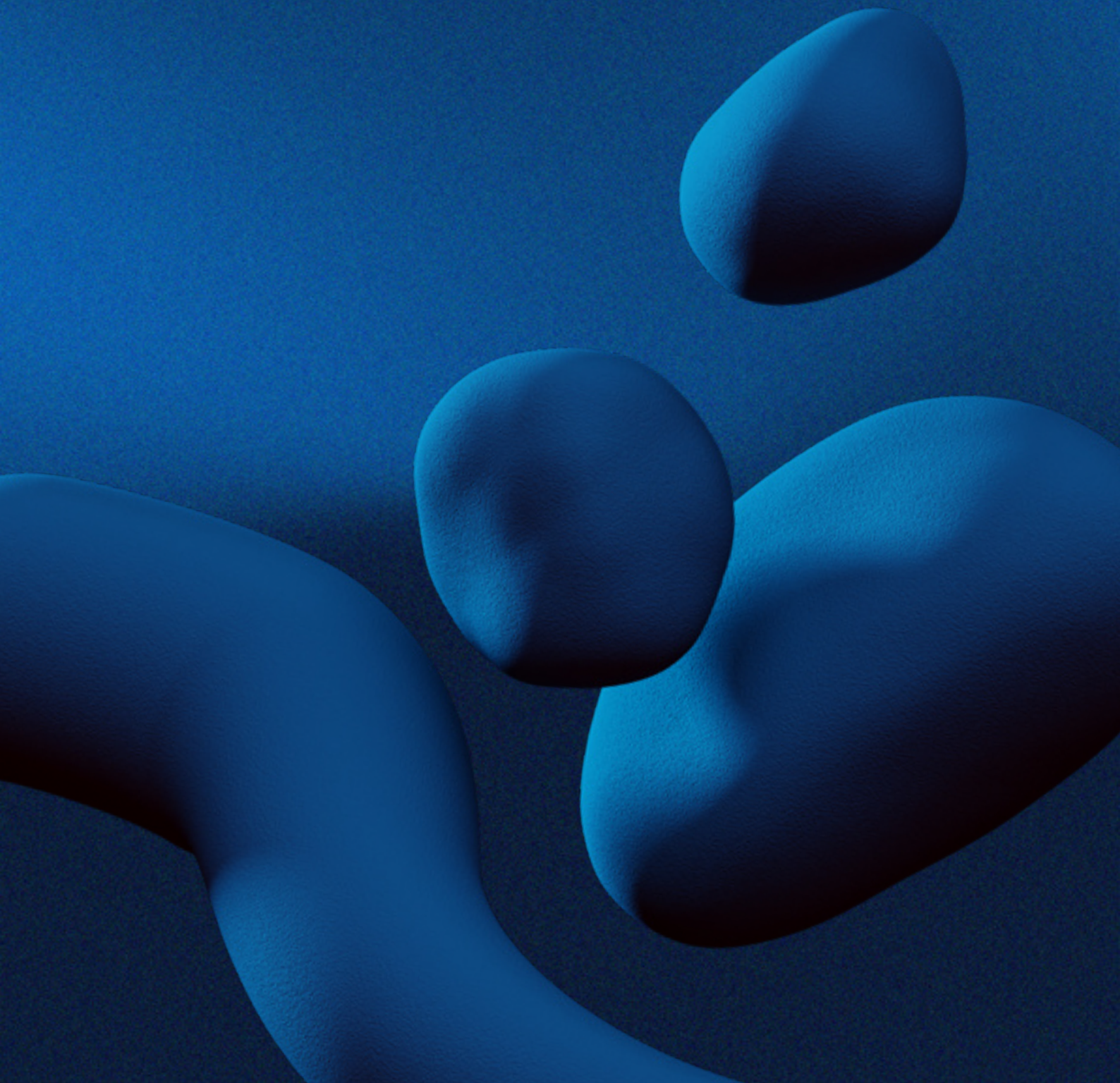
The ETH Domain may fund mission-oriented R&I through its Strategic Areas, which tackle Global Challenges. In Federal Research Institutes such as the PSI, there is a stronger command mode of planning than within cantonal universities. Therefore, such institutes may be particularly suited to deliver on missions. However, current funding and research project management within the ETH Domain is fragmented, and not conducive to addressing large-scale transdisciplinary challenges.

This chapter has shown that there are various mission-oriented activities in the Swiss research and innovation system. However, these activities are all located in the top right box of the Azoulay framework (see below). The following chapter therefore deals in depth with the ARPA approach, which covers the box at the bottom right.

		Idea generation	
		Investigator initiation	*Mission-inspired solicitation*
Project execution	*Investigator/innovator freedom*	SNSF projects Innosuisse projects ...	NRP SOR4D Flagship Initiative Departmental research (SWEET) ETH Domain Belmont Forum ...
	Empowered programme staff	Private Venture Capital	-

Figure 4: Mission-oriented funding instruments in Switzerland (right column; adapted from Azoulay et al. 2019: 92)

4 Implementing mission-oriented R&I: The ARPA approach



4 Implementing mission-oriented R&I: The ARPA approach

4.1 The ARPA approach

The ARPA approach has its origins in the end of the 1950s, when the United States founded the Advanced Research Projects Agency (ARPA) – later called Defense Advanced Research Projects Agency (DARPA) – as a response to the successful launch of Sputnik 1 by the Soviet Union. DARPA has since become famous for having contributed to technological breakthroughs such as the internet or GPS. From the 2000s onwards, several ARPA-like agencies have been launched, including ARPA-Energy (USA), ARPA-Health (USA), IARPA (USA), BARDA (USA), Wellcome Leap (UK/USA), ARIA (UK), and the Agentur für Sprunginnovation SPRIN-D[84] (Germany). The European Innovation Council EIC has also been inspired by the ARPA model.[85]

Azoulay et al. (2019) refer to the following characteristics, requirements and challenges of ARPA agencies:

Organisational characteristics of an Advanced Research Projects Agency (ARPA)

- Organisational flexibility: ARPA agencies have a high level of independence, a relatively flat organisation and fixed-term contracts.[86]
- Highly qualified staff: "ARPA program managers leave their positions in academia, industry, or elsewhere in government to join the agency. They remain continually engaged with the research community throughout the planning and execution of a technical program, and then return to work outside the agency after a short three- to five-year term."[87]
- Agile programme design: "Program managers at ARPA-like agencies are able to pursue technical areas based on the real-time changing need for innovation and opportunities for progress."[88]
- Discretion in project selection: Programme managers may use their own expert judgment in deciding which proposals to fund. They are not or only partly bound by external peer review.[89]
- Active project management: Programme managers may make decisions "related to capital, tasks, milestones, and technical goals throughout the project". They thus retain "control rights over the research after allocating funds."[90]

Requirements for an ARPA ecosystem

- Mission-orientation: The domain of research has to be organised "around a technology-related mission or a set of overarching goals. [...] The mission must be associated with quantifiable goals and subgoals with trackable progress metrics."[91]
- Nascent S-Curve: ARPA-like agencies bridge the gap between basic and applied research. The ARPA model "is optimized for technical areas that reside in nascent S-curves: the technology exists, is relatively unexplored, and has great potential for improvement".[92]
- Frictions in the markets for ideas and technology: "If there are frictions in the pathways through development, demonstration, and broad-scale deployment, the ARPA model for intervention is suitable."[93]

Challenges of the ARPA approach

- Measuring long-term transformation: ARPA projects often only run for three years.[94] This limitation must be kept in mind when the agency's progress toward its mission is measured.[95]
- One size does not fit all: "ARPA model organizations fund a diverse set of performers, including large firms, academics, start-ups, and national labs. They generally have one set of practices that apply equally to all research teams, despite the very different incentives and organizational contexts underlying participation across these different types of performers. Successfully implementing the ARPA model means navigating these differences to avoid conflicting motivations for researchers."[96]

84 SPRIN-D has gained more legal leeway in order to enhance its innovation capacity:"Die inhaltliche Kontrolle durch das Forschungsministerium soll wegfallen, ausserdem sollen innerhalb bestimmter Grenzen auch die ungehinderte Beteiligung an Start-ups, Kooperationen mit anderen Kapitalgebern und sogar Gewinne möglich sein. Zudem soll Sprind-Chef Rafael Laguna de la Vera künftig auch wettbewerbsfähige Gehälter an Mitarbeiter zahlen dürfen, die ihm bei der Suche nach Tüftlern mit Top-Ideen helfen" (Gillmann 2023: 2). Cf. EFI 2023b.

85 Van Atta et al. 2019: 2–4; EC 2020b; EIC s.d.

86 Azoulay et al. 2019: 76–77.

87 Azoulay et al. 2019: 75.

88 Azoulay et al. 2019: 78.

89 Azoulay et al. 2019: 80–81.

90 Azoulay et al. 2019: 82.

91 Azoulay et al. 2019: 86–87.

92 Azoulay et al. 2019: 88.

93 Azoulay et al. 2019: 89.

94 There might be the option of renewing the project, though.

95 Azoulay et al. 2019: 90.

96 Azoulay et al. 2019: 90.

- The dark side of discretion: "In the ARPA model, programme managers have significant freedom to craft programmes and select and manage projects and enjoy freedoms afforded by the organization's flexibility. [...] The core elements of the ARPA model cannot exist under micromanagement or with underqualified programme staff."[97]

- Tension between autonomy and accountability: "With fewer checks and balances in place, empowered [ARPA] staff members are less accountable for the impact of their decisions."[98]

- Building trust: "The programme design and proposal solicitation phases of the ARPA model depend heavily on the willingness of the researchers to share their ideas and their ongoing, and potentially confidential, work. If programme managers or the agency director do not treat these ideas with appropriate care, the agency can lose its reputation as a trustworthy partner."[99]

- Nurturing culture with high turnover: "An energetic and enterprising culture is a hallmark of the ARPA model. However, culture is a by-product of the individuals that make up the organization, and in ARPA-like agencies, the programme managers work on three- year contracts. It is a challenge to maintain and nurture an organization's culture with such high turnover."[100]

- Transitioning to market: "The focus of the ARPA model is on making progress along technical S-curves, but innovation also requires diffusion of new technologies. Overseeing the transition from research to development is a major challenge for ARPA-like agencies, especially when there is no public customer for the innovation."[101]

As we have already discussed above, ARPA agencies cover a specific part of R&I funding, namely mission-oriented activities that are closely supervised by programme managers. The figure below shows the original framework by Azoulay et al. (2019), which focuses on the R&I system of the USA.

Project execution	Idea generation: *Investigator initiation*	Idea generation: *Mission-inspired solicitation*
Investigator freedom	HHMI NIH NSF	Gates Foundation Chan-Zuckerberg Initiative
Empowered programme staff	Venture Capital Google X	DARPA ARPA-E

Figure 5: R&I management strategies (Azoulay et al. 2019: 92)

4.2 Examples of ARPA agencies

4.2.1 Wellcome Leap

Wellcome Leap was launched in 2020 by the Wellcome Trust Foundation, with the aim to tackle global health challenges in an ARPA-inspired style.[102] *The following statements summarize the interview with Regina E. Dugan and Ken Gabriel.*[103] *Regina E. Dugan is CEO and Director of Wellcome Leap since 2020. She has been the Director of DARPA from 2009 to 2012. Ken Gabriel has been the COO of Wellcome Leap from 2020 to 2023.*

Wellcome Leap focuses on use-inspired basic research programmes, according to the Pasteur's Quadrant, as introduced by Stokes.[104] Pasteur's Quadrant research is basic science focused on solving a problem or creating a new capability. The organisation's ARPA approach breaks the linear way of thinking, which often causes lags in bringing basic research to applications. Wellcome Leap is characterized by its international funding approach. This is possible due to the philanthropic set-up.

97 Azoulay et al. 2019: 90.

98 Azoulay et al. 2019: 90–91. On the other hand, achievement of a predefined outcome is the ultimate accountability for any R&I.

99 Azoulay et al. 2019: 91.

100 Azoulay et al. 2019: 91.

101 Azoulay et al. 2019: 91.

102 Dugan et al. 2022: 72–73.

103 Interview with Regina E. Dugan and Ken Gabriel 2023.

104 Stokes 1997.

Quest for Fundamental Understanding?	Considerations of Use?	
	No	*Yes*
Yes	Pure Basic Research (Bohr)	Use-inspired Basic Research (Pasteur)
No		Pure Applied Research (Edison)

Figure 6: Pasteur's Quadrant according to Stokes (1997)

Programme managers are selected by the Wellcome Leap CEO, based on extensive reach into scientific networks across academia, industry, and non-profits. Typical programme managers have a PhD-level university degree and 10–15 years working experience. Besides scientific skills, they should have also communication and leadership abilities and focus on creating impact. Wellcome Leap supports programme managers to develop a clear vision and then resources the resulting programme with the goal of achieving a breakthrough. The time from proposal to selection is short: performers are selected within 30 days and contracts are used as funding vehicles. Projects themselves are timeboxed and run for 3 years.

ARPA organisations are characterized by their sense of urgency, which keeps intensity high during the programme. A specific measure of that is the dollars the organisation deploys per FTE. For most organisations ranging from NIH to other philanthropies, this ratio is US$ 2m to US$ 4m per FTE. For DARPA the ratio is US$ 15m per FTE, for Wellcome Leap it is more than US$ 10m per FTE after 3 years of operation.[105] Focus is another important characteristic of ARPA organisations: Wellcome Leap concentrates on human health, while DARPA targets National Security. This focus facilitates knowledge about users and customers.

It is important that ARPA organisations remain independent of political pressures. An example of a breakthrough DARPA innovation, which was first not supported by the military, is the stealth technology. This was because stealth technology fell outside the envisioned way that the Air Force imagined it would prevail. It should thus be recognised that the breakthroughs may initially be fought against by the organisations holding the conventional wisdom.

ARPA agencies need sufficient funds to achieve critical mass. Wellcome Leap has launched nine US$ 45–60m programmes in its first 3 years. Many organisations that seek to be ARPA-like lack the resources needed to make a big shot on goal or to take enough shots on goal to achieve the big breakthrough. Furthermore, there is not sufficient global talent to stand up many versions of ARPA organisations.

105 Wellcome Leap uses the amount of research dollars deployed / FTE as a related measure of productivity. The FTE not only refers to programme managers but to the total staff, including supporting functions in fields such as finance, legal issues, security, etc.

4.2.2 ARPA-E

The idea for an ARPA organisation for Energy stems from the National Academies of the USA. The legal basis for ARPA-E was provided in 2007. ARPA-E became operational in 2009, within the US Department of Energy with a budget of US$ 400m.[106] *The following statements on ARPA-E summarize the interview with Evelyn N. Wang and Shane Kosinski.*[107] *Evelyn N. Wang is the ARPA-E Director as of 2023 and was previously Ford Professor of Engineering and Head of the Department of Mechanical Engineering at the Massachusetts Institute of Technology (MIT). Shane Kosinski is Deputy Director for Operations of ARPA-E.*

ARPA-E is inspired by DARPA and disposed over an annual budget of US$ 427m in 2021. ARPA funds between 10–15 programmes. Funding per programme varies between US$ 30–40m; funding per project between US$ 500,000 and US$ 20m. The pitching phase of programmes takes 6–12 months, they then run for around 3 years. Programme design includes top-down and bottom-up elements, and potential users are taken into account. There is a direct project management by ARPA-E and funding may be cut during the implementation process (quarterly reviews). The impact is measured both quantitatively (data-driven) and qualitatively. Examples of ARPA-E funded areas are methane emission monitoring and fusion.

Hiring the right programme manager (=programme director) is a major task. The contract duration is three years and salaries of programme managers are paid by both ARPA-E and their home institutions (e.g., universities or national labs). The rotating model is an advantage, but brings the challenge of finding a new programme manager before the old one leaves. In order to avoid conflict of interests, programme managers may not fund their home institution. There are also tech-to-market directors. They have a business approach (e.g., engineering degree and/or MBA) and have working experience in large companies or IP offices of universities. Tech-to-market directors should make technological solutions commercially viable.

While the Department of Defence is the single customer of DARPA, ARPA-E is targeting national and international technology markets. ARPA-E is not responding to specific policies or roadmaps but rather offers a wide range of disruptive technological options to contribute to the 2050 net zero carbon emission goal. The agency aims to de-risk technology development from an early stage to a proof of concept. In order to bring solutions even closer to the market and bridge the "valley of death", ARPA-E implemented the Scale-up programme, which provides additional funding. ARPA-E does not claim any IP.

106 The National Academies of the USA proposed in 2005 an agency that "would sponsor creative, out-of-the-box, transformational, generic energy research in those areas where industry by itself cannot or will not undertake such sponsorship, where risks and potential payoffs are high, and where success could provide dramatic benefits for the nation." ARPA-E s.d., NASEM 2007: 154, Hart et al. 2017: 8.

107 Interview with Evelyn N. Wang and Shane Kosinski 2023.

ARPA-E is focusing on the US but also funds beneficiaries from Canada and Europe, if there is a need of specific infrastructure. There are also collaborations with other funding agencies such as DARPA.

4.3 Opportunities and risks of a Swiss ARPA approach

The possibility of an ARPA approach in Switzerland was raised on several occasions.[108] In November 2022, the Security Commission of the National Council submitted a motion on fostering innovation in the security sector, which explicitly referred to DARPA as a role model.[109]

In its publication on "Dealing with disruption – The role of education, research and innovation in shaping financial innovation"[110], the SSC presented the ARPA model as a mission-oriented funding instrument with the potential to "efficiently organise research and innovation around a technology-related mission or a set of overarching goals". A dedicated programme could contribute to closing the gap in the value chain and would also be "useful to solve friction on markets for ideas and technologies in sectors where the path from idea to impact is extraordinarily difficult"[111]. The framework of the present study by Azoulay et al. also highlights that ARPA would complement the existing mission-oriented funding schemes in Switzerland.[112]

Behind this background, the SSC has asked its interview partners about the opportunities and risks of a Swiss ARPA approach. The following statements have been made:

General statements of interviewees on an ARPA-pilot in Switzerland

- The Swiss militia system could be an advantage for an ARPA approach.
- The specific conditions of Switzerland have to be taken into account. Switzerland has, for instance, no experience with ARPA-style programme management.
- ARPA might be an interesting instrument for Switzerland, even though a corresponding R&I culture is missing so far.
- It should be taken into account that there is already a wide variety of funding instruments in Switzerland. This makes it difficult to implement new R&I programmes without weakening the great strength of the existing system.
- Switzerland might seek cooperation with other countries that have ARPA-like organisations, such as Germany, France or Singapore and also consider becoming a leader internationally as the first country partner to Wellcome Leap.
- It might be interesting for Switzerland to focus on one thematic area and try out an ARPA pilot.
- An ARPA organisation in Switzerland should identify Pasteur's Quadrant programmes, be focused on Switzerland's specific interests, challenges, or opportunities, but involve global competence.
- An ARPA-like body would only contribute partly to overcome the Net Zero goal of 2050, as many of the challenges are not technology based but rather require societal implementation.

Institutional issues

- It doesn't make sense to develop ARPA outside an existing funding agency.
- The president of Innosuisse strongly supports the idea of an ARPA pilot at Innosuisse. This would probably require changes in the legal basis (e.g., regarding the salaries of programme managers or the Law on Federal subsidies).
- Innosuisse and departmental research (Ressortforschung) could reserve more money for ARPA-type programmes.
- An ARPA pilot in Switzerland could probably be implemented in Innosuisse or within departmental research. 5 % of the budget could be reserved for specific technologies, e.g., regarding space or a spectrometer.
- The administrative staff of Innosuisse is highly qualified and has often both experience in academic research and the industry, but not on the level of ARPA programme managers.
- Flagship Initiatives could become more ARPA-inspired if Innosuisse programme managers/experts got more flexibility to adjust funding during the project implementation phase. There are, however, legal restraints.
- An ARPA pilot at Innosuisse could be interesting for the Swiss R&I system, but different aspects would have to be clarified. As for applied research, this could look differently depending on the type of institution (e.g., at a university, at a university of applied sciences and arts or at a university of teacher education) or on the discipline.

108 SATW 2019, SERI 2020: 12.

109 Swiss Council of States 2023: 3.

110 SSC 2019.

111 SSC 2019: 11.

112 Azoulay et al. 2019.

- While SWEET has similarities with ARPA, e.g., when it comes to mission-orientation or project monitoring, there are also important differences. One concerns the annuality principle ("Jährlichkeitsprinzip"), which makes it difficult to spend funding in a more flexible way.

- The SWEET OUtside-the-box Rethinking SOUR programme shares also characteristics of ARPA, but has only limited funding (max. CHF 150,000 per project) for a relatively short period (max. 18 months) available.[113] It should also be taken into account that an ARPA-like body would only contribute partly to overcome the Net Zero goal of 2050, as many of the challenges are not technology based but rather societally relevant.

- In the future, NRPs might become more ARPA like, with higher agility, smaller budgets and smaller steering committees (1–3 persons).

- An ARPA pilot could be delegated to the ETH domain. The "Ressortforschung" could also implement such a pilot, but this probably requires structural changes.

4.4 Preliminary conclusion

ARPA agencies aim at rapid development of science-based innovation. They are traditionally hosted at governmental departments, but there exist also other forms, such as a philanthropic organisation in the case of Wellcome Leap. Highly skilled programme managers are at the core of the ARPA model. They join the organisation for a limited period and then go back to their home institution. The total budget of an ARPA organisation doesn't have to be above average, the investment per FTE, however, is considerably higher than in other funding institutions. ARPA agencies may be focused on governmental customers (as in the case of DARPA), but can also target national and international technology markets.

Over the last years, several countries have launched ARPA-inspired agencies. So far, such an organisation does not exist in Switzerland. As for an ARPA pilot in Switzerland, several aspects have to be taken into account:

- An ARPA organisation would cover the bottom-right box of the Azoulay framework and thus fill a gap in the Swiss funding system.

- The involvement of international competence is key.

- Finding competent programme managers willing to join an ARPA organisation for a limited time is a major challenge. This might require the adaption of existing regulations, e.g., regarding salaries and funding decisions as well as secondment for research performers from within and without Switzerland.

- The specificities of the Swiss R&I ecosystem have to be considered when launching an ARPA pilot.[114]

- An ARPA pilot should build on existing competences from existing funding agencies, including departmental research.

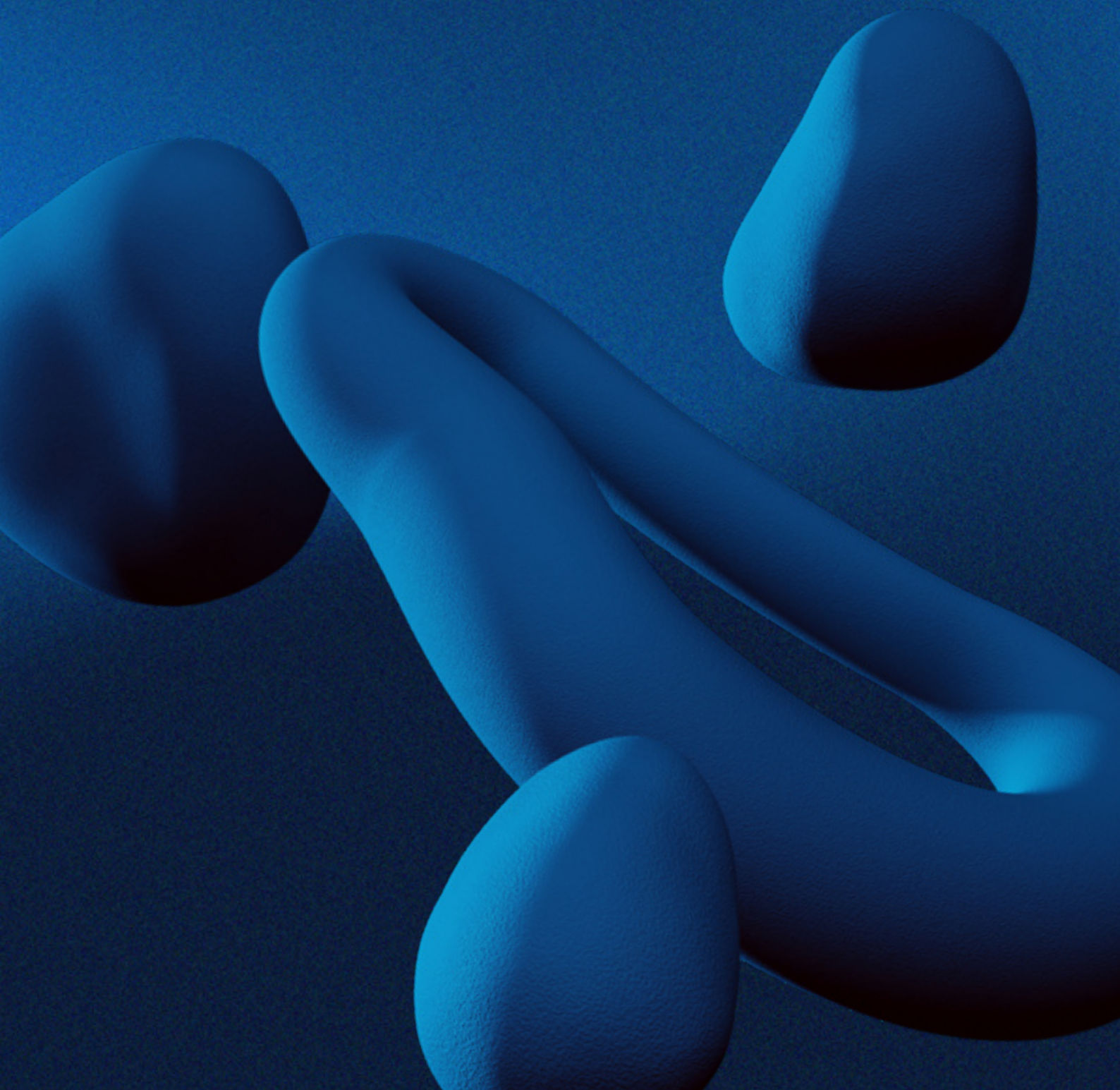
- The pilot should be implemented in an organisation that is compatible with the ARPA goals and participation should be open for all R&I stakeholders in Switzerland.

- Similar to the USA, an ARPA pilot in Switzerland could collaborate with a federal department as a signed-up customer for the outcomes of ARPA projects, e.g., in the field of energy security.

113 For the first SOUR call, CHF 500,000 were allocated and four projects funded (interview with Andreas Haselbacher 2023).

114 Cf. Ventresca et al. 2023: 26; ifo 2020.

5 Synthesis and recommendations by the Swiss Science Council



5 Synthesis and recommendations by the Swiss Science Council

Based on the interviews and research literature, the Swiss Science Council comes to the following conclusions and recommendations:

Improve the agenda setting and coordination of mission-oriented activities by funding agencies, departmental research and other stakeholders

The expert interviews of the SSC with representatives of the Swiss R&I ecosystem have clearly demonstrated that there is insufficient coordination, agility and agenda setting of mission-oriented funding within the existing funding bodies. This leads to inefficiency and incoherence, e.g., in the area of energy.[115]

An existing coordination body is the Interdepartmental Coordination Committee for Federal Government Research (KoorA-RF), headed by the SERI. It coordinates the R&I activities of the Federal Departments (departmental research/Ressortforschung) and includes representatives of the SNSF, Innosuisse as well as the ETH Board. The role of and commitment towards KoorA-RF should be strengthened, e.g., by involving representatives at a higher level of hierarchy and providing additional resources.

The scope of KoorA-RF is, however, limited. It only includes public funding bodies and has a minor impact on the agenda setting. Therefore, additional coordination mechanisms including other stakeholders may be implemented via Art. 41 of the Federal Act on the Promotion of Research and Innovation RIPA.[116]

Implement a Swiss ARPA pilot at Innosuisse in collaboration with the SNSF, departmental research, the ETH domain and universities

Switzerland has several mission-oriented R&I instruments in place. Those instruments predefine societal and technological challenges that should be addressed but leave a lot of freedom to the researchers to design and implement their projects. The funding body has therefore only limited or no possibilities to manage the project according to KPIs and intervene, if necessary. An ARPA-like instrument that combines mission-orientation with active project management is missing in the Swiss system. Therefore, the SSC recommends to start an ARPA pilot at Innosuisse. It could build on experiences of existing Innosuisse programmes (Flagship Initiative), departmental research (SWEET), the SNSF (NRP) as well as on the human resources of the ETH domain (programme managers from research institutes). However, the ARPA pilot should not be a simple extension of an existing instrument (unless the latter would be radically reinvented). Furthermore, potential customers – e.g., governmental departments with pressing technological needs – should be involved in the process.[117]

Such a pilot would not only contribute to mission-oriented technology development and closing the gap in the value chain. It would also have positive spill-over effects to the Swiss STI system, namely regarding the rotation of highly qualified scientists and innovators from research institutes and the industry to funding bodies and vice versa.

The ARPA pilot should address topics of national interest, matching clear societal and economical needs and be quantifiable in tangible KPIs. For instance, topics might be related to the focus areas of the Federal Council's Strategy on Sustainable Development 2030[118] or the National Cyber Strategy.[119] Within a focus area, highly qualified programme managers from technical positions in academia, industry, and government should be recruited for a limited term of 3–5 years.[120] The home institutions should be compensated for their absence. Within the ARPA pilot, the programme managers design their own thematic programme[121], which is then pitched to the ARPA leadership. If the latter approves the proposal, programme managers launch several projects and "make decisions related to capital, tasks, milestones and technical goals throughout the project"[122]. After their term of service, programme managers return to their home institution. The qualification level and the flexibility of ARPA staff may require legal and financial adaptions of existing regulations.

In the short term, the ARPA pilot could be financed under Art. 41 of the Federal Act on the Promotion of Research and Innovation RIPA. Should the pilot be evaluated positively, funding could come in the mid- and long term by a shift of the resources of existing mission-oriented instruments towards an institutionalised ARPA programme. An ARPA programme should not lead to a cut in bottom-up funding of R&I.

115 See also EAER 2023: 91.

116 RIPA 2012: Art. 41(2): "If cooperation cannot be achieved through self-coordination, the Federal Council shall take the required measures. To this end, it may in particular give existing commissions specific coordination tasks or set up special commissions."

117 On the role of Public Procurement for ARPA agencies see ifo 2020: 37–38.

118 EAER 2023: 25; Swiss Federal Council 2021.

119 Swiss Federal Council 2023a.

120 Renewing the contract in exceptional cases may be an option.

121 With consideration of the inputs by the research community and other relevant stakeholders.

122 Azoulay et al. 2019: 77.

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List of expert interviews

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Interview with Andreas Haselbacher, Technical Specialist, SWEET programme, 7 June 2023.

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Interview with Daniel Marti, Scientific Advisor National Research, SERI, 13 June 2023.

Interview with Evelyn N. Wang, Director, and Shane Kosinski, Deputy Director for Operations, ARPA-E, 15 May 2023.

Interview with Kathrin Kramer, Deputy Head of Division, and Marc Gerber, Scientific Advisor, Flagship Initiative/ Innosuisse, 25 April 2023.

Interview with Luciana Vaccaro[123], Rector of the University of Applied Sciences and Arts Western Switzerland HES-SO, 1 June 2023.

Interview with Nicole Schaad, Head a.i., National Research and Innovation Division, and Johannes Mure, Head of Strategy and National Relations Division, SERI, 25 May 2023.

Interview with Pierre Willa, Head of Division Programmes/ Thematic Research, Katrin Milzow, Head of Strategy, and Pascal Walther, Head of Unit NRP, SNSF, 8 June 2023.

Interview with Regina E. Dugan, CEO and Director, and Ken Gabriel, COO, Wellcome Leap, 10 May 2023.

Tables and figures

123 Luciana Vaccaro is also president of swissuniversities. swissuniversities has no official position on mission-oriented R&I, the following statement reflects the personal view of Luciana Vaccaro.

Abbreviations

ARPA	Advanced Research Projects Agency
ARPA-E	Advanced Research Projects Agency–Energy
CERN	European Organization for Nuclear Research
CORE	Federal Energy Research Commission
CTI	Commission for Technology and Innovation
DARPA	Defense Advanced Research Projects Agency
EAER	Federal Department of Economic Affairs, Education and Research
ERI	Education, Research and Innovation
ETH-Domain	Domain of the Swiss Federal Institutes of Technology
FDEA	Federal Department of Economic Affairs, Education and Research
Innosuisse	Swiss Innovation Agency
KoorA-RF	Interdepartmental Coordination Committee for Federal Government Research
MOIP	Mission-oriented Innovation Policies
NCCR	National Centre(s) for Competence in Research
NCCS	National Centre for Climate Services
NRP	National Research Programme
OECD	Organisation for Economic Co-operation and Development
PSI	Paul Scherrer Institute
RIPA	Federal Act on the Promotion of Research and Innovation
SCCER	Swiss Competence Centers for Energy Research
SDC	Swiss Agency for Development and Cooperation
SERI	State Secretariat for Education, Research and Innovation
SHK	Swiss Conference of Higher Education Institutions
SNSF	Swiss National Science Foundation
SSC	Swiss Science Council
SSTC	Swiss Science and Technology Council
SWEET	SWiss Energy research for the Energy Transition
SWEETER	SWiss research for the EnErgy Transition and Emissions Reduction

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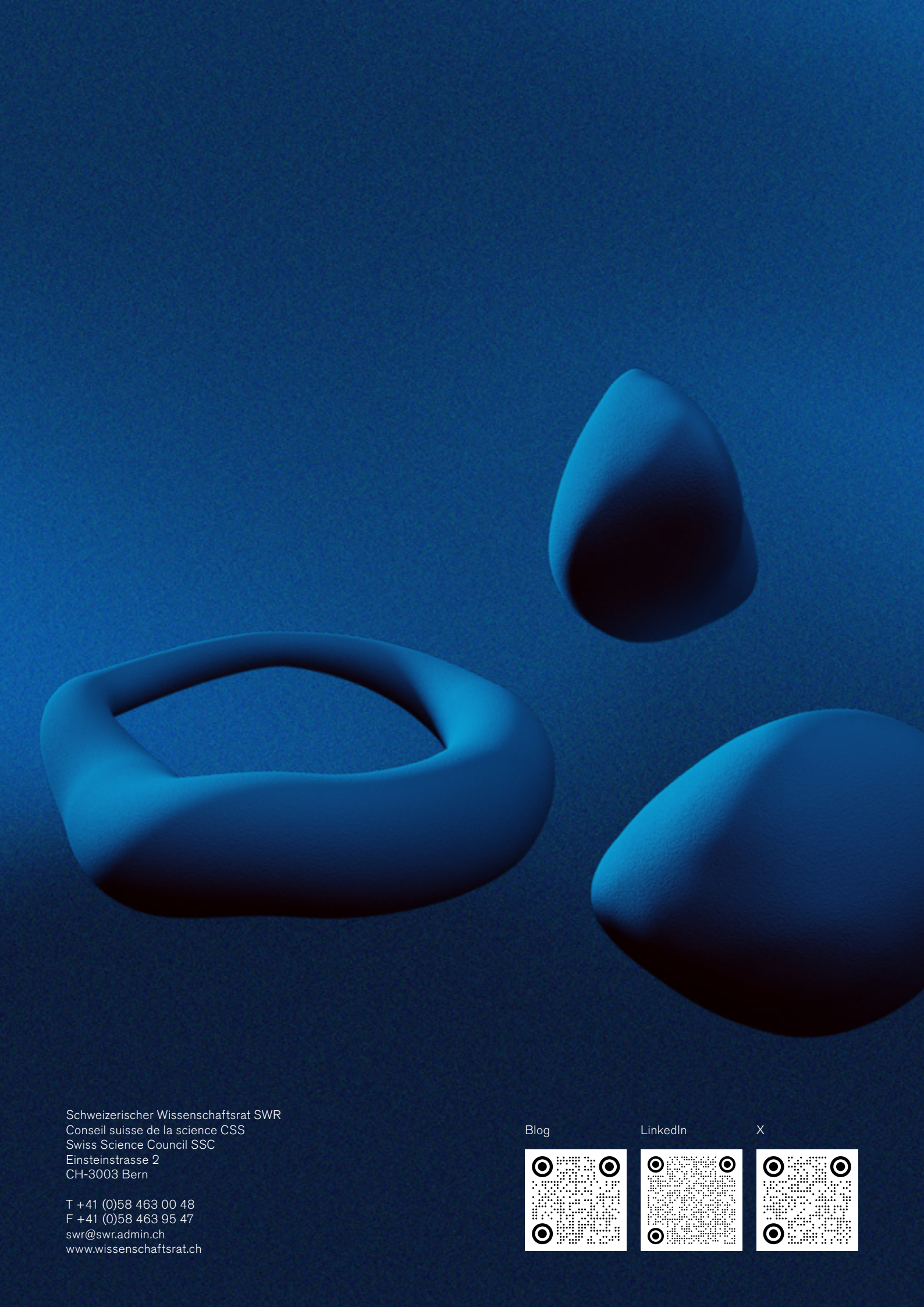

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