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From High-Tech Strategy to High-Tech Agenda Germany

An overview of 20 years of the German STI flagship policy

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Contents

Figure and Tables

Abstract

This discussion paper examines how Germany designs and implements its major federal science, technology, and innovation (STI) policies. Being a flagship policy since 2006, the High-Tech Strategy and its following successors have not only provided a framework for German STI policy but also evolved considerably over time. Shifting towards a mission-oriented approach in 2018 with the High-Tech Strategy 2025, the most recent High-Tech Agenda Germany in turn highlights six key technologies. This paper provides an overview of the federal *High-Tech Strategy* (and its successors). It analyzes strategy context, priority selection, implementation (including budgeting and instruments), and policy learning.

The *High-Tech Strategy* and its successors have served as the federal government's umbrella STI strategy, coordinating activities across ministries since 2006. Strategy development is coordinated by the *Federal Ministry of Research, Technology and Space* (*Bundesministerium für Forschung, Technologie und Raumfahrt; BMFTR*) and has relied on different approaches to prioritize activities including key technologies, missions and demand areas/future tasks. Despite these changing orientations and political priority setting, there is considerable continuity in overarching priorities, reflecting rather a gradual development than radical changes. Serving as an umbrella strategy, it lacks an independent budget and depends on the willingness of ministries to contribute to the strategy, being partly locked in a "STI trap". It focuses mostly on thematically oriented research funding, providing inputs to selected priorities, while acknowledging the importance of framework conditions (that are partly beyond the scope of the federal level, as universities are financed mainly by the regional level). Stakeholder involvement has increased over time but does not include the formulation process. While monitoring has been recently established, echoing repeated calls from advisory bodies, so far, no evaluation has taken place at the strategy level. The recently adopted *High-Tech Agenda Germany* reflects a paradigm shift, returning to key technologies and promising several innovations, including a stronger involvement of the regional level that so far has been widely absent from this strategy.

Note: This working paper builds on a case study commissioned by the Flemish Advisory Council for Innovation and Entrepreneurship that has been published as appendix to the Policy report Np 47: Strategic choices for Flanders. The original case study is available here: https://www.vario.be/files/VARIO_adviezen-en-rapporten/2026_FEBRUARI_VARIO_ANALYSERAPPORT_47_DUITSE-LANDENSTUDIE.pdf.

1 Introduction

German STI policy has, since 2006, been closely linked to the High-Tech Strategy, recently renamed as High-Tech Agenda Germany (2025). Serving as a cross-ministerial umbrella framework to structure German STI policy at the federal level, it aims to increase STI policy coherence. As a key flagship policy, it is characterized by multiple shifts with regard to underlying paradigms, including its front-runner role in mission-oriented policy with the High-Tech Strategy 2025 (2018) or the shift back to key technologies with the High-Tech Agenda Germany in 2025.

Against the background of recent on-going activities to bring the High-Tech Agenda Germany into realization, this paper seeks to provide an overview of almost twenty years of High-Tech Strategy/Agenda in Germany and summarizes key developments and characteristics. Bringing together documents from a variety of sources (including different analyses, reports, insights from parliamentary requests, etc.), this paper focuses on discussing key priorities, institutional arrangements and learning structures of the strategy.

2 Embedding of the strategy: Position in the STI system

Overview of different strategies over time

Germany's science, technology, and innovation (STI) system is widely regarded as strong. Its decentralization distributes competencies horizontally across federal ministries and vertically between the federal government and the Länder, including basic funding for universities and universities of applied sciences. While this decentralized approach enables policies to be responsive to local socio-economic needs and to remain agile, it also creates substantial coordination challenges across multiple levels and actors, resulting in limited policy coherence (Edler et al. 2008; OECD 2022).

Horizontally, STI competences are concentrated in the *Federal Ministry of Research, Technology and Space* (BMFTR)[1] and the *Federal Ministry for Economic Affairs and Energy* (BMWE)[2], which together account for roughly 70% of federal public R&D funding through both institutional and project-based schemes (BMBF 2024, p. 72). Strong sectoral orientations and fragmented responsibilities hinder cross-cutting, mission-oriented approaches (EFI 2008; OECD 2022, p. 308). This dualism offers opportunities for coordinated cooperation (OECD 2022, p. 303), but also entails efficiency losses and implementation problems (Edler et al. 2008, p. 274).

To address this issue, research and innovation policy in Germany since 2006 has been coordinated by an overarching joint strategy of the federal government that brings together the different ministries and is adopted for the duration of an electoral term, i.e. usually four years and being actively communicated by newly elected governments (Hufnagl 2025, p. 11).[3] It was introduced in 2006 as an umbrella framework, aiming to increase the coherence of different activities of federal ministries and enhance strategic coordination (Edler et al. 2008, p. 271; OECD 2022, p. 119) and to move beyond the paradigm of a broad and thematically open funding approach (EFI 2008, p. 45). The *High-Tech Strategy* has quickly established itself as a shared label for coordinating STI activities in Germany and helped to mobilize activities/enhance policy coordination (EFI 2008, p. 6; OECD 2022, p. 119).

Initially labeled as *High-Tech Strategy* (*HTS*) (2006, 2010, 2014, 2018), the name was later changed to *Future Strategy for Research and Innovation* (*Zukunftsstrategie Forschung und Innovation*; 2023) and *High-Tech Agenda for Germany* (2025) (*Figure 1*). Alongside these changes, underlying conceptions also have evolved. While initially focusing on technology fields, the *HTS* [4] shifted in 2010 towards a more challenge-oriented perspective (BMBF 2010) while the *High-Tech Strategy 2025*, adopted in 2018, explicitly embraced a mission-oriented approach, making Germany a front-runner for this emerging policy paradigm (BMBF 2018).

Hufnagl (2025, 13ff) attributes the emergence of strategy to a combination of different factors, including a growing (international) consensus of a more systemic policy approach, spill-over of academic advice and attempts of the BMFTR to reposition itself after the loss of competencies in federalism reforms (2006/2009). With the relabeled edition of the *High-Tech Agenda* in 2025 also

[1] With the reshaping of ministerial portfolios of the election, the former Ministry of Education and Research (BMBF) was renamed and lost its responsibility for Education that was assigned to the newly formed Federal Ministry for Education, Family Affairs, Senior Citizens, Women and Youth. To avoid confusion in the text, we use the acronym BMFTR also for the BMBF.

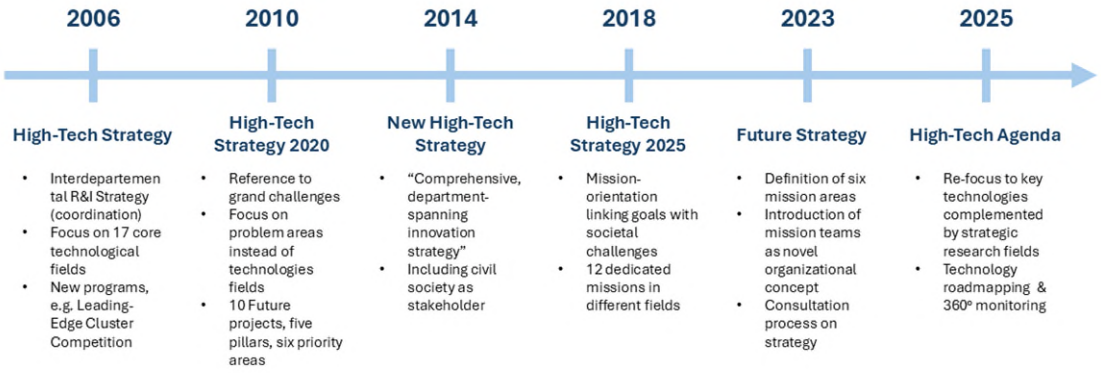
[2] We use this abbreviation also for earlier names of the Ministry of Economics that experienced several changes (Federal Ministry for Economics and Technology, Federal Ministry for Economics and Energy, Federal Ministry for Economics and Climate protections).

[3] After the collapse of the coalition government in the end of 2024, snap elections took place in February 2025, therefore leading to the formulation of a new strategy. As the most recent High-Tech Agenda for Germany was officially presented in October 2025 and there is a lack of details on the implementation, this Strategy will be discussed primarily in the section addressing recent discussions and developments.

[4] In the following we refer to *HTS* as a shared denominator for all editions including the most recent *Future Strategy* (2023) and *High-Tech Agenda Germany (*2025*)*.

came a return to key technologies as the main structuring element, resembling the label/approach of the Bavarian High-Tech Agenda adopted in 2019.

Figure 1: Overview of different strategy editions over time



Source: Own elaboration.

Position of the HTS in the policy landscape

Acting as an overarching umbrella strategy, the *HTS* prioritizes topics of key national interest, bringing together ministries and policy initiatives. At the same time, it is complemented by more sector/technology-specific strategies that are coordinated by one or multiple ministries on behalf of the federal government. Priorities of these strategies may thematically (partly) overlap with priorities of the *HTS*. This includes, for example: [5]

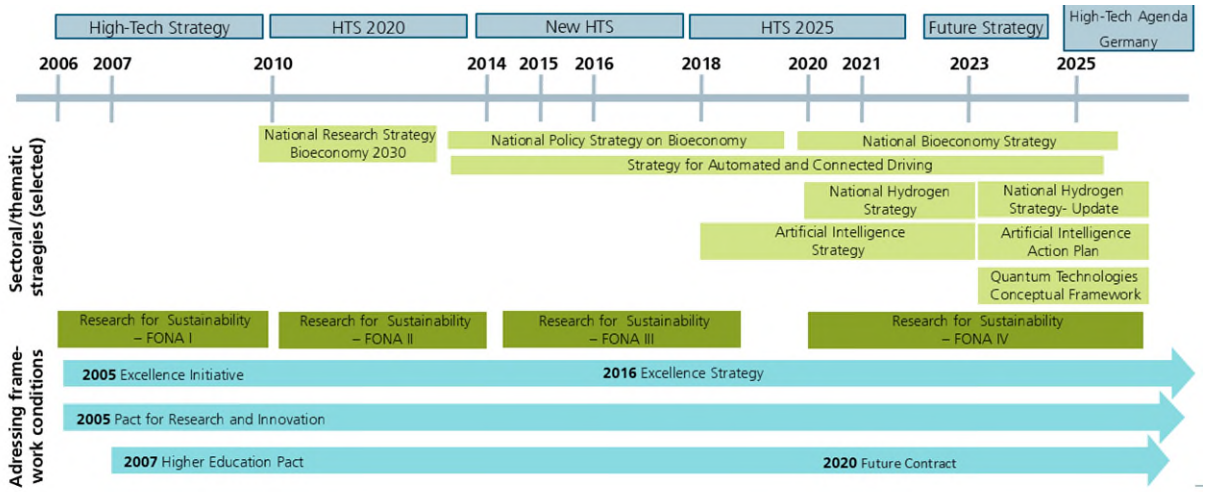
- *National Bioeconomy Strategy* (2010/2013//2020) – *BMFTR/BMEL*
- *Artificial Intelligence Strategy* (2018/2020) – Federal Government (lead by *BMFTR/BMWK/BMAS*)
- *Automated and Connected Driving Strategy* (2015) – Lead *BMV*
- *Quantum Technologies Conceptual Framework Program* (2023) – Lead *BMFTR*
- *National Hydrogen Strategy* (2020/2023) – Lead *BMWE*

Figure 2 provides an overview of selected key initiatives in the field of STI policy and neighboring fields. These strategies – depending on the lead ministerial responsibilities – reach beyond STI policy and include more sectoral policies such as regulation, taxation, standardization, and investment into infrastructure etc.

Being linked to the aim of coordinating strategy priorities, the relationship between the *HTS* and other strategies is, however, ambiguous. On the one hand, it is highlighted that there are comprehensive overlaps between different (sectoral) strategies and the *HTS*. In case of the *Future Strategy (2023-2025)*, the *BMFTR* identified approximately 150 strategies/action plans that share some links (BMBF 2023a). Furthermore, there is a multitude of cross-references between strategies, with the *HTS* in its different manifestations continuously referring to key strategies for its implementation, while other strategies are explicitly stated to be part of the *HTS* (e.g. in case of the *National Bioeconomy Strategy*, BMEL 2014, p. 16).

[5] Explanation of abbreviations: Federal Ministry of Food and Agriculture (*Bundesministeriumg für Ernährung und Landwirtschaft; BMEL*); Federal Ministry of Labour and Social Affairs (*Bundesministerium für Arbeit und Soziales*; *BMAS*); Federal Ministry of Transport (*Bundesministerium für Verkehr; BMV*).

Figure 2: Key policy strategies and instruments at the federal level



Source: own elaboration.

On the other hand, strategic coordination with other strategies – even when explicitly linked to the *HTS* – is often limited or remains ambiguous. First, defining itself as an R&I strategy, the *HTS* and its successors – despite a claim to be a mission-oriented strategy (2018/2023) – remain mostly restricted to the STI domain (OECD 2022; Roth et al. 2021 cf. also section 3.3). In consequence, the *HTS* only subsumes selected STI initiatives, whereas the role of more implementation-oriented elements remains unclear (cf. also strategies above). Secondly, serving as an overarching framework, complementary strategies do not necessarily closely align with the overarching goals of the *HTS*. This is demonstrated, for instance, by the case of *Research for Sustainability – FONA*. While *FONA* was linked to several of the missions of the *HTS 2025* (2018) (Circular economy, climate neutral industry, biodiversity, good living conditions across the countries), it pursues multiple other priorities alongside (BMBF 2021b).

Temporarily coinciding with the introduction of the *HTS* were different agreements between the federal level, regional level and actors in the field of science and higher education. First, the creation of the so-called *Pact for Research and Innovation (Pakt für Forschung und Innovation; PFI)*, grants non-university research organizations (*Max-Planck Society , Fraunhofer Society, Leibniz Association, Helmholtz Association of German Research Centres, German Research Foundation*) a reliable financial budget (with a 3% annual increase) in exchange for increased coordination, cooperation and contributions to overarching policy objectives (Frietsch et al. 2022; OECD 2022, p. 119). Goals are negotiated individually for each research organization and cover the topics transfer, scientific excellence, cooperation with other actors in the field of science, attracting talents and provision of research infrastructures that are constantly monitored (BMFTR 2024).

In parallel, the *Excellence Initiative* was created in 2005, providing additional funding for self-selected excellent research priorities of universities to strengthen Germany's research excellence and international competitiveness. Until 2017, when the *Excellence Initiative* was replaced by the *Excellence Strategy*, approximately 4,6 bln were granted, 75% funded by the federal level and 25% by the *Länder* in which the universities are situated. The subsequent *Excellence Strategy* continues this approach by funding clusters of excellence, and excellence universities generally. Some argue that while strengthening institutional competition, it produced only limited gains in international competitiveness due to funding constraints and insufficient scale (Sieweke 2010) or providing mixed results (Frietsch et al. 2017b; Schubert et al. 2024). Moreover, critics claim that the institutional competition fosters tensions between universities and between research and teaching, while also

shifting competitive pressures from researchers to institutions, which might have adverse effects on scientific performance (Hartmann 2010; Schlegel 2011).

Third, the so-called *Higher Education Pakt* (Hochschulpakt) between federal and regional governments that was initially adopted in 2007 and then prolonged for the periods 2011-2015 and 2016-2020 to meet the growing demands for university places without compromising on quality. From 2017 until 2020, the federal level provided approximately 17,7 bln and the *Länder* 16,6 bln towards this goal (German Science And Humanities Council 2024; GWK 2022). 2020 a new agreement was reached (*Future Contract for Strengthening Studying and Teaching in Higher Education* (Zukunftsvertrag Studium und Lehre stärken)*),* which aims to maintain the capacity and quality of universities and continues to be co-funded with same parts by the federal and *Länder* level.

These three pacts, alongside the federalism reform of 2006, formally aimed to strengthen the autonomy and scope for action of the *Länder* while establishing clearer frameworks for joint federal-Länder funding and cooperation in higher education and science/research more generally (Mayer 2016; Storm 2007). The reforms and pacts were also intended to promote competition between higher education institutions (and, thus, *Länder*), to foster differentiation, and to expand institutional autonomy at the level of individual higher education institutions (Storm, 2007; Pasternack, 2011). In practice, however, the actual development diverged from this intention. Rather than a clear disentanglement (Entflechtung) of federal and *Länder* responsibilities, the reform arguably increased the influence of the federal level, with the Bund remaining an active and equal actor, specifically regarding funding and the intended separation of competencies could not clearly be sustained. (Mayer 2016; Pasternack 2011; Teichler 2018). While the three pacts did result in greater investment in science and research and strengthened commitments from the *Länder*, this also came at times at the cost of other areas of financing, such as teaching and basic institutional funding (Mayer 2016).

Institutional responsibility and coordination activities

Formally the different editions of the HTS are strategies of the whole federal government bringing together ministries, aiming to bundle different activities in the field of STI policies. The approach of an overarching cross-ministerial strategy has been characterized as a form of "soft" coordination between ministerial actors aiming to increase overall policy coherence (Edler et al. 2008, p. 274). Particularly in the first years it stimulated increased coordination, such as the joint *Agreement on Strengthening the Innovation Focus of Public Procurement* ("Beschluss zur verstärkten Innovationsorientierung öffentlicher Beschaffung") by state secretaries of six federal ministries (BMI et al. 2007). The development and implementation of the strategy itself since 2006 have been coordinated by the *BMFTR* while responsibility for priorities is shared among ministries. For example, the *Future Strategy* (2023) indicates that its six missions were co-lead by two or three ministries and involved up to nine additional ministries (BMBF 2023b).

Despite this broad formal involvement, in practice the *HTS* is closely tied to the *BMFTR* as its lead ministry. Consequently, it is often perceived as a *BMFTR*-strategy resulting in difficulties to mobilize other ministries to actively commit to the priorities of the strategy (Wiarda 2025a). The overall mode of coordination in the *HTS* therefore rather resembles the approach of "negative coordination" (Roth 2011: 31 Hufnagl 2025, p. 28), i.e. attempts to avoid overlaps between different ministries without aiming for coordinated action or a coherent policy framework (cf. Braun 2008; Scharpf 2000). A fact which has been, despite some progress, a repeated issue in the annual reviews of the *Commission of Experts for Research and Innovation* (*Expertenkommission Forschung und Innovation; EFI*) (EFI 2009, 2010, 2011, 2012, 2015, 2018, 2019, 2025). The established mode of interministerial coordination in combination with the strong sectoral principle has proven difficult to establish enhanced policy coordination (cf. EFI 2017, p. 90). The systematic involvement of state secretaries to

facilitate cross-ministerial coordination activities has been recommended (EFI 2017, 2021, 2024). A first attempt to overcome the silo structure by the creation of mission teams in the *Future Agenda* (2023) has not yet yielded the expected results, leading to calls for more decisive approaches (EFI 2023; Wiarda 2025a).

Regarding the internal management of the HTS, it is moreover important to note that responsibilities are split across different units within the same ministry (*BMFTR*). Above all, there is a division between a strategic unit in charge of the overarching coordination of the strategy and the thematic units that are responsible for specific priorities/missions. This dualism has in the past proven to be a challenge in the implementation of novel concepts/approaches like mission-orientation, creating obstacles to ownership in the relevant units (Roth et al. 2021, 40ff). A key challenge in this regard is that there are no dedicated budgets for priorities/missions (EFI 2017, 2024) or additional resources for coordination, resulting in such activities being added on top of existing workloads (Roth et al. 2021, p. 42).

Involvement of regional entities and other stakeholders

Overall, there have been demands for broader approaches to involve stakeholders across institutional, territorial and sectoral boundaries to shape the implementation of the *HTS* (OECD 2022, p. 24).

The subnational/regional level – despite early calls from expert bodies (EFI 2008:45) and expectations for an alignment with the regional level (Edler et al. 2008, p. 271) – has been widely excluded from the formulation of the *HTS* and the limited coordination between the federal and Länder level, e.g. in regards to thematic priorities, has been criticized (Gebert et al. 2024).[6] Overall, the HTS positioned itself as a federal level strategy, with regional governments reacting to the strategy and adjusting their priorities. Similarly, the OECD has called for a better alignment of domestic policy with strategic considerations of the EU level to increase leverage at both EU and national levels (OECD 2022, 25; 45).

However, the new *High-Tech Agenda Germany* (2025) has brought back the issue of regional involvement, postulating the goal for stronger involvement of subnational governments (*Länder*). Whether this will enhance an increased bi-directional coordination remains to be seen (cf. also the Section High-Tech Agenda Germany: Recent discussion and developments).

There have been multiple demands to ensure a stronger participation of new actors and civil society for policy-making (EFI 2011, 2013, 2015, 2016). While the advisory board, has been successfully extended to new stakeholder groups, the ambition for broader engagement approaches has been only partly fulfilled, particularly with regard to strategy formulation.[7] Consequently, mobilizing additional stakeholders to commitment to strategies, particularly with financial contributions, has largely been absent (Roth et al. 2021).

[6] This includes also the limited links between the HTS and the 2019 adopted High-Tech Agenda Bavaria. Most subnational units do not have a similar strategy.

[7] The *HTS 2025* (2018) – among others – attempted for a series of workshop trying to bring implementation closer to different territorial areas such as regions, but suffered from a lack of clearly defined goals (Priebe et al. 2024; Wittmann et al. 2023).

3 Setting priorities: From technology fields to missions and back to key technologies

Formulation process

The formulation process of the *HTS* is primarily an internal process driven by priorities outlined in the coalition agreements of federal government, which set thematic priorities, the name of the strategy, and partly also the approach (CDU et al. 2005, 23f; CDU et al. 2009, p. 63; CDU et al. 2013, 16; 25, 2017, 34; 40, 2025; SPD et al. 2021). Building on these negotiated results, the strategy is further developed and specified within the relevant ministries. Despite being a strategy of the whole federal government, the process of setting up the *HTS* is coordinated by the *BMFTR* that acts as the lead ministry. This implies that a first draft is provided by the lead ministry that subsequently seeks coordination with other ministries involved in relevant areas. This has been characterized as a hierarchy-type of coordination (Hufnagl 2025).

The *EFI* (EFI 2008, p. 6, 2009, 2010) has highlighted the need for a systematic development of transparent selection criteria for relevant priorities, making use of foresight activities and stakeholder involvement. The BMFTR has institutionalized foresight activities (Warnke et al. 2022, p. 53) that fulfil a cross-cutting function and contribute to different strategy processes within the ministry, including the *HTS* (BMBF 2021a; Warnke et al. 2016). However, it is important to note that foresight activities across different ministries are not well coordinated, leading to fragmented activities and a lack of a cross-ministerial perspective (EFI 2008; Warnke et al. 2022). Another issue remains a limited linkage to the EU level and activities in *Horizon 2020/Horizon Europe*. While other countries, like Austria have closely aligned domestic RTI policy with EU missions, the *German Future Agenda* (Deutscher Bundestag 2023) points to existing thematic overlaps without linking its activities specifically to dedicated EU missions. Besides the role of priority setting in coalition negotiations, the thematic continuity/path-dependency (see below) here might act as a barrier to systematically align the strategy with the European level.

The formulation process does not entail systematic and strong involvement of external stakeholders. While the implementation of the *HTS* is accompanied by some expert panel/consultation forum (cf. subsequent chapters for further details), these advisory boards are created after strategy formulation and therefore the selection/prioritization process is out of scope. In the *Future Strategy* (2023-2025), stakeholders from research organizations, professional associations etc. were for the first time invited to submit written comments on the draft of the *HTS* as part of a consultation process (BMBF 2021a, p. 14; Warnke et al. 2016). The consultation process, among other things, asked for suggestions regarding prioritization within the six mission areas. The final strategy was published two months after the end of the consultation process, without providing a statement on the nature of changes.

Development of thematic priorities over time

The way priorities are structured within the *HTS* has changed considerably over time (cf. *Figure 2*). While the first edition of the *HTS* in 2006 formulated 17 key technology fields (within three major categories) the subsequent editions have followed a more concerted approach. Moving from multiple challenge-oriented themes (which encompassed multiple technologies/areas of prioritization) the *HTS 2025* (2018) formulated twelve dedicated missions at different levels of granularity. While the *Future Strategy* (2023-2025) relied on six rather broad mission areas that were considered as a "downgrade" of the mission-oriented approach (Hufnagl 2025, p. 42), the new *High-Tech Agenda Germany* identifies six key technologies as the main strategic focus, plus five strategic research

areas. This structure has usually been combined with a set of additional/cross-cutting elements that relate to structural conditions of the innovation system/general principles (like open innovation etc.) or crosscutting (key enabling) technologies fields. Framework conditions comprise a wide range of different activities, including for example, support for start-ups, disruptive innovation (particularly with the creation of the agency for disruptive innovation SPRIN-D in 2019) or thematically open initiatives such as *the Clusters4Future initiative* (2019) in case of the *HTS 2025* (2019) that are not systematically linked to thematic priorities.

The question of priority setting has accompanied the *HTS* since its inceptions, resulting in repeated discussions of these issues in the annual reports of the *EFI* (EFI 2010, 2011, 2015, 2017, 2018, 2025). Particularly in the beginning, the number of key technologies was considered too high and the *EFI* called for a stronger prioritization (EFI 2010, p. 44). While prioritization of topics has generally been welcomed by the *EFI* by acknowledging their relevance, a persistent weakness remains the poor translation of overarching priorities into distinct actions. In this context, the *EFI* has also repeatedly pointed to the need for clearer specification of goals and the formulation of milestones or roadmaps on how to achieve them (EFI 2008, 2015, 2017, 2019, 2023).

Thematic priorities can be considered as a rather broad portfolio aiming to combine different (already existing) priorities and activities. Priority setting therefore – despite different approaches for structuring (missions, key technologies, priority fields) – reflects rather a logic of gradual evolution and continuous development over time instead of radical changes. The majority of topics at the strategy level were existent throughout all editions of the HTS between 2006 and 2025. As can be seen from *Figure 2*, there is considerable continuity among certain clusters of topics that are characterized by shifting internal priorities/adjustments to existing technological developments, instead of changing priorities altogether. While this does not exclude newly emerging priorities (such as the mission on new sources of knowledge in the *HTS 2025 (2018)*), the overall picture is one of gradual change and adjustment reflecting recent developments, such as the growing importance of AI and quantum computing. At the same time, some topics like space and maritime technologies/research moved to the background after the initial *HTS* in 2006, only to re-emerge as a mission area in the *Future Strategy* (2023) or as a strategic research field in the *High-Tech Agenda Germany* (2025). Among overarching priorities that remained constitutive (with varying internal priorities and framing) for the *HTS* over time are:

- IT/communication technology
- Mobility
- Health
- Sustainability
- Security

The priorities set in the *High-Tech Agenda Germany* (2025) confirm this picture, combining a renewed emphasis of existing topics (biotechnology), a response to growing importance of selected technologies (quantum technologies, AI), as well as an overall continuation of existing priorities (partly subsumed in the newly created strategic research fields or the cross-cutting levers that aim to facilitate the implementation). It is important to highlight that a number of technologies identified as key technologies in the *High-Tech Agenda Germany* (2025) were already identified in 2006 as key technologies (biotechnology, fusion research) but were subsequently less prioritized in the *HTS* editions until 2020.

The topic of sustainable energy has been a continuous theme of the *HTS* (though there was no dedicated mission in the *HTS 2025*), showing strong thematic continuity over time. This may be linked to the on-going efforts and debates about the German *Energiewende (energy transition),* putting this topic high on the political agenda. Fusion energy as a specific technology, after being an explicit part of the *HTS* in 2006, largely disappeared until the *Future Strategy* in 2023 brought

back this technology as a promising avenue for tackling challenges in energy production. Similarly, the issue of mobility has been continuously emphasized in the different editions of the *HTS*. Over time, electromobility aspects gained increasing importance, shifting the focus more towards sustainability.

A major shift is evident regarding biotechnology, which became highly visible again with the *High-Tech Agenda Germany (*2025*)*. While it was defined as one of the key technologies in the *HTS* (2006), subsequent editions of the *HTS* did not dedicate a prominent position to this field. The *Future Strategy* (2023) defined biotechnology as a key technology, linking it to different mission areas. A similar picture also emerges for microelectronics, which has been continuously present in strategies, however, without giving it a key position.

Two cases of prioritization are quantum technologies and AI, which are linked to technological progress in these fields. While they were not being explicitly referred to until 2014, topics gained importance with the *HTS 2025 (*2018*)*. Formulating a dedicated AI mission in the *HTS 2025* (2018), the *Future Strategy* (2023) strongly anchored these topics in the mission on technological sovereignty, with AI however, being a cross-cutting solution to almost all missions.[8]

Besides the key technologies, the *High-Tech Agenda Germany (*2025) lists five strategic research fields: i) space and aviation, ii) health, iii) security and defense, iv) maritime/climate and sustainability, and v) humanities and social sciences. These strategic research fields show considerable continuity with regard to previous editions, addressing thematic clusters like health and sustainability that are not covered in the key technologies. The purpose of strategic research fields is not clearly defined in the strategy, instead the description mainly focuses on the importance of fields and lists selected (technological) initiatives/activities. According to some observers, these strategic research fields may have served as a counterbalance in coalition negotiations, to move beyond the strong tech-push approach advocated by the *CSU* (*Christian Social Union; current coalition party*) and its *Bavarian High-Tech Agenda* (Wiarda 2025c).

The strategic research fields are rooted in previous editions of the *HTS*. Space, aviation, and maritime were particularly prominent in the first *HTS* in 2006 with space and maritime forming the foundation for one of the mission areas in the *Future Strategy* (2023). In a similar vein, the topics of health and sustainability have been longstanding priorities of the *HTS* and key elements throughout all editions. Both topics have, likewise, been paired with different additional priorities, health e.g., with nutrition care or digitalization and sustainability with energy, biodiversity or food security. Security research clearly illustrates changing priorities over time, linked to major geopolitical shifts. Initially centered on issues of crime/terrorism (2006), it shifted towards response to natural disasters, cyber security, and the protection of critical infrastructure (2010, 2014). After the Russian attack on Ukraine, it increasingly took up threats to democracy and issues of defense and civil protection (2023, 2025).

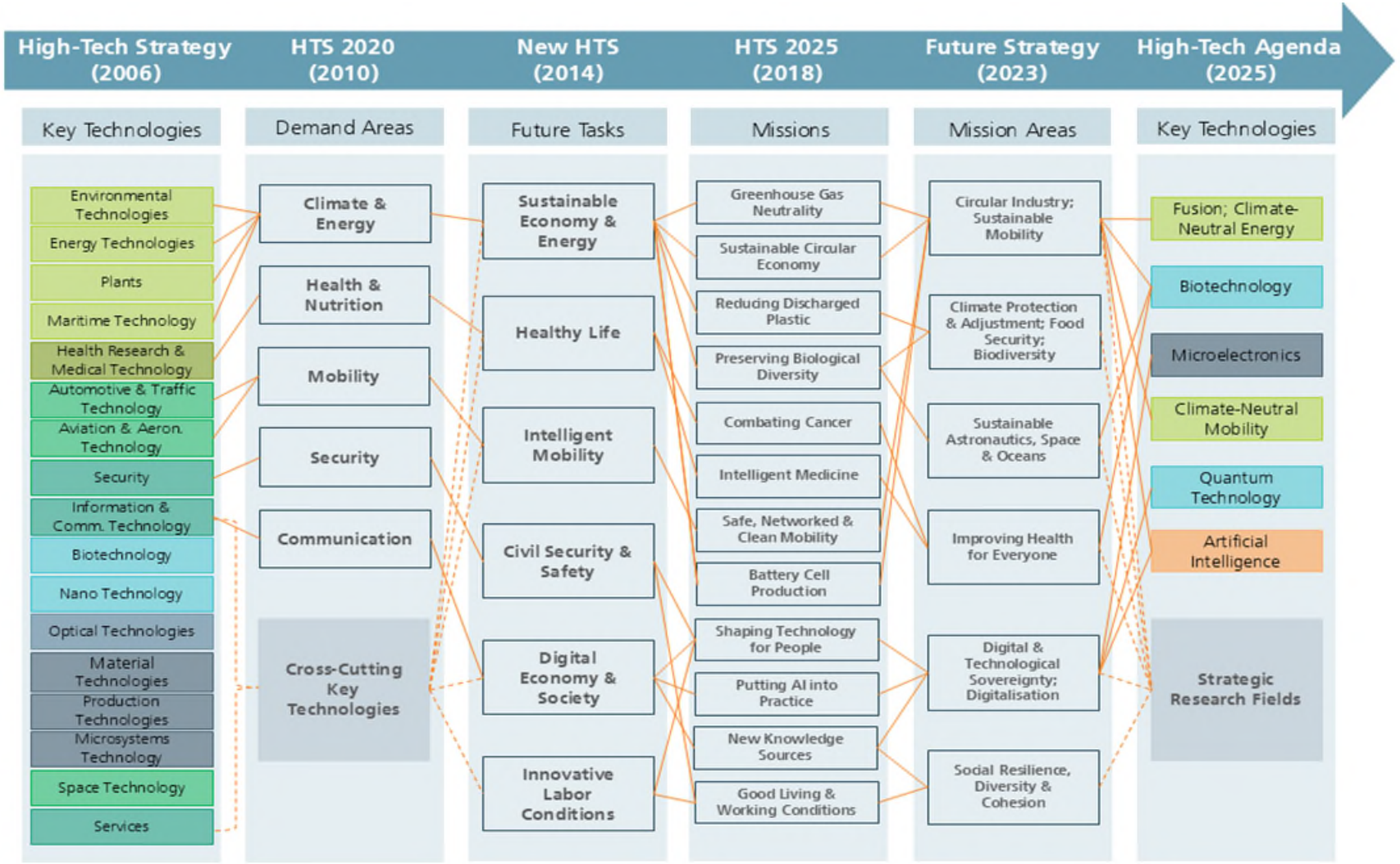
The third pillar of the *High-Tech Agenda Germany* (2025) are the so-called levers that accompany the implementation of key technologies. This includes topics like transfer, legal framework, venture capital and labor force and can be understood as an adjustment to current circumstances, including e.g. issues of dual use, resilience of research and raw materials.

There is a number of technologies/topics from earlier editions of the HTS that do not feature prominently in the High-Tech Agenda Germany as (part of) key technologies or strategic research fields. This includes among others, optical technologies, material research or industry 4.0. However, this

[8] AI is a good example for specific strategies that were formulated below the HTS as the umbrella strategy and which was then continuously adapted to new developments. As one of the first countries, Germany already formulated a specific AI strategy in 2018, which allowed Germany a specific influence when the European strategy as well as the AI Act were formulated. The AI strategy in Germany also adapted to the European developments, especially over a period of about five years (up to 2023, when the coalition already fell apart).

does not imply a termination of this topic – instead they come back in to the *High-Tech Agenda Germany* via specific applications or even the levers. Optical technologies, for examples are referred to as elements for advancing the fields of fusion and quantum technologies. Material research, in contrast, is part of the lever 7 aimed to tackle resource constraints, by highlighting a novel programme for material innovations. In a similar vein, Industry 4.0 and production technology do not appear as a distinct topic, but are referred to multiple times as application areas.

Figure 3: Key priorities of the federal High-Tech Strategies



Source: Own elaboration based on *BMBF* 2006, 2010, 2014, 2018, 2023, 2025.

4 Implementing the strategy: Budget and policy instruments

Financing

In line with its character as an umbrella strategy there is no dedicated budget for the *HTS* or its individual priorities/units (Bundesregierung 2024, 1f). Instead of allocating resources "top-down" to the strategy the budget results from the sum of relevant funding schemes and programs that are part of the strategy but remain under the responsibility of the respective ministries in charge. Consequently, there is no dedicated budget for the strategy or selected priorities, but the budget of the *HTS* depends on the willingness of ministries to contribute to the strategy, mobilizing their own budgets and linking these activities to the *HTS*. This vagueness, particularly with regard to the endowment of selected priorities, has been a major point of criticism of the *EFI* since the beginning of the strategy, limiting the transparency on available funding (EFI 2008, p. 45, 2011, p. 30).

As a result, no consistent picture concerning the budget emerges, pointing to different underlying definitions and approaches for defining the budget. Whereas the first *HTS* reports a budget of EUR 14.6 bn., for later years estimates are mostly available via parliamentary requests. While for the *HTS2020* a budget of approximately EUR 27 bn. (2010-2013) is provided (Bundesregierung 2012, p. 4), for 2017 alone (*New HTS*) the annual budget is estimated at EUR 17.4 bn. (Bundesregierung 2017, p. 4). In contrast, for the *High-Tech Agenda Germany* (2025) for the whole electoral period (2025-2029) recent reports indicate a budget of EUR 18 bn. (Wiarda 2025b). The *HTS* therefore covers only parts of federal spending on science, research and development, its delineation, however, remains a challenge.

Types of policy instruments

A key ambiguity is the link between individual policy instruments and the relevant strategies. Acting as an umbrella strategy, the *HTS* provides a framework for different priorities but has only limited agency to shape new initiatives. While in the first period the *HTS* – among others – lead to a streamlining of different funding lines in one thematically-open program for SMEs by the *BMWE* (*ZIM – Zentrales Innovationspogramm Mittelstand*) (OECD 2022, p. 119) and went along with new initiatives like the *Spitzencluster-Initiative* in 2007 as part of the *HTS* (BMBF 2006), it is questionable whether the instrument mix is systematically developed based on the priorities of the strategy or rather evolves (partly) in parallel.[9] The development of the instrument mix is influenced by subsuming existing activities and often unclear delineation of instruments (Roth et al. 2021), pointing to an overall limited connection between strategy and individual policy instruments beyond selected key initiatives.

While strategy documents of the *HTS* define a list of key activities related to priorities/missions, there is no comprehensive overview of all instruments associated with a priority (cf. Wittmann et al. 2021b, p. 21). Moreover, complex strategies like *FONA – Research for sustainability* may, with some of their elements, contribute to certain priorities but not necessarily in their entirety (Wittmann et al. 2021b, p. 63). Consequently, the link between specific instruments and the overarching strategy can be considered rather limited, implying a dualism between overarching strategic priorities and the continuity/path-dependency of individual instruments and their specific development logic.

A review of policy instruments in the context of the *HTS 2025* (2018) (BMBF 2021a) provides some insights into the instrument mix: First, there is a considerable continuity of various, partly long-

[9] One example might be the Clusters4Future initiative that was announced in the *HTS 2025* (2018) that might be linked to recommendations of the evaluation of the Spitzencluster initiative (Dehio et al. 2014, p. 225).

standing policy instruments that are supposed to contribute to existing priorities. While in some cases (Mission on Combating Cancer) there has been a deliberate shift towards the introduction of newly tailored instruments for specific priorities, other missions relied on a set of existing instruments/continuation of existing platform/strategies (EFI 2011, p. 30, 2017, p. 90; Wittmann et al. 2021b, p. 68). Although this continuity is a common practice in STI policy, there was little evidence of a systemic alignment of individual instruments with the relevant strategies (Wittmann et al. 2021b, 67f.). Second, funding is closely linked to established R&I funding and the creation of incentives with the majority of funding being instruments of direct distribution (project/Institutional support) (Roth et al. 2021, p. 27; Wittmann et al. 2021b, p. 65). Complementary elements are information-based instruments or approaches for systemic management.

Besides initiatives in the thematic priorities, instruments may also target overarching framework conditions, e.g. with technologically open initiatives and activities related to transfer such as ZIM or the *Spitzencluster-Initiative*. However, the relation between the thematic priorities of the *HTS* and thematically open, large-scale funding instruments such as *ZIM* (*Zentrales Innovationsprogramm Mittelstand*) are often rather unclear (Wittmann et al. 2021b, p. 51).

Resources provision in the *HTS* for thematic priorities pursues a thematically bound funding, inviting different stakeholders (universities, research institutes, private enterprises etc.) to engage in competitive funding application processes for resources that go beyond basic public funding of universities etc. In contrast, resource mobilization from non-public actors – beyond own contributions to project financing – has remained widely absent (Roth et al. 2021). Given its self-understanding as an STI strategy and its strong anchoring in the *BMFTR*, companies mainly appear as beneficiaries/partners in collaborative research projects or are addressed via cross-cutting priorities/thematically open instruments.

5 A learning strategy: Role of advisory structures, monitoring, and evaluation

Advisory structures

Since its creation in 2006, the *HTS* has been accompanied by its own top-level advisory board. Initially composed of selected representatives from science and industry, since the *New HTS* (2014-2018) representatives of civil society were also included in the *High-Tech Forum (previously Research Union*). The main purpose of this advisory board was to accompany the implementation process and provide recommendations for further development. While the *High-Tech Forum* in the *HTS 2025* (2018) opted for an approach providing impulses that cut across the structure of missions, the *Future Agenda* (2023) assigned the members of its advisory board (*Forum #Zukunftsstrategie*) to specific missions to better align recommendations with individual missions.

Moreover, the *Commission of Experts for Research and Innovation (EFI)* as an advisory body to the federal government, usually comments on the development of the HTS in its annual reports. Drawing on own research and externally commissioned studies it formulates recommendations for German STI policy. Among other things, the EFI outlines the need for further adjustments and developments covering both thematic priorities and provides hints regarding the organizational/structural forest-up of the *HTS*. While these reports are non-binding, it appears that the *EFI* has considerable "soft power" (cf. also OECD 2022, p. 308). A number of recommendations/requests formulated by the *EFI* have experienced some uptake in the *HTS* over time (e.g. broadening of stakeholder involvement, monitoring & evaluation activities, involvement of state secretaries.), whereas other issues (like budget) were not addressed.

Monitoring, and evaluation

Despite a self-understanding as a learning strategy (Bundesregierung 2012) and calls by the *EFI* for monitoring and evaluation (EFI 2015, 2019, 2023), efforts to monitor activities have only recently been undertaken. Progress and final assessment the strategy has been provided by the *BMFTR* in the form of a progress and final report (BMBF 2024). For the *Future Strategy* (2023) an internal monitoring system was established that focuses on 17 cross-cutting indicators for the innovation system[10] (BMBF 2023b) but does not yield insights into the progress of dedicated missions. Moreover, an internal monitoring of mission goals was reported to take place.[11]

While Germany generally has a strong system-oriented evaluation culture (Borrás et al. 2019), there is limited systematic evaluation of the *HTS* as such. Evaluation is mandatory for individual instruments according to paragraph 7 of the Budgetary Regulations (BMJV 2025). In contrast, policy mix evaluation is only moderately developed (Borrás et al. 2019). For the time being, no comprehensive evaluation of the *HTS* has taken place and is not foreseen (Bundesregierung 2024). However, there have been different activities accompanying the implementation such as commissioned studies looking at dedicated aspects such as the fit of thematic areas (Frietsch et al. 2013; Frietsch et al. 2017a). Moreover, in 2017 a review of the first decade of *HTS* took place but has not been published (Daimer et al. 2017). For the *HTS 2025* (2018) the *Fraunhofer ISI* was mandated to conduct accompanying research supporting the implementation process of selected missions and to develop a framework for impact assessment of the mission-oriented approach (Roth et al. 2021; Wittmann et

[10] This includes among others R&D spending, creation of new enterprises in high-tech sectors, the success of some flagship initiatives (such as SPRIND, DATI), employment and education in the field of R&D, gender equality and internationalization in research, number of spin-offs and framework conditions ((Deutscher Bundestag 2023, pp. 16).

[11] https://stip.oecd.org/moip/case-studies/28 (last accessed on November 27, 2025).

al. 2021a). While relying on individual missions to test this approach, no comprehensive assessment of mission implementation took place.

6 High-Tech Agenda Germany: Recent discussions and developments

The current edition of the *HTS*, labelled *High-Tech Agenda Germany* (2025) was adopted by the government in July 2025 and was publicly presented in November 2025, thus a number of issues related to implementation were not yet specified at the time of this publication. This section provides a brief overview of relevant changes, developments, and on-going discussions related to the *High-Tech Agenda Germany* (2025).

Overall, there has been a positive reception regarding the ambitious priorities set by the *High-Tech Agenda Germany* (2025) as such, including its priority setting on selected key technologies (BMFTR 2025). At the same time, concerns have been raised about a number of potential negative developments and barriers, in particular regarding the implementation and budget (Ronzheimer 2025; Wiarda 2025b). This includes the absence of the *BMWE* in the agenda's public kick-off pointing to a continued dualism between *BMFTR/BMWE*, the lack of further operationalization of goals and overall limited financing. The latter is particularly relevant against the background of increased public spending in the coming years, aiming to spend around EUR 500 bn. on additional resources for infrastructure and sustainable development within the next twelve years. In addition, and partially due to disputes within the coalition, BMFTR budget items included in the Special Infrastructure and Climate Neutrality Fund (*Sondervermögen für Infrastruktur und Klimaneutralität*[12]*)* remained blocked until the start of 2026 by the Budget committee of the German Bundestag. This includes funds designated, for instance, for central projects of the *High-Tech Agenda Germany* such as quantum computing (Wiarda 2025d). While mid-January 2026, EUR 569m of the budget were released for 2026, the budget committee nevertheless continues to demand revisions of initiatives within the *High-Tech Agenda Germany*, for instance regarding milestones (Wiarda 2026).

While the *EFI* (2025, p. 24) has argued in favor of continuing the mission-oriented approach in German STI policy, the *High-Tech Agenda Germany* (2025) indicates a shift away from addressing grand societal challenges, placing again – like the 2006 version – key technologies at the heart of the strategy (BMFTR 2025). The shift towards key technologies has been anchored in the coalition agreement of the current government (CDU et al. 2025) and might be potentially driven by different factors: i) difficulties with the implementation of the concept of mission-oriented policies, ii) a paradigm shift of the political discourse highlighting the importance of economic growth and competitiveness, iii) the blueprint of the *Bavarian HTA*[13] that is closely linked to one of the parties of the coalition that took over the newly created *Ministry of Research, Technology and Space BMFTR* (cf. also Wiarda 2025c).

Following long-standing calls for increased monitoring and roadmapping by the *EFI* (EFI 2015, 2019, 2023), the *High-Tech Agenda Germany (*2025*) (BMFTR 2025)* formulates the ambition for a 360° monitoring approach and the provision of key indicators on overall systemic developments and the formulation of technology specific roadmaps. These roadmaps for the six key technologies are to be developed with input from stakeholder dialogues with relevant stakeholders including representatives from industry, science and regional governments.[14] For each of the key technologies,

[12] This special asset that was agreed upon 2025 aims to provide additional 500 bln EUR for investments into infrastructure and climate neutrality that are debt-financed and aim to update infrastructure/enhance economic growth (Bundesministerium der Finanzen 2026).

[13] The *High-Tech Agenda Bavaria* (*Hightech Agenda Bayern*; *HTA*) was introduced in 2019 to strengthen science, research, academia and the regional economy of Bavaria and concentrates on four key technologies: artificial intelligence, super and quantum computing, aerospace and CleanTech (Bavarian State Government 2019).

[14] https://hightech-agenda-deutschland.de/en/key-technologies/dialogues/ (last accessed 04/10/2026).

multiple stakeholder formats are organized, partly linked to existing platforms/conferences and/or focusing on subtopics within the respective technology (e.g. software engineering and robotics in AI). Stakeholder dialogues with representatives from the state level are organized as distinct stakeholder dialogues, covering so far, the topics of fusion/climate-neutral energy generation, microelectronics, climate-neutral mobility (battery), and biotechnology.

7 Summary

The *High-Tech Strategy* and its successors became the key flagship policy for STI policy at the federal level that is linked to the electoral term of federal governments. It serves as an umbrella strategy, aiming to provide an overarching framework for different STI activities of ministries of the federal government.

- **While aiming for enhanced policy integration and portraying itself as a cross-departmental strategy of the federal government, the *HTS* is strongly anchored in the *BMFTR (formerly BMBF)* since its first edition in 2006, defining it as a STI strategy**. In consequence, the *HTS* struggles with established practices of "negative coordination", resulting in limited mobilization and commitment of other ministries (particularly the *BMWE*), i.e. falling into the "STI trap". **Links with other sectoral and implementation-oriented policies therefore rather remain weak** (even with regard to *BMFTR* strategies). At the same time, it mainly serves as a **national STI strategy, having only limited connection with either the European or the regional level**.
- While addressing crosscutting framework conditions as well, **main priorities of the *HTS* were either clustered around technology fields or societal challenges**. Priority setting for the HTS often takes place at the political level, anchoring priorities of the *HTS* in the coalition treaty of governing coalitions. **Overall thematic development points to a gradual evolution allowing to embed recently (re)emerging topics** (e.g. quantum, AI) **and themes** (such technological sovereignty) within the framework, **instead of radical thematic shifts**. This approach has the advantage to

  i) **flexibly react to recent developments** with managing a portfolio of different topics that may have changed importance over time and
  ii) **being relatively resistant to abrupt policy changes** by allowing existing topics to continue under new labels (cf. also OECD 2022, pp. 301 on German STI policy in general) and therefore providing reliable framework conditions.

  The downside is a certain **path-dependency that often comes along with a continuity of established instruments and policies subsumed under changing labels instead of comprehensive policy change** – in consequence, while adding new initiatives in line with key priorities, it does not necessarily lead to the adjustment or phase-out of existing priorities and approaches. Moreover, thematic prioritization in the strategy is counterbalanced by cross-cutting/thematically open priorities being linked to large-scale funding schemes.
- Having experimented with a mission-oriented approach (particularly in the *HTS 2025* (2018)) there has been a **shift backwards to key enabling technologies** as main priorities of the strategy, linking the agenda again more to economic and competitiveness considerations instead of societal challenges.
- Acting as a main **umbrella strategy**, the HTS has contributed to a prioritization of STI polices, and contributed to policy change, both within the *HTS* (*ZIM*, *Excellence Clusters*) and the policy landscape with the Pact for Research and Innovation and the Excellence Initiative (OECD 2022, p. 119). At the same time, it has **limited agency and guidance for introducing new policy instruments**. **Lacking an independent budget, it is dependent on the willingness of ministries to contribute to the agenda** by indicating relevant policy initiatives. In consequence, the instrument mix is not designed top-down to fit with the goals but emerges from a bottom-up negotiation/coordination process at the ministerial level, creating difficulties to partly delineate what is part of the strategy and creating a potential disconnect between strategy and policy. The continuity of priorities with long-term goals has been seen at odds with the electoral

cycles (EFI 2024, p. 13). **Strategic priorities do not necessarily translate into policy change, as the instrument level is often not directly linked to the HTS.**

- Strategy implementation primarily takes place via **instruments of direct distribution**, generally delivered through thematic calls. Regulatory aspects etc. are beyond the scope of the strategy given its self-understanding as STI strategy and the strong role of negative coordination.
- Formulating the **self-understanding as a "learning strategy" overall means for reflexivity are only weakly developed**. Internal monitoring was only introduced in 2023, a comprehensive evaluation at the strategy level has not taken place so far. The *EFI* can be considered as a driver for change, as there is an uptake of its recommendations in its annual reviews of STI policy.

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