Orientation, Strategy, Smart Specialization, Missions & Directionality - five reflections on the normative turn in innovation policy

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AIT	Austrian Institute of Technology
BIS	Department for Business, Innovation and Skills
BMBF	Ministry for Research and Education
BMWi	Ministry of Economy and Technology
CBRIS	Cross-Border Regional Innovation System
CE	Circular Economy
CME	Coordinated Market Economy
DARPA	Defense Advanced Research Projects Agency
EC	European Commission
EFI Kommission	Expertenkommission Forschung und Innovation/Expert Commission for Research & Innovation
ENCYT	Estrategia Nacional de Ciencia y Tecnología
EUCOR	The European Campus/Europäischer Verbund für Territoriale Zusammenarbeit EVTZ
Eu-SPRI	European Forum for Studies of Policies for Research and Innovation
GC	Grand Challenges
HTS	High-Tech Strategy
IA	Impact Assessment
ICT	Information and Communication Technology
IMA	Interministerieller Ausschuss/inter-ministerial committee
INFU	Innovation Futures
IS	Innovation Systems
JRC IPTS	Joint Research Centre Institute for Prospective Technological Studies

LME	Liberal Market Economy
MOIP	Mission-Oriented Innovation Policy
NESTA	National Endowment for Science, Technology and the Arts
NIS	National Innovation System
OECD	Organisation for Economic Cooperation and Development
R&D	Research and Development
RDA	Regional Development Agencies
RIS	Regional Innovation System
RIS3	Research and Innovation Strategies for Smart Specialisation
RMT	Region Metropolitaine Trinationale du Rhin superieur
RRI	Responsible Research and Innovation
RTI	Research, Technology and Innovation
S3	Smart Specialisation Strategy
SME	Small and Medium-sized Enterprises
SNM	Strategic Niche Management
SPRIND	Bundesagentur für Sprunginnovationen/Federal agency for breakthrough innovation:
SRI	strategies regionales d'Innovation
STEM	Science, Technology, Engineering, and Mathematics
STI	Science, Technology and Innovation
STS	Science and Technology Studies
TIP	Transformative Innovation Policy
TNO	Trinationale Metropolregion Oberrhein
TSB	Technology Strategy Board
UKRI	United Kingdom Research and Innovation
VIP	Validation of the Innovative Potential of Scientific Research
WBGU	Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen
ZIM	Zentrales Innovationsprogramm Mittelstand

1 Introduction and research framework

> "The important thing for Government is not to do things which individuals are doing already, and to do them a little better or a little worse, but to do those things which at present are not done at all." John Maynard Keynes (1926)
>
> "The ability of innovation to spur economic growth has long been recognised. Less recognised is the fact that innovation has not only a rate but also a direction." (Mazzucato, 2018, p. 4)

1.1 A puzzling observation

Over the past two decades science, technology and innovation policy (STI) has become increasingly associated with the "Grand Challenges of our time" formulated in the Lund Declaration 2009. Accordingly, these policies ought to support research and innovation activities that provide "sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security." (Vetenskapsrådet, 2009, p. 1)

Thereby, societal, „grand or global challenge[s] are often used interchangeably as umbrella concepts that shape policy frameworks" (Ludwig et al., 2022, p.6) in STI (Kallerud et al., 2013). Academics have conceptualised this new focus on societal challenges and expectations "as directionality. […] (which) means promoting innovations that 'contribute to a particular direction of transformative change' (Weber & Rohracher, 2012, p.1042) instead of promoting all innovations as inherently desirable." (Parks, 2022, p.1) The most popular narrative concerning those directed initiatives are mission-oriented policies that "have taken Europe by storm" (Kattel & Mazzucato, 2023, p.1) and are also prominent in the US. There were high hopes that these policies would promote new ideas, processes, and products that would not only address but solve these problems by also incorporating systemic perspectives and push for an orientation of entire innovation systems in sustainable directions (Daimer et al., 2012; Lindner et al., 2016). We could therefore observe rising political interest and increasing budgets in western European countries, aimed at fostering STI hoping to ultimately increase the directed innovative potential of humans, companies, regions, and entire countries in the cross-cutting field of innovation policy:

> "Innovation policy is the interface between research and technological development policy and industrial policy. It aims to create a framework conducive to bringing ideas to market […]. The importance of innovation policy is widely recognised, and it is closely linked to other EU policies, such as those on employment, competitiveness, the climate and environment, industry and energy. The role of innovation is to turn research results into new and better

> services and products in order to remain competitive in the global marketplace and improve people's quality of life."[1]

Given the nature of the „wicked problems" which underlie grand challenges, more differentiated debates broadened the discourse beyond economic motivations and fear. New scholarly communities emerged, using or developing dedicated research methods. They focused on topics such as sustainability innovation, transformative system changes or responsible research and innovation (responsible research and innovation) and just transitions, citizen science/involvement and (capacities for) social innovation that target the social dimension, impact and accountability of STI.

Corresponding to the debate on "how to cope with grand challenges", among STI scholars from the domain of political science or sociology, there is a discourse within economic sciences that draws on a reinterpretation and return to the ideas of Keynes to bring about the desired change. If humankind is to consequently tackle and overcome the challenges mentioned above, a radical transformation (among others greening the economy, intelligent inclusive growth) is needed. For those substantial changes to happen, scholars call for a much more active role of the state (including the "willingness to pick winners" (Mazzucato, 2019b), by e.g. targeted support for selected industrial sectors or technical solutions by public authorities) or propose and observe a much more differentiated role of government per se (Borrás & Edler, 2020).

Regarding the former argument some scholars, such as Mazzucato and Penna, argue that governments need to take on the role of risk takers, entrepreneurs and big thinkers, pushing for transformation and call for a new economic as well as political framework:

> "[…] finding a way for government to think big is not just about throwing public money at different activities. It requires a new economic framework that can justify the role of the public sector in "directing" change, forming the right institutional structures that can foster and adapt to change in a dynamic way. It requires a framework that justifies the catalytic role of government, its ability to transform landscapes, and create and shape markets—not just fix them. It requires new indicators through which public investments can be evaluated, which capture the "transformational" catalytic impact that Keynes (1926) suggested should be the objective ("doing those things which at present are not done at all"). It requires different insights on the organization of government, and on the distribution of risks and rewards that emerge from the collective effort toward "smart" innovation-led growth." (Mazzucato & Penna, 2015, p. 3)

This demand for a "new economic framework" as well as the changing role of the state and the public sector in fostering innovation, was the starting point and the puzzling observation for this thesis, addressing the core question:

[1] https://www.europarl.europa.eu/factsheets/en/sheet/67/innovation-policy, last access online: 24.09.2024

Is normative change expressed in innovation policy practice?

Five reflections on systemic orientation, national strategies, smart specialisation, mission orientation and translation processes in policy practises aim to give a partial answer to this question.

To introduce this investigation, Chapter 1.2 presents a short history of innovation policy, tracing early roots of directionality and leading towards current policy paradigms. Chapter 1.3 presents the structure, research design and outline of the thesis. Chapters 2 to 6 which consist of five independent paper contributions form the core of this thesis. The thesis concludes with pointing out the main findings and further avenues for research (Chapter 7).

1.2 Brief history and status quo of innovation policy

According to Grupp et al. (2002, p.2) the very beginning of academic debate and analysis of the interplay of inventive and entrepreneurial activities can be traced back to the 1880s when „Fundamentals of economics: a guidebook and reader for businessmen and students “, was published by Wilhelm Roscher (1880). This publication is seen as the first serious attempt to fathom the value of inventions for economic activities. In the years to come, particularly the thoughts and work by Joseph Schumpeter (economic theory), John Desmond Bernal (indicators for innovation) and Vannevar Bush (science push model, policy implications) laid the basis for the innovation policies that we know today.

Roscher’s analysis laid the foundations for Schumpeter's “Theory of Capitalist Motion” (1908) which differentiates between six different economic activities. According to this theory the first economic activity is the act of invention and discovery, followed by mining, agriculture, manufacturing, distribution of goods, trade and services. Throughout his entire academic career, Schumpeter emphasised the importance of innovation, which in his view, was the emergence of a new production function with an associated far-reaching, deliberate and targeted process of change, for successful entrepreneurship and economic growth (J. Schumpeter, 1939). His thoughts and work were heavily influenced by the late „long 19th century“[2] when he witnessed the impacts of the industrial revolution, and the profound political changes brought about in the realm and atmosphere of restoration, nationalism and democratisation. The writings of Marx and Engels had an especially large influence on his work. In 1942 he derived the concept of “creative destruction” from Marxist economic theory which, in addition to “the theory of business cycles and development” and the emphasis on innovation

[2] The expression was coined by Eric Hobsbawm in his in his trilogy on the 19th century to denote the period from 1789 until 1915, in this case I am referring to Hobsbawm (1987).

as a crucial factor for economic prosperity, turned Schumpeter's work into the epoch-making foundations of innovation theory and policy which it is today.

Thus, new and smart solutions are periodically a prerequisite for change. Their systemic embeddedness as well as acceptance by users and the wider society are what is necessary for a real paradigm shift. A crucial connection that, according to Edler & Fagerberg, was already referred to by Schumpeter:

> ”For Schumpeter, a main reason for his distinction between invention and innovation was the realization that what matters economically and societally is not the idea itself but its exploitation in the economic and social system. Hence, if we want to maximize the contribution of innovation to economic and social change, it is not sufficient to focus on what explains the occurrence of a novelty, we also need a thorough understanding of its adoption and subsequent exploitation.” (Edler & Fagerberg, 2017, p.4)

Precisely this *exploitation and contribution to economic and social change* and the question whether this can be influenced sufficiently or even steered into certain directions by policies lies at the heart of this thesis. In his historic context, Schumpeter conceptualised the context of radical shifts (triggered by market forces) as a result of ”creative destruction“. He used this expression to describe the “process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” (1942, p.82f). This Schumpeterian theory of dynamic economic growth laid the theoretical foundation for most activities that are part of innovation policy today. At about the same time J.D. Bernal published a reasoned differentiation between public research budgets and the role of war-related expenses (1939). This included one of the first measurement systems for research and development (R&D) output. This “conception of a specific research process, that leads to innovation, that can be measured and needs financial and human resources” was most relevant at the time (H. Grupp, 2000, p.20). With a view to innovation policies today, Bernal's work is seen as the “forerunner” of today's OECD R&D indicators in the Oslo (2018) and Frascati Manuals (2015).

Just before the Second World War the rationale behind the enormous financial support for research was the demand articulated by policymakers regarding defence policy and the physical wellbeing of citizens. Private businesses did not play a major role pertaining to these objectives. Furthermore, the diffusion of results into other scientific fields was not a core goal and results were carefully monitored and managed by state authorities.

In retrospective Vannevar Bush's “Science – The endless frontier” (1945), a report commissioned by US president Franklin D. Roosevelt, is seen as the beginning of modern science and innovation policy. That governments and associated agencies have played a key role in financing research and science for

centuries e.g. with a view to naval expeditions, advances in agriculture or regarding war-related "advances" in chemistry, engineering or physics is undisputed. But by outlining the role of science in relation to innovation and "loosely describing what became known as the 'science-push' linear model of innovation" (Martin, 2012, p.1227), Bush called for an active and centralised role of government with a view to financing science during peace times and therefore also guiding progress into certain directions:

> "[…] since health, well-being, and security are proper concerns of Government, scientific progress is, and must be, of vital interest to Government. Without scientific progress the national health will deteriorate; without scientific progress we could not hope for improvement in our standard of living or for an increased number of jobs for our citizens; and without scientific progress we could not have maintained our liberties against tyranny. […] There are areas of science in which the public interest is acute, but which are likely to be cultivated inadequately if left without more support than will come from private sources. […] we are entering a period when science needs and deserves increased support from public funds." (Bush, 1945, Chap.1)[3]

By revisiting this historic conceptional document two aspects become evident: firstly, the intellectual as well as financial connection between government STI agendas regarding societal issues such as health, standard of living and defence ("liberties against tyranny") are not a new phenomenon. The latter aspect, historically known as the *military industrial academic complex* and critically reflected by academics such as Mills (1956), particularly brought about technical advances which are denoted with the cypher "classic mission orientation". Famous examples of this period are e.g. the Manhattan project (constructing nuclear weapons) or the Apollo project (human space flight programme to the moon). Secondly, the close ties between scientific expertise and consulting (by boards or specially set up Offices for Science etc.) for political agenda setting, which also play a large role today and sometimes critically counteract Bush's second argument. He particularly stressed the freedom of science and importance of curiosity-driven research. These aspects have been contested ever since and even today; Bush's pleas have not lost their relevance:

> "The Government is peculiarly fitted to perform certain functions, such as the coordination and support of broad programs on problems of great national importance. But we must proceed with caution carrying over the methods which work in wartime to the very different conditions of peace. We must remove the rigid controls which we have had to impose and recover freedom of inquiry and that healthy competitive scientific spirit so necessary for expansion of the frontiers of scientific knowledge. Scientific knowledge on a broad front results from the free play of free intellects, working on subjects of their own choice, in the

[3] See https://www.nsf.gov/about/history/vbush1945.htm#ch1.2 , last access online: 01.07.2024

manner dictated by their curiosity for exploration of the unknown. Freedom of inquiry must be preserved under any plan for Government support of science […].” (1945, Chap.1)

Evidently, the political and intellectual developments around the 1940s resulted in an increasing openness of (western) societies[4] towards technical advancements. This paired with the search for new ways of employment and industrialisation during the postwar era, paved the way for innovation as we know it today: ”the positive assessment of “the new”, the esteem of innovation and the hype concerning inventions and patents are historically fairly recent achievements of the European-American dominated modernity” (Dohrn-van Rossum, 1999, p.39, own translation). Obviously, this development laid the basis for innovation-associated policies as we know them today, with the characteristic set of policy instruments[5] and policy mixes[6].

After the Second World War, early attempts of STI policy in the 1960s tried to compensate for ”market failures“ through funding certain basic research activities. The assumption which guided policies, was that innovation is a linear activity, with a direct connection of spill-over effects from basic research leading to technological applications with their associated progress. During the early stages of innovation policy two different kinds of linear models could be distinguished, according to Koschatzky drawing on Rothwell (1994):

- “The “first generation: technology push” models of the 1960s, which emanate from a technology-driven innovation activity and
- the “second generation: need-pull” models of the 1970s (e.g. Utterback, 1974), which regard innovation as a result of market and demand-induced R&D activities.” (Koschatzky, 2012, p.4).

These two paradigms played an important role over the following decades and traces of both modes are still observable today and subject to debates concerning technology push and demand-pull.

4 Connecting this statement to western societies is by no means meant to imply that non-western societies did/do not share the same openness. However, the literature referred to in this chapter has a very Euro-centric perspective.

5 Generally, policy instruments can be defined as the "set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (Vedung 1997a: 21). Furthermore, they can also be described as "the "means" through which the "ends" of political life are achieved" (Doern/Phidd 1983: 111).

6 According to Nauwelaers et al 2009: „A policy mix is defined as: The combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors.” A definition that points out the incremental nature of policy mixes as well as the diverse objectives and means is provided by Kern, F., Howlett, M., 2009: „Policy mixes are complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years.” For further elaboration of policy mix concepts and building blocks, please see Rogge/Reichard 2016, p. 1621 ff.

Since the 1960s it has become a political practice to support technologies with a promising potential for commercial application beyond solely defence or military issues. Therefore, a wider range of technologies has been supported such as information, communication and production technologies. More actors were supposed to gain access to the technological advancements and small and medium-sized enterprises (SME) were steadily targeted as a group of innovative entrepreneurs. The funding schemes changed their aims towards smaller-scale project funding with the inclusion of more actors. Overall, the diffusion orientation of civilian key technologies was the major concern.

Following a classification by Braun (2008a) the 1980s were characterised by questioning the assumption of an automatic occurrence of spill-over effects from basic research to immediate applications in business and industry and the identification of non-linear, recursive interactions of heterogeneous actors became prominent in innovation studies. Empirical studies show that the 1980s mark the beginning of a closer interaction of basic and applied sciences by an increasing number of interorganisational cooperation of universities and private sector research – this was particularly true for the situation in Western Germany (Bührer, 2003; Schmoch, 2003). Still, most policies solely targeted selected actors (e.g. universities), sectors (e.g. microelectronics) and technologies (e.g. photovoltaics) during this phase. It was only with a growing popularity of the innovation system approaches in the late 1980s and early 1990s that systemic perspectives were taken into account (and also geographic aspects were taken into account e.g. with cluster approaches): "Innovation has come to be seen as the interplay of market and non-market forces and as denoting a policy of 'structuration', of framework-setting that helps to correct 'market failures' and improve interaction, within the 'innovation system'." (Braun, 2008b, p. 227) The first to publish the idea of "innovation systems" (IS), as the heuristic that we know today, were Freeman and Lundvall. Freeman used the IS to explain Japan's economic success in high-tech sectors (1987, 1988). Whereas Lundvall (1985, 1992) referred to it by describing innovation as an interactive process and the need to move from focusing on user - producer interactions to analysing the wider national system of innovation. Freeman as well as Lundvall, "traced the origin of the concept back to List (1841), with his notion of the 'national system of political economy', which he used to explain the catching up [to] and overtaking of Great Britain by Germany." (Martin, 2012, p. 1233). By describing and explaining this process,

> „List was not talking in a purely abstract way about industrialisation and technology transfer but about a process which was unfolding before his eyes. […] Not only did List analyse many features of the national system of innovation which are at the heart of contemporary studies (education and training institutions, science, technical institutes, user-producer interactive learning, knowledge accumulation, adapting imported technology, promotion of strategic industries, etc.) he also put great emphasis on the role of the state in coordinating and carrying through long-term policies for industry and the economy." (Freeman, 1995, p.7)

To put Lists' observations of the Prussian situation in the proper historical perspective Freeman cites Landes, who points out the central role of the state in the mid-18th century regarding the transfer of knowledge and the right materials to build steam locomotives:

> „Only the government could afford to send officials on costly tours of inspection as far away as the United States; provide the necessary buildings and equipment; feed, clothe, house, and in some cases pay students for a period of years. […] Finally, the government provided technical advice and assistance, awarded subventions to inventors and immigrant entrepreneurs, bestowed gifts of machinery, allowed rebates and exemptions of duties on imports of industrial equipment. Some of this was simply a continuation of the past – a heritage of the strong tradition of direct state interest in economic development." (Landes, 1979, p.151)

When considering the current debate on the role of the state for STI we have now come „full circle" from List's observations of the 19th century to Mazzucato's plea for an "Entrepreneurial State" and bold and ambitious missions today (see introductory quote) and will conclude this subchapter with this comprehensive illustration.

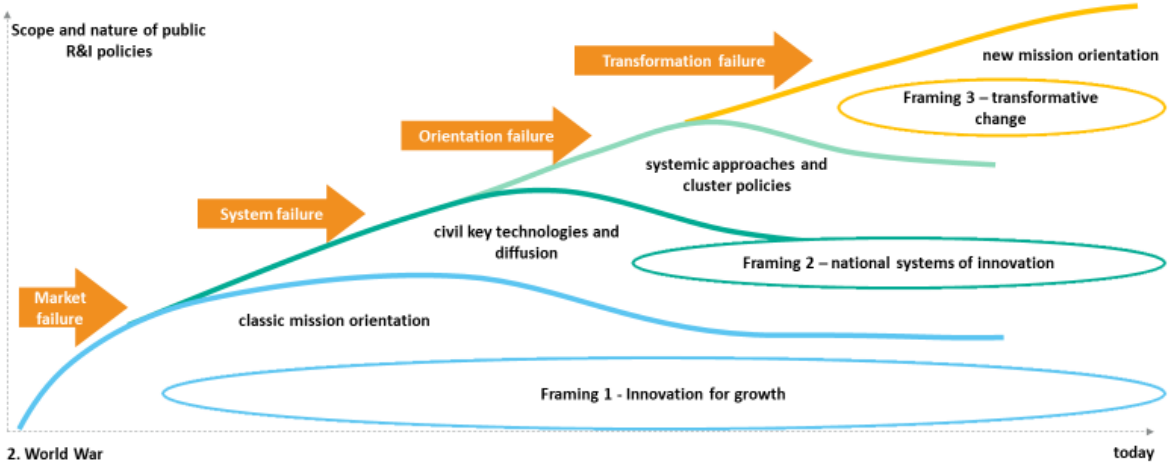

Figure 1: Schematic representation of trends in R& I policies: intervention rationales, priorities, and framings[7]

In addition to depicting the historical sequence of the paradigms and rationales put forward by the scholarly community, three framings produced by "interpretive connections", as suggested by Schot and Steinmueller (2018, p.1554) are included in Figure 1. They are included to emphasise the leitmotifs

[7] Source: supplemented by insights from Daimer et al. (2012); original source: Gassler et al. (2006), p.9; framings according to Schot and Steinmueller (2018)

that overlap and complement each other: namely *innovation for growth*, *national systems of innovation* and the current framing of *transformative* change, which provides the background for the five individual chapters.

1.3 Aim, structure and outline of the thesis

The guiding question of this thesis is whether and how normative change and directionality is expressed and reflected in innovation policies. The increasing expectation towards this policy domain, which was framed as the normative turn (Daimer et al., 2012) around ten to 15 years ago and is now discussed as directionality (Bergek et al., 2023; Lindner et al., 2016; Parks, 2022) is of a different quality and scale than the historic expectations as discussed above. As Edler states it brings about:

> "an additional legitimation for innovation policy […]. The new, or more pronounced, imperative for innovation policy towards societal challenges forced policymakers and politicians in all policy areas to focus policy much more on contributing towards solving the associated problems, and to become more directional. This development led to OECD wide national strategies for demand side policies (OECD 2011)." (2023, p.5)

This thesis was originally planned as a monograph dealing only with exactly those national strategies. Due to the growth and pace of research and project opportunities in the innovation policy domain including regional strategies, mission-orientation, and governance processes surrounding STI directionality during the past decade and for personal reasons, the plan was adapted halfway. For this reason, the main part of the thesis is now structured into five subject matter chapters (Chapters 2-6), each of them representing one individual publication with a different thematic focus reflecting possible directionality and critically examining whether a "normative turn" has materialised in the innovation policy domain.

Chapter 2 focusses on the intervention rational *Orientation Failure* and case studies on (systemic) policy instruments and deals with the question: **Are systemic innovation policy instruments appropriate to implement challenge-oriented innovation policy?**

Chapter 3 focusses on the practise and perception of national innovation strategies as realised by policymakers and tries to answer the main research question: **How do individual policymakers - from formulators at ministries to implementers at agencies - perceive the introduction of national innovation strategies and how does it alter their practical work?**

Chapter 4 focusses on the regional dimension exploring the smart specialisation strategy concept (S3) and its implications for innovation policy in cross-border settings by asking: **Do smart specialisation strategy processes alter the innovation policy governance in cross-border regions?**

Chapter 5 attempts to categorise missions in innovation policy (taxonomy based on the missions of the German High-Tech Strategy 2025) by sorting out **which common features we can distinguish when analysing missions and their level of transformative ambition including the challenges in the implementation process of the associated policy instruments.**

Chapter 6 further explores these challenges of the implementation process by deconstructing the governance patterns between different actors and entities and asks: **Can we learn more about potential effects or missing impacts of missions if we conceptualise missions as multiple translation processes?**

At the time of submission all articles are accepted for publication, three have been published already, notably Chapter 2, 4, 5. Chapter 3 will be published as a discussion paper by Fraunhofer ISI, Chapter 6 has been accepted for publication as a contribution in an anthology on transformative innovation policy. The following table offers an overview of the topics, methods, my role as a contributor to the articles and the status of publication:

	Topic	Methods & work steps	Contributor Role	Status
Chapter 2	Conceptual paper on systemic policy instruments and "orientation failure"	Literature review Conceptual writing Case studies	Co-author, CRediT:4,7,12,13,14,	Published as a book chapter in 2012
Chapter 3	Empirical study on national innovation strategies of the UK, Sweden and Germany	Document analysis Concept and conduct of interviews Qualitative analysis and interpretation of empirical material	Single author paper	Presented at Eu-SPRI conference 2024, U. of Twente, accepted for publication
Chapter 4	Conceptual and empirical paper on smart specialisation strategies in the Upper Rhine region	Conceptual writing Surveys and interviews Qualitative analysis	Co-author, contribution of chapter: S3 and choice of innovation policy instruments, : 1, 12,13,14	Published in *Environment and Planning C: Politics and Space* in 2017
Chapter 5	Conceptual and empirical paper on mission-oriented innovation policies; case study: missions of the German High-Tech Strategy 2025	Document analysis Cluster analysis Conceptual writing	Co-author (one of three main project contributors), CRediT:1,2,3,5,11, 12,13,14	Published in *Science and Public Policy* in 2021
Chapter 6	Conceptual paper proposing a process-oriented analytical perspective on MOIPs (translation processes of policy making)	Literature review Conceptual writing	Co-author (one of three main project contributors), CRediT: 1,3,5,12,13,14	Accepted for publication as a book chapter in 2024

Table 1: Structure and outline of the thesis

The Contributor Roles Taxonomy CRediT[8] is used to explain my roles in the individual papers using the 14 high-level categories as confirmed by my co-authors in the Annex and indicated in column 3 above. The remainder of this chapter offers a short outline of all five chapters, including a brief contextualisation of the publication (e.g. project outcome, institutional cooperation).

8 As proposed in Leuphana Gazette 86/23 – 09. November 2023, § 8, Abs.3 c, online: https://credit.niso.org/ last access online 13.12.2023

Chapter 2: Challenge-oriented policy-making and innovation systems theory: reconsidering systemic instruments

Published in:

Knut Koschatzky (Ed.) 2012: Innovations Systems Revisited – Experiences from 40 years of Fraunhofer ISI research, Stuttgart: Fraunhofer Verlag, p. 217-234

by Stephanie Daimer, Miriam Hufnagl and Philine Warnke

Abstract:

Since the turn of the century the dominant rationale of innovation policy seems to be changing. Increasingly, innovation policy is expected to contribute towards addressing societal demands or even to respond to the "Grand Challenges of our time". These responses should take the form of broad areas of issue-oriented research in relevant fields.

This "normative turn" in innovation policy implies changes in the requirements of its instruments. Therefore, our contribution seeks to revisit established notions of system-oriented innovation policy patterns in the light of the new "grand challenge-oriented" paradigm on research and innovation policies. We will discuss whether current systemic innovation policy instruments are suitable to implement a challenge-oriented innovation policy. A reflection on the now well-established innovation system approach underlines that this heuristic concept focuses on the well-functioning of the system but does not provide for a strategic or normative orientation. Such an orientation function is suggested here, followed by a few practical considerations on how this function could be translated into innovation policy, i.e. how systemic policy instruments would need to be further refined to address the strategic orientation of the system. After these conceptual considerations, we illustrate our conclusions by analysing two prominent systemic instruments namely participatory evaluation and foresight.

Keywords: Innovation policy, grand challenges, policy instruments, foresight

To commemorate the first 40 years of the Fraunhofer Institute for Systems and Innovation Research ISI in Karlsruhe an anthology to highlight the most important topics and insights was conceptualised in 2011. Through an abstract contest, topics were chosen that should be developed into articles which, on the one hand best reflect the achievements of the conceptual and empirical work regarding innovation policy analysis of the past decade, and on the other hand, should simultaneously advance and contribute to the current debates in the field. Chapter 2 was reviewed twice by senior scientists and presented at the international Eu-SPRI Conference in 2012 for further comments and underwent a thorough revision prior to its publication. It deals with the crucial aspect of *systemic policy*

instruments to foster STI introducing the narrative of "orientation-failure", while two examples of these tools (and current research project results at the time) namely *foresight* and *participatory evaluation* are depicted.

The core question was whether systemic policy instruments, which were designed to address the capability of innovation systems, are also appropriate to address new requirements of research and innovation activities implied by the normative turn of innovation policy. Our hypothesis was that introducing any kind of goal orientation into complex innovation landscapes and modulating innovation trajectories requires an intimate understanding of innovation systems and a strong role of government as the conductor of the system. Consequently, "options for socio-technical transition need to be identified by linking up technological and societal change into 'configurations that work' in new transformative ways" (Daimer et al., 2012, p.176). Today, 12 years after this article was published, this challenge dominates the scholarly debate even more and has been explored further by different strands of STI policy communities (see also chapter 7). Parallel to MOIPs approaches (see chapters 5 and 6).

- the expression transformative innovation policy (TIP) was coined to describe the aims of developing a new narrative for STI policies: "one that does not focus on maximising economic growth but instead establishes STI as a crucial element in achieving the Sustainable Development Goals."[9].
- Furthermore, at the time of publication of Chapter 2, the self-conception and work ethics of researchers, as well as the justification and legitimacy of STI had gained attention within the approach of Responsible Research and Innovation (RRI). It became more popular at the European-level with the Horizon 2020 framework programme (European Commission, 2011) and aims to stimulate the engagement of science in society by focussing on the "democratic governance of the purposes of research and innovation and their orientation towards the 'right impacts'" (Owen et al., 2012, p.751). Therefore, RRI focusses on increasing a wider societal relevance and establishing greater awareness for ethical standards within the research community (Schomberg, 2015); topics that also touch on the systemic perspective and orientation of STI that Chapter 2 deals with, and are more relevant than ever today.

Following the conceptional part of chapter 2 on the "normative turn" of STI policies, we discuss two tools of social sciences to investigate the effect and impact of STI policies (and possibly help to improve them). These are described as short case studies in the contribution. Firstly, participatory evaluation

9 https://tipconsortium.net/about-tipc/ last access online 06.08.2024

”which can be understood as the study of the use or (added) value of the subject of analysis, based on academic standards considering relevant empirical data“ (Daimer et al., 2012, p.177) and involving the relevant actors in a bi-directional way. Thus, enabling learning processes for all participants and investigating whether a policy instrument is fit for purpose, considering its appropriateness and consistency, effectiveness and efficiency. Secondly, foresight which ”engages diverse actors in a joint learning process, thus creating future-oriented attitudes and linkages and therefore ultimately enhancing the responsiveness of the innovation system towards future challenges.” (Daimer et al., 2012, p.180) While setting these systemic instruments in relation to the overall debate on the normative turn, we point out major findings and stimulate reflection. Firstly, against the background of challenge-oriented STI paradigms, the raison d'être and public financial support of basic science and curiosity-driven research is questioned (see chapter 7). The negotiation processes regarding foci areas and responsible actors in STI policy have intensified over the past decades at both, the national as well as EU level, and the quest to achieve a good balance is part of the policy routine despite the willingness to establish longer term strategies (see chapter 3). Secondly,” modulating innovation journeys towards certain desirable objectives“ can only successfully happen when the STI policy domain is intertwined with other domains for systemic socio-technical solution-seeking. Obviously, this statement is more relevant than ever and became paramount in the academic debate on policy mixes and transition concepts (Edmondson et al., 2019; Kern et al., 2019; Rogge & Reichardt, 2016). The plea for further reflections and investigation on ”whole-of-government“ approaches (Diercks et al., 2019; Steward, 2008) was furthermore connected to the question on how policy instruments could be better complemented to account for a normative orientation. We conclude that our two tool examples:

> “[…] indicate some common features which might apply to the question of how systemic instruments would need to be refined to address challenge orientation: They point out the value of participation and dialogue which, however, should not be restricted to stakeholders only, but reach out to society. Furthermore, technological aspects of innovation will need to be accompanied by societal aspects, meaning social impacts and transitions, or respectively, social innovations. Our considerations show the need to develop new methods, e.g. to measure new impact types or to mobilise and rethink beliefs, tacit assessments, emotions or behavioural patterns.” (Daimer et al., 2012, p.184)

Over ten years after the publication of the article, the latter statement describes one of the aspects that still dominates today’s STI policies research agenda: the quest to investigate and trace new impact types (Roth et al., 2021) for real change, regarding not only the effect of innovation, but a change in behavioural patterns and societal impacts as well (Bührer-Topçu et al., 2022).

Chapter 3: Unboxing innovation policy strategies: an empirical exploration of objectives, coordination, and capacity

by Miriam Hufnagl

Fraunhofer ISI Discussion Papers Innovation Systems and Policy Analysis No. 91 (2025), Karlsruhe, DOI: 10.24406/publica-4880

Abstract:

In times of multiple crises such as climate change or global pandemics, science, technology, and innovation (STI) are expected to contribute to solving these grand challenges of humankind. Regarding the related policies, we observably entered an era of strategy that started in the mid-2000s. Nation states set up large-scale policy strategies (e.g. Germany's Hightech Strategy 2025, UK's Innovation and Research strategy for growth) to support innovation-related research and development activities, which were supposed to generate solutions for existential problems. But how do individual policy practitioners perceive this development and how does it alter their practical work? This contribution focuses on the perception and practice of individual policy practitioners from formulators at ministries to implementors at agencies in Germany, Sweden, and the UK via a contextualised empirical investigation (including the qualitative analyses of 53 guideline-led interviews).

Key words: STI policy strategies and instruments, policy coordination, challenge-orientation, policy practitioner, empirical investigation

Around the mid-2000s national innovation strategies were introduced in e.g. some EU countries and the US. It was at that time when the author started working at Fraunhofer ISI and was involved in around ten different research projects (2009-2012) when the notion of directionality and the rhetorical shift from *simply* fostering innovation for economic growth towards systemic policies for "green transitions" or "fighting cancer" as headlines for policies gained prominence and momentum. Furthermore, when evaluating policies at the time, ministries and agencies increasingly asked for recommendations from a strategic point of view. As a junior researcher at Fraunhofer ISI the author experienced this in various projects and different subject matters such as

- the *Evaluation of the programme start and execution of 'Zentrales Innovationsprogramm Mittelstand' (ZIM)/Central Innovation Programme for small and medium-sized enterprises (SMEs)* (Kulicke et al., 2010), an instrument by the Ministry of Economy and Technology (BMWi) initiated in 2009 to help SMEs to overcome the effects of the financial crises, continue to

develop their portfolio and their R&D staff. The programme still runs today to "foster the innovative capacity of SMEs"[10]

- the 'Research on the relationship between science, politics and society' (Grande et al., 2013) initiative by the Ministry for Research and Education (BMBF) where we conducted an investigation on benefits for universities to getting involved in regional networks (Koschatzky et al., 2013) and whether politics should *strategically* support this and include networking activities into assessment criteria for academic staff and faculties (Hufnagl, 2014; Koschatzky et al., 2014)

- or the BMBF project 'Gender Chances: utilising the potential of women in the innovation system' on the innovation potential of diversity (Bührer et al., 2009; Schraudner, 2010) and its *strategic relevance* for different industries and the German economy (Bührer & Hufnagl, 2010) by investigating the relevant intraorganizational parameters as well as general framework conditions for women to enter into and stay in science, technology, engineering, and mathematics (STEM) associated career paths.

Even though these selected project examples had different research foci the contracting ministries always asked for *strategic* advice on how to make the corresponding policy instrument fit the overall long-term aspirations for change by the federal government (and their guiding document, the German High-Tech-Strategy, first introduced in 2006).

On a larger scale I found it particularly intriguing at the time to see how Sweden used its EU presidency in 2009 to showcase and make a bold statement about the policy domain of STI and the expectations linked to it. With the Lund Declaration in 2009 the Swedish commitment to support STI was formulated, which should help solve the "Grand Challenges of our time": these "challenges must turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security." (Vetenskapsrådet, 2009, p. 1)

Hence STI by political will became associated with and responsible for not only the advancement of scientific understanding as such (science policy) and the commercialisation of inventions and increasing national economic performance (technology and innovation policy) but also addressing and overcoming threats to humankind. Several countries joined this rhetorical (and possibly normative) turn and formulated national strategies. When studying these documents, I was very eager to learn how the process of translating insights into solutions is supposed to be organised, how cross-

[10] See https://www.zim.de/ZIM/Navigation/DE/Meta/Englisch/englisch.html, last access online 14.07.2024

departmental issues such as reducing emissions are to be arranged between different ministries and how progress was to be monitored and advanced. This was the starting point for the investigation in chapter 3, which was originally planned as a monograph looking at three different countries. Sweden, the UK and Germany were chosen as cases to further investigate how the concept of policy strategies was conceptualised, designed and implemented. One of the first learnings was that the circumstances of the introduction of the strategies differed and were routed in institutional reforms paired with personal commitment by the political leadership (Germany), the hope to rebalance the economy by closer engaging with industrial partners and help to reduce time to market of new products and process innovations (UK) and the chance to take on a new and improved approach to innovative public procurement while aligning regional with national levels of policy-making (Sweden).

Through an empirical analysis of a solid body of 53 qualitative guideline-led interviews (17-18 per case) with policymakers, which were involved in the life cycle of the strategies at different institutions (ministries, research and innovation agencies, or research councils), the contribution had the goal to answer the following questions:

- **Why** did the government decide to launch a national innovation policy strategy?
- What are the **guiding principles and policy objectives** underlying the national strategy as perceived by individuals formulating and implementing the strategy?
- What patterns can be identified regarding the **coordination and cooperation** of the actors implementing the strategy?
- Does the formulation and implementation of the national innovation strategy require **specific "strategic" skills and capacities** from the actors, and if yes what are these?
- Which **obstacles** to (impactful) strategies and **most urgent systemic challenges** do the individuals involved identify?

Up to this point policy experts had not yet systematically addressed national innovation strategies as an object of study but instead examined ‘strategic policy-making’ as different models for directed actions focusing on fostering certain technologies in different contexts. Drawing on conceptual backgrounds from the STS community such as the Strategic Niche Management (Schot & Geels, 2008), mission-orientated innovation policy (Mazzucato, 2017, 2019a) and others, this contribution tries to “unbox” the notion of national innovation strategy. Since policy and document analyses were unable to reproduce the practices forming the basis of these strategies, guideline-based interviews and their qualitative analysis were chosen to address two main research questions: Firstly, to identify the goals

of the strategies and their underlying processes (e.g. formulation of instruments; cooperation or demarcation patterns between departments) from an empirical perspective reaching beyond desk research and the headlines of communication material. Secondly to discuss the past views and future opportunities for strategies and their elements by interpretative reasoning. This will help to identify recommendations. The core questions mentioned above were posed deductively from the scholarly literature and strategy documents and formed the first hierarchical code structure of the qualitative analysis. The further sub-categories (30 in total) were formulated in a second order (inductive categorisation). A third order of categories (around 110) was developed in parallel to the statements of the interviews coming in, to further group the quotes.

The contribution illustrates the results in a contextualised manner presenting original quotes (and visual overviews) e.g., "the conceptual "paring of societal and technological challenges" is a very demanding and often neglected task, which requires a lot of scientific, technical and sectoral understanding by the policy practitioner responsible .

Furthermore, the much-acclaimed user involvement needs special attention to handle the challenge that should be solved in practical terms, here voiced by a Swedish agency representative:

"[…] to push our researchers and companies to think about needs from different parts of the society not just to focus on selling their products or writing their paper, but really embracing the research and the developing process to actually identifying needs from health care professionals or from teachers or whoever and really working with the user side much more profoundly [is crucial]" (SWE_6, 51)"

Regarding the identified differences between the strategies investigated, the contribution ends with summarising the key differentiating characteristics in "pitches":

- **The Grand Gesture**: **Germany** clings to delineation as cooperation: even though holistic narratives are used and high level committed is expressed, solitary action by departments seems to prevail.
- **The Grand Growth**: struggling with its financial sector at the time, the **UK** lays its emphasis on creating and shaping markets through tech transfer and providing evidence analyses. New entities, such as the Technology Strategy Board, were created for this assignment.
- **The Grand Grid**: for **Sweden**, regional participation and networks are key aspects as well as fostering innovative public sector procurement. In combination with an impactful national agency such as Vinnova, Sweden creates a net to carry the strategy.

Additionally, recommendations put forwards by the interviewees regarding elements of strategies such as policy instruments were discussed. For instance: “concrete and consensual operationalising of the contribution to the challenge solution that turn overwhelming headlines into concrete sector specific meaning as a basis for workable concepts” is a much needed first step when formulating policies, according to some practitioners. Another main lesson learned in combination with this observation is, that there often is no assessment of whether and how ministries steer activities. How does the community of actors responsible react if objectives are not achieved (or whether objectives are “simply” changed in that case)? The scholarly debate on e.g. transformative innovation policy practises, policy learning and evaluation practises so far falls short on tracing rerouting by policymakers, if the expected effects and impacts do not materialise.

Chapter 4: Smart specialisation strategies and cross-border integration of regional innovation systems: Policy dynamics and challenges for the Upper Rhine

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Environment and Planning C (35: 4), pp. 684-702. 2017. SAGE Publishing. DOI:10.1177/0263774X16688472

By Emmanuel Mueller, Andrea Zenker, Miriam Hufnagl, Jean-Alain Heraud, Esther Schnabl, Teemu Makkonen and Henning Kroll

Abstract:

The aim of this paper is to provide insights into the implications of the European Commission's smart specialisation agenda in a specific, cross-border context. The paper critically reflects on some of the RIS3 (research and innovation strategies for smart specialisation) agenda's premises by illustrating its practical implementation in the Upper Rhine area (i.e. Alsace in France and Baden- Württemberg in Germany). The first chapter revisits not only the smart specialisation concept *but* also discusses it vis-à-vis the subject matter of cross-border regional innovation systems and outlines some implications that it may have for the choice of innovation policy instruments. The second chapter introduces the specific framework for the Upper Rhine area and outlines possible options for the co-ordination of innovation policies *based on* a yet to be developed, theoretically possible joint RIS3 strategy. The last chapter brings together these conceptual and applied perspectives on smart specialisation and outlines suggestions for progressive cross-border integration via regional innovation policies.

Key words: Innovation policy, regional development, smart specialisation strategy

The article is mainly a joint effort between a group of colleagues from Fraunhofer ISI and BETA (Bureau of Theoretical and Applied Economics) at the University of Strasbourg, France. It deals with a core topic of STI policy research, namely the geographical scope of policy-making and (cross-border) regional innovation systems and tries to answer the core question: Do "smart specialisation strategies" (S3) processes alter the innovation policy governance in cross-border regions significantly?

My responsibility was to provide a chapter on the choice of policy instruments that are best suited to support S3 and draw conclusions which also incorporate the empirical analyses of the article. As we argue, "The core idea of smart specialisation – the entrepreneurial process of discovery according to Foray et al. (2009, 2011) – urges the entrepreneurial forces of a region to take action and defines the role of policy as that of a moderator." However, since policy instruments can be defined as the "set of

techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change“ (Vedung 1997a: 21) and ”the ’means‘ through which the ’ends‘ of political life are achieved“ (Doern/Phidd 1983: 111) this moderator role can be crucial and might determine a certain direction of change. Several scholars (Bemelmans-Videc et al., 1997; Lowi, 1972; Salamon, 1981) including the author (Hufnagl, 2010) have suggested taxonomies to systematically group the huge number of policy instruments In the article this taxonomy is revisited and a critical reflection is presented of some instruments that, in my view, are better suited than others to promote the formulation and implementation of S3 concepts. Among the better suited instruments are distributive elements, support measures for better cooperation and policy expertise. I furthermore point out that the meta goals supported by systemic instruments, as proposed by Smits and Kuhlmann (2004) are crucial, such as “*providing a platform for learning, experimenting and an infrastructure for strategic intelligence*; *Stimulating demand articulation, strategy and vision development”*. These characteristics allow for a more inclusive, forward-looking and directed mode of policy-making in these regional settings, which might ease the increased complexity as Magro et al. (2014, p.372) observe: ”the process of decentralisation in the governance of innovation policies from national to regional and local levels constitutes another trend that has raised the complexity of the policy system, pleading for multi-level governance processes.” To gain further insights into how the policy practise in the cross-border region of the Upper Rhine[11] is affected by S3 concepts, the article employs two empirical approaches: In a first step, two questionnaire-based online surveys with the policymakers responsible for RIS3 across the European Union were conducted. In a second step 14 telephone or personal interviews were performed in France and Germany to expand the collection of information.

With a view to the Upper Rhine region, the analyses showed that there had already been many well established cross-border initiatives and self-organised cooperation, before the S3 concept was introduced. For this region especially the ”spirit of smart specialisation existed years before the name was branded, so that its final institutionalisation in European support policy merely reinforced existing trends.” (Muller et al., 2017, p.697) Furthermore ”this paper illustrates how processes of joint discovery emerged both within the regions themselves and in cross-border collaboration[12] long before the formal

11 Besides parts of Switzerland and the Southern Palatinate, Alsace and Baden – the western part of Baden-Württemberg – constitute the Upper Rhine region.

12 Examples we quote include a cross-border cluster in biotechnology (Biovalley), a university network (Eucor), collaborative political initiatives (RMT: Region Metropolitaine Trinationale du Rhin superieur and TMO: Trinationale Metropolregion Oberrhein), as well as cross-border institutions at local (Eurodisctrict) and regional (Pamina) levels.

RIS3 agenda (and ex-ante conditionality) of the European Commission had ever been announced. […] [we can conclude that] the recent formal requirement to draft smart specialisation strategies and set up related governance mechanisms in fact added very little to existing dynamics, as the two administrative processes were very weakly linked in practice." (ibid. p.698)

As a result, we can state, if there "is enough congruence and shared visions in a cross-border area, individual actors will naturally find their interest in collaborating across the border around specific projects and lobby for support for this in their respective environments." (ibid. p. 698) This offers policymakers the opportunity to foster joint discovery between partners from both regions by supporting informal processes of exchange and, indeed, entrepreneurially minded encounters (which could be conferences, fairs, or cooperation competitions). With a view towards the main question of this thesis (directionality), joint specialisation does explicitly play a role. In the specific case of the Upper Rhine region, traditional cooperation routines seem to be more impactful though, rather than new policy agendas. However, "more so even than regions, cross-border areas are situated in a complex environment of multi-level opportunities and obstacles that must be acknowledged and assessed in mutual consultation to take action accordingly." (ibid.) This can be effectively facilitated via the policy instruments mentioned earlier on. We further suggest offering support in the following five domains, which can be aspects of regular processes of exchange: (1) the identification of areas of joint specialisation, (2) the transfer of good practices, (3) the facilitation of knowledge transfer, (4) the promotion of network formation and (5) the exploitation of positive differences (related variety).

Finally, chapters 5 and 6 originate from the project “Hightech Strategy 2025 – Scientific support of missions and performance measurement in the context of accompanying the Hightech Forum”[13] funded by the BMBF (duration April 2019 to December2021). The project’s main aim was to draft a scheme for an impact assessment (IA) for mission-oriented innovation policies (MOIPs), which we defined as follows:

”We understand mission-oriented innovation policy as a cross-sectoral and cross-policy approach to achieving ambitious and clearly formulated goals via the generation and application of knowledge and innovation that address pressing societal challenges. The goals must be clearly defined as well as being measurable and verifiable, and they must be implemented within a clearly defined timeframe. Only when missions aim at behavioural and structural change, in addition to generating knowledge and innovation, do they contribute to comprehensive system transformations. Practices, actors and institutions must all be reconfigured as a result of the transformations.” (Lindner et al., 2021, p.7)

While crafting this IA concept, which was finalised in 2022 (Wittmann, Hufnagl, Roth, Lindner, & Kroll, 2021; Wittmann et al., 2022), we worked on several conceptual milestones such as a typology of missions (chapter 5). While we were seeking for an alternative explanatory figure adding to the policy cycle heuristic, we also conceptualised a more process-oriented perspective, drawing on the empirical material from project case studies and argued that missions are shaped by three interrelated but distinct translation processes (chapter 6).

13 See https://www.isi.fraunhofer.de/en/competence-center/politik-gesellschaft/projekte/htf2025.html for more details on the projects structure and outcomes, last access online 14.07.2024

Chapter 5: Governing varieties of mission-oriented innovation policies: A new typology

Published in:

Science and Public Policy, 2021, 48, 727–738; https://doi.org/10.1093/scipol/scab044

by Florian Wittmann, Miriam Hufnagl, Florian Roth, Ralf Lindner, Jakob Edler

Abstract:

Many governments in Europe and beyond have subscribed to mission-oriented innovation policies (MOIPs), aiming to steer innovation systems towards directly addressing grand societal challenges. The emerging diversity of MOIPs, however, creates difficulties in defining this approach and assess its effectiveness and efficiency. In this article, we propose a new typology for MOIPs. It consists of four ideal types of missions and extends the established dichotomy of transformer and accelerator missions. The framework emphasises the role of the state in MOIPs, drawing attention to the implementation process and governance requirements as key features of mission implementation. A first application across the diverse missions of the German High-Tech Strategy 2025 demonstrates the analytical value of the framework and enables the identification of type-specific challenges. Overall, the new typology and its operationalisation improve the understanding of MOIPs and enhance the possibilities for systematic comparisons and impact assessments.

Key words: mission-oriented innovation policy, typology, transformative politics, Hightech Strategy

This contribution seeks to enhance the comparative and systematic empirical analysis of mission-oriented innovation policies (MOIPs) by proposing a novel typology. To demonstrate its usefulness, we apply it to the German High-Tech Strategy (HTS) 2025 as an illustrative case study. The origin of the article is rooted in the first attempts to conceptualise an impact assessment (IA) concept for MOIPs. We realised that we need to disentangle the diversity of missions before looking at their potential, since they can differ substantially in their ”transformative ambition and the challenges in the implementation process of the associated instruments“. Previous approaches to systemise MOIPs had focussed on the extent of current policies actually meeting the baseline of mission-oriented innovation, as such (e.g. Mazzucato, 2018); a second strand of research looked at the underlying challenges (e.g. Wanzenböck et al., 2020) and ”the level of societal contestation around the challenges“, whereas a third approach (e.g. Larrue, 2021) ”primarily focuses on the actor constellations at play, specifically during the implementation phase of the policy process“. Finally, a ”fourth approach combines several characteristics, such as the motivation, means, and scope of missions“.

To start the elaboration of our typology, we employed the established distinction between accelerator and transformer mission by Kuittinen et al. (2018) to further differentiate between four ideal types. Broadly speaking, the former emphasises scientific-technological solutions, while the latter also includes and aims at wider socio-institutional transformations. The insights presented by Kuittinen et al. as well as Polt et al. (2019) were based on the inductive systematisation of hundreds of case studies with regard to ”the motivation (aspiration vs. problem-driven), the intention (understanding vs. solution), the definition of a target/the scope (well- vs. ill defined), and the means (technological vs. socio-institutional)” of different MOIPs in different countries.

We took several learnings from the previous research such as

a) one needs to focus on the classification of individual missions instead of whole strategies

b) improved understanding should reflect the variations between various missions with a transformative agenda

c) the focus must lie on the complexity of the underlying challenges with much more direct attention paid towards the implementation of missions. This implementation is another source of complexities (see also chapter 6).

Regarding the latter, our typology ”takes a clearly empirical or ‘realist’ approach, as it emphasises the importance of the implementation process and governance of MOIPs rather than relying solely on the underlying problems that the missions are *supposed* to address.” Considering that several steps or ”translation processes“ (definition, design, implementation), which in turn depend on each other, are necessary for rolling out MOIPs, we consider this practice an additional source of variation among missions. The quality and quantity of the involvement of (policy) actors and the need for coordination among those, add complexity to missions in addition to the transformative ambition that might be expressed in pushing for scientific progress (accelerator type missions) or ambitious behavioural change (transformer type). In a previously published working paper (Wittmann, Hufnagl, et al., 2020) we illustrated the relationship between the focus of ambition and the governance complexity by using Figure 2. As can be seen, the complexity of missions and their implementations rise with the level of aspired transformative goals and cross-cutting responsibility, increasing the number of involved actors.

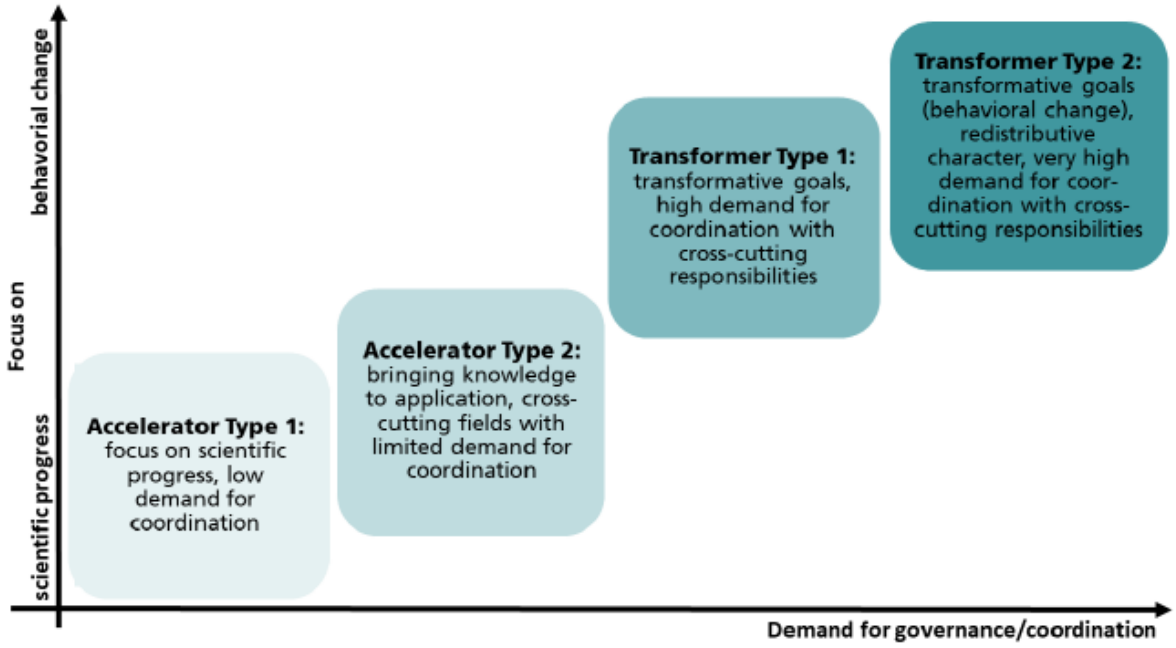

Figure 2: Types of missions (own elaboration)[14]

The operationalisation of mission characteristics according to the previous learnings was undertaken by applying the taxonomy to the 12 missions of the German High-Tech-Strategy 2025 (BMBF, 2019). In addition to the underlying motivation and the importance of STI, we focussed on further analysing four governance requirements we derived from the literature (with an additive index 0-4, categorial variables or binary coding respectively):

- Cross-sectoral diversity (state, science, economy, and society)
- Dimensions of activity (informing, financing, regulating, and destabilising)
- Number of involved ministries/actors
- Multi-level dimension

As a result, we could see ”considerable variation across the missions of the HTS concerning their approach to the mission (goal- vs. solution-orientation; dominance of STI), as well as with the emerging governance requirements. While the association between the latter and the role of STI policies is—as expected—relatively high, missions generally differ with regard to the involvement of key stakeholders, range of (potential) instruments, and the horizontal and vertical coordination. Whereas some missions rely on a narrow horizontal coordination (e.g. combating cancer/open knowledge), others are

14 Source Wittmann, Hufnagl, et al. (2020): Working paper published prior to the reviewing process for SPP, p. 11

characterized by the involvement of up to six different federal ministries (e.g. plastic waste)." In addition, we use the values obtained to run a cluster analysis to identify clusters of missions with shared characteristics; an important step to be able to choose "ideal types" for the further project work on the IA concept. Wittmann et al (2021; 2020) present in-depth analyses of these selected missions:

- Combating cancer (accelerator type 1 mission with strong focus on research),
- Reducing CO_2 emissions in industry (accelerator type 2 mission with emphasis on translation of scientific/innovative solutions to be brought into practice),
- Circular economy (transformer type 1 mission aiming for a systemic change at the production level),
- Ensuring good living and working conditions throughout the country (transformer type 2 mission striving for transformative change including human behaviour).

The further analyses of the cases pinpointed policy challenges regarding the different types. Accelerator type 2 missions, for instance, need to be accompanied by solid support measures to ensure the translation of scientific insights into practical solutions. Whereas transformer type 2 missions often deal with major challenges, among those the involvement of a larger group of actors (e.g. end users, population) at the micro-level who facilitate the change as well as possibly the need to soften the consequences of exnovation[15], when leaving traditional paths.

In summary, the authors hope that the article contributed significantly to a better understanding of MOIPs and enriched the academic debate. By offering ideal types as points of reference, the typology fosters a better comprehension of obstacles in the realisation of diverse missions by pointing out the relevance of the complex steps of policy making. Furthermore, highlighting variance in characteristics due to the level of transformative ambition and systemic outreach helps to distinguish further aspects to focus on for policymakers regarding the choice, scope and time constraints of the policy mix employed within the mission. Then again, the contribution identified several theoretical and methodological limitations e.g. with a view to governance processes (**Chapter 6** displays an attempt to further conceptualise the above mentioned" translation processes"). In addition, we acknowledge the need for a bigger sample of cases and the repeated assessment of missions to prove the typology's usefulness. Furthermore, we saw the necessity for a refined concept for mission evaluation anticipating the realisation processes and including a good balance of qualitative as well as quantitative indicators to track their progress (see **conclusion**).

[15] Exnovation in this context can be described as changing the architecture of an existing system and deliberately challenging existing constellations, e.g. when trying to decarbonize industries (see also our generic pathway 9 Regime destabilization/exnovation in Wittmann et al. (2021, p.33)

Chapter 6: From mission definition to implementation: Conceptualising mission-oriented policies as a multi-stage translation process

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Abstract

Mission-oriented innovation policies (MOIP) promise to address some of the grand societal challenges as a cross-sectoral and interdisciplinary approach to innovation policy. They aim to do that via increased directionality, which has led to high hopes of success. However, their complexities constitute/pose challenges for both policymakers and innovation scholars.

Seeking to enhance our understanding of MOIPs and the diverse policy choices and challenges involved, we propose a conceptualisation of missions as multiple, interconnected translation processes. We argue that adopting a process-oriented perspective is well-suited to account for the different levels of contestations and negotiations of missions at different stages (formulation, design, and implementation) and allows a more pronounced perspective of the complexity and the role of potential bottlenecks of MOIPs. The conceptual framework provides practical insights for policymakers, as well as analytical leverage for scholars studying missions and those trying to ultimately grasp the impacts of missions.

Keywords: mission-orientation, conceptual framework, negotiation process, translation processes

”While the importance of different dynamics and negotiations for missions within ‘innovation bureaucracies’ (Kattel et al., 2019), as in public actors striving for positive change, has been acknowledged (Kattel & Mazzucato, 2018; Larrue, 2021; Lindner et al., 2021) a more comprehensive understanding of the dynamics that characterise the setup of missions and how these elements relate to each other is still missing.” (Wittmann 2025, p.36) Therefore, the contribution proposes a process-oriented analytical perspective on MOIPs that considers different actors and levels of contestation. It argues that missions are shaped by three interrelated but distinct translation processes.

To start with, we unravel a few assumptions and challenges commonly associated with MOIPs. Firstly, the conviction that missions need to be completely novel. Even though new headlines or programmes might be associated with MOIPs, they are not established in a vacuum but rather rely on the context of already established instruments and even display policy layering by combining different generations of innovation policies (Arnold, 2019). Secondly, introducing directionality imposes a politicisation of STI policies. While MOIP are often accompanied by a "language of cooperation", one should not underestimate the challenges this entails with a view to incorporating different actors and their views. In a similar vein the third observation concerning MOIPs, which should not be seen as static and rigid policies, is crucial: they might develop over time as new insights or conditions emerge and political constellations change. Hence the variety of missions, as pointed out above, has different roots and calls for different routines. Taking on a process-oriented perspective can also help to overcome traditional output-oriented policy perspectives that fall short of understanding the underlying dynamics and might not find adequate answers as to why policies do not achieve the intended effects.

By revisiting Callon (1986) and Latour (1986) and their understanding of *translation* as complex negotiation processes, we acknowledge that policy-making and programme realisation is "ideation, negotiation and decision-making that is driven and governed by multiple actors" (Kroll, 2019, p.637). This includes" multiple, loosely coupled streams of implementation and policy debate, each driven by its own path-dependent logic" (Wittmann et al. 2025, p.37).

To better grasp MOIPs, we claim there are three main translation processes along the way, from deriving a mission out of a societal challenge to finally implementing policies that deal with this challenge:

- Mission formulation: translation of a societal challenge into a specific mission with dedicated priorities/goals
- Mission design: translation of mission goals into a specific set of instruments, activities and coordination structures
- Mission implementation: translation of mission activities and inputs into specific actions and effects.

Once again we also build our work on Larrue (2021), who distinguishes between strategic orientation, policy coordination/administration and policy implementation. The following overview comprehensively ties together the key actors and aspects associated with each translation process:

	Mission formulation	Mission design	Mission implementation
Main function	Narrowing down societal challenge to specific mission goal(s)	Choosing an adequate instrument mix/coordination structures fit for purpose to meet the goal(s)	Implementing instruments and activities within the mission
Key actors	High-level politics, representatives of responsible ministries, key stakeholders, society	Mission owners, i.e., involved ministerial authority, work-level ministry officers	Executing administration, funding agencies, etc.
Issues of negotiation and contestation	Directionality, scope, level of ambition Priority and agenda setting Stakeholder involvement and representation	Actor & resource mobilisation/involvement Mix/types of instruments Re-design vs. development of new instruments Coordination structures	Administration and implementation of instruments Role of monitoring, flexibility and learning Role of civil servants

Table 2: Selected key characteristics of translation processes[16]

Even though we highlighted the analytical value of distinguishing the different steps of translation, we also “believe that only an integrated view on the entire process provides a holistic picture of the dynamic of MOIPs and […] acknowledge that missions hardly follow a simple linear logic from design to effect, but rather are characterised by multiple interaction and feedback loops between these steps “with possible interactions, spill-overs and feedback dynamics. Therefore, we advocate for a perspective of interconnected processes with interdependencies. Adopting this process-oriented perspective might help researchers as well as policymakers to reconnect the sometimes ”fuzzy“ mission narrative and realisation of MOIPs with the solid strand of policy science established around, for instance, policy coordination and reflexive governance. We are convinced that this perspective can also be useful for addressing the challenges of conceptualising and measuring the impacts of MOIPs. Here we once again draw on Kroll (2019), who argues that attempts to measure impacts against initial ambitions might fall short of anticipating the process of translation and interpretation. And ”finally, for

[16] Based on Wittmann et al. (2025)

policymakers, our framework clarifies the different procedural steps and points to the specific challenges and pitfalls that are connected with each of them." (Wittmann et al.)

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2 Challenge-oriented policy-making and innovation systems theory: reconsidering systemic instruments

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2.1 Introduction

In their attempt to analyse the "rise of systemic instruments", Smits and Kuhlmann (2004, pp. 5–8) identify three trends that characterise the "changing nature of innovation processes and systems":

– the end of the linear model

– the rise of the systems approach and

– inherent uncertainty and need for learning.

They argue that – as a consequence of these trends – systemic instruments increasingly complement classical approaches in the innovation policy portfolio (R. Smits & Kuhlmann, 2004, p. 11). Recently, however, the dominant rationale of innovation policy seems to be changing. Increasingly, innovation policy is expected to contribute towards addressing societal demands or even to respond to the "Grand Challenges of our time".

The Lund Declaration of 2009, which was assigned by a large group of policy- makers, researchers and business representatives to the Presidency of the European Council, for example stated that these "[…] challenges must turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security. […] Responses to Grand Challenges should take the form of broad areas of issue-oriented research in relevant fields"[18]. This "normative turn" in innovation policy implies changes in the requirements of its instruments. Therefore, our contribution seeks to revisit established notions of system-oriented innovation policy patterns in the light of the new "grand challenge-oriented" paradigm on research and innovation policies. We will discuss whether current systemic innovation policy instruments are suitable to implement a challenge-oriented innovation policy. A reflection on the now well-established innovation system approach underlines that this heuristic concept focuses on the well-functioning of the system but does not provide for a strategic or normative orientation. Such an orientation function is suggested here, followed by a few practical considerations on how this function could be translated into innovation policy, i.e. how systemic policy instruments would need to be further refined in order to address the strategic orientation of the system.

[18] As stated during the Swedish Presidency of the European Union in July 2009: The Lund Declaration – Europe must focus on the Grand Challenges of our time, online: http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf, accessed 4 May 2012, http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_ver- sion_9_july.pdf

We start by describing the growing relevance of the notion of the "Grand Challenges" as a normative, strategic goal of innovation policy. Chapter 2.3 will briefly summarise recent changes in the nature of innovation, while Chapter 2.4 illustrates implications posed by the system of innovation approach as the underlying heuristic of most of today's innovation policies. Chapter 2.6 asks whether systemic policy instruments, which are designed to address the new nature of innovation, are also suited to address new requirements of research and innovation activities implied by the normative turn of innovation policy. Here, we outline our main proposition of how an orientation function should be introduced in order to permit the normative orientation the "Grand Challenges" call for in policy-making. After these conceptual considerations, we illustrate our conclusions by analysing two prominent systemic instruments in Chapters 2.6.1 and 2.6.2, namely participatory evaluation and foresight. For both instruments we will explore how the requirements of challenge-oriented innovation policy impact on the rationale and implementation of the approach. This will finally allow us to derive possible refinements of systemic innovation policy instruments in the context of challenge-oriented innovation policy.

2.2 The normative turn of innovation policy

Innovation policy has gone through several paradigm shifts. Early attempts in the 1960s tried to balance "market failures" through funding certain basic research activities. This was followed by various forms of "mission-oriented schemes" that aimed at specific targets such as the US Apollo 1 space program; lately the innovation systems school is addressing "system failure" by enhancing systems' learning capability, by trying to improve the management of interfaces as well as by building up the capacity of different actors in the system. Each paradigm emphasised different policy instruments such as direct funding of research and development, demand-side instruments (e.g. public procurement, establishment of lead markets) or systemic instruments.

Braun (2008) delineates three phases of innovation policy, the first representing the classic mission orientation. Yet the combination of instruments in a well-balanced policy mix has been emphasised since the 1980s. This second phase was characterised by the fact that the assumption of an automatic occurrence of spill-over effects from basic research to immediate application in business and industry was questioned, and the identification of non-linear, recursive interactions of heterogeneous actors became prominent in innovation studies. Still, policies solely targeted selected sectors and technologies during this phase of innovation policies. It was only with the establishment of the innovation system approaches in the 1990s that "innovation has come to be seen as the interplay of

market and non-market forces and as denoting a policy of 'structuration', of framework-setting that helps to correct 'market failures' and improve interaction, within the 'innovation system'" (Braun, 2008, p. 227). Notably, an important characteristic of the development of innovation policies is the fact that established forms of support measures, respectively policy instruments, were not necessarily replaced by new policy paradigms but complemented (Boeckholt, 2010; Gassler et al., 2006). Early innovation studies had shown that some countries were developing faster than others in spite of similar economic circumstances due to different characteristics of their innovation systems. Consequently, the idea was established of optimising "innovation ecosystems" in order to enhance innovation capability and thereby foster economic growth and competitiveness.

This rationale has been complemented in recent years. Besides competitiveness and innovation capability, several innovation policy strategies aim to foster innovation that addresses the "Grand Challenges of our times" such as health, sustainability, mobility and security and thus contribute to better living conditions worldwide. Prominent examples are the US "Strategy for American Innovation", the EC's Europe2020 strategy and the German "Hightech Strategy". In parallel, the notion of economic growth as the key driver of innovation policy is under consideration. Particularly in the wake of the current financial crises the "limits of growth" already indicated by the Club of Rome in 1972, are of public concern. Specifically, the focus on the Grand Challenges calls for indicators that not only reflect a focus on the mere quantity of the economic output and market-based innovation, but also display qualitative issues of contentment, well-being and happiness. Though this debate is beyond the scope of this contribution, it is still important to keep these aspects in mind when reflecting on implications of this normative turn in the nature of innovation activities and the fit with the innovation system approach.

2.3 Changes in the nature of innovation

For decades the dominant definition of innovation as 'new products and processes that are successfully introduced to the market' was hardly ever questioned. Companies were considered the key actors of innovation landscapes and the number of science-based high-technology innovations was deployed as the most relevant measure of innovation capability. Nowadays, a new understanding of innovation is gradually emerging from a number of different directions[19]. Increasingly, phenomena like social innovation, service innovation, low-tech innovation, frugal innovation, relational innovation and value

[19] See also the recently finalised Foresight project on the "future of innovation" INFU where eight dimensions of change in innovation patterns were highlighted (www.innovation.futures.org).

innovation are being recognised as highly relevant innovation arenas that are challenging the standard definition (among others, see Kim & Mauborgne, 1999; Miles, 2005; Mulgan et al., 2007). At the same time, with the notion of "open innovation" and corresponding practices such as 'crowdsourcing' (Howe, 2006) and 'co-creation' (Prahalad & Ramaswamy, 2004), the focus on the firm as the key innovation actor has substantially broadened towards social entrepreneurs, users, customers, the public sector and citizens (Chesbrough, 2006; Reichwald & Piller, 2006). Creativity and innovation capability is no longer exclusively assigned to specific professions such as designers and artists or entrepreneurs, but extends to "ordinary people" and everyday life (Miller et al., 2008). This goes hand in hand with a perception of innovation as a local phenomenon that is emerging across the globe wherever it is required and not just exclusively in a few innovation hubs. At the same time, markets are complemented as the main coordination mechanisms between innovation demand and supply. Due to the lowering of transaction costs caused by the widespread use of the internet and mobile devices, more and more services are being coordinated directly between the parties involved through "peer to peer production" on the base of shared common goods (Benkler, 2006).

At the same time, the "normative turn" in innovation policy outlined above is creating demand for different types of innovation patterns. Findings from innovation studies indicate that addressing the Grand Challenges requires much more than just replacing the topics of RTI funding programmes; indeed, a different type of research and innovation projects altogether is called for. In particular, the following characteristics of challenge-driven innovation activities have been proposed:

- Socio-technical: Aligning social and technological innovation
- Systemic: Focusing on system change rather than on individual elements alone
- Transition-oriented: Envisaging system transition rather than only incremental trajectories
- Experimental: Providing spaces for experimenting with socio-technical and system innovations in the real world
- Glocal: Mobilising and aligning a diverse range of local solutions to address grand challenges on a global level
- Transdisciplinary: Joint research and innovation across disciplines
- Participatory: Involving users and providers as well as stakeholders in joint learning processes around innovation trajectories.

Steward (2008) suggested the term "transformative innovation" for this type of innovation pattern. Joly et al. (2010) propose the concept of "collective experimentation" to characterise such 'transformative' innovation journeys directed at societal issues. Other studies have emphasised that challenge-driven innovation also implies different types of scientific research. In a recent memorandum, a scientific

council of the German Chancellor proposed a shift towards “transformative research” in order to address climate change (WBGU, 2011). These demands have unleashed a debate on the appropriate balance between curiosity-driven and challenge-driven research and the institutional setting required to underpin this balance which is still ongoing.

To sum up, we can say that changes in innovation patterns are driven by the dynamics of socio-economic framework conditions and newly emerging technologies, on the one hand, and by new policy demands, on the other. Before turning to the implications for systemic innovation policy instruments, which is the focus of our contribution, we will now briefly revisit the system of innovation approach which forms the basis for the notion of systemic instruments.

2.4 Grand challenges and innovation systems

The field of research and innovation policy is characterised by multi-actor and multi- level structures, without one hierarchical-statist centre. This observation is acknowledged within innovations system approaches. Freeman’s concept of national (or regional) innovation systems was the first attempt to illustrate a broad interaction between all types of institutional networks in the private and public sector “whose activities and interactions initiate, import, modify and diffuse new technology” (Freeman, 1987, p. 1). This conceptual framework was followed by other systems of innovation approaches focusing on different aspects besides national ((Edquist, 2005; Freeman, 1987; Lundvall, 1992; R. R. Nelson & Rosenberg, 1993) and regional innovation systems (e.g. (e.g. Braczyk et al., 1998), like technological (e.g. Carlsson & Stankiewicz, 1995) or sectoral ones (e.g. Malerba, 2002). However, common to all approaches is the assumption that innovations as such are embedded within the systemic context of all relevant stakeholders and institutions. Innovations come to life under complex, iterative circumstances since they “[…] encompass […] the ‘biotopes’ of all those institutions which are engaged in scientific research and the accumulation and diffusion of knowledge, which educate and train the working population, develop technology, produce innovative products and processes, and distribute them. Hereto belong the relevant regulatory bodies (standards, norms, laws), as well as the state investment in appropriate infrastructures” (Kuhlmann et al., 2010, p. 3).

While the neo-classical, linear view of innovation referred to market failures as a rationale for state interventions, this evolutionary view of innovation has brought forward systemic failures to justify state interventions and the involvement of state actors. Among others, Chaminade and Edquist point to the different lines of theoretical reasoning: “market failure in mainstream economic theory implies a comparison between conditions on the real world and an ideal or optimal economic system. However,

innovation processes are path dependent over time, and it is not clear which path will be taken as they have evolutionary characteristics. […] what is more, the system never achieves equilibrium, and the notion of optimality is irrelevant in an innovation context" (Chaminade & Edquist, 2006, p. 115). In practice, the different existing categorisations of market and system failures show that the types of imperfections are often not formulated in such a way that they can be sharply differentiated from one another and that various links exist. The current consideration of "systemic imperfections" (Klein Woolthuis et al., 2005, p. 610) has been broadened over the past years and now includes different types identified and formulated by various scholars in the field (among others, see Chaminade & Edquist, 2006; Klein Woolthuis et al., 2005; Smith, 2000): infrastructure provision and investment problems, transition problems, lock-in problems, hard and soft institutional problems, network problems, capability and learning problems, unbalanced exploration-exploitation mechanisms, and complementarity problems. All these aspects of "systemic imperfections" reflect a gradual gain in knowledge in innovation research and innovation-related policies whose foundation has been – and still is – an improved understanding of the relationship between research, innovation and socio-economic development (Soete, 2007, p. 278): "Sectoral explanations of either technology push or demand pull kind have gradually lost in policy influence. Instead, it is now widely recognised that economic growth and well-being is founded in a much broader, well-functioning 'knowledge and innovation system', in which all actors perform well."

Despite all the refined understanding of innovation systems, the instruments derived from the innovation system approach are mainly directed at enhancing the innovation ecosystem in order to strengthen innovation capability. So far, there is no attempt to build on the innovation system heuristic in order to modulate innovation journeys towards certain desirable objectives. So, whereas system failure appears to be addressed, "orientation failure" has largely not been tackled.

2.5 Systemic instruments and orientation failure

The question is whether systemic policy instruments, which are designed to address the capability of innovation systems, are also suited to address new requirements of research and innovation activities implied by the normative turn of innovation policy.

Our hypothesis is the following: introducing any kind of goal orientation into complex innovation landscapes and modulating innovation trajectories requires intimate understanding of innovation systems. The orientation function can be introduced into the system only when 'government' is seen as the potential 'orchestrator' of the system (Shapira et al., 2010, p. 461). Systemic policy-making that

allows for coordination of different parts of the system (sectors, subsystems, etc.) and engages them in discursive processes (reflexive governance, transition management), is the precondition for successful strategic policy-making. Accordingly, imposing grand challenges as a major rationale of policy and hence a major goal of research and development by a top-down organised process will most likely not lead to any real transformative innovation, but will rather lead to subsuming previous research under new headlines like putting "old wine into new bottles". Thus, any innovation policy instrument underpinning transformative governance will have to embrace the notion of systemic instruments. At the same time, nurturing innovation ecosystems alone will not be sufficient. Systemic and strategic policy-making needs to be connected. Such a connection may draw on experience from policy realms with longstanding experience in strategic policy-making, such as sustainability policy. Concepts like transition management, strategic niche management (Loorbach, 2010) and constructive technology assessment (Schot & Rip, 1996) may provide valuable starting points.

This governance aspect of programmatic strategies is also implicitly put forward by a former OECD expert: "An innovation strategy […], has to take account of [cultural, geographical, legislative and regulatory] conditions to ensure that any interventions combine to contribute to the policy goals and do not weaken one another […] with emphasis on whole-of-government policies" (Gault, 2010, 92ff.). The identification of "whole-of-government policies" is a very important and increasingly observable feature of programmatic strategies, like for instance, the German Hightech Strategy. According to Susana Borrás, an important criterion for strategic innovation policy is the "evidence that the vision and priorities are transposed to the choice, design and implementation of innovation policy instruments" (Borrás, 2009, p. 15). Whether or not this statement holds true for the already mentioned programmatic strategies is subject to evaluations in the near future. Yet considerably more research must be carried out to further define the composition, must-have features and application modes of strategic policies altogether. In order to address this conceptual shortcoming in terms of a coherent definition of programmatic strategies, we would like to undertake some practical considerations about the elements of such policies, namely, the policy instruments.

2.6 Aligned systemic and strategic policy making: Some practical considerations

From the point of view of innovation policy, it seems obvious that challenge-oriented innovation requires different types of supporting instruments and therefore narrow types of demand articulation no longer seem adequate. However, it is still little understood whether and how this type of innovation can be fostered by innovation policy. Several current challenge-driven innovation policy strategies

embrace measures to address some of the characteristics of "transformative innovation" (cf. Warnke, 2012 for a recent overview). The Europe 2020 strategy explicitly calls for novel combinations of policy instruments and new foci of established instruments[20]. It is widely acknowledged that picking the winners among key technologies – be it in terms of competitiveness or in terms of supposed contributions to abstract societal goals – will no longer do the job. Rather, options for socio-technical transition need to be identified by linking up technological and societal change into "configurations that work" in new transformative ways. But what kinds of instruments are suitable to address this? Besides the classical canon of policy instruments that mainly fund, regulate or either provide or gather information – Bemelmans-Videc et al. (2007) also describe the set rather vividly as "carrots, sticks and sermons" – the category of systemic instruments already seems to be part of the answer, since they incorporate specific needs of innovation policy, respectively, the level of systemic management of innovation processes (Hufnagl, 2010). The key feature of systemic instruments is "that they aim to address problems that arise at the innovation system level and which negatively influence the speed and direction of innovation processes" (Wieczorek & Hekkert, 2012, p. 74). According to the advancing debate in innovation studies over the past years, Wieczorek and Hekkert (2012, p. 82) provided an extended and enhanced overview of the goals of systemic instruments, building on the work of Smits and Kuhlmann (2004) to:

1. stimulate and organise the participation of various actors (NGOs, companies, government etc.),
2. create space for actors' capability development (e.g. through learning and experimenting),
3. stimulate the occurrence of interaction among heterogeneous actors (e.g. by managing interfaces and building a consensus),
4. prevent ties that are either too strong or too weak,
5. secure the presence of (hard and soft) institutions,
6. prevent institutions being too weak or too stringent,
7. stimulate the physical, financial and knowledge infrastructure,
8. ensure that the quality of the infrastructure is adequate (strategic intelligence serving as a good example of specific knowledge infrastructure).

Prominent examples of systemic instruments that "influence the speed and direction of innovation processes" and therefore address transition goals is transition management and strategic niche management (Kemp & Rotmans, 2009; Loorbach, 2010). However, there is no widespread application

[20] "Member States should seek to shift the tax burden from labour to energy and environmental taxes as part of a 'greening' of taxation systems." European Commission (2010, p. 26)

of those instruments (beyond the Netherlands) and they were implemented for rather specific goals. In a similar way, the technological innovation system approaches explicitly target change in a specific direction, for instance, the uptake of a certain technology that is thought to be more desirable than others e.g. in terms of ecological impact. Finally, several scholars have proposed "demand-oriented innovation policy strategies" (Edler, 2010). Rather than trying to address societal demand, these strategies deploy demand-side measures in order to foster technological innovation with no specific societal goal apart from spurring innovation.

Therefore, we see the need to further advance these and other systemic instruments in order to address the strategic orientation of the system. To convey our ideas in this regard, we chose participatory evaluation and foresight processes as illustrative examples of classical systemic instruments that need to evolve in order to underpin transformative governance approaches.

2.6.1 Participatory evaluation: Addressing normative challenges through new impact dimensions and behavioural additionality analysis

Evaluation can be understood as the study of the use or (added) value of the subject of analysis, based on academic standards considering relevant empirical data. In the field of research, technology and innovation policy, evaluation can have the following different subjects of analysis: research projects, actor networks, clusters, institutions or organisational entities, processes, (funding) programmes and other policy instruments or policies. Furthermore, evaluations of whole sectoral or national innovation systems are carried out. The evaluation of funding programmes and other policy instruments is of highest relevance in the field of innovation policy (e.g. Arnold & Guy, 1997; Edler et al., 2010; Fahrenkrog et al., 2002; Miles et al., 2006) and is therefore the main subject of the subsequent thoughts. The basic purpose of evaluations can be either summative or formative and each programme evaluation can cover different aspects, such as appropriateness and consistency, effectiveness and efficiency or impacts. Evaluation is not per se understood as a systemic policy instrument. In a more classical view, the main functions are legitimation, control, insight and understanding or learning. In the evolutionary understanding, learning is most important and policy evaluation is regarded as a source of strategic intelligence (Kuhlmann, 2003) "providing actors with the information they need to develop and implement their strategies" (R. Smits & Kuhlmann, 2004, p. 9) or to stimulate the occurrence of interactions by building consensus among the actors (Wieczorek & Hekkert, 2012, p. 85). In classical evaluation studies, stakeholder involvement is often uni-directional; this means that they are involved via surveys and similar methods to provide the relevant empirical data. Thus, in a systemic perspective, evaluation can be regarded as bi-directional, i.e. evaluations should ensure that relevant

information is provided in a useful manner to the stakeholders and that feedback loops to the involved actors are established, in order to provide room for learning, which eventually leads to improving systemic capabilities. This bi-directionality allows us to speak of real stakeholder participation. With our proposition as to how evaluation could be applied as a systemic instrument by adding participatory elements, the question remains how it could provide orientation in the strategic, normative sense outlined above. This is defined by the policy programme subject to the evaluation, i.e. by its goals and the terms of reference of the evaluation. Programme goals can be formulated normatively or challenge-oriented in two different ways:

– They are either defined as external goals, i.e. impacts reaching beyond the programme participants, such as contributing to less environmental pollution or addressing issues of demographic change, or they formulate a sustainable long- term effect on the participants, i.e. a change of behaviour. In the first case, this means covering new impact dimensions beyond mere economic or technological impacts, such as sustainability or social impacts during the evaluation. As these new impact types occur rather intangibly in the wider society or the environment and are of a qualitative nature, they are hard to measure. Our proposition is that, in these cases, a participatory evaluation approach involving experts and different societal groups is a suitable way to include these issues. By studying new impact dimensions, participatory evaluation would need to go beyond the systemic character of evaluation sketched above.

– In the second case, the evaluation will also need to assess any transformative impacts on the actors, i.e. evidence of behavioural additionality, understood here as a change in the persistent behaviour related to R&D and innovation activities (Gök, 2011)[21]. In the same way as evaluation can be used as a systemic instrument to strengthen the systemic capabilities of the actors, it could be used to trigger the normative orientation of the actors. At best, the orientation function could eventually be implemented in evaluation studies by combining a participatory approach through the analysis of behavioural additionality.

In practice, however, a purely systemic participatory evaluation approach and an evaluation approach which goes beyond the systemic character and adds a normative or challenge orientation, both face implementation difficulties as the following considerations show:

[21] He elaborates on at least three other conceptualisations of the term in literature.

- Participatory evaluation in the described systemic sense is not a common approach in evaluation practice. The feedback loops and formats like focus groups or workshops are time-intensive and can hardly be realised in short-duration contracts.

– Secondly, clients and evaluators need to share the same intentions about the evaluation. Accordingly, they must agree on the participatory approach, which obviously requires a high level of transparency of information. An example is the accompanying evaluation of the German funding programme VIP ("Validation of the Innovative Potential of scientific research"). The programme is an innovative element in the German funding landscape which aims to bridge the gap between basic research and applied R&D for marketable products. One of the goals is to strengthen the knowledge transfer and valorisation culture at academic institutions. In order to achieve this, the evaluation set out to engage the target group (researchers at publicly funded institutions) in different formats to contribute to a more sustainable transfer culture.

– Thirdly, participatory evaluation generates challenges to principles of good practice of evaluation, as evaluators are no longer in the role of impartial observers but take an active part in generating impacts and shaping reality. Thus, defending impartiality, independence and credibility becomes a constant task for evaluators in a participatory setting.

– The INNO-Appraisal project[22] which compared a large number of evaluations across Europe has shown that formative evaluations, although quite numerous, do not exploit their full potential of actor involvement and learning: "Evaluations which are (at least partly) summative tend to be more often widely discussed within government and with participants/ stakeholders than formative evaluations. Even if the differences are not statistically significant, it appears the results of summative evaluations, with clear 'numbers' and messages, are better suited for wider discussion, while the virtue of formative evaluation is not so much their dissemination, but the learning within the process itself " (Edler et al., 2010, p. 78).

– Another result of the project is the insight that studying new impact types (as required by challenge-oriented programmes) is not as uncommon as one might think: Almost half of the studies cover social impacts, almost one third cover environmental impacts (Edler et al., 2010, p. 132). However, this high account is linked to the high number of structural fund evaluations

[22] Nota bene: Final Report of this EU funded project for *Understanding Evaluation of Innovation Policy in Europe* can be found online: https://research.manchester.ac.uk/en/publications/inno-appraisal-perspectives-on-evaluation-and-monitoring-contract, last access: 07.08.2025

in the sample, and the requirement by the European Commission as a sponsor to cover economic, social and territorial cohesion in the evaluation studies (ibid. 127, 136)

– The measurement problem for these new external impact types was already mentioned. A participatory approach is suggested here, however, the task of thinking about new measurement methods for social and environmental impacts in the future still remains.

– As for behavioural additionality, the INNO-Appraisal project again finds that a large number of evaluations use this concept (Edler et al., 2010, p. 127). Thus "behavioural additionality is mainly linked to direct economic impacts" (ibid p. 139), while social impacts such as the promotion of innovation mentality, changes of risk attitudes, the awareness of societal needs, acceptance of technology or attitudes towards entrepreneurship are studied more rarely with this concept.

– Moreover, "interestingly, and neglecting its full potential, behavioural additionality is not as common in accompanying evaluations as one would assume, given the focus on interaction and learning and the need to re-adjust programme and implementation should learning effects not be observed in real time. The concept is used in formative evaluations, but not as extensively as one would think" (Edler et al., 2010, p. 154).

These considerations show that there is still a large potential for implementing evaluation as a systemic instrument, and beyond this, as an instrument to evaluate normative and challenge-oriented programmes.

2.6.2 Foresight processes: Identifying strategic priorities through joint learning processes

Foresight processes set up strategic conversations among key actors of innovation systems, thereby providing platforms for joint learning processes, combining heterogeneous elements and ultimately "wiring-up innovation systems" (Martin & Johnston, 1999). In the context of innovation policy, Foresight is a systemic instrument par excellence. For more than a decade, European Foresight practitioners have been emphasising the benefits of the Foresight process for the learning capability of innovation systems. "Wiring-up innovation systems" through the "process benefit" of Foresight exercises was thought to be of equal relevance to the anticipatory intelligence arising from the actual findings of Foresight processes. Foresight, so it is argued, engages diverse actors in a joint learning process, thus creating future-oriented attitudes and linkages and therefore ultimately enhancing the responsiveness of the innovation system towards future challenges. Many Foresight processes in the

realm of research and innovation policy set out to define priorities for public support for research and innovation activities. In doing so, most Foresight exercises aimed at identifying "key technologies" and selecting the ones that seem most promising to underpin the competitiveness of domestic industry through prospective debate among key stakeholders (Salo & Cuhls, 2003). Typical examples are the French "Étude Technologies clés"[23], the Spanish "Ejercicio de Prospectiva a 2020"[24] and the Foresight process launched by the German BMBF from 2007–2009 (Cuhls et al., 2009). Such Foresight studies requested top experts to assess the contributions of key technologies to demand criteria such as quality of life, quality of environment and social cohesion. Even though these processes used societal benefits such as selection criteria, the demands themselves were usually taken as a given fact. Only few processes such as the German FUTUR exercise provided space for value debates and normative Foresight approaches. Thus, while the provision of orientation is an explicit goal of Foresight as an innovation policy instrument, the "orientation failure" inherent in the systemic instrument approach was reflected by most Foresight processes. Accordingly, the normative turn of innovation policy, on the one hand, and the changes in the nature of innovation that were described in the previous chapters pose new requirements for Foresight processes. In the FORLEARN process, that was set up by the European Commission through the JRC IPTS (Joint Research Centre Institute for Prospective Technological Studies) in 2006 in order to foster exchange and capture of Foresight knowledge across Europe (Da Costa et al., 2008), the need for more normative Foresight elements was highlighted.

- Another issue gaining relevance in the context of systemic instruments for demand-oriented innovation policy is the uptake of insights from social sciences and humanities. In many Foresight processes, societal evolution was tackled in much less depth than technological trajectories and engineers far outnumbered social scientists among Foresight coordinators and participants (P. Warnke & Heimeriks, 2008).

- Instead of "wiring-up" the known "key actors" of the innovation system in terms of different contributors to technological innovation, joint learning processes between technological AND societal innovators are required. Different socio-technical trajectories need to be debated and assessed. For this, Foresight processes need to reach out to civil society as a whole. Rethinking patterns that are deeply entrenched in our culture, such as the close knit between economic growth

[23] Étude Technologies clés 2010, online: http://www.industrie.gouv.fr/techno_cles_2010/html/som- maire.php (last accessed for the article on 4th May 2012)

[24] Estrategia Nacional de Ciencia y Tecnología (ENCYT) 2020. Ejercicio de Prospectiva a 2020, online: http://icono.fecyt.es/informesypublicaciones/Documents/ENCYT_prospectiva.pdf. (last accessed for the article on 4th May 2012)

and quality of life, requires much broader notions of 'stakeholder' or 'expert'. New, diverse actors such as social innovators, artists, children, immigrants, the global poor, animals and robots come into the picture.

- Both sides of the coin, the 'socio' and the 'technical', need to be tackled with an equal level of complexity. Social innovation needs to be factored in. Accordingly, expertise from the social sciences and humanities need to be recruited at an equal level with technology expertise.

- New methods are required in order to facilitate value debate and to imagine new working configurations. Analytical prospective methods such as scenario building, Delphi surveys and cross-impact analysis need to be complemented by methods that mobilise emotions and tacit assessments such as visioning processes or approaches from ethnographic design.

- Traditionally, Foresight exercises placed great emphasis on consensus building. However, to address Grand Challenges, consensus might have to be challenged in some cases. Addressing issues such as global climate change involves rethinking fundamental value notions such as global justice (Hulme, 2009). Foresight processes that seriously venture towards this challenge need to avoid premature closure on easy fixes and actively bring these conflicts into the open. In other cases, a greater diversity of solutions may have to be fostered in order to break out of lock-in situations (Könnölä et al., 2007).

- In several cases, transformative innovation will require rethinking established paradigms. Rather than extrapolating today's trends, we need to imagine change in the conditions of change in order to discover the transformative potential of the present (Miller, 2007). Methods that underpin exploration of new paradigms are likely to gain relevance (Schirrmeister & Warnke, 2013).

- Even though dialogue and, in particular, value debate and socio-technical scenario building are key elements of socio-technical transition, they are not sufficient to actually identify feasible transition trajectories due to the complexity of social systems. In order to understand real life processes of possible co-evolution between society and technology, we need experimental spaces at the nexus of social and technological change where "configurations that work" can actually be tried out. Foresight needs to extend the notion of "structured stakeholder dialogue" towards "collective experimentation" (Joly et al., 2010) and link up with appropriate instruments, such as transition and strategic niche management (Kemp et al., 2007), as already practised in the realm of sustainability transition. Methods from fields like participatory design (Buur & Matthews, 2008; Jegou & Liebermann. J., 2003; Jégou, 2009; Jégou & Vincent, 2009), lead user approaches (Herstatt & Hippel, 1992), behavioural economics and agent-based modelling may well have a role to play. Enabling

spaces for this type of experimental Foresight processes and collective solution-seeking, such as within innovation camps or living labs, may become just as crucial for the competitiveness of innovation systems as e.g. incubators and Fraunhofer Institutes.

Yet there is no Foresight process which fully reflects all these requirements. Still, several recent Foresight processes aiming to underpin challenge-oriented policy strategies show one or more of the above-mentioned characteristics:

The Netherlands Horizon Scan proposed priorities that are clearly socio-technical. Instead of settling on specific technologies, open value debates were initiated, such as "understanding what the 'greying' of society really means" or "transdisciplinary research on issues of changing human nature and societal responses in the face of medicotechnical research". The process drew on imaginative methods with one of the key results being presented in the form of a prime minister's speech. It was fully open to the citizens and used card games to foster wide public debate. A similar approach was adopted by the Danish Forsk 2015[25] Foresight exercise in Denmark which resulted in complex holistic priorities such as "health and well-being of animals and people and at the interaction of bio-production with, and impacts on, the surrounding society, environment and biological diversity". Other Foresight processes such as the Poland 2020[26], France 2025[27] and the Ireland 2025[28] exercises allowed for extensive exploration of social change as well as value deliberations. Finally, the German "BMBF Foresight Process" set out from a more classical technology push approach, but ended up linking emerging technologies with changing societal patterns in priority fields, such as "production consumption 2.0, human-technology cooperation" (Cuhls et al., 2009). In the follow-up process, the ministry explicitly emphasised an in-depth exploration of demand patterns and research in social sciences and humanities.

[25] The follow-up process Research2020 focuses on socio-economic challenges, online: http://en.fi.dk/research/research2015-and-research2020/research2015 (last accessed for the article 4th May 2012)

[26] Bendyk, E. (2009): Poland 2020. A Look from the Future. Alternative Visions of Poland's development based on the National Foresight Programme Poland 2020 scenarios. Online: http://www.nauka.gov.pl/filead-min/user_upload/Nauka/Polityka_naukowa_panstwa/Prognozy_rozwoju/20100104_Look_from_the_Future_wersja_wydrukowana.pdf (last accessed for the article 4th May 2012).

[27] Online: http://www.strategie.gouv.fr/article.php3?id_article=811 (last accessed for the article 4th May 2012).

[28] Online: Sharing our Future: Ireland 2025 – Strategic Policy requirements for Enterprise Development, online: www.forfas.ie/media/forfas090713_sharing_our_future.pdf (last accessed for the article 4th May 2012).

2.7 Conclusion

The trend of the increasingly acknowledged need of innovation policy to respond to the Grand Challenges of our time was the starting point of our thoughts. Today's challenges are defined as societal and environmental tasks and are perceived to trigger a normative turn in innovation policy, which is evolving into a major rationale for policy, besides economic growth and competitiveness. This new mission orientation, however, harbours several challenges in its own right: What are the implications of this normative turn in innovation policy for research and innovation? Is the heuristic of the innovation system approach able to incorporate normative orientation? What kind of policy instruments are needed to address those challenges? We have focused our conceptual thoughts in this article on this last question and discussed in particular whether current systemic innovation policy instruments are suited to implement a strategically oriented innovation policy.

Firstly, the normative turn creates new uncertainties, such as the need for researchers and innovators to define the contribution of their research to the Grand Challenges orientation. In the light of such challenge-oriented research, the importance of curiosity-driven research is a meaningful caveat, and a good balance has yet to be found. This "normative turn", however, implies more. Findings from innovation studies indicate that addressing the Grand Challenges requires a different type of research and innovation projects altogether. "Transformative innovation" is characterised by the following aspects: socio-technical, systemic, transition oriented, experimental, glocal, transdisciplinary and participatory.

Secondly, with all the refined understanding of innovation systems, the instruments derived from the innovation system approach are mainly directed at enhancing the innovation ecosystem in order to strengthen innovation capability. So far, there is no attempt to build on the innovation system heuristic in order to modulate innovation journeys towards certain desirable objectives yet. So whereas system failure seems to be addressed by the system heuristic, "orientation failure" still remains untackled. Accordingly, we propose that the innovation system approaches should draw on an orientation function as an integral element, in order to optimise innovation capability along the Grand Challenges orientation. The analytical and theoretical implications of national innovation systems analysis need to be widened from 'only' research and innovation to socio-technical solution-seeking and therefore capture social and technological innovation equally. Specifically, approaches that focus on technologies like the technological innovation system concept therefore seem less suitable to inform open, challenge-oriented learning processes where a wide range of solutions, including non-technical ones,

is taken into consideration. Particularly the active role of society as an innovative collective actor instead of simply “consumers and/or users” should be recognised.

Besides this consideration, we also see the need to further reflect on the potential and strength of “whole-of-government” policies. One prominent attempt in this regard is the German Hightech Strategy. The synergies that such a programmatic strategy can convey still need to be fostered in a more systemic manner. This statement also calls for the demand to further identify and analyse the ‘must-have’ features of political programmes and policy instruments in order to qualify as strategic measures at all. In our view, ‘strategic’ means more than simply goal-oriented and focused on the future. With regards to programmatic strategies like the Hightech Strategy, the term also implies a cross-ministerial, systemic effort at solution-seeking along the identified challenges.

Thirdly, based on these thoughts, we put forward some ideas and two illustrative examples of how systemic policy instruments would need to be further refined in order to address the strategic orientation of the system. The example of participatory evaluation shows how this systemic instrument could be complemented with the analysis of new impact types or behavioural additionality to account for a normative orientation of the policy programme considered. Similarly, foresight processes that explore innovation journeys in a holistic manner are a suitable orientation instrument.

More generally, these two examples indicate some common features which might apply to the question of how systemic instruments would need to be refined to address challenge orientation: They point out the value of participation and dialogue which, however, should not be restricted to stakeholders only, but reach out to society. Furthermore, technological aspects of innovation will need to be accompanied by societal aspects, meaning social impacts and transitions, or respectively, social innovations. Our considerations show the need to develop new methods, e.g. to measure new impact types or to mobilise and rethink beliefs, tacit assessments, emotions or behavioural patterns.

To sum up, we have suggested some straightforward, but as yet missing links for strategic and systemic policy-making. In particular, the examples of participatory evaluation and foresight have shown that it is not necessary to invent new policy instruments to address orientation failure; instead, we should exploit the full potential of existing systemic instruments. This may lead the way to implementing strategic policy-making, which for us is still a research desideratum in itself.

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3 Unboxing innovation policy strategies: an empirical exploration on objectives, coordination, and capacity

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"Modernity is complex (Niklas Luhmann), accelerated (Hartmut Rosa), and multiple (Shmuel N. Eisenstadt), it is shaped by capitalism, digitalization, and globalization, and it has vulnerabilities due to climate change, pandemics, global social inequality and threats of war and terrorism." (Busen, Weiß 2023, p. 5)

3.1 The puzzling observation: the emergence of national innovation policy strategies

In times of multiple crises, "vulnerabilities", and the need for the so-called twin transition – the transformation to a more sustainable and digital economy – science, technology, and innovation (STI) are expected to contribute to solving the grand challenges of humankind. Regarding the related policies, we observably entered an era of strategy that started in the mid-2000s. Nation states started to set up large-scale policy strategies to support innovation-related research and development (R&D) activities, which might generate solutions for existential problems[29]. But how do individual policymakers - from formulators at ministries to implementors at agencies- perceive this development and how does it alter their practical work? This contribution will focus on the perception and practice of individual policymakers working within or close to state authorities in Germany, Sweden, and the UK by an empirical investigation on guiding principles, coordination practises and strategic capacities of the involved actors concerning both: the formulation and enactment of STI policy strategies.

Among others, prominent examples of this policy phenomenon are the Swedish initiative Innovative Sweden – A strategy for growth through renewal from 2004 that was replaced by The Swedish Innovation Strategy in 2012, the British Innovation and Research strategy for growth from 2011 and Germany's four generations of Hightech-Strategies (BMBF, 2006, 2010b, 2014, 2019) with its successor: the recently introduced Future Strategy: Research and Innovation (BMBF, 2023b).

This development is not only restricted to Europe. For instance, the Obama Administration also established a national innovation strategy in 2009, "A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs," updating it in 2011. China also joins in this undertaking by establishing a National Medium- and Long-term Science and Technology Development Plan (2006-2020), considered the Chinese national innovation strategy.

[29] Furthermore, these strategies often put the focus (of the wording) on innovation, integrating the policy domains of science and technology as well, at times blurring the boundaries of the different areas from the observer's perspective.

The conceptualization of innovation strategy policies is not limited to nation-states, however. The release of "*The OECD Innovation Strategy*: *Getting a Head Start on Tomorrow*" in 2010 serves as an example of the engagement of an international organisation in that respect (OECD, 2010). Furthermore, the executive organs of the European Union, with their supranational institutional structures, have been involved in formulating an innovation strategy for quite some time. One milestone of this process was the Communication from the Commission *EUROPE 2020 - A strategy for smart, sustainable, and inclusive growth (European Commission, 2010)* that led, among other building blocks, to the formation of the *Horizon 2020 – Framework Program for Research and Innovation (European Commission, 2011)* just a year later. The aim of the latter was bringing "together all existing Union research and innovation funding, including the Framework Program for Research, the innovation-related activities of the Competitiveness and Innovation Framework Program and the European Institute of Innovation and Technology (EIT)" (2011, p. 2) in a combined strategy. Although all these policy strategies stem from different responsible authorities in different countries with diverse governance settings, they have multiple aspects in common.

The first apparent feature is the commitment to support STI, which should help solve the "Grand Challenges of our time" formulated in the Lund Declaration 2009. Accordingly, these "challenges must turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security." (Vetenskapsrådet, 2009, p. 1) This objective can also be found in the US Strategy, which ought to "harness science and technology to address the "grand challenges" of the 21st century" (Exe.Off. of the President, 2009, iif). Compared to the Lund declaration, the US challenges are vividly described as "developing solar cells as cheap as paint, building anticancer drugs that spare healthy cells, and fitting the contents of the Library of Congress on a device the size of a sugar cube." (2009, p. 5) This main feature of shifting the focus of STI policies towards an aspired more significant societal impact, however, is a complex undertaking: "While this re-orientation towards addressing challenges, which can be empirically observed, might be welcomed from a normative point of view, it poses significant challenges for the substance, procedural design and coordination of STI" (Lindner et al., 2016, p. 1).

Secondly, following the narrative on tackling those challenges, the innovation strategies all mention long-term goals, spanning over legislative periods or even generations, as the titles, for instance, Horizon 2020 and Hightech Strategy 2025, already indicate. However, adding time horizons to the strategies' headline does not necessarily result in formulating concrete milestones, specific timelines, and indicators to assess progress towards tackling these challenges in the corresponding strategy policies.

The third apparent standard narrative of the strategies is the cross-ministerial constitution of those goals, which implicitly and often also explicitly suggests that several ministries need to be involved in designing, formulating, and implementing the related policy instruments. Furthermore, they draw on existing measures and simultaneously add new policy instruments. Those inter-departmental efforts pay tribute to the cross-cutting character of innovation itself. According to Kaiser, commenting on innovation policy and its strategies of the mid-2000s, these "do not display a novel field of political actions altogether: It is rather the extension of a more traditional understanding of innovation policy as an "interchapter between industry policy as well as science and technology policy" (Meyer-Krahmer, 1989, p. 1), to a much more comprehensive policy approach (Borras, 2003)" (Kaiser, 2008, p. 8). This aspired inclusiveness of programmatic strategies is also proposed by a former OECD expert: "An innovation strategy […], has to take account of [cultural, geographical, legislative and regulatory] conditions to ensure that any interventions combine to contribute to the policy goals and do not weaken one another […] with emphasis on whole-of-government policies" (Gault, 2010, 92ff). More than a decade after Gault's observation was published, the "European Commission, in close collaboration with the European Research Area Committee delegates, launched a Mutual Learning Exercise on the application of a whole of government approach (WGA) to the design and implementation of national research and innovation policies."[30] In practical terms this means that the above mentioned observation has turned into a policy exercise and monitoring practise within the EU (European Commission. DG Research, 2023a) to support the policy design of emerging innovation countries such as Bulgaria (European Commission. DG Research, 2023b).

Fourthly, all strategies went through an editorial process that involved actors of the political and administrative sphere, e.g., different departments, parliament in general, and research and innovation agencies, which had to activate their institutional capacity working towards a joint agreeable document in terms of content (e.g. policy instruments and their direction) and linguistic style (e.g. fitting narratives to instruments). A further observation is thus: through the joint editorial processes, national strategies serve as means to coordinate and navigate towards compromises within the "ingroup of policymakers", as well as an end of communicating action towards the "receiving end" of the associated policies like, e.g., research organisations, companies, and universities. If these activities also involve a concise design, formulation, coordination, and implementation of the associated policy measures, which would also rely on specific strategic capacities of policymakers, is yet an open question.

[30] ttps://op.europa.eu/en/publication-detail/-/publication/c6f35ad2-be33-11ed-8912-01aa75ed71a1/language-en, online last accessed 26.11.2023

Although the "humble observation" of Borras and Edler can still be shared today, that „ how the change in socio-technical systems and innovation systems (ST&I systems) is actually governed remains understudied in the social sciences" (Borrás & Edler, 2014, p. 2), this contribution falls short of comprehensively analysing the actual content and execution of the national strategies. It will instead explore the perceptions and understandings of the "ingroup of policymakers" – representatives and officers at the ministries and agencies – concerning the complexity of shaping and the ability to (possibly) orchestrate policy communities towards change. Furthermore, the observation that "scholars in STS (science and technology studies), economics and political science disciplines have been concerned with the complex micro- and macro-level dimensions of the relation between science/technology and society/economics/politics and their mutually shaping interactions" (ibid.) is shared by the author. Hence, this contribution will focus on the perception and practice of individual policymakers (from formulators at ministries to implementors at agencies) working within or close to state authorities, which has mostly not explicitly gained attention by the scholarly community yet. As the term governance has raised the gaze on the meta-level for the past two decades of policy analyses, serving– among other crucial aspects – as a general cypher for the complex interplay of individual and collective actors in socio-technical systems, including the politico-administrative sphere[31], the perspective of policy practitioners has been slightly neglected, which poses the question: is scholarly theory building running ahead of policy practice? Linked to the modest hope to contribute to shortening this assumed distance between action and analyses by focussing on the individuals' perspective, this contribution aims to examine the following questions through an empirical analysis of a solid body of fifty-three qualitative guideline-led interviews with policymakers (ministries, research and innovation agencies, or research councils) involved:

- **Why** did the government decide to launch a national innovation policy strategy?
- What are the **guiding principles and policy objectives** underlying the national strategy as perceived by individuals formulating and implementing the strategy?
- What patterns can be identified regarding the **coordination and cooperation** of the actors implementing the strategy?

[31]Another observation supporting this argument is "Innovation policy governance, arguably very important for the design and implementation of effective innovation policies, is an under-researched topic, on which more work, benefitting from an interdisciplinary perspective (including political science/public administration), is needed" Edler and Fagerberg (2017, p. 17)

- Does the formulation and implementation of the national innovation strategy require **specific "strategic" skills and capacities** from the actors, and what are they?
- Which **obstacles** for (impactful) strategies and **most urgent systemic challenges** do the involved individuals identify?

The remainder of this contribution is organised as follows: a compact discussion on strategy as a research object in policy science (drawing on literature from the period of the first occurrence of national strategies and the current debate on MOIP, as distinct features of some strategies) in chapter 3.2 will aid to finetune the categories for the empirical work. Chapter 3.3 will further elaborate on the research design and choice of the three country cases, followed by the central part (Chapter 3.4), presenting the empirical analysis and interpretation. Chapter 5 concludes the findings and points out further avenues for research.

3.2 Policy strategies as an object of study

Reflecting on the above-mentioned questions the overall interest of this contribution is: what kind of incidents are national STI strategies? Are they a new approach to systemic policy making, traditional policy instruments with new headlines, simply a public relations coup or something in between?

Drawing on Swedberg (2012) like Borrás and Edler (2020), in their recent work on the transformative role of the state, this contribution can be seen as a "pre-study and early discovery phase" (Swedberg, 2012, p. 10) of the phenomena of national STI policy strategy: "that is, an analysis based on consistent insights from empirical observations that serve to conceptualise (and eventually theorise) about a phenomenon that remains understudied (…) [like national STI strategies]." (Borrás & Edler, 2020, p. 2)

This pre-study is such an "attempt to understand and explain something that happens in society" (Swedberg, 2012, p. 14) guided by the first two rules formulated by Swedberg (p.17, original in bold and italics)

„***Rule # 1 Observe - and Choose Something Interesting:***

You can only theorize on the basis of observation. Anything that can stimulate to a full view of the phenomenon should be used, from sturdy scientific facts to art in various forms. "Don't think but look!" (Wittgenstein)

Rule # 2 Name and Formulate the Central Concept:

Give a name to what you observe and try to formulate a central concept based on it.“

After parts of the academic literature on “strategy as an object of study” has been taken into account and categories for the analysis are formulated (3.2.1), these rules will serve as guidance for the empirical investigation that will recapture public policy practices of national STI strategies (see 3.3.2 and 3.4).

3.2.1 Strategies in STI studies prior to the New Mission Era

So far, policy scholars have not yet systematically addressed documents of national innovation strategies as an object of study but “strategic policymaking” **as different models for directed actions focusing** on fostering certain technologies in different contexts. One elaborate attempt, for instance, to develop an analytical model to explain (and support) radical innovation is Strategic Niche Management (SNM), which is rooted in evolutionary innovation economics and operationalized by transition literature and works – among other aspects – with societal experiments and Social Network Theory (i.a. Hoogma et al. 2002). The concept of SNM does – under certain circumstances – include recommendations to policymakers about strategically supporting a certain technological niche, although it is not yet profitable. „[Formulating] [...] a quasi-evolutionary perspective on technical change [...] Rip and Schot [argued] [...] that variation is not blind, as is assumed by many evolutionary economists, but directed to some extent. Technology actors not only anticipate future selection but also try to shape the selection process itself by setting up special programs in R&D settings or demonstration projects.“ (Schot & Geels, 2008, p. 539)

However, the SNM approach offers helpful hints in terms of policy strategies about directionality. This term intends to describe the circumstance, that “transformative change not only require that innovations be generated as efficiently and effectively as possible, but also that these innovations contribute to a particular direction of transformative change.” (Kallerud et al., 2013, p. 2) However, due to its rather narrow perspective on a specific technology or a technical solution (and the corresponding niche or technological regime according to the heuristic), the SNM approach does not necessarily help to explain or conceptualize support for non-technological drivers and the societal embeddedness of national strategies. A more systemic view in connection with clear goals is put forward by transition management models (Loorbach, 2007, 2010) as emphasized by Weber and Rohracher (2012) in their attempt to formulate different framings legitimizing policies for transformative change: “(…) transition management is about innovation and transformation of the systemic context itself and about strategies

to direct this system transformation towards particular **goals** (which in many concrete cases is approximated by the notion of sustainability)." (2012, p. 1039)

Furthermore, since "the model of transition management tries to utilize innovative bottom-up developments more strategically by coordinating different levels of governance and fostering self-organisation through new types of interaction and cycles of learning and action for radical innovations offering sustainability benefits" (Kemp et al., 2007, p. 3) it does provide a more pronounced perspective on **actors** with a focus mostly on the self-organizational part by non-government actors. According to another stream of literature focusing on innovation governance, the analytical criteria for strategic innovation policy are the „existence of an explicit **political vision and priority-setting**; Evidence that the vision and priorities are transposed to the choice, design and implementation of innovation policy instruments."(Borrás 2009: 15) Certainly a clearly expressed vision and corresponding priorities is a major aspect of national policy strategies and often stated in the documents. However, expressing visions does not necessarily mean policymakers always design and implement new policies to address these "corresponding priorities"; they often stick to the already existing measures: "[…]public policies, just like innovations, display irreversibility and path-dependency: they are adopted not on a tabula rasa but in a context of pre-existing policy mixes and institutional frameworks which have been shaped through successive policy changes." (Flanagan et al. 2011:708). Accordingly, the question arises if national innovation strategies are **integration constructs**? And are they "intended to „rationalise" multiple goals and then combine policy instruments in new ways […]" like Rayner & Howlett, 2009, suggested when introducing the concept of *Integrated Strategies* after working on large scale policies for (mainly) environmental protection such as National Forest Policies or Integrated Coastal Zone Management. These programs "attempt to *integrate* existing, and sometimes competing, policy initiatives into a cohesive strategy; to *coordinate* the activities of multiple agencies and actors; and, generally, to substitute a *holistic approach* to a problem for one that has decomposed policy into a set of multiple and apparently unrelated problems and solutions (Briassoulis, 2004; 2005; Stead et al., 2004)." (Rayner & Howlett, 2009, p. 101). Furthermore, policy integration was identified as a phenomenon or, better – necessity - marking the development from environmental policy plans to the very first Sustainable Development Strategies (Meadowcroft, 2007; Steurer, 2007), which also feature "addressing cross-sectoral challenges" just like innovation strategies. Steurer also highlights the importance of administration in that respect:

> "Both scholars and practitioners address the issue of policy integration often by discussing particular policy instruments (such as Environmental Fiscal Reforms) or mechanisms (such as inter-ministerial coordination structures) rather than by exploring new, more appropriate patterns of governance or administrative narratives in general. However, since policy integration strongly depends on better coordination on the administrative level of

> government, I advocate that the challenge cannot be met without an adequate administrative pattern in place." (Steurer, 2004, p. 2)

Since most STI policy strategies also rely on "**inter-ministerial coordination structures**", according to the document analysis (see 3.7 for an overview on the strategy cases) this impetus for sound and effective coordination routines is worth investigating when looking at the core aspects of national strategies. Furthermore, the holistic claim of a national strategy might benefit from the individual yet systemic perspective Raschke and Tils put forward with their groundwork publications on the matter (Raschke & Tils, 2007, 2010, 2011). They describe "Political Strategy"[32] of individual and collective actors as "success-oriented constructs, which rely on cross-situational calculations that consider the goal, the means and the environment." (Raschke & Tils, 2007, p. 127) These calculations constitute furthermore "directed, systemised and *calculated considerations* (calculations) that aim at *desired conditions* (goals) for targeted *options for action* (means) by taking into account the cross-situational, *relevant context* (environment)." (2007, p. 129, original in italics, own translation) Keeping this definition in mind, it is also proposed that policymakers cling to a certain "orientation-scheme [...], that guides their actions throughout the entire process of the strategy-making, therefore when developing strategic capability[33], designing strategies and in strategic steering processes." (ibid., p. 80) The latter might even be the very crucial core of an innovation policy strategy since its overall impact relies on the answer to whether or not steering processes towards solving the grand challenges by STI activities can a) even be enacted by a single or collective core actor such as a ministry or government cabinet and b) are carried out successfully aiming at a certain target and direction. Supplementary, Raschke & Tils connect to the aspect of belief systems, in their words "orientation-scheme", which according to Sabatier & Jenkins (2010) relates to sets of priorities, values and causal assumptions, which would need to approve and incorporate the overall strategic demands.

Another crucial aspect is the dynamic process dimension: to set up a meta-scheme for policy measures that foster environmental innovation, Quitzow distinguishes similar elements of policy strategies and points to the recursive process dimension and the importance of strategic capacity: "The process of strategy development and implementation is an ongoing and iterative process, which requires

[32] Even though the focus of Raschke & Tils lies on „political strategy" not „policy strategy", which in German words can be more distinctly described as „politische Strategie" not „Politikstrategie", their conceptualisation is still useful in this context.

[33] Strategic capability in this context is defined as the „distinct ability for target tracking […] which is not only the cognitive capacity, but also the strategic capacity for action of an (organized) collective actor [like a party or ministry]". Raschke and Tils (2007, p. 274)

continuous and systematic review and adaptation of policy measures (**Process dimension of strategy**)" (Quitzow, 2012, p. 9)

3.2.2 National STI Strategies and mission-oriented innovation policies: two sides of one coin?

A key motivation for the investigation of national innovation strategies is the observation that this policy phenomenon, first occurring around the mid-2000s appears to be the comprehensive commitment to achieve both meta-targets of contemporary societies by STI policies: solving grand challenges associated with fundamental and systemic threats like climate and demographic change while simultaneously enabling economic growth and prosperity. Around the early 2010s, however, the notion of new mission-oriented innovation policies (MOIP) - sometimes just referred to as missions - respectively, entered the political arena and seems to have taken over the vivid debate on strategic policy making and policy strategies that had just gained momentum (Gault, 2010). Since MOIP and innovation policy strategies share the same motive – (a) grand societal challenge(s) – and ambition in terms of "addressing" (ideally solving) it/them by STI to facilitate real transformative change, it is plausible to argue that each mission is a policy strategy in its own right. MOIP – be it *fighting cancer*, an example from Germany's Hightech-Strategy 2025, or the *Industrial Clusters Mission*, an example from the UK strategy of 2019[34] claiming to "establish the world's first net-zero carbon industrial cluster by 2040 and at least one low-carbon cluster by 2030" – obviously have to establish, train and pull together their own set of policy capacity, instruments, budgets, target groups, and evaluation practices.

The point is: MOIP and national innovation policy strategies stem from the same core understanding, that STI are mostly publicly financed to provide solutions for the most pressing challenges if drafted accordingly (Foray et al., 2012; Kattel & Mazzucato, 2018; Mazzucato, 2017; Robinson & Mazzucato, 2019). And both types of initiatives do – more often than not – follow similar policy principles and practices pursuing a specific direction. Nevertheless, national strategies in addition encompass more general targets like increasing skilled labour or strengthening knowledge transfer between heterogeneous actors to secure economic growth and prosperity. MOIPs are ideally more focused on constructively contributing to the solution of an explicit societal challenge and are embedded in specific socio-technological systems that they seek to change or adapt to new circumstances or conditions (Wittmann, Hufnagl, Lindner, et al., 2021; Wittmann, Hufnagl, Roth, et al., 2021a). MOIPs - as critical

[34] https://assets.publishing.service.gov.uk/media/5ce3c654ed915d247e03364c/industrial-clusters-mission-infographic-2019.pdf , last accessed online: 29.11.2023

elements of most national innovation strategies today - can therefore be interpreted as carriers of attempted directionality[35].

But as Wanzenböck et al. (2020, p. 484) have recently argued, "the policy discourse about directionality and mission-orientation insufficiently considered the contextuality of societal challenges related to different views on both the problem and the solution." Following this argument it might be the case that there is still a missing embeddedness - or better resonance - of STI policies within the group of addressees of the associated funding programmes as well as society due to the fact that the complexity of steering towards change via STI measures has been underestimated right from the very beginning in the mid-2000s (see 3.4.2. for an empirical perspective on this statement). Furthermore, Janssen et al. offer another impulse to the MOIP debate by describing them as boundary objects:

"This entails bridging understandings of missions as a guiding principle in strategic policy debates—where stakeholders engage with the MIP [Mission Innovation Policy] concept but adapt it to their particular challenges—and the actual implementation of the mission they formulate. We argue that to facilitate the so far troublesome operationalisation of MIPs, what is necessary is not a very prescriptive set of design principles, but instead understand missions as 'boundary objects' (BOs) around which heterogeneous communities—comprising but not limited to policymakers—gather and craft together shared understandings of what is at stake, what means are necessary, and what processes should ensue." (Janssen et al., 2023, p. 399).

This concept states a workable, flexible concept but does allow for the interpretation: missions have simply not yet lived up to their expectations. One can think of many reasons in addition to Wanzenböck et al. why this promising concept does – so far – not unfold its full potential, but the expectation and excessive demand for real transformative change by the STI activities fostered by MOIP have been enormous right from the beginning and "their effectiveness [...] is still be proven" (Larrue, 2021, p. 12). Therefore, the empirical material and analysis of this contribution will return to the initial phase of national innovation strategies and their missions (the period from 2006 – 2014) to investigate where this overload, or missing expectation management towards the transformative power of this policy field might be rooted.

[35] Discussing the concept formation and current use of the term *directionality* would exceed the scope of this contribution. But just like Andy Stirling in his presentation at the Eu-SPRI general conference in 2023 vividly demystified the term "political roadmap process" for prioritising support for technological infrastructure ("They are always linear, what does that have to do with a real roadmap?"), one might question the meaning and potency of the popular term directionality as a catch-all phrase for (ideally) steering towards a holistic direction of change, somehow calling into question that policies before the era of MOIP had a direction at all.

3.3 Choice of cases & qualitative analyses

To try to recapture public policy practices around national innovation strategies, guideline-based interviews and their qualitative analysis was chosen to gain two main insights. Firstly, the focus on the perception of the practitioners in charge will serve to identify the spirit and goals of the strategy and its underlying processes from an empirical perspective reaching beyond a document-based analysis and the headlines of communication material. Secondly, discussing the past views and future opportunities for strategies and their elements by interpretative reasoning and theorizing of the learnings will help to identify recommendations not only for future policy strategies but also for further research on the matter. Or in the words of Lowi from the early days of policy analysis: "[...] if we can discover empirically the policy conditions underlying our political patterns, we have a basis for better public policies as well as better political science" (Lowi, 1972, p. 309).

3.3.1 Choice of cases

To find tentative answers, three countries have been chosen for further investigation, namely the UK, Sweden, and Germany. The selection is based on two reasons, first the pragmatic aspect of timing, as these countries established strategies roughly around the same time and have been renewing them with every change of government[36] while being members of the European Union at the time when the interviews were conducted. The second reason is related to the strategies meta-targets of enabling economic growth and prosperity while possibly following (slightly) different normative assumptions considering regulatory policies and the role of the state as such. On that account it is useful to also select the cases along the Varieties of Capitalism heuristic (Hall, 2001; Hall & Gingerich, 2009; Hall & Soskice, 2001). While acknowledging the original focus on firms and its general contestations (Hancké, 2013), according to Streeck it still enables “considering capitalism as an institutionalized social order. Conceiving of capitalism as a social order draws attention to the micro-dynamics of its enactment and re-enactment within a specific context of instituted constraints and opportunities.” (Streeck, 2013, p. 3). Therefore, the UK is chosen as an example for a (sort of) Liberal Market Economy which, in the aftermath of the financial crisis in 2008, is trying to recalibrate and improve its knowledge and technology transfer from science to businesses. Sweden serves as a small state example representing a (sort of Scandinavian social democratic) hybrid economic system (Crouch, 2013), with a prominent

[36] The political systems however, UK Westminster Democracy with monarchy, Sweden parliamentary monarchy and Germany a parliamentary democracy with a strong federal system, will not play a role in the investigation.

division of labour between the ministerial authority and appointed policy implementors in agencies. Whereas Germany is considered a (sort of) coordinated market economy (CME). Even though STI policy strategies are not (solely) focussed on firms and market creation, this heuristic is still helpful in choosing the cases, since the "institutional complementarities" (Hall & Gingerich, 2009) within national economies and the support and commercialization of "the new" is crucial. Summarizing his empirical investigations, Wood, outlines why this might be instructive for public policy: „In an LME [Liberal Market Economy], where relations between firms are mediated by markets, the state will be more effective if it restores and 'sharpens' market mechanisms. In a CME [Coordinated Market Economy] effective policy consists in supporting the institutions and networks of coordination that connect companies." (Wood, 2001, p. 274)

3.3.2 Sample of interview partners and method

All interviews were conducted via online calls (via Skype) and all interview partners agreed, that the exchange was recorded and transcribed. The shortest conversation lastest 27, the longest 118 minutes, and all interviews took place between March 2013 and April 2014. All respondents were contacted by the author by email first. German representatives were identified via the organizational charts of the ministries, e.g., the Forschungsbeauftragte (representatives for STI) of each ministry, or by personal recommendations of colleagues. Swedish and British interview partners were identified by direct inquiry via the ministries or agencies' contact offices or by personal recommendation. As for the selection of the interview partners regarding Sweden and the UK, the sample contains both representatives of the ministries in charge of the strategy documents and employees of the agencies, responsible for formulating and implementing the corresponding policy instruments, mostly Vinnova for Sweden and the Technology Strategy Board (now Innovate UK) for the UK. Though Germany also employs agencies to implement and administer policy instruments, the hierarchical structure of decision-making is very different from the other two cases (see 3.4.4 for further elaboration) and is mainly limited to the ministries themselves.

Germany 17 Interviews: 3 women, 14 men	United Kingdom 18 Interviews: 6 women, 12 men	Sweden 18 Interviews: 7 women, 11 men
Ministries		
8 x Federal Ministry of Education and Research 3 x Federal Ministry for Economic Affairs and Technology[37] 2 x Federal Minister for the Environment, Nature Conservation, Housing, and Reactor Safety[38] 2 x Federal Ministry of the Interior and Community 1 x Federal Foreign Office 1 x Federal Ministry of Food, Agriculture and Consumer Protection[39]	6 x Department for Business, Innovation and Skills (BIS)[40] 1 x Academic, seconded to BIS (co-author strategy)	4 x Ministry for Enterprise[41] 2 x Ministry of Education and Research
	Agencies, Research Councils & Associations:	
	7 x Technology Strategy Board[42] 2 x NESTA (National Endowment for Science, Technology, and the Arts): Innovation Agency for the Social Good 1 x Research Council 1 x PERA Int. Research Association	8 x Vinnova (Innovation Agency) 2 x Tillväxtanalys (Swedish Agency for Growth Policy Analysis) 2x Vetenskapsrådet (Swedish Research Council)

Table 3: Sample of interview partners

Considering the qualitative analysis, the three focus areas

I. Frameworks for policy making – guiding principles and characteristics of the strategy

II. Policy practices – coordination and cooperation pattern of the strategy

III. (Strategic) capacities – skills and capacities of the involved actors

were set deductively from the scholarly literature (3.2.1) and the strategy documents (see 3.7) and built the first hierarchical code structure. The further sub-categories (30 in total), such as *process*, *benefit*, or *monitoring* as selected examples, were formulated in a second order according to the content of interview passages marking observable recurring incidents (inductive categorization).

[37] In 2023: Federal Ministry for Economic Affairs and Climate Action

[38] In 2023 Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

[39] In 2023 Federal Ministry of Food and Agriculture

[40] In 2023 Department for Business, Energy & Industrial Strategy

[41] In 2023 Ministry of Climate and Enterprise

[42] In 2023 Innovate UK

Furthermore, a third order of categories (around 110) was established along the material that explicitly further conceptualized the codes or quotes. One example from the segment of monitoring is the "need for new indicators". To ensure a focussed and systematic analysis of the qualitative interviews, the established methods and routines were followed (Kuckartz, 2014; Mayring, 2014; Rädiker & Kuckartz, 2020), with a particular focus on the coding techniques advocated by Corbin and Strauss (2015). The software MAXQDA 2022 was used for the analysis. As the potential for conceptual and practical reflections on the gathered empirical material is vast (1512 individual quotes)[43] the paper focuses on the five core questions listed in Chapter 3.1 (the interview guideline can be found in the Annex).

3.4 National innovation strategies: productive features and excessive demand

The practise of national innovation policy strategies dates to the mid-2000s when Sweden (in 2004: *Innovative Sweden*) and Germany (in 2006: *Hightech-Strategy*) introduced their first policy documents; while the British White Paper "Innovation Nation" (also published in 2006) was the first conceptual attempt towards a policy strategy which was ultimately introduced in 2011 (*Innovation and Research Strategy for Growth*). Figure 3 depicts the evolution of the strategies since 2004 and displays two observations on frequencies: firstly, German subsequent national governments introduce a new strategy after each election with a distinct corporate design and elaborate communication campaign; secondly, both British and Swedish governments have so far published a new strategy every ten years (and leave the implementation and further elaboration of workable concepts and policy instruments to agencies, notably the British Technology Strategy Board[44] and the Swedish Innovation Agency Vinnova[45], both non-departmental public bodies, and research councils).

[43] Further topics for possible future investigations include the interviewees perspectives on different policy instruments and mixes applied, on monitoring and impact assessment, the role of advisory committees and division of labour between research councils, agencies etc., agenda setting between the EU and the nation states, project and program planning, time horizons and strengthening the role of companies in innovation policies.

[44] The British Technology Strategy Board (TSB) was established as a separate organisation in 2007 and is a non-departmental public body sponsored by the Department for Business, Innovation and Skills. In 2014 the TSB changed its name for communication purposes into Innovate UK which is part of UKRI, but the legal name TSB still exists.

[45] The Swedish agency Vinnova was established in 2001 and is a government agency under the Ministry of Climate and Enterprise, and the national contact authority for the EU framework programme for research and innovation.

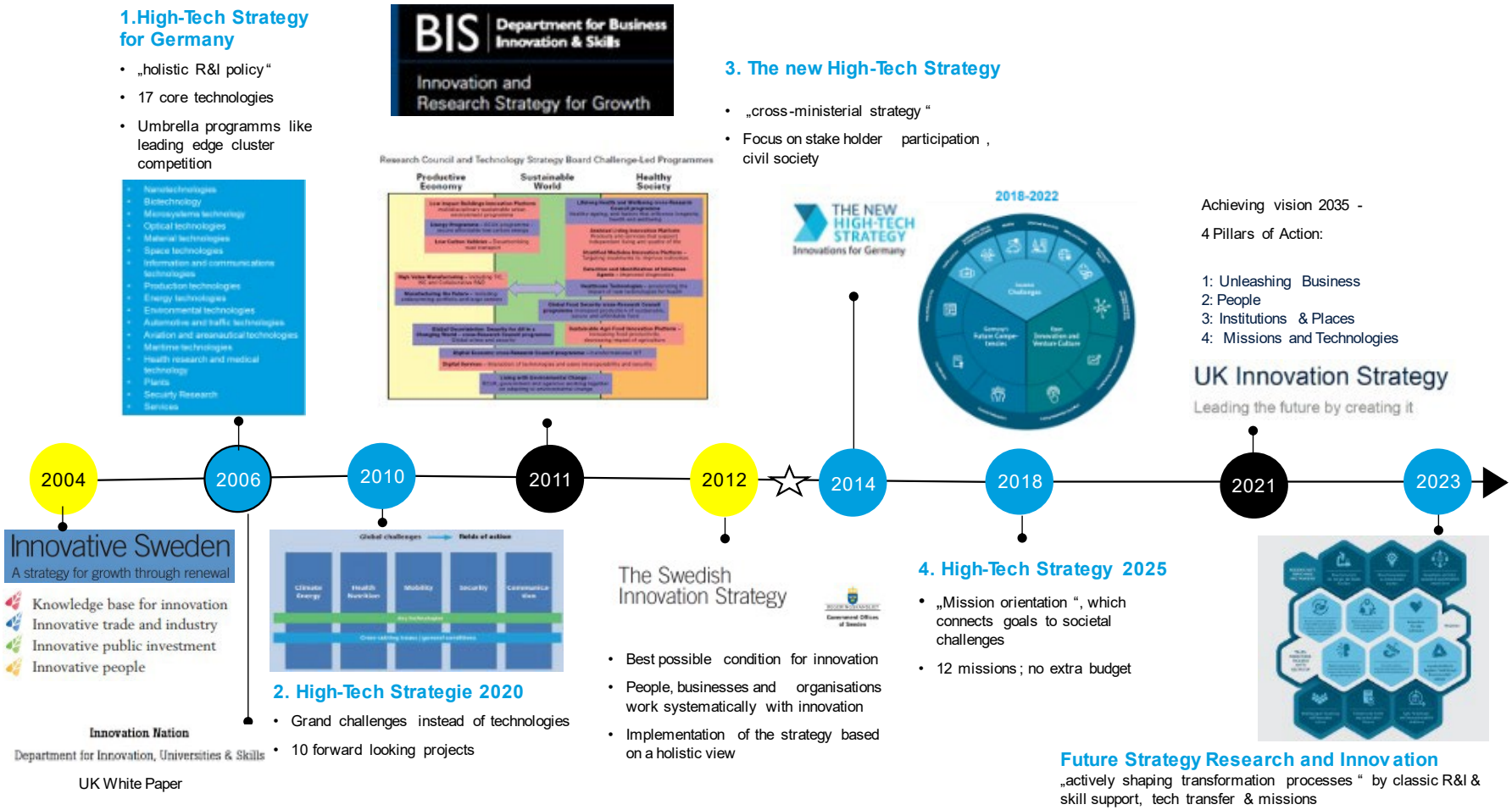

Figure 3: Timeline of national innovation policy strategies in Germany (blue), Sweden (yellow) and UK (black)[46]

[46] The star indicates the interview period between March 2013- April 2014

Since the analytical focus of this contribution lies on the qualitative analyses on the perception and practise of public servants in ministries and agencies, a detailed document analysis was omitted but a comprehensive presentation of main strategy categories can be found in 3.7.. Because the empirical material was gathered between March 2013 and April 2014, the interview partners refer to the policy practises and documents from this period (as indicated by a star on the timeline in Figure 3), notably: The *German Hightech Strategy 2020* (BMBF, 2010a), the British *Innovation and Research Strategy for Growth* (BIS, 2011) and *The Swedish Innovation Strategy* (Swedish Ministry of Enterprise, Energy and Communications, 2012). As a starting point for the analysis, the vision statements have been selected to showcase the policy ambitions and foci (see Table 4). All of them attribute an influential and forward-looking role of the state with the idea of market creation and growth, with the German example advocating to "find solutions to global and national challenges" by joining scientific and economic forces, the British clearly stating intervention actions by its agency "when the market is unable to foster innovation alone in critical technologies or sectors" and finally the Swedish pointing out the creative economic potential of all regions by stating that "People in all parts of Sweden can and want to contribute to creating value".

Vision Statement	we want to stimulate **Germany**'s enormous scientific and economic potential in a targeted way and find solutions to global and national challenges. Germany must continue its efforts to open up promising lead markets through innovation, develop these markets through social changes, and thus secure material, cultural and social wellbeing. (BMBF 2010a, p.3)
	UK: This strategy is based upon an understanding that Government can be an important driver of innovation. We will support independent bodies, like the Technology Strategy Board, to intervene when the market is unable to foster innovation alone in critical technologies or sectors. More commonly, we will work with the grain of the market by getting rid of unnecessary red tape, making public sector data more accessible and establishing a fund to run inducement prizes in areas where innovation is needed. (BIS 2011, p. V)
	Sweden is a creative country characterised by pioneering ideas and new ways of thinking and doing in order to shape our future in a global community. People in all parts of Sweden can and want to contribute to creating value for people, the economy and the environment through new or improved solutions. (Swe. Min. EEC 2012, p. 13)

(BIS, 2011; BMBF, 2010a; Swedish Ministry of Enterprise, Energy and Communications, 2012)

Table 4: Vision Statements of National Innovation Strategies

3.4.1 Contextualisation and motivation

Considering the historical process and motivation to formulate and implement a national innovation policy strategy most interview partners argued that there was a general supranational European consensus and expectation that STI should aid solving the "grand societal challenges" of our time. To ultimately tie in with this grand narrative – particularly in the wake of the Lund Declaration in 2009 and the Europe 2020 strategy introduced in 2010 – a new, committed and encompassing policy statement was needed. An interviewee from Germany shares the belief that expanding the expectation on STI contributions towards solving global challenges in (Western) European industrialized countries is an effect of the past 30 years prior to the turn of the century that the narrowed view on regional environment problems was complemented by the perception of global threats and solutions that cannot be solved by single states:

> "*In the 1970s we had regional environmental challenges and followed slogans like: the sky above the Ruhr must turn blue again. […] [Nowadays], we have nearby national environmental problems like air pollution, water pollution, waste disposal reasonably well under control. […] But the global environmental problems that violate the sustainability goals are still a long way off and we can only solve them as a world community. The discussion about global climate change, global environmental changes have become more important, in recent years*." (GER_5, Pos. 23)

Furthermore, the understanding of innovation as - exceptions prove the rule - a result of cross-cutting (or even systemic) activities and decades of interplay between policy and academia in connection with the associated scholarly analysis and debate about heuristics of *national, regional, sector and technological systems of innovation* (e.g. Braczyk et al., 1998; Carlsson, 1995; Edquist, 2005; Lundvall, 1992; Malerba, 2002; Nelson, 1993) had led to a political recognition and willingness to address the involved actors from science , society and industry in a more holistic manner (Warnke et al., 2016). As the following selected statements illustrate, the believe in the combined forces of the "overall system" is shared among the three cases, with the British ministerial servant pointing out the need to better align their excellent research base at universities with the overall system and the lack of support for development and commercialisation aspects so far:

> "*And the other motivation for the strategy is, we want to improve the national engagement of the overall system: UK universities are very good in engaging with founding programs, they are very international within the academic system. But that's academic research, UK has not been very productive in innovation. It is not supporting*

RnD and business, the commercialisation, technology. And yet we also have huge geographical disparity in the UK." (UK_1, Pos. 26)

A similar, yet reverse, take is expressed by a Swedish ministerial representative, thus taking the business focus of innovation policy as the perspective that needs to be broadened:

"*So, we decided: let`s do a comprehensive innovation strategy and take the global challenges as a point of departure. We cannot look at innovation only from the business sector. We must put another focus, […] as a tool, as a perspective and as a venue where different organizations, different perspectives, different resources, and competences can meet and combine to develop these new solutions that the society needs and that will also lay the foundations for the future competitiveness. […] We received quite some heavy criticism for not being focused enough […]. Then again, my response to that was, that we have made a very well underpinned strategic choice for an all-inclusive innovation strategy.*" (SWE_15, Pos. 41-43)

Furthermore, a kind of spill-over effect of the academic debate on the systemic nature of innovation, coupled with the perception of positive experiences in other nation states was notably one of the driving forces of the holistic narrative behind the German strategy, according to a ministerial representative who was involved in the formulation, design and implementation of the first strategy:

"*I would attribute the [aspired] systemic approach of the Hightech-Strategy to two motivations: On the one hand, there was a lot of advice from the scientific community, […], that innovation was increasingly understood as a holistic activity, and it became acceptable to ask for a policy strategy in one casting ["aus einem Guss"]. All the buzzwords of systemic policy, which had already been circulating since the nineties, were increasingly negotiated in Germany and in some cases already played a role in other European countries. I do not remember exactly when - among others - the Finns started, around 2002, 2003...insofar, and this is the second reason: there were already successful examples in the OECD."* (GER_11, Pos.10-11)

In addition to observing motivational similarities, a look at the **specific national circumstances** at the time, when the first strategies were introduced, will provide insights that mirror the expectations on the effects and long-term impacts of the strategies right from the start. Staying with the German example, the public servant provides more anecdotal insights about consensus in cabinet and personal engagement by the chancellor at the time, that research should be given higher priority and

"[…] *the policy field should receive more attention and political ambition. This upgrade was pursued by both, Ms. Merkel and Ms. Schavan [NB: Research Minister at the time], as a tandem. To achieve this, it had to become a policy field, which was expanded from*

the narrow client base of science towards a broader public including industry." (GER_11, Pos.14)

An additional perspective refers to the political consequences and task readjustment enforced by the Federalism Reforms I and II in 2006 and 2009. These were concerning the legal and budgetary responsibility for research and education between the German Länder and the Federal Government. The loss of most of the already limited shared responsibility for education on Federal level is identified as another driving force for the establishment of the Hightech-Strategy by the BMBF, since "*This research ministry [BMBF] looked like a plucked chicken. Plucked most recently by the federalism reform, among other things. Because the education sector was finally torn out of its plumage, for good. Such a ministry - for its raison d'être alone – must reposition itself.*" (GER_8, Pos. 25)

Taking the lead in a national strategy that sets out to foster technology and innovation meant repositioning the Ministry for Research and Education as a more important actor regarding not only the future economic development but also an elevated role by caring for key services of general national interest in the areas of e.g., health, energy provision and security. As one observer of the negotiations puts it in retrospective, "*they [BMBF] clearly moved from being a discussant at the table of societal demand to a powerful actor. And we all moved from addressing issues no longer from the supply side of new technologies. This [NB: roll out of the strategy] was really a shift towards societal demand pull and no longer the classic technology push situation.*" *(GER_12, Pos. 47)*

With a strong focus on the financial service sector and a relatively low amount of producing trade the British economy, and particularly London as a financial centre, had suffered enormously in the period of the financial crisis 2007-2010. For this reason, the British *Innovation and Research Strategy for Growth* was driven by the hope to finally overcome the negative effects brought by the financial crisis. Therefore, it put the strongest emphasis on innovation as a source for economic growth and prosperity compared to the other two cases: "*our manufacturing sector had somewhat suffered from the focus on financial services and so in the wake of the financial crisis […] one of the objectives of the government was the so called "re-balancing". To make non-financial sectors grow.*" *(UK_10, Pos. 43)*

After the election in 2010 the government embarked on a radical program on a) reducing the *public* sector and red tape in order to tackle the high deficit, b) introducing new instruments to bridge the gap between science and industry to speed up commercialization with e.g. founding the Catapult Centres and granting a bigger budget and power to the innovation agency Technology Strategy Board (TSB; today Innovate UK) and c) centralizing the RnD and innovation support. According to a quarter of the British interview partners concerning the latter, the most significant changes to the support landscape

in UK was the abolishment of the Regional Development Agencies (RDA), as these representative statements emphasise:

> "*Before the BIS strategy innovation was more of a place-based policy. And the RDA were set up to reduce the differences between the regions of England, (…) and so they were responsible for promoting innovation in a particular area. They knew what was happening in the area and they could choose what to prioritize and where to focus their investment. […] Now their function in relation to the European fund and the framework programs moved to the national level and were transferred to the TSB*" (UK_2, Pos. 8)

> *"[…] the enthusiasm for cutting in the first years led the government to abolish the RDA. There has been a major gap for the support of local innovation in England ever since […] to my taste they destroyed the strategic capability in the areas to identify the successful projects"* (UK_6, Pos. 59; 66)

> *"The conservative government when it came in didn`t like the concept of regions and the RDAs because they thought it was a European opposition to Britain."* *(UK_13, Pos. 57)*

The introduction of the Catapult Centres, however, was fuelled by the hope that these intermediary structures – like the Fraunhofer Society in Germany – might quickly find co-financing by industrial partners and help to reduce time to market of new products and process innovations. To spark the entrepreneurial spirit of the academics and business partners alike, the "*Catapults are funded only by one third by government (the TSB) […]and they have to find another third of that budget from contractors through business, and one third through collaborative research projects […]. We [TSB] have a lot of interest in accessing other government department funding, e.g., the Dep. for Transport or the Dept. for Energy and Climate Change.*" *(UK_17, Pos. 188)*

For Sweden, according to the European Innovation Scoreboard one of the most innovative EU states of the past decades[47], the motivation for a national innovation strategy in addition to the grand challenge or mission orientation seemed to be rooted in two different perceived needs for action: first, to align and consolidate the regional with national levels of policy making and second, the chance to take on a new and improved approach to innovative public procurement. According to interview partners there had been a tradition of formulating strong region-specific strategies whereas a national strategy taking on a systemic perspective was a new phenomenon. Consequently, efforts had to be made to foster togetherness and spark a joint policy spirit and common understanding of innovation (beyond the well

[47] See https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/european-innovation-scoreboard_en#european-innovation-scoreboard-2023 and current scoreboards online; last access 15.09.2023

known hubs in the south like Stockholm, Goteborg or Lund/Malmö), as two representatives of the Ministry for Enterprise reported:

> *"We have been travelling around the country to visit different regions. We have had like 12 different council meetings in different parts of Sweden. […] And we talked about what issues are related to the regions. We were inviting people from the universities, the local administrations, local businesses, and a very broad spectrum of participants. […] we have this very broad approach for innovation [and] then it`s necessary to engage people around Sweden to work with it."* *(SWE_13, Pos. 60)*

> *"When we started the work after the prime minister's announcements, governmental encouragement, and the order from the minister of enterprise we decided the process should include and should be open for all partners of societies that had not been part of the established innovation policy discussions and networks before. So, we had to find a way of engaging broadly with people in the regions within different industries and in different parts, in different systems of society."* *(SWE_15, Pos. 39)*

In addition to these perceptions an interview partner, representing the Ministry for Education and Research, concluded that, since the regional actors felt that also their local initiatives should be slightly reorganised to better align with the national strategy, proactive regional debates about the strategy were essential, "*because the different regions in Sweden find that changing collaboration should be based on a document that will lead the way. And I think for them [regions] it`s been very important to have this document because it`s been a long tradition of regional innovation strategy and now they face a national innovation strategy […] you`ve got to see different points of view.*" *(SWE_1, Pos. 28)*

Vinnova, the agency in charge of translating the strategy document into funding programmes and further initiatives, embarked on regional policy discussions (as indicated in Figure 4) together with the responsible Ministry and took care of the administrative roll out of the associated projects in regards with the second and third driving forces specific for Sweden: coupling the support for innovative public procurement with the improvement of public services.

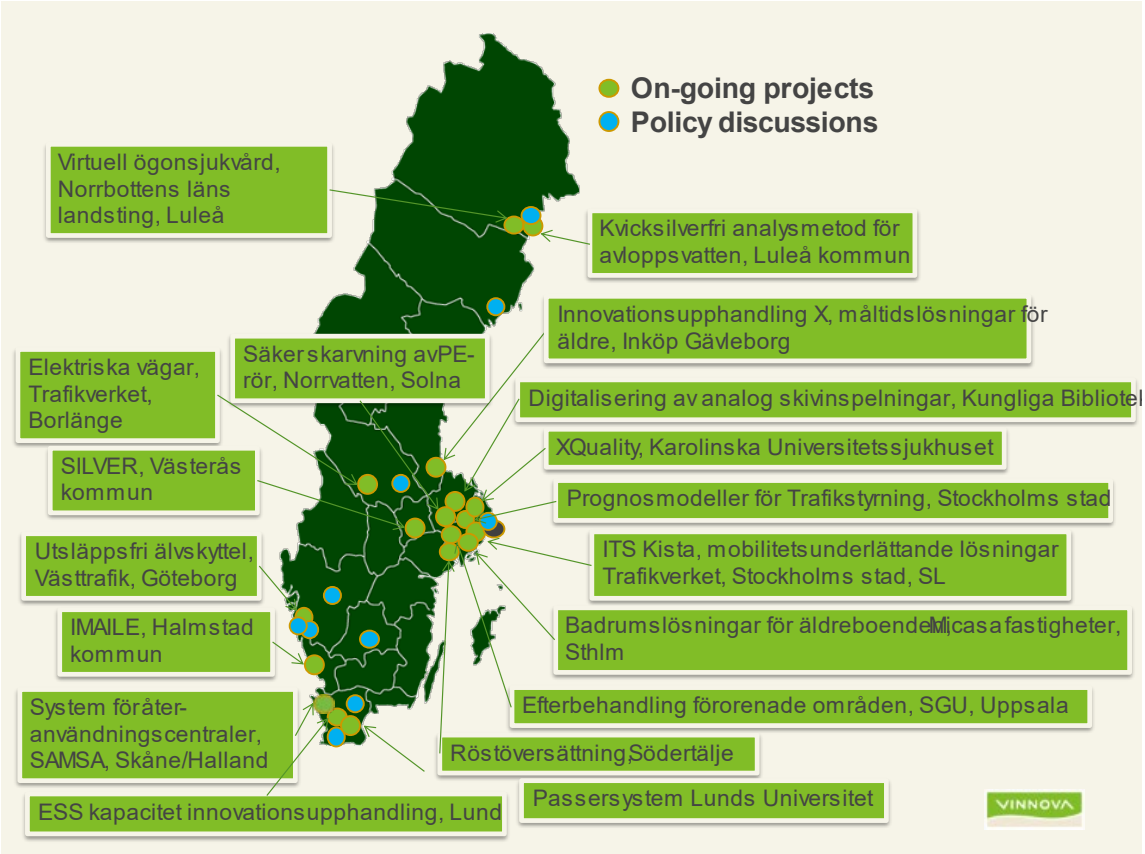

Figure 4: Regional discussion for and pilot projects of innovative public procurement[48]

A representative of the agency elaborates further on the motivation for this action and the associated challenges:

> *"How would you go about to make sure that you enable innovation procurement? How can you give companies the chance to offer new products? Innovative public procurement is important but yet different: You absolutely need something you could always buy, but still sort of open up to the uncertain. […] We spend so much money on new innovation to come forward and when we go into the market mode as a governmental agency, we are very very careful with money. It`s a sort of bizarre balance to spend all that money for people to produce new things and then: who will be buying them? […] Demand in innovation is very important as well, public procurement can be a driver of change."* *(SWE_12, Pos. 30; 100)*

Notably, no other interview partners put such an emphasis on the topic of public procurement than the Swedish. In addition to the strong statement above, the establishment of the strategic area

[48] Source: Outtake Presentation by the "Public Demand of Innovation" Division, Vinnova, slide 6

"Innovation Capacity in the Public Sector" at Vinnova underlined this focus. Communication material of the agency also carries this spirit by acknowledging "Challenges for innovation work in the public sector: Large sums are invested into conceptualisation and pre-studies but too little into development, implementation and use! We define solutions instead of identifying needs! (…) Vinnova contributes to make the public sector a driver for both development and use of innovations!"[49].

3.4.2 Ideational frameworks for policy making: guiding principles and policy objectives of the strategies

The guiding principles of policy strategies can be identified as a major element of strategy altogether. The willingness to reach a certain goal is a key element and a driving force of strategies in business contexts or concerning military and defence operations as well as policies. Regarding the latter, one must remember that the aim to reach a certain policy goal seems to "tell only parts of the story". The policies are not chosen on a tabula rasa, and instruments always reflect an inherent normativity that replicates the involved polity structure, resonates with the socio-economic context and reveals the current government's value system, the institutional tradition, belief systems and its way of "doing politics".

By asking about the guiding principles, the respondents can reflect upon the underlying values, norms, and thus the contextualization of the goals that they associate with the innovation strategy and its instruments. Furthermore, the perception of the agency representatives should help to learn if meta-goals like *grand challenges* serve as guideposts for actual policymaking (bureaucratic obedience of official guidance) and receive an institutional contextualisation (March & Olsen, 2013; B. Guy Peters, 2006; Schofield, 2001). The main questions concerning the investigation on the ideational framework guiding the national policy strategies are:

> What do you think are the main characteristics that turn policies into a strategy?
>
> What are the guiding principles and policy objectives of the strategy, in your opinion?

Concerning the first question crucial feedback was given, that around one fifth of respondents even question the possibility of strategic guidance towards (generating) innovation all together when stating

[49] Source: Outtake Presentation by the "Public Demand of Innovation" Division, Vinnova, slide 7

"it`s almost an oxymoron. How can you have an innovation strategy?" (UK_16, Pos. 27) or stating that there is a disjunct temporal sequence:

> *"A strategy is above all simply designed for long term goals […]. And there is of course a definitional contradiction in what is often called a strategy, when it is clear evidence that these are political-static measures that are simply a reaction to something."* *(GER_1, Pos. 36)*

The latter of these two representative statements already points towards the single most mentioned characteristic: a national strategy ought to follow and support a **long-term perspective** both, concerning the aspired goals and considering the duration of the support measures:

> *"We need to have consistency: there is no point changing it [the strategy] every 2 to 5 years and expecting you are not to waste a lot of money on the way. You must decide what you are doing, and you must stick with it. […] Every time they [companies] come to us we change the tools, and we change the game. They will be confused. We have to set out a standard set of this is how we operate."* (UK_5: 48).

Even though the time horizon is mentioned as the most crucial aspect, the interviewees raising the issue are at a variance about the realistic time span that fulfils both: tying in with the political dynamics of the legislative periods as well as supporting an "overarching narrative that simply survives elections" (second most mentioned aspect). Most of the policy practitioners are either pessimistic ("*You know, it [government] changes all the time. You cannot go long-term with policies; it would just be a waste of time believing that.*" *(SWE_1: 63)*; "*I do see short term policies only.*"(UK_17: 63)) or simultaneously realistic and sceptical, considering the effectiveness of promising long-term missions, as major pillars of strategies, corresponding with short-term policy instruments, timebound budgets and the need to communicate successes *("[…] if we launch an initiative e.g. within a mission it`s so much time two, three, four, even ten years before it shows any kind of effect. And getting the politicians to understand that is quite difficult."* (SWE_13, Pos.*101))* A German ministerial representative furthermore reflects:

> *"These missions with their long-time horizons have a characteristic that they must have, but it is difficult for a political actor to deal with them: horizons that extend far beyond the legislative period; political actors can hardly take this into account in their work."* (GER_12, Pos. 36)

Despite the complexity of the time horizon and all associated challenges (e.g. program management and budgetary planning, evaluation and impact assessment practises) most agree that policy strategies first and foremost should set out and communicate "*direction and prioritization of government*", "*display a guiding document, which is agreeable to most – no rule book*", "*create good conditions for processes, both within the politico-administrative as well as STI communities*" and "*encourage people to want to achieve something together"* by providing a certain "flexibility on how to achieve it".

In addition to the frequency of the mentioned characteristics, a contingency analysis revealed that those interview partners (eight people) that mentioned more than five different characteristic elements to define strategies, also admitted being very challenged by formulating and/or implementing the strategies content, while sharing vivid examples of these struggles during the interview[50].

Enabling scientific freedom as a core claim

All three cases refer to scientific freedom as an important foundation of STI policy in general and this aspect has been mentioned by around one third of the interviewees as an important framework condition. The British Haldane principle ("is popularly used to describe the notion that "decisions about what to spend research funds on should be made by researchers rather than politicians"[51]) or Article 5[52] of the German constitution (Freedom of expression, arts and sciences) are legal manifestations of this freedom and need consideration against the background of more "directionality" or challenge-led or mission-orientation in STI funding, respectively. Concrete aspects to consider revolve around the allocation and decision on budgets, as these two quotes exemplify:

> *"The point is, unlike many other countries including some in Europe, a [British] ministry is not really directing science and research money. Because of this [Haldane principle] you cannot have a strategy involving research expenses which comes from the minister or the agency to decide what`s going to be happening with the money. Because you cannot have this directionality within the science and research budget. So, you have to be outside this budget to be guiding certain fields."* (UK_15, Pos.22)

> *"In the UK there is a very strong version of the Haldane principle. And there is endless debate about what that actually means. But the fact on the ground is, that people accept the research councils and the actual allocation towards certain areas of research and technologies cannot be influenced by politicians."* (UK_18, Pos. 34)

Furthermore, the perspective of technology neutrality (NB: Technologieneutralität) was emphasized by German interview partners (only) and brought forward as one of the unalterable core principles of STI

[50] Nota bene to advance more qualitative insights: This contingency might have identified a group of individuals that could be particularly suitable for a cross-national focus group on detecting general voids of demand and reality (Anspruch und Wirklichkeit) in mission-oriented innovation policies, advancing, and possibly overcoming the conceptual and practical shortcomings.

[51] https://publications.parliament.uk/pa/cm200809/cmselect/cmdius/168/16807.htm online; last access 15.09.2023

[52] Article 5, Absatz 3: Arts and sciences, research and teaching shall be free. The freedom of teaching shall not release any person from allegiance to the constitution.

funding per se, as one interviewee states referring to energy research: "[…] *as we, of course, allocate research funds completely neutral; the support from the federal government is completely technology-neutral. […] There will certainly be no single technology that will be focused on individually by the bodies that conduct energy research.*" *(GER_13, Pos. 20)* Another voice raised the issue of neutrality or even non-directionality in more general terms, by mentioning "*this simply contradicts the basic attitude of the current government to single out individual technologies and promote them in this way."* *(GER_03, Pos. 50-51).*

Grand Challenges and Mission-Orientation as guiding principles

Around two thirds of interview partners (38 or 71,7% of all) mentioned grand challenges (GC) or mission orientation (MO) as a meta guiding principle of the national strategies altogether. Figure 5 presents a hierarchical code-subcode-model with relevant impressions on the matter. When asked to elaborate further on these aspects[53] the responses reflected two intertwined core complexities:

Firstly, a **missing conceptualization and operationalization** that turns overarching (and therefore often overwhelming) headlines in concrete sector specific meaning as a basis for **workable concepts.** These could provide more practical concepts proposing the allocation of political and administrative responsibility and means to formulate, design, implement and evaluate policy instruments and reflect their impact in terms of sustainability and other contribution to solving grand challenges.

Observers concerning the latter – missing workable concepts – mainly mention practical and organizational challenges which point out the necessity to reorganize parts of the politico-administrative work. The yellow chapter in Figure 5 explicates these needs for "deconstructing challenge-led or mission-oriented in project funding" further. Interview partners involved in funding decisions and research project evaluation point out a fundamental adjustment within their domains of decision making, they mention a (necessary) shift towards:

- problem – solution perspective
- societal instead of institutional compass
- increased interdisciplinarity and intersectoral work
- less focus on (countable) results and indicators (e.g. publications), but more on identifying effects (e.g. application of insights)
- heterogenous addressees (of funding), increased complexity
- beyond domain expertise needed for evaluating proposals

[53] "How do you perceive grand challenges as a guiding principle?" and "To what extent can specific objectives, like an orientation towards "solving the grand challenges of our time", provide added value (regarding the strategy)?"

Furthermore, a group of interviewees already proposed some solutions on how to deal with this "need to break the complexity of grand challenges down in general" (see dark blue chapter for quotes in Figure 5). According to those interviewees, the narrative of missions or GC must be very practically coupled with the

- need to create a commercial opportunity
- focus on competitiveness, growth, job creation: using incentives to twist industry towards GC
- better resource overview & policy mixes: how much budget in one area and how does that match with another
- need for an institutional or organizational conduct: the policy landscape should adequately gratify those following the challenge led approach
- pin-pointing priorities, since there will be interlinkage and systemic effects

However, the "vague operationalization" is also and foremost a plea for more strategic capacity (see 3.4.4) and a different dynamic and intellectual (and entrepreneurial) mind-set of the policy practitioners involved, as almost a third of respondents argued (green and partly red chapters), that mentioned GC as a guiding principle. Obviously, these characteristics would also tie in with a different kind of responsibility and decision-making practise (see 3.4.3)

In addition, the conceptual "paring of societal and technological challenges" is a very demanding and often neglected task, which requires a lot of "scientific, technical and sectoral understanding" by the responsible policy practitioner. Furthermore, the much-acclaimed participatory user involvement needs special attention to grasp the challenge that should be solved in practical terms, here voiced by an agency representative:

> *"[…] to push our researchers and companies to think about needs from different parts of the society not just to focus on selling their products or writing their paper, but really embracing the research and the developing process to actually identifying needs from health care professionals or from teachers or whoever and really working with the user side much more profoundly [is crucial]"* *(SWE_6, 51)*

Additionally, the obvious challenge on reconciling the paradigm of distributing funding according to "**research excellence** peer review practises" with "**anticipating directionality** and research addressing GC" is a constant "battle". Evidently tough, practical solutions e.g. different calls and funding schemes have been implemented. Thus, just as the traditional controversy about the societal necessity and benefit of basic and applied research has become more differentiated and seems outdated, the debate on allocating funding ("excellent science vs. challenge related projects") and an appropriate policy mix to foster transformative cutting-edge research and driving innovation (in technological processes as well as products and services) is in flux. However, the practical takeaway question from the voices

raised here, is the need for new programs and different indicators for choosing projects and evaluating their output and impact.

As it has been nearly ten years since the interviews were held, this question has partly been answered by new policies e.g. the Challenge-Led Program by Vinnova, but is often still a challenge to reviewers and evaluators (among other aspects due to interdisciplinary research designs and/or the difficulty to rate and assess the benefit of the outcome and solution contribution towards GC).

Remarkably, only German respondents (7 altogether) indicated that "challenge led" or "mission oriented" for them individually and within their units only serves as a rhetorical cipher and not as a (concrete) guiding principle initiating different policies than before.

Naturally, the **geographical perspective** has also been raised as an important aspect to be acknowledged, on the one hand associated with the practical advice that "*regional societal challenges can serve as starting point*" to draft policies. On the other hand, even though global threats are widely acknowledged as such, the following observation points out that there are of course *differently felt urgencies depending on the geographical location and scope*:

> *"It is certainly the case that not every problem area is of interest to the same group, but that there are countries or groups of countries that are more or less interested in a particular problem area. The USA and Russia are less interested in climate change than other countries. Other areas such as demographics are of course of interest to countries such as Japan, Korea or the like, which are perhaps even more affected than we are."* *(GER_6, Pos. 12)*

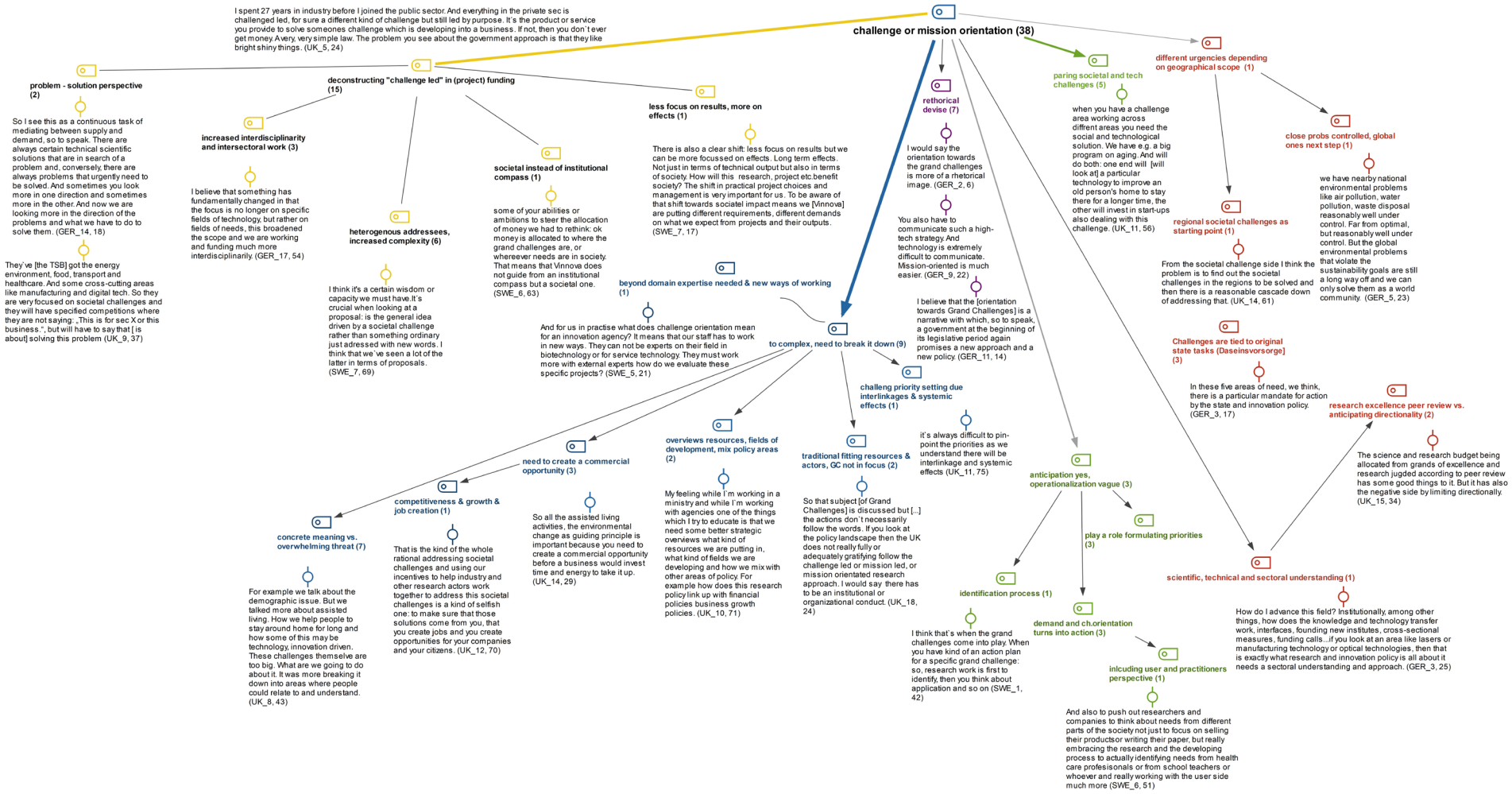

Figure 5: Hierarchical code-subcode-model concerning challenge or mission orientation

3.4.3 Practises of coordination

Coordination in general encompasses nearly every aspect important for shaping the political agenda, instruments, implementation, outcomes, and impact of policies. Scholars have been working on the subject in enormous detail since decades trying to distinguish patterns of 'good' coordination from empirical cases as well as building theory to contribute to grasp the *coordination puzzle;* this concerns policy studies focusing on e.g. implementation (e.g. Bullock et al., 2021; Sabatier & Mazmanian, 1979; Schofield, 2001), public administration e.g. (new) public management (Hjern & Porter, 1981; Lynn, 2009; Naschold & Bogumil, 2000; B. G. Peters, 2000), aspects concerning the role of (individual and collective) actors e.g. as *street level bureaucrats (Lipsky, 1980) or within* advocacy coalition frameworks (Bandelow, 2006; Sabatier, 2009) and many more issues. Concerning the STI domain, analyses of the coordination in national knowledge and innovation policies settings (Edler & Kuhlmann, 2008; Griessen & Braun, 2008) and in cross-country comparisons (Edler et al., 2003; Magro et al., 2014) have been made.

But as Braun once asked "What do we mean, exactly, when we speak of the need for coordination with regard to political governance in general and the machinery of government in particular? What kind of coordination do we need to be effective in innovation policy?" (Braun, 2008, p. 229)

Well, even against the background of more differentiated "roles of the state in the governance of socio-technical systems" (Borrás & Edler, 2020) due to more complexity and ambition in policy mixes within mission or GC led programs and the recent appreciation of and appeal for the "entrepreneurial state" (Mazzucato, 2013), motivating public organizations and authorities not to restrict themselves to fixing markets but also create them (Mazzucato, 2016): when looking at the division of labour within the machinery of government and its departments, policy coordination and the need for it, can still be defined along five objectives, suggested by Painter around 40 years ago in 1981 as quoted by Braun (2008, p. 230):

1. Avoidance, or at least minimization, of duplication and overlap.
2. Avoidance of policy inconsistencies.
3. Minimisation of conflict, both bureaucratic and political.
4. Quest for coherence and cohesion and an agreed ordering of priorities.
5. Promotion of a comprehensive or 'whole government' perspective against the constant advocacy of narrow, particularistic, or sectoral perspectives.

Particularly the latter two aspects, "referring to the coherence of decision making […] [by] drawing separated forces together in order to pursue common priorities and strategies developed on a 'systemic' level (the 'whole government' perspective)," (ibid.) lie at the center of national strategies. As Kattel and Mazzucato (2018) observed in addition the "'normative turn' in innovation policy that underlies the search for next generation of innovation policies (Cantner & Vannuccini, 2018; Daimer et al., 2012; Kuhlmann & Rip, 2018) is based on much more 'distributed agency'"(p.2), involving more stakeholders from different sectors and strands of society. So, it seems that policy coordination is a fundamental requirement for the challenging and ambitious policy strategies studied here, but is it really sought after by the actors and if so "what kind of patterns can be identified regarding the coordination and cooperation?"

Before turning to the empirical material, one furthermore needs to acknowledge that broadly two segments of coordination have been recognized in the policy debate (Lindner, 2012, p. 274 referring to Braun 2008), that are both reflected and referred to in the answers of the respondents:

1. "Policy coordination: Coordination in this area has the objective of developing clear, consistent measures and activities, the agreement on priorities and the formulation of implementation strategies.
2. Administrative coordination: Here, coordination primarily deals with the actual implementation of the goals and strategies that have been agreed upon."

Both descriptions are analytically sound, but this clear distinction is not necessarily applicable or up-to-date with the complex formulation and implementation practices of policy instruments within missions for instance (which is also reflected in some results in chapter 3.4.4 on capacities). Due to the (formative) nature of STI policies today, there is hardly a clear distinction of policy *time zones* of formulation and implementation possible, still: with a view to national strategies there is surely a distinction between publishing the document (more involvement by the hierarchy in any case) and putting it into action. However, for agency units in UK and Sweden, where the development of consistent policies as well as the administration of these go hand in hand, the cipher "agency with agency" ("Agentur"/Projektträger mit Handlungs- und Gestaltungsmacht) seems appropriate as this quote exemplifies:

> *"We [Vinnova] get a ten-page document from the ministry it really only says you should work with supporting, stimulating, sustainable growth and building effective innovation systems and then we have our annual budget around 200 million €. And that is basically it. These are our guidelines. It is really up to us to develop our own strategy and to really spend the money."* *(SWE_18: 22)*

Furthermore, in their cross-country analysis for coordination patterns Arnold & Boeckholt (2003, p.27) distinguish not only the segments but also the "levels" of responsibility and actions from a highest Level 1, involving "setting overall directions and priorities across the whole National Innovation System […] through advice to government or […] a cabinet subcommittee. […] Level 2 is co-ordination among ministries, whose sectoral responsibilities otherwise encourage them to pursue independent policies. […] Level 3 is more operational, in an attempt to make the actions of funding agencies into a coherent whole. This level, too, can involve administrative co-ordination […]." (ibid.) Drawing on the document analysis (see 3.7) and the interview content (remainder of this chapter) it is recognizable that the cases differ concerning the intensity of involvement of the different levels. With Germany mostly relying on "hierarchy-type" coordination (Level 1) with hardly any direct micro-management between the different units responsible for the concrete policies, the strategies' overall direction is, due to the department principle (Ressortprinzip), set top-down by the leading figures of the ministry for research (of course based on preparatory work of the ministerial staff) and approved by cabinet decision; during the runtime advisory support was provided from a high level committee: the Hightech-Forum[54], consisting of representatives of research organizations, universities as well as industry. However, no regular consultation between agencies[55] and the high-level figures happened concerning the overall strategy and roll out of measures; hence single ministry units, responsible for specific policies, would consult their agency as the "administrative arm" on a regular basis.

The situation in the UK and Sweden is quite different. In the case of UK, a kind of "super ministry approach" was in place at the time with a view to genuine knowledge related policies and STI support: "*Compared to many other countries I think in some ways the coordination situation has been easier in the UK because BEIS is such a big department. It has all the university funding, it has skills funding, it has challenge-led funding, it has industrial policy.*" *(UK_6: 82)* With the involvement of powerful, independent agencies such as the TSB ("*Creating an independent national body [NB: TSB] to support business innovation, I think was a very good thing*". *UK_6: 70*), the UK show a mix of Level 2 and 3 coordination workflows.

As already outlined above, the Swedish case is an example of strong and independent Level 3 coordination after negotiations by Level 1 (high-level of cabinet) and 2 (high-level of ministries) have been finished and comprehensive meta-guidance was given (strategy document). In other words: once

[54] https://www.hightech-forum.de/en/about-high-tech-forum/ last access 27.11. 2023

[55] In some cases, agency employees are also called as legal consultants or strategic advisors, however, the working relationship between most agencies and ministries in Germany is not (intended to be) at eye level and the strategic decision-making authority of most agencies is much stronger in UK and Sweden.

the priorities have been clearly expressed by policymakers, employing a robust independent agency like Vinnova, which oversees operationalizing the strategy, can serve to "depoliticize" or deconflict the policy domain while formulating and implementing the strategies instruments:

> *"[…] the minister of enterprise said: 'No, no, no.' We won`t point out anything because we let the experts at the agency do it."* (SWE_3: 91)

> *"So, we are given those more general goals for the national strategy, we [at Vinnova] then formulated our own goals so to say, more related to specific areas or more related to specific measures. So, e.g., it could be some goals around public procurement [...]. So, we are trying to find ways to break down the more general goals and the more specific ones and link activities to those internal goals within Vinnova. "*(SWE_6: 29)

> *"The minister of enterprise is representing one party, the minister of education the other one. And in that you see that you have kind of fundamental different views on how things go towards innovation. Therefore, we do have a clash of sides, which makes it hard to deal with. I mean it`s not easy to solve for us at the ministry: so, employing an agency certainly brings progress and things forward."* (SWE_1: 80)

In addition to the identification of the involved levels of coordination, a more qualitative categorisation on the - simply speaking – corresponding work flow towards policy action has been coined: the differentiation of negative and positive coordination, as well as policy integration and strategic coordination, see Figure 6 for definitions (Braun, 2008) and proposed localisation of the cases. Whereas UK and Sweden show meandering routines of positive coordination and policy integration, the clearest assignment of one single mode was negative coordination in Germany, according to the answers provided, contrasting the official strategy document. Even though Edler and Kuhlmann called the German routine "cooperation within fragmentation" and have identified "a communication process […] [as a] new means of coordination, as it creates inter-ministerial transparency and reduces transaction costs," between the central ministries during the formulation of the first Hightech-Strategy, proposing to "interpreted [it] as an attempt to coordinate through common strategy building across fragmented policy areas ('soft' external coordination) initiated at cabinet level and supported by advisory bodies," (Edler & Kuhlmann, 2008, p. 271), the empirical material allows to draw the conclusion that this high-level attempt has not pushed towards a constructive forward looking routine but rather the manifestation of tradition trench wars.

A central forum has been installed with the inter-ministerial committee (interministerieller Ausschuss IMA), meeting two to four times each year, with representatives of each ministry *"[…] a so-called research officer since 1976. This research officer, who is responsible for coordinating the R&D area for*

the respective ministry, is always reappointed by cabinet decision." *(GER_8, Pos. 5).* *Despite a few* individuals emphasizing good working relationships on an informal level (see first bullet point below) the general spirit was described as conflictual and non-cooperative: thirty-one single statements about negative coordination and counterproductive rivalry between political entities have been made by the 17 German interview partners. Representative illustrative examples read as follows:

> *"You are most likely to be successful if not too many players are involved. That's why there is a tendency in every ministry to deal with issues on a stand-alone basis, then you can control everything to some extent and know your routines. […] [If you need to interact] the classic way of doing business in the federal government is negative coordination, the lowest common denominator survives."* *(GER_11: 29_41)*

> *"Systemic policy making for real change fails due to practical and institutional problems: a good proposal that comes from the opposition is always bad. That's the game in politics. If we receive a proposal from the opposition in the committees where we currently sit as government representatives, of course we cannot say that the opposition's proposal is good. Even if we are convinced that it is […] but the leadership of our ministry would slap us in the face if we would support this statement."* *(GER_5: 70)*

> *"This dispute is constantly smouldering, and people are keeping a close eye on who gets which topic and budget and who must go to the gallows, so to speak, if things go wrong. And this dispute runs through many topics [of the strategy]."* *(GER_8: 38)*

> *"And the strategy [metaphorically] makes this claim about coordination and says: "People, this can only work if you all feed your contribution into this strategy. Only then will it become a meaningful whole. […] the entire federal government does not lack the basic understanding that the strategy is a meaningful thing, but when it comes to the actual work, the dispute usually starts. […] These are not strategic considerations but obvious power games."* *(GER_12: 51_54)*

In addition to the strong departmental principle (Ressortprinzip, Art.65, 2 of the German constitution), which was established in order to structure the departmental budgets and to avoid contradictory action by a clear division of responsibility, the rather drastic statements reveal that the first two generations of the Hightech-Strategy were characterized by challenging cross-ministerial processes. As respondents noted, "*cooperation in demarcation*" might not necessarily be a bad thing, since this can be beneficial for decision making. However, against the background of systemic solutions necessary for GC or mission-oriented strategies seems to hamper or even hinder transformative policy making.

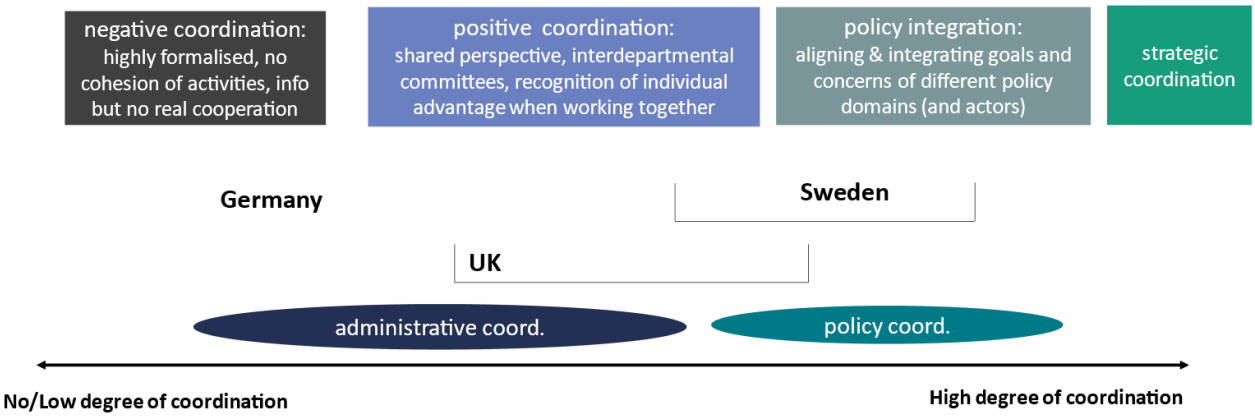

Figure 6: Simplified overview modes of cooperation[56]

Furthermore, the following (more pragmatic) aspects were associated with supporting policy strategy practise and coordination in general:

- **Proximity and direct, informal contacts on working level are crucial:**

  "And proximity matters: the TSB and the research councils were all based in the same hemisphere or building sector in Swindon and Camden/ London. And there were monthly get togethers plus a multitude of personal exchange of the people who work for the research councils and TSB, and they trust each other." (UK_1: 54)

  "The Swedish government offices are quite a small organization. We work within ten blocks or buildings from another and we always work quite tightly together between the different ministries." *(SWE_13: 28)*

  "Basically, a lot of things run informal; […] I have good contacts with colleagues at the other ministry. Cooperation is basically based on very intensive personal dialogue. The informal aspect, e.g., conversations over lunch, that is actually the crucial factor." *(GER_4: 25)*

- **Strategy work and coordination needs prudence and long-term commitment**

  "We are definitely in an exciting phase of putting the best people together with a significant budget around a joint strategy. We need sturdiness and patience. I mean it might sound more perfect than it actually is, it`s quite messy, but again that is quite often where innovation comes from." *(UK_9: 49)*

  "In any system this [better coordination] will be an ongoing project. It not likely that suddenly the system is coherent and integrated. In any system that`s always work in progress which is dynamic to the system- it`s always changing and developing." *(UK_11: 25)*

[56] Source: Adopted from Braun (2008, p. 231) and Lindner (2012, p. 276) with insights from Bouckaert et al. (2010); B. Guy Peters (2006); Tosun and Lang (2017)

"[…] coordination is the most important thing; it`s a huge challenge still. And we need to take it, everyone intends to call for quick fixes (…), but the courage to act towards a more integrated view is essential today." *(SWE_15: 89)*

- **Teaming up in cash-strapped times or positive cooperation by incentives**

  "Well, the main incentive now for better coordination is if the finance ministry cuts the benefits, that`s then the driver which encourages coordination between government departments because you need a partner." *(UK_3: 109)*

  "We have tried to connect everything as much as possible since we are small […] we work with the Innovation Strategy, with Horizon 2020, try to integrate many things and resources […] we work very close together." *(SWE_16: 100)*

  "It can work […] if sufficient participation is assured and practised, so that the other departments also see that there is some benefit for them, not only in terms of honor and reputation, but also in terms of resources." *(GER_11: 14)*

- **Combining STI strategies with more regulation can encourage change (see also next chapter)**

  "You can see that some of the constellations are working with a broad set of actors: with companies, with supplies, with academics, with users, with customers and those who put the requirements in practice like regulatory actors. Because the latter is essential if you want to change society." *(SWE_7: 27)*

  "The state should regulate more, of course. If you really have a strategy, you have to do more than just say that we want to promote environmental technologies. The state should actively promote environmental technologies, from basic research to diffusion into the market, and then actively implement the findings." *(GER_16: 26)*

3.4.4 Capacities for (strategic) policy making

Particularly the role and purpose of public organizations capacity to foster change has gained a lot of scholarly attention over the past decade (Borrás, 2011; Wu et al., 2017). About ten-15 years ago policy analysis seemed more focused on the observation of modes and routines of policy learning (Biegelbauer, 2013), described in concepts like government-learning and lesson-drawing (Etheredge & Short, 1983; Lorentzen, 2009; Rose, 1993), policy-oriented learning (Bennett & Howlett, 1992; Sabatier, 1987), and the more fundamental reflexive-strategic learning (Bandelow, 1999). The following pragmatic definition of policy learning offered by Koschatzky and Stahlecker, based on an analysis of attempts to align regional innovation- and EU-cohesion policy, illustrates why the term works on a

meta-level, but falls short of capturing the practice among policymakers and shapers involved in national innovation strategies:

> "Policy learning includes […] the creation and absorption of new knowledge among those who are responsible for political decision making, forgetting of past routines when necessary and the understanding of new opportunities which new policy options offer. In this way it is related to professional expertise and proficiency in policy skills. As the innovation itself, learning is a cumulative process (Lundvall, 1992). Policy learning is thus based on already acquired competences and experiences in learning." (Koschatzky & Stahlecker, 2009, p. 10)

Today the practical and scholarly debate on individual and collective policy actors' abilities seems much more differentiated and shifted heavily towards the more comprehensive concept of capacity which broadly refers to "[…] the ability to perform functions, solve problems, and set and achieve objectives" (Fukuda-Parr et al., 2002, p. 8) from societal to institutional and individual levels." (van Kerkhoff & Lebel, 2015, p. 13). It is remarkably "transformative capacity of public sector organizations", that should provide practical policy guidance and, according to Borrás et al. (2023), could be subdivided into the three elements of roles, skills and resources that public organizations can activate and provide for the policy process (Borrás et al., 2023, p. 14). This ties in with the argument put forward by policy advisors as well as scholars: the need for more reflexive governance (Lindner et al., 2016; Voß et al., 2006) to handle complex and 'wicked' problems with suitable policy mixes (e.g. MOIP, sustainable development), which calls for more "dynamic capabilities" within the public sector:

> "Indeed, we can argue that today innovation policy landscape is in something of a cognitive paralysis: governments increasingly realize the "wicked" nature of some of the most pressing problems they face and at the same time also realizing that existing policy toolboxes (of design, coordination, and evaluation) are not enough to tackle these challenges. In other words, governments increasingly recognize that they need more dynamic toolkits—capabilities—at their disposal." (Kattel & Mazzucato, 2018, p. 790)

The latter observation summarizes the question guiding this chapter: Does the formulation and implementation of the national innovation strategy require specific "strategic" skills from the actors, and if so, what are they?

Generally, two thirds of all respondents agreed that different strategic skills and capacities are needed in the context of national innovation policy strategies by public actors. Twenty-nine interviewees further elaborated on their personal policy practise. Figure 7 shows the clustered sub-categories of their answers and their frequencies.

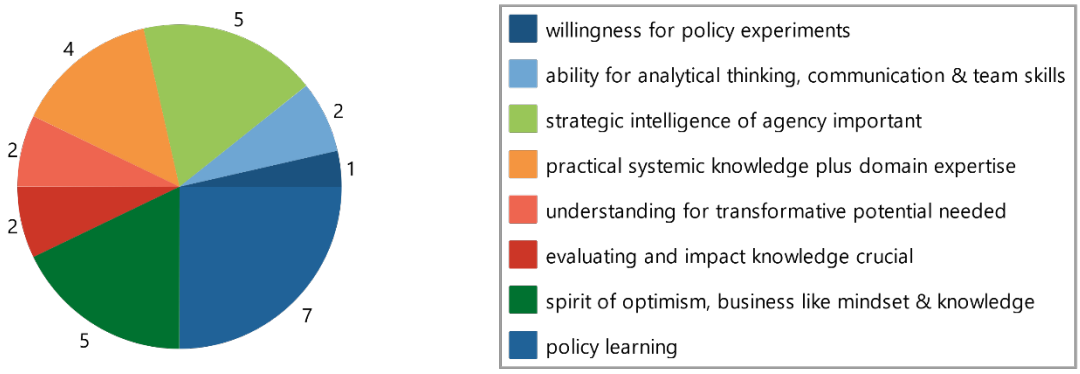

Figure 7: Sub-categories of strategic capacities

Clearly the answers displayed in the following chapter all concern individual abilities, but of course they also symbolize the entity (ministry, agencies etc.) in the need for e.g., more "*Willingness for policy experiments*": one UK policy implementer, for instance, outlined the importance of experimenting with new instruments while simultaneously acknowledging the willingness of learning by understanding and tracking impact:

> *"We are keen to expand the sort of experimentation within innovation policy as a way of kind of really improving quality …]. We are going to spend more time with tracking the trends and looking at how it [NB: accelerator program for start-ups from the US] is unfolding and trying to understand this in more detail to really work out what the impact has been. You know in our [policy] businesses buzz words travel a lot quicker than evidence does."* (UK_11, Pos. 72)

The following quote by a German respondent serves as a combined answer to both aspects guiding this chapter: she offers examples of needed skills (e.g., analytical thinking), but also points to the fact that real strategy and directionality in policy making cannot be driven on the side: it needs real expertise, authority, and commitment:

> *"It requires strategic skills, some of which are no longer available. I'm quite honest about that. Firstly, it requires clear analytical thinking. It requires networked thinking. It requires special communication and teamwork skills. We urgently need a strategy unit - every unit does, but especially in the Federal Ministry - that is headed by someone who can really drive in this direction and whose colleagues are suitably qualified. Firstly, they need the expertise and authority and secondly, they need to be able to utilise their working hours accordingly."* (GER_15: 78)

Furthermore, two representatives of Vinnova share their view on the importance for an *understanding of transformative potential* of a program (first quote) and its practical implications for choosing projects for funding (second quote):

> *"I think it`s essential that you do formulate your goals [concerning GC]. Then it`s important to formulate an impact logic and much more clearly what sort of things you want to achieve but then to step away from it and see: do I need to rethink this?"* (SWE_12:58)

> *"It's a certain wisdom or capacity we must have. It´s crucial when looking at a proposal `is the general idea driven by a societal challenge rather than something ordinary just addressed with new words´. I think that we`ve seen a lot of the latter in terms of proposals. But they are a different kind of project to run and that requires that we have a different understanding of how to evaluate and support this kind of projects."* (SWE_7: 69)

Hence contributing to a national strategy and its goals by aligning funding programs and the criteria for the review of proposals with the narratives of societal goals in alignment with scientific, technological and/or entrepreneurial ones is a complex undertaking. And of course, this challenge is not limited to (ex-ante) assumptions about the potential contribution of programs and projects but needs formative assessment along the way. A British ministerial representative mentions that up-to-date **evaluation skills and knowledge** on how to assess and understand impact beyond the classic canon of science indicators in the departments is crucial: "[...] *before you develop a program you have to set out your evaluation plan. So, would we like more qualifications of employees in departments to understand this? Yes, I think yes."* *(UK_3: 129)*

Predominantly British respondents (every third) stressed the **importance of monitoring and evaluation** throughout the interviews in general and clearly outlined, that a robust evidence base on outcome, effects and impact is an important pillar of UK policy making. The inhouse expertise in departments as well as agencies for crafting and documenting indicators to estimate numerical effects was mentioned by six respondents. If this has a direct effect on adjusting and improving policy instruments, however, was not sufficiently answered. Generally, the routines for analysis and evaluation are well established though, since

> "*In the UK we`ve got reviews every two years, [which means] the government studies and gets policy reviewed. Then we are going through the objectives that should have been delivered and track progress. You look at change and you look at the objectives, because clear objectives are the best way for organizations to coordinate [themselves].*" (UK_18, Pos. 30)

In addition, a strong case was made by emphasising that GC or mission orientation needs to be connected to the absolute necessities for driving innovation to unleash its potential for change. To do so, four respondents identified **practical systemic policy knowledge paired with domain and market expertise** as a prerequisite to craft suitable research and innovation policies and provide support during

the implementation phase to give "real life advise", here is one representative quote by an agency employee:

> *"So, before drafting a policy we spent all of our time on the road listening to people, reading about specifics. There is no use of only reading books about how innovation is going, you have to understand the specific markets, the specific customers in the market and specific manufacturing capabilities of who will answer to those needs and connect all of this with the political ambition."* *(UK_5: 108)*

In fact, this hands-on attitude is articulated by most British interview partners and is also quite dominant within the group of Swedish experts. Like the abovementioned perspective, the following two quotes are characteristic examples of this mentality as well as an indicator for another set of strategic abilities needed for current policy making that first and foremost aims at rebalancing the economy and speeding up commercialization in the UK, namely ***a spirit of optimism, business like mindset & business knowledge*** (reflecting the "liberal market economy" categorisation of UK on market mechanisms and abilities of companies)*:*

> "*Most important are people willing to learn. I have a team of people [at the agency] they are mostly on the road and within companies listening to people. If you open a meeting and say, I will be interested in your ideas? It needs people to take this opportunity. Are you on it? You need experienced practitioners, not a bunch of economists who are next to useless."* (UK_5: 109)

> "*The organization we set up [NB: TSB] and the people we recruited from business to carry out the policies, that is quite crucial; we were having conversations with businesses and for those we needed people from businesses.*" (UK_7: 48)

At this point an observation needs to be expressed that is not only relevant in the context of capacity: In the German case only representatives of ministries were interviewed that, more often than not, seem to lack the practical view on policy implementation and therefore did not contribute as much to this chapter as the other two cases. This is undoubtedly a regrettable shortcoming of the author. At the time though, many ministerial interview partners indicated that the German agencies ("Projektträger") were not essential players, since they only had to "follow orders"; in fact, they have been described as the "administrative arm" or even "dorsal horse of ministries" by some. In retrospect this somewhat elitist ministry centred practise seems unfit to deal with the challenging requirements of the aspired influence for transformative change by national STI strategies and the underlying policy instruments: the "translation" of the strategies' concepts, starting with the comprehension of how to turn the (theoretical) underpinning of GC or mission orientation into workable concepts beyond policy

headlines - like “fighting cancer”- seems to be “in good hands” of policy practitioners accountable for funding, that not only carry the administrative burden, but also the design of the content and direction of the instruments. Particularly Sweden, has made notable efforts to de-conflict and de-politicize the policy area of STI by appointing agencies that are responsible for the entire policy life cycle. Particularly with a view to innovation policy, separating party politics from this policy domain in UK is even pursued as a goal, within the national strategy:

> “*And that was kind of the centrepiece of the strategy that came out. It was a direction of travel, so to say: „It`s important we separate the role of government from, you know, what we want to achieve for innovation and technology*." (UK_12: 18)

The current debate in Germany on mission agencies and change agents (Jackwerth-Rice et al., 2023; Lindner et al., 2022) and the establishment of new actors[57] can be interpreted as an acknowledgement of this institutional gap or missing competence and responsibility in this respect, which is reflected in the empirical material of this contribution.

A “very” German topic though is the changing role of (citizen) participation, a significant pillar of all three national innovation strategies. It was emphasized in the conversations on capacity as an unresolved challenge, ranging from practical realisation to the concern of manifesting a democracy deficit by overhearing the “broad masses”:

> *“This [participation of civil society] will certainly keep us busy for many years because there is no longer THE group that perhaps pursues different interests, but the range of interests is so diverse. In other words, we should not see it as a coordination process, because then we will never be finished. It really is a dialogue, a communication process.”* (GER_15: 35)

> *“I really do see a serious problem here because, ultimately, there is still no modus vivendi as to how the necessary infrastructure for innovation in our country, taking into account the diverse interests of citizens and other social groups, should be organised to be able to get anything at all off the ground, I think there is still a relative lack of imagination at the moment.”* (GER_13: 69)

> *“So, is there a commitment that goes beyond clicking on "I like" and "I don't like"? this is a question that I am currently asking myself. This goes hand in hand with the question of which formats we would need for this. Quite frankly, we do not know how we could integrate this even better into the Hightech-Strategy and develop this strand of*

[57] *E.g., SPRIND: Federal agency for disruptive innovation:* https://www.sprind.org/en/ *last access 22.11.2023*

participation even better. In this respect, I personally am not yet sure whether I find this generally promising or whether such a willingness will also slacken as soon as you demand a little more time commitment from people. The question is, of course, do I end up generating a circle whose opinion is then seen as representative, and the broad masses are not heard?" (GER_12: 19)

With a view to the **cooperative active inclusion of professional stakeholder groups** and networks (not the public) into topic-specific policy debates, positive influence of broadening the perspective and possibly the constructive potential and usage of measures have been shared and exemplify the often called for "holistic approach":

"Then you must include the medical professionals, the care providers, the funders of this service and perhaps some other governmental agency, the medical modern health [facilities] and some other key stakeholders to build knowledge around this. You increase the potential of the usage by thinking about implementing it." *(SWE_6: 54)*

"This means taking a holistic approach to safety and security technology as well. This included the topic of security in soccer stadiums. We sat down with the Red Cross, the technical assistance service, etc. These players have never been involved in an innovation or technology policy measure, let alone sat at the table." *(GER_11: 14)*

Routines of **policy learning** were also mentioned by seven individuals. Nonetheless, these observations referred to the apparent element of "gaining more knowledge" and therefore provide no real added value to the debate. In summary, the answers concerning capacity and strategic skills point to the observation that it is about **skilful motivated individuals with authority to act in the public service** (as well as research and industry) working collectively for the common good:

"I am a big believer in people: good things will happen if you just get the right people into the right place and then give them power and money to get on to it." (UK_9: 45)

"It's not about the document […] the strategy work for me: it's a bunch of people wanting to achieve something together: where we have to start with creating a common understanding on the language that we use and on who we are, that will do this together." (SWE_15: 119)

3.4.5 Perceived obstacles for (impactful) strategies and most urgent systemic challenges

Generally, around one-third of interviewees were doubting if comprehensive national strategies, with their mix of instruments and narratives, are the right tool to increase the impact of STI policies, and some individuals were even doubting the effects of support instruments altogether. It is not surprising that the larger the distance of the interviewee from the inner circle of policymakers responsible for the strategies' instruments and decisions, the more substantial the doubts brought forward about the effects of the strategies. However, even some policymakers from the core group of responsible decision-makers stress the **limits of policy impact** (or even the insignificance of policies for substantial change) in a very blunt way, illustrated by the following example:

> *"[..] but the point is: the best projects we have done have a return rate of forty cents per pound. If you take the XX projects budget that is about 440 million pounds a year and you get forty cents back, for the one pound you`ve spent, then you actually generate something like point 1 of percent of GDP. Overall, that`s nothing. If everything we did is as good as the best things we did, you still would make no real difference."*
>
> *(UK_5, Pos. 76)*

British public servants representing different Ministries were furthermore very outspoken about lacking domain-specific expertise by politicians (parliamentarians and ministers alike) and were missing **a modest perspective on and expectation management** about content, complexity and pace of change that STI policies might deliver:

> *"Politicians are happy to commit money, but they are not coming to see what is happening, and that is something quite hard to deliver when you are talking about programs where you solve complex problems or fund research projects where you are cutting edge. We have problems in managing the expectations of some ministers."* (UK_1, Pos. 46)

> *"Government, certainly in the UK, is a simplifier. And it cannot cope with the complex. We actually have complexity for a reason or for several reasons. And I think there are moments when it is overtly desired to reduce the complexity."* (UK_4, Pos. 54)

> *"There is an artificial split between science and research and innovation and research. And if we go back to the point, we`ve had earlier about "do politicians understand business, the answer is: they don`t. Another question is, do the politicians understand science? And again, the answer is no."* (UK_5: 72)

Strong statements were also made about the **exaggerated expectations towards STI policy as a fix for societal challenges** in general, backed through a tendency for symbolic policy by superelevation and rhetoric politics; this has been observed by representatives of every country case, e.g. "*I have difficulties to see how we want to achieve this. It`s lots of nice words but how to do it, how to do it?*" (SWE_3, Pos. 10); a German voice "*we always formulate lofty goals and beautiful headlines, but not too much happens."* (GER_9, Pos. 32); accordingly, a British interviewee states: "*The problem is really that the strategy is not big enough for the comprehensive change we announce"* (UK_10, Pos. 132).

Thus, criticism towards (policy) communication that presents the outcome of research as a global remedy has been voiced, as well. This **overload of the policy domain and science and research itself** is expressed by a British agency representative "*It`s part of our job to say: research is a risk bearer for society."* (UK_4, Pos. 40) She moreover sees a pattern of blame shifting or responsibility avoidance by (society and) government, neglecting the impact for fundamental change through an adequate policy mix including state-led regulation beyond STI advancements, e.g., with a view to a comprehensive ban on non-recyclable plastic or behavioural (societal) change regarding e.g., consumption patterns.

Besides the normative influence towards change, the impetus for innovation driven by regulation is missed by some, as this statement illustrates: "*Regulation, whether it is ecological or consumer protection-driven, is far too preoccupied with immanent issues and is not linked to the impulses for innovation that can be triggered by regulation."* (GER_11, 68).

This observation ties in with the argument that only "*the market is the driver [of real change]* "(UK_7, Pos. 16) brought forward by an agency representative, furthermore advocating for a constant dialogue with companies and society about the possible direction of change (or even systemic transformations) by consensually negotiated **regulation and standardisation** that set a reliable framework for decisions: "*because only if we have these standards (e.g. in energy efficiency) will entrepreneurs or investors in general know, that it is worth investing in this or that technology or product."* (GER_16: 55)

As already pointed out in Chapter 3.4.2, the ideational drivers for STI policy have become more complex, and the systemic and mission-oriented claim imposing directionality per se is questioned by policymakers, as this representative statement by a Swedish ministerial discloses: *"Where should the government put its forces on? We can't do it the soviet way, force sectors towards "this is where innovation happens". I always said it`s something strange getting direction into this policy area."* (SWE_3, Pos. 72)

Collectively, eight major aspects were mentioned as neglected areas or missing elements in the interview partners' perceptions[58]. Interestingly, around ten years after the interviews were held, today, the national policy debates in some cases are still dominated by the aspects that have been raised as the "most pressing ones": Thereby, German respondents were mostly concerned with a missing focus "on sustainability & energy supply" since seven of nine voices raised these aspects. Today, the challenging rollout of the "Energie- und Wärmewende" (the concept-forming neologism of a broad energy systems transition including shifting resources and changing societal and individual demand) is one of the most pressing political challenge and controversial policy topic in Germany.

On the other hand, the majority (six out of eight) of the voices pointing out a missing "activation of capital & investment by businesses "are British. And indeed, the UK is still struggling today to rebalance their economy and strengthen the ties between science and industry. Regarding the historical context of the interview phase (March 2013-April 2014), another striking observation is the EU scepticism that was expressed by half of the British interview partners. The Brexit referendum was held only around two years after the interviews in 2016, and the exit of UK from the European Union was finalized in January 2020 (concessions in research and innovation-related policies, e.g., within Horizon Europe, were successfully negotiated afterwards). Additional major focus aspects are the following, which are backed with representative quotations in Figure 8. Apart from pointing out individual knowledge gaps on the one hand, systemic shortcomings are emphasized on the other hand, that would need to be addressed in national multi-level governance settings across government, ministerial hierarchies, and the involved addressees (e.g., industry, universities, research organizations) as well as in cooperation with the implementers and evaluators at agencies:

- missing interaction, transfer science towards industry (8)
- missing link regulation & frameworks directing innovation (6)
- missing skills & work force plus career options for scientists (5)
- missing understanding of SMEs needs (5)
- missing consistency, scale, direction (5)
- missing holistic practise & coordination (5)

More individual views were put forward regarding "Missing data handling knowledge and standards" (4), "missing efficiency of funding and emphasis on evaluation" (4), "missing links between national

[58] Based on the question "What do you see as the most urgent challenge in innovation policy?" Aspects that have been mentioned around 5 times have been selected as key concerns.

and regional perspectives" (3), as well as "missing internationalization and openness", an aspect that two Swedish respondents worried about. With a view to the core ambition of GC, mission-orientation, and strategy – in simple terms: all comprehensive and systemic approaches that aim at changing socio-technical systems for good, not only targeting "quick wins" – systemic shortcomings were identified as missing or underrepresented: consistency, scale, direction, coordination, holistic practices.

All these factors have been dominating the debate of political science and other academic disciplines for the past decade and are core research desiderata that need empirical investigation and validation of the STI policy studies community: a more intersectoral debate on the design of the corresponding policy instruments and the challenges or even barriers of implementation plus an honest account of associated misconception of the effectiveness of such policies and strategies is needed.

In addition, the arguments about the lack of individual skills such analytical and methodological knowledge as well as missing domain and system expertise point out that civil servants need a different skill set today, that is up to date with the current policy dynamics. In this respect more education and training in cross thematical, strategy relevant aspects are needed and only if the different levels, responsible for STI strategies, engage in an honest, solution orientated and formative dialogue necessary policies for the necessary change can be realised.

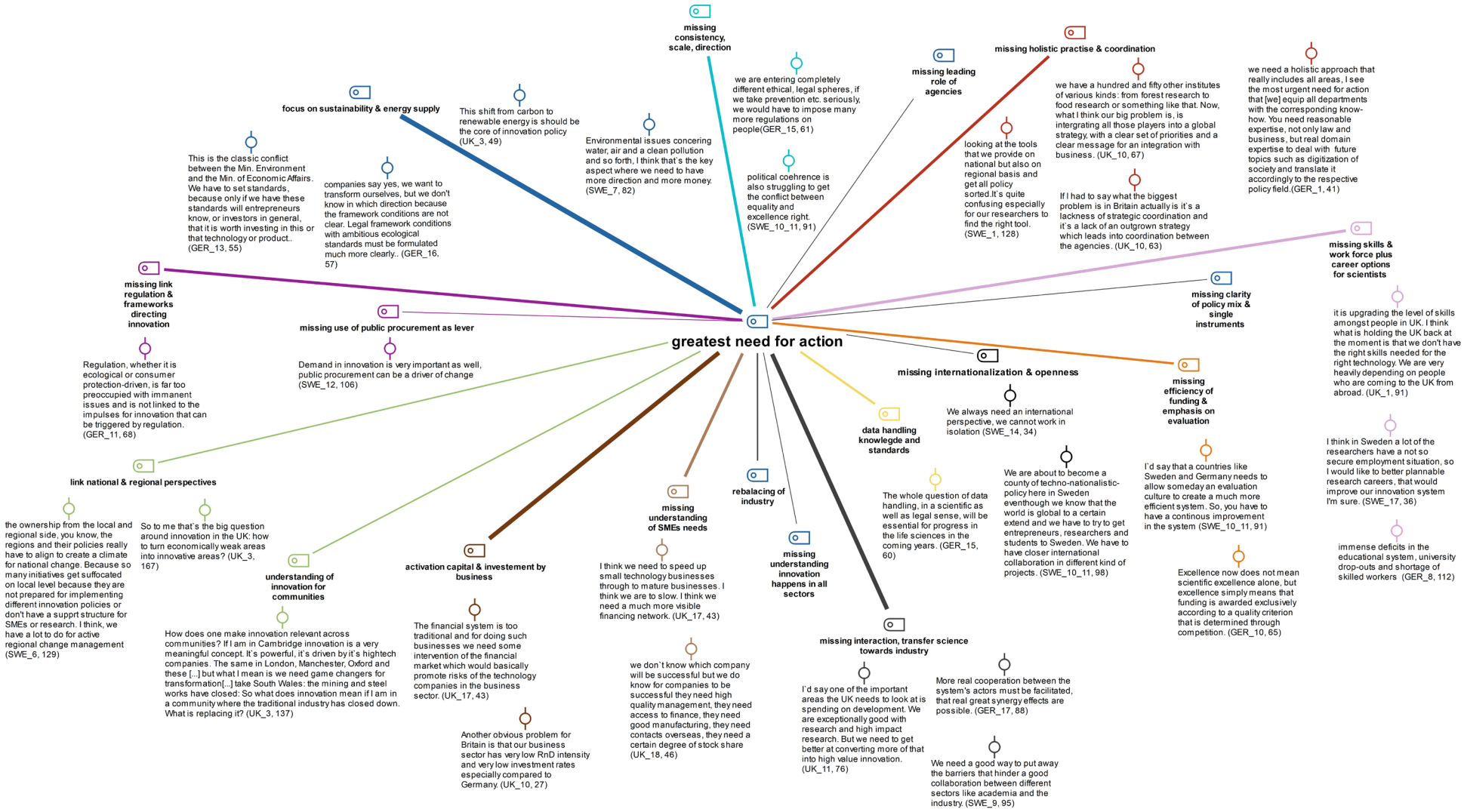

Figure 8 Missing elements or needs for policy action mentioned by interviewees

3.5 Main findings and further avenues for research

The key interest of this contribution was to shed light on the question: what kind of phenomena are national STI strategies? Since several western countries introduced national STI policy strategies in the mid-2000s, this question had not been addressed by political science yet. Clearly, according to the official wording they are motivated by the desire to expand the impact of the STI policy domain towards contributing to solutions for *grand challenges* in addition to the initial assignment of increasing technological progress and economic prosperity.

Nevertheless, as this empirical prestudy[59] (Swedberg, 2012) revealed, they serve several different but also shared purposes: regarding the latter, all documents aim to shift the focus from technology push to societal demand driven actions and try to enhance participation to broaden the stakeholder base (e.g., interested citizens, patient groups, students, regional industry networks) in general. With regard to the identified differences between the strategies investigated, the following "pitches" summarize the key differentiating characteristics:

- **The Grand Gesture**: Germany clings to delineation as cooperation: even though holistic narratives are used and high level committed is expressed, solitary action by departments seems to prevail
- **The Grand Growth**: struggling with its financial sector at the time, the UK puts its emphasis on creating and shaping markets through tech transfer and providing evidence analyses, new entities, such as the TSB, were created for this assignment
- **The Grand Grid**: for Sweden, regional participation and networks are key aspects and fostering innovative public sector procurement; in combination with an impactful national agency such as Vinnova span a net to carry the strategy

The circumstances of the introduction of the strategies also differ to some extent and were routed in institutional reforms paired with personal engagement by the political leadership (Germany), the hope to rebalance the economy by closer engaging with industrial partners and help to reduce time to market of new products and process innovations (UK) and the chance to take on a new and improved approach to innovative public procurement while aligning regional with national levels of policy making. Table 5 describes the strategies on a comprehensive level.

[59] on national R&I policy strategies drawing on original qualitative work showcasing the German, UK and Swedish strategies during the period 2006-2014

	Germany	UK	Sweden
"Pitch"	**The Grand Gesture**: delineation as cooperation: holistic narratives but singular actions?	**The Grand Growth:** creating & shaping markets through tech transfer and evidence analyses?	**The Grand Grid:** regional participation and public sector procurement as an effective net?
Top priority	• mobilizing more R&D investment by industry in key technologies • more engagement in social dialogue	• fostering tech transfer • speeding up commercialisation process	• regional networks to create ownership across the country • innovative public procurement.
Top instrument	• forward-looking projects (similar to missions) • improving the general conditions for start-ups, SME and venture capital	• more responsibility, budget and personnel for the Technology Strategy Board (TSB) • initiation of Catapult centers[60] (as intermediary actors)	• reorganisation of Vinnova; • setup of cross-institutional challenge-led program (competitive three stage project funding.
Distinguishing feature	• strong department responsibilities (editorial process as coordination) • agencies as administrative arms of ministries	• role of monitoring was emphasized • a triad of public servants for finance, planning and analysis in place in each department unit	• agencies oversee budget and content • regional engagement important
Summarizing quote	*"We are moving from a supply-orientation to a demand-orientation. This approach is also reflected in the key areas and, for example, in our new foresight process. We are clearly approaching topics from the social perspective and no longer from technology push." (Ger_12:47)*	*"We [the UK] are one of the leading science performance countries in the world […]. Because we have a very strong university-based science system, we have the big problem of how this should be interacting with the strong industrial performance."* (UK_10: 23)	*"[…] after the prime ministers' announcements, we decided the process should be open for all partners of societies […]. We work with regional network partnerships […] I'd say they are nexuses for the change processes." (SWE_15: 6; 39)*

Table 5: Comprehensive overview of strategies and take aways

[60] "Catapults are physical centres with a unique combination of cutting-edge R&D facilities and world class technical expertise. There are nine Catapults, working in over fifty locations, in every region and nation of the UK", see https://catapult.org.uk/about-us/our-centres/ last access 16.11.2023

A general challenge mentioned by all groups of interview partners was the shortage of skilled labour with the relevant expertise in technological and digital sectors. With a view to the demographic change in the countries studied, this problem potentially only got worse. Surely since the empirical material was gathered around two legislative periods passed by and new national strategies were published and implemented (see the overview in Figure 3). So, the question is valid if the aspects raised in this empirical contribution have not been solved by now?

Of course, it is difficult to judge real progress or development from the interviewees point of view without revisiting them or collecting similar material. Still, some encounters and document insights provide for very few selected signs towards a different understanding of an important part of strategies: missions and MOIP. With a view to UK for instance, missions have been established as a vital part of the national policy agenda and the observed formative monitoring practises have even been translated further into the delivery plans of each mission as well as elaborate attempts on "co-creation, co-delivery and co-evaluation of missions with industry and citizens" (Hufnagl et al., 2019, p. 3).

Furthermore, Vinnova cultivated the methodological toolbox (Hill, 2022) and also put more emphasis on its' challenge-led program. Germany experienced a period of prominent mission wording (with some attempts of MOIP design and implementation) with the last two generations of the Hightech Strategy (BMBF, 2014, 2019) but did not fully live up to the expectations of the scholarly community working on the MOIP concept with regard to coordination: "Cooperation and coordination are often complicated by interdepartmental competition. There was little evidence that missions facilitate positive exchange between different ministries going beyond a delineation of responsibilities and negative coordination. Overall, frequency and intensity of inter-ministerial or trans-ministerial activities appear to be relatively low." (Roth et al., 2021, p.VI) The current *Future Strategy* seems to downgrade the mission concept further by formulating unspecific sub-headlines (e.g., Developing modern technologies for a competitive, circular and climate-neutral industry) to overarching „transformation processes" such as "Enabling a resource-efficient and circular economy-oriented competitive industry as well as sustainable mobility" (BMBF, 2023b, 35ff).

Further avenues for research

Since this contribution was focussing on the national level a neglected aspect is the **interplay within multi-level governance settings** between the EU-level and the member states as well as

in the federal system of Germany the interaction of the national state with the German Länder. With a view to the EU, however, a puzzling observation was that many interview partners were convinced that their country was THE agenda setter per se and could "direct" EU policies to best suit their country's interest.

The **importance of communication** in politics (e.g., targets, success, failure) and science communication in digital as well as traditional channels has grown since the investigation. But already ten years ago it was seen as a major task of the document to carry the message of urgent challenges: "*[…] we come to the core of an essential function of such an overarching strategy. That is communication. The communication and communicability of key social issues.*" *(GER_8: 90)*

In that respect some respondents made the critical claim that the national strategies are simply not more than a communication tool of the government or insisted that the cross-departmental coordination and cooperation has sufficiently been achieved when the document was published, and the editorial process finalized. Further investigation on the **practical exchange and consensus seeking (coordination)** among the involved stakeholders and **public relations patterns regarding STI policy** and national strategies are needed. Particularly, since the STI domain is complex, and content is not easy to communicate ("*I mean as a politician research and innovation policy is nothing to get elected for. You would need to talk about schools. Talking about innovation, it`s nothing to win an election."* *(SWE_4: 37))*. Insights on whether connecting STI policy to societal demands has "more appeal to the voter" is an exciting research desiderate.

Many interview partners, however, described this plea for linking STI policy to providing solutions to the grand challenges as a positive and motivating leitmotiv. However, the majority seems overwhelmed by this expectation due to several interconnected reasons. First, often a missing **concrete and consensual operationalizing of the contribution to the challenge solution,** that turns overwhelming headlines in concrete sector specific meaning as a basis for **workable concepts** (e.g., breaking down "climate change" to "inventing alternative emission-free mobility concepts" etc.) is criticized by some. Second, the need for new policy instruments and programs to support systemic transformation also calls for different **formative evaluation practises and indicators** to assess output and impact than before.

In conjunction with these observations another main lesson is the missing empirical as well as academic examination of how the community of actors responsible for strategy and policies,

either in ministry or in agencies, learns from experience and if decision makers respond when objectives are not reached (or “simply” change the objectives)? The scholarly community has been very much focused on patterns of policy learning (see 3.4.2) but not on evaluating the results of these actions. Today, even some national strategies are referred to as “learning strategies”, like the current German document for instance: “As a learning strategy, the Future Research and Innovation Strategy will respond quickly and flexibly to change. To this end, progress will be monitored on an ongoing business, experience contributed, and goals adjusted where necessary.” (BMBF, 2023a, p. 3).

Reacting to change is surely smart. However, what does this statement reveal in practice? Can actors of the STI system really rely on a formative support system by policy, based on professional monitoring practises? During the past generation of the Hightech-Strategy (BMBF, 2019) scientific support was provided, but hardly any advice led to altering the policy practices so far (Wittmann, Hufnagl, Roth, et al., 2021b; Wittmann et al., 2020). Also, British respondents could only confirm that monitoring is happening, but not report if and how change based on analyses is initiated.

Therefore, more insights and empirical work is needed to reveal patterns of processes of changing policies to trace **if and how policy learning and counteracting is happening**.

This could furthermore help to gain insights on the methods and effectiveness of evidence-based policy advise for recalibrating policy instruments and help to close the gap – already mentioned in the introduction – between academic theory and policy practise little by little.

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3.7 Annexes

Annex 1: Description by category of innovation policy strategies in place 2013-2014

	Germany	UK	Sweden
Titel	*Ideas. Innovation. Prosperity.* *High-Tech Strategy 2020 for Germany (HTS)*	*Innovation and research strategy for growth*	*The Swedish Innovation Strategy*
Publication year	2010	2011	2012
Published by	Federal Ministry of Research and Education	Department for Business, Innovation and Skills	Swedish Ministry of Enterprise, Energy and Communications
Corresponding document	Action plan for Parliament (DS 17/9261)	Economics Paper: Inn. and Research Stra.	no explicit reference made
Agencies (with independent configuration of programs)	No: German Agencies (Projektträger) & Research Councils (e.g., DFG) are bound to their role of managing & administering project funding	Yes: TSB Driving Innovation (2011): Concept to Commercialisation A strategy for business innovation, 2011-2015 Establishment of Catapult Centers	Yes: E.g., Vinnova's Challenge-Driven Innovation program • Future Healthcare • Sustainable Attractive Cities • Information Society 3.0 • Competitive Production
Vision/target date	2020	This vision will not be realised immediately; it will take years of sustained investment and effort (…)	2020
Previous document	The Hightech Strategy for Germany (2006)	Innovation Nation White Paper	Innovative Sweden – A strategy for growth through renewal (2004)

		(2008)	
Reference to EU or other policies	Yes, Horizon 2020 ("The Federal Government wants to extend the successful approach of the HTS to the rest of Europe." p.9)	Horizon 2020. Anglo-US Financing Innovation symposium in 2012	Yes, Europe 2020, Horizon 2020, reference to urgent societal challenges (EU Comm 2010) (p.5) OECD 2010
Motivation - Justification - Aim	Individual fields of technology are seen as contributions to realizing important social policy aims or as innovation drivers for other fields of technology ("key technologies"), while social change is an essential prerequisite for the generation of technological knowledge. (p.4)	The Coalition Government is putting innovation and research at the heart of its growth agenda. Innovation is essential to competitiveness and higher living standards. Through more significant investment and increased collaboration, we will make sure that the UK has a promising future.	• Meet global societal challenges. • Increase competitiveness and create more jobs in a global knowledge economy. • Deliver public services with increased quality and efficiency (p.7)
Guiding Principles	The Federal Government's innovation policy activities are geared towards […] five fields of action, with the aim of tapping emerging markets. (p.5) Critical key technologies and measures to improve the general conditions for innovation will be funded to encourage new developments in […] five fields of action.	This strategy sets out the Government's approach to • boosting business investment in innovation and ensuring UK success in the global economy. • Universities and research, entrepreneurship, and risk taking, more significant connections between people and organisations, • a more open environment will all be at the heart of our approach. p.5	1. Best possible conditions for innovation 2. People, businesses and organisations that work systematically with innovation 3. Implementation of the strategy based on a holistic view p.21
Structure & Priorities	**Headlines and descriptions**, no	**Headlines and listings** of planned initiatives, no process description:	**Stating meta-targets e.g.**

	process or milestones, general outline: • Focus on global challenges • Mission-oriented approach: Forward-looking projects • Key technologies • General conditions **Five fields of action** (incl. "Lines of action" summarising planned or existing policies, strategies) ○ Climate & Energy ○ Health & Nutrition ○ Mobility ○ Security ○ Communication	1. Discovery and Development 2. Innovative Businesses 3. Knowlegde and Innovation 4. Global Collaboration 5. New Innovation Challenges ➔ Emphasis on **Technology Strategy Board** as main independent agency for innovation ➔ Introduction of **Catapult Centers** as integrated approach that brigdes gap betw. academia and business ➔ Focus on **four emerging technologies**: Synthetic Biology, Energy-Efficient Computing, Energy Harvesting, Graphene	Innovative regions and environments **Goal:** Sweden's regional innovation environments have international appeal **Sub target:** Sweden's regions are increasing their innovation capacity based on their unique conditions **Sweden therefore needs to e.g.:** Develop collaboration between actors on different levels that strengthen the regional appeal, based on e.g., clusters and test and demonstration facilities where relevant. P.48
Monitoring	No mentioning of progress monitoring in document. Expert Commission for Research & Innovation (EFI) as independent advisory body appointed. Note on finances: The various measures of the HTS are financed within each Ministry's own operating budget. p.6	The complex nature of innovation and inter-actions within the innovation system means that monitoring progress in implementing the Strategy needs a **broad range of indicators**. We will report on the baseline for these commitments in the Annual Innovation Report 2012, which will be published early next year, and we will continue to monitor through NESTA's Innovation Index (p. 89 ff)	An effective way of monitoring initiatives is required to develop and adapt initiatives without compromising the long-term character and clarity of ambitions. […] To enable continuous learning, objectives that are possible to monitor over time, as well as good analyses for well-founded priorities are needed. p.52
Implementation	Outline of "Forward-looking projects for	Our overall objective is to increase levels of innovation	The Government intends to present an overview

	Parliament (HTS Aktions-plan, Drucksache 17/9261) • Intro to challenge e.g. climate change • **Project description** e.g. "renewable primary product alternatives to oil" • Tentative **goal description** e.g. strentheing the expansion of the bio-based economy • **Lines of action** for implementation (mostly research funding), contribution by diff. actors	that drive growth and create jobs in all parts of the UK, and we need to demonstrate that we are delivering the programmes and initiatives set out in this strategy. The key milestones are set out in the **delivery plan** (p.91-96)	of the implementation. As the implementation of the strategy is also a matter that concerns many actors in society, the Government also **intends** **to report at regular intervals** on the development of the innovation climate in Sweden. p.51
Mission-like concepts	forward-looking projects, reference to stakeholder engagement (Drucksache 17/9261)	*challenge-led innovation and research programmes, often reference for need to economic exploitation*	*challenge-driven Inn. Program; o*ften references to societal challenges

Annex 2:

Questionnaire addressing frameworks of policy making, practices and (strategy) capacities of actors regarding national innovation strategies of Germany, UK and Sweden

Opening questions:

Could you please define your role and the role of your unit/ministry/agency in the (strategizing and) implementation process of the national innovation strategy? (Further questions to "identify" the addressee, see last part of questionnaire)

Können Sie mir bitte Ihre persönliche Rolle und die Ihres Ministeriums/Referates in Bezug auf die Formulierung und Umsetzung der Hightech-Strategie beschreiben?

Why did the government decide to launch a national innovation policy strategy?

Warum hat die Regierung eine nationale Innovation-Strategie eingeführt?

Focus 1: Frameworks for policy making:
guiding principles and policy objectives of the strategy

The guiding principles of policy strategies can be identified as a major element of strategy altogether. As numerous studies have shown, the willingness to reach a certain goal is a key element and a driving force of strategies in business contexts or concerning military and defense operations as well as policies. Regarding the latter, one must remember that the aim to reach a certain policy goal seems to "tell only parts of the story". The policies are chosen, and their related instruments always reflect an inherent normativity that replicates the involved polity structure and reveals the current government's value system and its way of "doing politics".

Therefore, by asking about the guiding principles, I would like the respondent to reflect upon the underlying **values, norms,** and thus the **contextualization of the goals** that he or she associates with the innovation strategy and its instruments. The perception of the implementers should help to learn about the motivation/mission behind the strategy and the way in which abstract goals for instance "the Grand Challenges" serve as guideposts for actual policymaking.

Core interest: What are the guiding principles and policy objectives underlying the national strategy, and how are these perceived and actualized by the organization implementing the strategy?

Welche Leitlinien und politischen Zielsetzungen liegen der nationalen Innovationsstrategie zugrunde und wie werden diese von der für die Implementierung verantwortlichen Organisation verstanden und operationalisiert?

Main questions:

1.1. In your opinion, what are the guiding principles and policy objectives of the strategy?

Was sind Ihrer Meinung nach die Leitlinien und politischen Zielsetzungen der Hightech-Strategie?

1.2. What do you think are the main characteristics that turn policies into a strategy?

Does the innovation strategy fulfill these criteria?

Was sind für Sie die wichtigsten Kriterien einer strategischen Policy/politischen Strategie? Erfüllt die Hightech-Strategie diese Kriterien in Ihrer Wahrnehmung?

1.3. To what extent did introducing the national innovation strategy alter the innovation policy? Is the strategy addressing all actors relevant for innovation?

Wie hat sich die deutsche Innovationspolitik mit der Einführung der Hightech-Strategie gewandelt? Inwiefern addressiert die Strategie alle für Innovationen relevanten Akteure?

1.4. To what extent can specific objectives, like an orientation towards "solving the grand challenges of our time", provide added value (regarding the strategy)?

Inwieweit unterstützen Vorgaben wie die Orientierung an den "Lösungen der großen Herausforderungen unserer Zeit" die Zielerreichung der Hightech-Strategie?

Add on questions / weitere Fragen

- If challenge-led or mission-orientation was mentioned: How do you perceive and operationalized grand challenges as a guiding principle? Wie haben Sie die großen Herausforderungen als Leitprinzip verstanden und umgesetzt?
- How are the strategy objectives translated into policies/policy instruments? Can you give me an example? Wie werden die Zielvorstellungen in konkrete Policy-Instrumente übersetzt? Können Sie mir hierfür ein Beispiel nennen?
- In your opinion, are the targets of the strategy reasonably straight forward? Sind die Ziele der Hightech-Strategy Ihrer Meinung nach eindeutig formuliert?
- Do you see a conflict between setting up long-term policy strategies and short or mid-term policy planning? Sehen Sie einen Widerspruch zwischen der Etablierung langfristiger politischer Strategien und kurz- bis mitterfristiger Politikplanung?
- From your experience, can you describe the process of strategizing (setting up a policy that is strategic)? Können Sie mir aus Ihrer Erfahrung den Prozess der Strategiebildung erläutern?
- How were the policy objectives of the strategy selected and do you think that the priorities are suitable? Wie wurden die Zielsetzungen der Hightech-Strategie festgelegt und haben Sie das Gefühl, dass die richtigen Prioritäten gesetzt wurden?
- What is "strategic" about the current national innovation policy? Was ist Ihrer Meinung nach strategisch an der Hightech-Strategie?

Focus 2: Policy practices:Coordination and cooperation patterns of the strategy

The national innovation strategies of the UK, Sweden and Germany all pursue a "whole-of-government" approach, according to the respective *White Papers*. Among other aspects, this entails that the strategies are carried out by several ministries (or agencies) at the same time, engaging them in a collaborative effort. Consequently, the **implementation** of national strategies is bound to incorporate practices of **coordination and cooperation** between the actors involved. But what form do these practices take? How is the practice of implementation "achieved by various dynamic effects, such as decision making, communication, bargaining, negotiation, even conflict." (Schofield 2001: 254[61])

Core interest: How are national innovation strategies implemented and what kind of patterns can be identified regarding the coordination and cooperation of the actors involved?

Wie wird die Hightech-Strategie implementiert und welche Koordinations- und Kooperationsroutinen bzw. Muster zwischen den beteiligten Akteuren können identifiziert werden?

Main questions:

2.1. The national innovation strategy is presented as a combined effort of several ministries/units and a top priority of the current government. How do you coordinate your unit's actions and policies with other units/agencies?

Die Innovationsstrategie wird als gemeinsame Aufgabe verschiedener Ministerien und als wichtige Priorität der Bundesregierung präsentiert. Wie werden die verschiedenen Aufgaben zwischen den beteiligten Ministerien und Referaten koordiniert?

2.2. How regularly, and concerning which issues, do you cooperate with other ministries/units/agencies (contents of policies, targets, operationalization)?

Wie häufig kooperieren Sie mit anderen Referaten/Ministerien und bezüglich welcher Themen (Inhalte, Ziele, Umsetzungsvorschläge)?

2.3. How do the goals of the national strategy influence the institutional set-up of your unit and the way you collaborate with other entities?

Inwiefern beeinflussen die Ziele der Strategie die institutionelle Struktur (des Referats/Ministeriums) und die Art und Weise wie Sie mit anderen zusammenarbeiten?

2.4. Could you describe how you actually execute the policies in your ministry/unit/agency? What works and why? What doesn't and why?

[61] Schofield, J. (2001): Time for a revival? Public Policy Implementation: a review of the literature and an agenda for future research, in: International Journal of Management Reviews, Vol. 3 Issue 3, pp. 245–263.

Könnten Sie mir bitte beschreiben wie Sie/Ihr Referat die Strategie konkret umsetzt? Was funktioniert hier gut, was weniger?

Add on questions / weitere Fragen

- Could you describe the workflow between the people/departments involved in the implementation process? Könnten Sie mir den Arbeitsablauf zwischen den beteiligten Personen / Abteilungen erläutern?
- How do you avoid contradictory action/action pulling in different directions? Wie gewährleisten Sie, dass es nicht zu widersprüchlichen Maßnahmen innerhalb der Strategie kommt?
- How do you avoid neglecting some areas (technologies, research topics, actors)? Wie stellen Sie sicher, dass es nicht zur Vernachlässigung von Bereichen kommt (Technologiesparten, Forschungsthemen, Akteure)?
- What are important barriers to a successful implementation? How do you deal with those? Worin sehen Sie wichtige Hürden für eine erfolgreiche Politikimplementation und wie gehen Sie mit diesen um?
- Are there any noticeable incentives for better coordination? Gibt es spürbare Anreize für eine besser Absprache und Koordination unter den Beteiligten?

Focus 3: Capacities: (strategic) capacities of the involved actors and aspects of leadership

The success and failure of public policies does not only depend on coherent formulation and implementation but also on the commitment and the **strategic capacities** of the actors involved. Thus, it is crucial to elaborate on the topics of leadership, management, and strategic skills when analysing the national innovation strategies.

Regarding this analysis, some scholars suggest a division between "**strategy thinking**" and "**strategy making**" of the actors involved, the latter referring to the actual task of setting up and implementing certain policy strategies (external strategy process), the former suggesting an analysis of the internal strategy process. The following questions focus on the internal strategy process and the management of this undertaking respectively.

Core interest: How is the *strategic capacity* of the actors involved and coherent management (leadership) organized/operationalized regarding the strategy?

Wie werden die strategischen Fähigkeiten der Beteiligten eingebracht und ein kohärentes Management der Hightech-Strategie gewährleistet?

Main questions:

3.1. Does the formulation and implementation of the national innovation strategy require specific "strategic" skills from the actors and what are they?

Erforderten die Formulierung und Umsetzung der Strategie Ihrer Meinung nach spezielle "strategische" Fähigkeiten der *beteiligen Akteure? Wenn ja, welche wären das?*

3.2. What unit/department is most influential in the implementation of the strategy? Why? Who else is a key figure/unit?

Wer hat Ihrer Meinung nach die operationale Leitung der Strategie inne und wie äußert sich das? Wer ist weiterhin wichtig (Person/Referat)?

3.3. Do you think your unit/ministry is adequately equipped for the implementation of the strategy in terms of workforce and qualification of employees? The time frame given? Information gathering and processing (*ex-ante expertise, ex post evaluation)*?

Haben Sie das Gefühl, dass Ihr Referat/Ministerium für die Umsetzung der Strategie angemessen ausgestattet ist u.a. mit Blick auf die Anzahl und Qualifikation der Mitarbeiter/-innen, dem Zeitrahmen für die Implementation sowie den Möglichkeiten Informationen einzuholen und zu verarbeiten (ex ante Expertise, ex post Evaluationen)?

3.4. In your opinion, what are the areas that have been most relevant in the management of the strategy? How would you characterize the relationship between politicians and civil servants in the implementation of the strategy?

Was sind für Sie die wichtigsten Aspekte des Managements der Hightech-Strategie?

Wie würden Sie die Beziehung/den Austausch zwischen Politikern und politischer Administration im Zuge der Umsetzung der Strategie charakterisieren?

Add on questions / weitere Fragen

- What are the easiest and the most difficult issues in the leadership and management when implementing the strategy? Was sind Ihrer Meinung nach die einfachsten und schwersten Aufgaben mit Blick auf das Management der Hightech-Strategie?
- What are your knowledge/data sources and who do you turn to when you need expertise regarding the strategy (components, technology fields, branches)? Is there an internal knowledge unit? Or do you request external expertise? Was sind Ihre wichtigsten Informationsquellen und woher beziehen Sie relevante Expertise (bzgl. Technologie, Branchen)? Gibt es eine interne Rechercheabteilung? Oder wird die Expertise extern angefordert?
- Which other countries or country strategies serve as a benchmark? What about the role of the EU regarding the national strategy? Welche anderen Länder und deren Strategien dienen Ihnen zur Orientierung? Wie beurteilen Sie die Rolle der EU im Bezug auf die Hightech-Strategie?
- What triggered the changes between the first national strategy and the revisions later on? To the extent that this necessitated changes in particular policies: How did you go about improving/changing them? Wie kam es zu Veränderungen zwischen der Hightech-Strategie von 2006 und der Hightech-Strategie 2020? Anhand welcher Kriterien haben Sie Veränderungen durchgeführt?

- Who and what do you think is most important for the long-term success of the strategy? Wer und was, denken Sie, ist am Wichtigsten für den langfristigen Erfolg der Hightech-Strategie?

Concluding questions:

What changes, if any, do you think the introduction of the notion of "strategy" brought about in innovation policy making?

Glauben Sie, dass sich durch "die Rede von Strategie" Veränderungen im Bezug auf die Innovationspolitik ergeben haben?

What do you see as the most urgent challenge in innovation policy?

Wo sehen Sie den größten Handlungsbedarf in der deutschen Innovationspolitik?

Annex: Identification of interviewee

Date of the interview _____

Name	_____	
Current position *(to identify the level of insight and impact the interviewee has)* ☐ High impact ☐ Medium impact ☐ Low impact (observer) Personnel responsibility ☐ yes ☐ no	_____ ☐ Ministry/Unit _____ ☐ Agency_____ ☐ Association _____ ☐ _____	
What is your professional background?	☐ Law / Administration ☐ Economy ☐ Social Science & Humanities ☐ Other _____	
What is your responsibility in this ministry/unit/agency/association?	_____ _____ ☐ policymaker ☐ implementer / practitioner ☐ administrator ☐ evaluator ☐ _____ _____	☐ Level of high politics ☐ Sectoral level ☐ Agency Level
How long have you been involved with innovation policies? How long have you been working at this ministry/unit/agency/association? When were you first involved with the innovation strategy?	☐ less than five years ☐ more than five years ☐ less than five years ☐ more than five years ☐ right from the start (formation) ☐ entered during the implementation phase ☐ very recently	☐ Junior ☐ Senior ☐ Less experienced staff ☐ Experienced staff

4 Smart specialisation strategies and cross-border integration of regional innovation systems: Policy dynamics and challenges for the Upper Rhine

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4.1 Introduction

The aim of this paper is to provide new insights into the meaning and implications of the concept of 'smart specialisation' (S3) by illustrating a specific case of two border regions engaged in a progressive integration process of their innovation systems. The issues addressed concern the conceptual meaning of smart specialisation processes as well as their implications for innovation policy governance.

Recently, the originally quite academic – and not specifically regional – smart specialisation concept has gained tremendous importance for regional innovation policy and has 'enjoyed a short but very exciting life' (Foray et al., 2011, p. 3) from a taboo concept to becoming a policy hit. As, according to those who developed it: 'Smart specialisation is not just for the ''best'' regions and technology leaders [but] for any region'. (Foray et al., 2011, p. 5), its political appeal was substantial and prompted a swift takeover by the European Commission.

In practice, however, things have proven less simple. When the development of smart specialisation strategies was made compulsory by the European Commission, different expressions of at least initial reluctance could be observed in several regions (Kroll, 2015).

Notwithstanding, the final interpretation of RIS3 (research and innovation strategies for smart specialisation) by Europe's diverse regions can be seen as a perfect illustration of how policy dynamics and different institutional frameworks at regional level can transform and adopt such straightforward (in theory) approaches (Iacobucci, 2014; Kroll, 2015).

The first chapter depicts not only the S3 concept itself but also the implications for the choice of innovation policy instruments and introduces the model of regional innovation systems integration between border regions coined by Lundquist and Trippl (2013).

These prerequisites allow for the introduction of the case of the Upper Rhine in the second chapter. Accordingly, this chapter will conceptualise opportunities for the co-ordination of innovation policies in Alsace and Baden-Württemberg that a potential, future RIS3 concept could imply. The empirical elements encompass: (i) an original online survey (on a European scale) of regions engaged in the S3 process which helps to better characterise the respective positions of Alsace and Baden-Württemberg; (ii) an analysis of the most important policy documents (the so-called 'grey literature') on those two regions as well as; (iii) a set of interviews with the main persons in charge of S3 in the two regions. The final chapter discusses the results of the empirical

investigations in the light of the model of progressive cross-border integration of regional innovation systems and attempts to address specific consequences of S3 for cross-border regional innovation policies, in particular with regard to the necessary diversity of areas of investments and excellence but also in terms of challenges related to multi-level governance. The conclusions address possible future policy developments and research.

4.2 Conceptual backgrounds: S3 and choice of innovation policy instruments

Generally, policy instruments can be defined as the 'set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change' (Vedung, 1997, p. 21). Furthermore, they can also be described as the 'means' through which the 'ends' of political life are achieved (Doern & Phidd, 1983, p. 111). Ever since the economic crisis hit the European Union, both innovation and cohesion policies at the European level have been undergoing substantial changes with respect to this 'means' dimension. 'Smart specialisation' was the new and upcoming paradigm in this regard, which has attempted to change the main premises that have dominated European regional policy during the past decades:

> *"We are suggesting an entrepreneurial process of discovery that can reveal what a country or region does best in terms of science and technology. That is, we are suggesting a learning process to discover the research and innovation domains in which a region can hope to excel. In this learning process, entrepreneurial actors are likely to play leading roles in discovering promising areas of future specialisation, not least because the needed adaptations to local skills, materials, environmental conditions, and market access conditions are unlikely to be able to draw on codified, publicly shared knowledge, and instead will entail gathering localized information and the formation of social capital assets." (Foray et al., 2009, p. 2)*

This statement illustrates quite well the most important challenge that smart specialisation implies for policymakers. The core idea of smart specialisation – the entrepreneurial process of discovery – urges the entrepreneurial forces of a region to take action and defines the role of policy as that of a moderator. Additionally, the concept underlines that regions cannot do everything in terms of science, technology and innovation action and related policies so they do need to focus on specific (carefully chosen) domains. In other words, regions should not try to

imitate each other but develop distinctive areas of specialisation and then strategically concentrate their policy efforts on those 'smart specialisation domains'.

Since it became an ex-ante conditionality for structural funds (European Union 2013), the concept has very quickly turned into a dominant paradigm of EU cohesion policy. In the context of the debate on the reconfiguration of European regional policy that has been ongoing for some years, the dependence of funding on the drafting of smart specialisation strategies can be seen as an attempt to integrate goals and approaches of cohesion and innovation policy. Such efforts, however, have repeatedly been contested by several critics (BMBF, 2010; Council of the European Union, 2010; EFI, 2011, p. 52).

Generally, applying the credo of S3 holds quite some challenges for policymakers since "The complexity of the process [of S3] resides both in discovering the right domains of future specialisation and fixing the many coordination failures that can prevent emerging trends from becoming real and solid drivers for regional economic growth" (Foray et al., 2011, p. 4).

From the point of view of policy instruments, the two consecutive core ideas of S3 – the notion of 'entrepreneurial discovery' and 'discovering the right domains for future specialisation' – bring up a number of propositions with regard to the instruments that will be chosen and implemented. Most importantly though 'the main issue to be addressed by policy is not ''what to do'' but ''how to help agents to discover what to do and how to implement the policy according to what has been discovered''' (Foray et al., 2011, p. 10). In a nutshell, two main fields can consequently be identified for policy action: the application of a portfolio of strategic intelligence measures and learning processes that are associated with the identification 'of the right domains' are of significance followed by more traditional support measures for the associated 'entrepreneurial discoveries' and respectively by the distribution of financial and regulative aid in support of these discoveries. By citing among others Bijker et al. (1989) Flanagan et al. (2011, p. 706) point out that it is important though, to consider that

> *"in the real world 'policy instruments' are intangible and, as a piece of social technology have a high degree of what science and technology studies scholars call interpretive flexibility, carrying quite different meanings from time to time, place to place and actor to actor [. . .] The context and implementation of an instrument can be fluid over time as instruments are interpreted and reinterpreted in the light of changing rationales. Implementation is another factor here, and decisions taken during implementation may be critical in determining the impacts of policy action,*

potentially leading to major variations in 'the same' instrument across time and space quite independently of differences in strategies, policy rationales or meta-rationales (see e.g. Slembeck, 1997).“

Apart from the above mentioned 'interpretive flexibility' that policy instruments feature, a further challenge is the question: how to organise a coherent arrangement of different policy instruments, since they don't work in isolation. Most of the times when an instrument is introduced, it 'joins' the instruments that have already been implemented. In some cases, there might be no challenge associated with this new instrument at all; in other cases, a very careful fine-tuning of the interaction of instruments is needed. Particularly over the past decade, innovation policy scholars have taken up the debate on this so-called 'policy mix' (among others Borrás & Edquist, 2013; Flanagan et al., 2011; Guy et al.; Howlett & Rayner, 2007; Rogge & Reichardt, 2016). A very first careful analysis on smart specialisation policies showed that 'it is possible to conclude that the gravity is especially on policies in support of better networking and connectivity among different actors at the sub-national level' to better facilitate the process of discovery (Walendowski, 2011, p. 16).

The following taxonomy of instruments that are in use in innovation policy points out the most relevant policy tools for implementing the concept of S3 according to the core ideas (Figure 9). The highlighted boxes show that mainly distributive elements as well as support measures for better cooperation as pointed out by Walendowski and policy expertise are needed for the formulation and implementation of the concept.

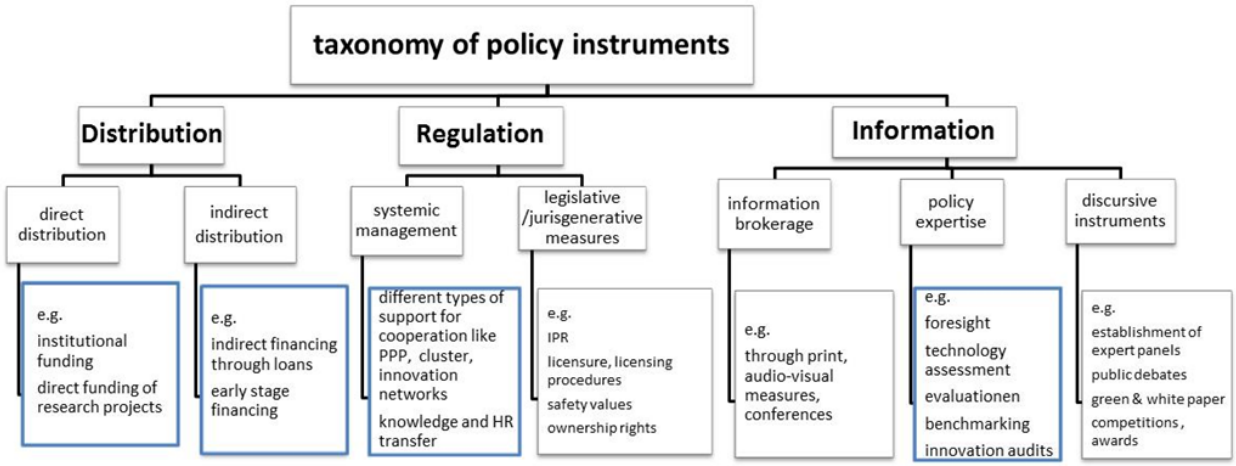

Figure 9: Taxonomy of policy instruments used in innovation policy[62]

Particularly, the latter two categories presented in Figure 1 belong to the group of the so-called 'systemic instruments' which 'according to Smits and Kuhlmann (2004) are tools that focus on the level of the innovation system instead of focusing on specific parts of innovation systems and support processes that play a crucial role in the management of innovation processes' (Wieczorek & Hekkert, 2012, p. 74). As can be seen below, the two core ideas of S3 are reflected in the heuristic (Smits & Kuhlmann, 2004, p. 12) proposal for systemic instruments which – among other aspects – support the following functions:

- *Providing a platform for learning and experimenting*: Create conditions for various forms of learning such as: learning by doing, learning by using and learning by interacting (Lundvall, 1992; Rosenberg, 1983).
- *Providing an infrastructure for strategic intelligence*: Identify sources (technology assessment, foresight, evaluation, benchmarking), build links between sources, improve accessibility for all relevant actors (clearing house) and stimulate the development of the capacity to produce strategic information tailored to the needs of actors involved (Kuhlmann et al., 1999).

[62] Source: Adapted from Hufnagl (2010: 102).

- *Stimulating demand articulation, strategy and vision development*: Stimulate and facilitate the search for possible applications, develop instruments that support discourse, vision and strategy development.

As Flanagan and Uyarra point out though:

> "despite the "strong claims […] about the potential for 'systemic' instruments and 'strategic policy intelligence' tools such as foresight exercises to improve coordination and build shared and thus more coherent policy visions. These arguments are superficially plausible but evidence is scarce''. Furthermore, these instruments do contain even more interpretative flexibility than traditional 'substantive' levers of public policy, how can we really know that they are working? Such instruments actually introduce further complexity into the system to be coordinated". (2016, p. 181)

If those systemic instruments for gathering relevant information are to complement or rather inform the more classic support measures for a sound S3 concept, a sense-making, coherent policy mix between those two instrument categories seems absolutely crucial and might be the prerequisite for fostering innovation within S3 concepts. Associated with this challenge of a well-balanced policy mix is the aspect of coordination (Braun, 2008; Metcalfe, 1994) and multi-level governance, respectively. As Magro et al point out "the process of decentralization in the governance of innovation policies from national to regional and local levels constitutes another trend that has raised the complexity of the policy system, pleading for multi-level governance processes (Borrás & Jacobsson, 2004; Taylor, 2007)" (2014, p. 372), which challenges the already complex quest for coordination between policy shaping entities even more. This holds true particularly for activities across the border where several policy layers (administrative, political, organisational) of local as well as regional levels might interact with each other (see Co-ordination of innovation policies in the Upper Rhine area as a background for S3 implementation chapter) (Magro et al., 2014; OECD, 1991).

Furthermore, in connection with the needed 'fine tuning' of the inherent dimensions of the instruments, the observations so far also depict another challenge in its own right: the appropriate addressing of different actors within the regional innovation system. Policymakers are always confronted with the question 'which policy instruments to implement at what time?' but when it comes to the formulation of S3 concepts finding answers to the questions 'who should we address with our measures? Should there be more emphasis on enterprises?' pose a particular challenge.

Evidently, the instance of ‘entrepreneurial discovery’ is a process that mainly takes place in entrepreneurial settings like SMEs or large-scale enterprises. But of course, also members of higher education institutions or research institutes – mainly with a focus on applied sciences – show entrepreneurial knowledge and spirit. To exemplify upcoming challenges for actors that are different from firms, observations and thoughts by Goddard et al. (2013, p. 93) on the role of universities point out ‘underlying tensions between regional and academic drivers’:

> “First, the involvement [. . .] of universities in regional governance and policy making that is required to inform strategic choice. Second, a possible mismatch between the current academic profile of universities in a region – the knowledge domains within which teaching, and research is undertaken – and the specific industrial and locational assets of the region which are the focus of smart specialisation. Third, the synergy (or lack of it) between globally defined academic excellence and spatially blind higher education and research policies and geographically bounded regional needs/opportunities. Finally, and underpinning each of the preceding headings are questions about the nature of the university as a ‘loosely coupled’ institution which has often been ‘black boxed’ in much of the regional development literature and related regional policy and practice.“ (Goddard et al., 2013))

As already mentioned, it has always been challenging for policymakers to formulate and implement instruments that take into consideration the needs of different regional actors and entities. However, when considering S3 concepts, there seems to be another level of complexity and responsibility associated with the right choice of instrument: Since specialising mainly means leaving out other choices respectively focussing on a certain domain, the choice should be well prepared and thought through.

This encounter also poses fundamental questions with regard to the right division of labour and legitimacy between the sphere of politics, economics and society at the meta-level that go beyond the scope of S3 concepts and this paper. However, it should be acknowledged that S3 policies might hold upcoming defiance with a view to several aspects: which sphere is the determiner when it comes to choosing the ‘right domains’ within a regional innovation system? Can actions of different policy actors and spheres be well coordinated and if so: how? Does the portfolio of instruments by the EU acknowledge the different local settings and requirements of the various European regions? Evidently to some extent the market potential of ‘entrepreneurial discoveries’ is quite unknown and unforeseeable: do public policies therefore really reflect the required degree of risk awareness? As Foray et al. make clear, if applied wisely, S3 concepts might

offer room for being adventurous on the one hand, but at the same time create a kind of safety net through considering strength on the national level on the other hand:

> "The discovery process is thus an issue in its own right. If accomplished properly through an entrepreneurial process of discovery [. . .], such a process should logically identify [. . .] the domains where new R&D and innovation projects will complement the country's other productive assets to create future domestic capability and interregional comparative advantage." (Foray et al., 2011, p. 4)

4.3 Cross-border regional innovation systems

Recently, a theoretical model has been proposed, by Lundquist and Trippl (2013), to scrutinise the potential integration processes in border regions vis-a-vis regional innovation systems and systemic innovation policy instruments (Figure 2). Basically, what the model proposes is that border regions exhibit certain stages of integration across the border and that in time they can gradually develop from a 'weakly integrated system' with almost impermeable borders into a (more utopian-type) common 'cross-border regional innovation system' (CBRIS). This development does not proceed as a balanced economywide phenomenon, but rather certain parts of the regional innovation system might be/become more integrated than others. This holds when, for example either the knowledge generation sub-system (including universities, public research institutes, etc.) or the knowledge application and exploitation sub-system (i.e. the private business sector) would be cooperating intensively across the border: the CBRIS of a border region in question could be described as semi-integrated, since cross-border cooperation has not penetrated itself across all the different parts of the economy (Lundquist & Trippl, 2013; Trippl, 2010; van den Broek & Smulders, 2014).

Here also lies the potential for RIS3 in border regions: by linking knowledge producers from the one side of the border with the ones applying this knowledge on the other side, the potential for innovation can be jointly enhanced.

Still, the knowledge application system on the other side of the border has to be able to exploit the knowledge produced on the other. Therefore, the concept of proximity plays an important role in the integration process between border regions: border regions benefit from similarities when it comes to the ease of cooperation and integration. These similarities can be observed through the lenses of a shared culture including, for example language and values (cultural

proximity), knowledge bases (cognitive), rules, laws and regulations (institutional), trust-based relationships (social) as well as through shared technological expertise (technological) (e.g. Boschma, 2005). In short, since national borders still demark barriers for most proximity types, for border regions, simply being proximate in geographical terms does not automatically lead to high cooperation and similarity in the other more intangible dimensions of proximity (Koschatzky, 2000; Makkonen, 2015).

Again, being too similar might also be detrimental for the innovative success of border regions: if the border regions are highly similar, for example they are involved in precisely the same industries and in the same research fields, there is not much that can be learned from the other side. Therefore, a system displaying, what in the literature (e.g. Frenken et al., 2007; Jauhiainen, 2014) is termed as 'related variety', would potentially constitute a much more viable CBRIS in terms of potential innovative outcomes: for successful radical innovations, it would be beneficial that the regions on the opposing sides of the border are similar enough so that they can cooperate but different enough for novel combinations of existing knowledge to emerge, offering in turn, opportunities for joint smart specialisation and entrepreneurial discovery. The role of regional innovation policies in this setting is to support exploiting this potential via for example intermediaries and bridging organisations, through transferring experiences of role models and successful collaborations and by promoting cross-border networking (Lundquist & Trippl, 2013; Trippl, 2010).

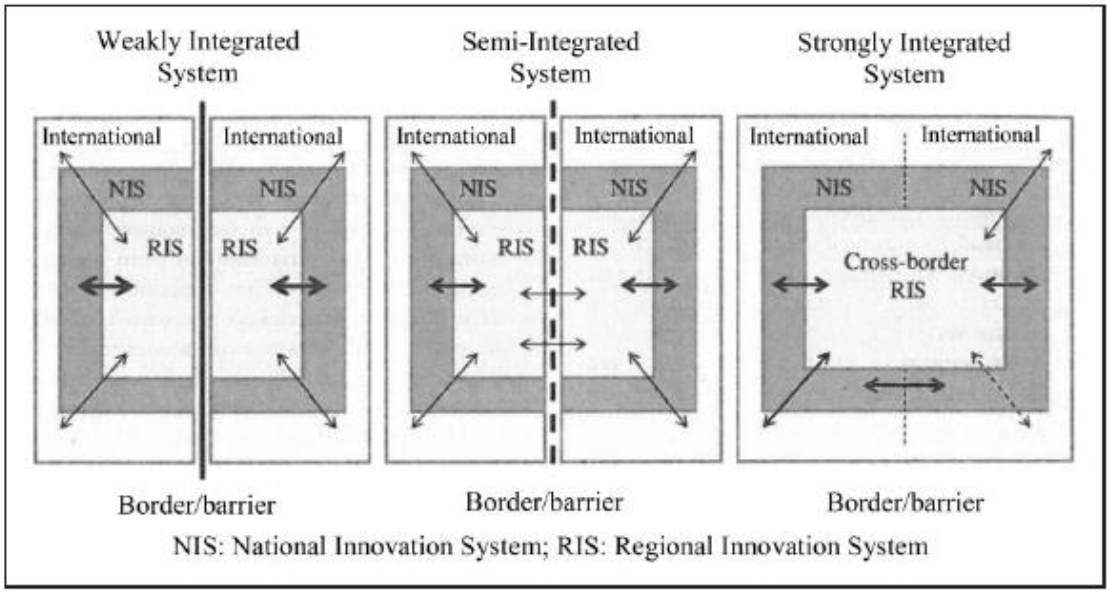

Figure 10: The different stages of cross-border innovation-policy integration[63]

4.4 Coordination of innovation policies in the Upper Rhine area as a background for S3 implementation

This chapter addresses the issue of innovation policy coordination in the cross-border region of the Upper Rhine as a background for the implementation of a joint concept for smart specialisation. Besides parts of Switzerland and South Palatinate, Alsace and Baden – the western part of Baden-Württemberg – constitute the Upper Rhine region. Cooperation activities in different areas have been in place for several decades, but (joint) smart specialisation could serve as a vehicle for further deepening the existing links across the border. The empirical approach is detailed below.

Empirical basis

The analyses of the paper are built on two questionnaire-based online surveys that were conducted with the policymakers responsible for RIS3 across the European Union in summer to autumn 2013 and 2014. Secondly, a range of in-depth phone interviews were conducted in late 2013 to gain deeper insights into regionally specific RIS3 processes' characteristics and

[63] Source: Adapted from Lundquist and Trippl (2013, p. 455)

implications. The motivation behind the survey was to achieve a deeper understanding of strategy-building and the implementation of smart specialisation across Europe, the assessment of regional policy and the changes resulting from the smart specialisation requirements, as well as the options of regional policy (Kroll, 2015; Kroll et al., 2014).

Basically, the questionnaires covered a range of aspects referring to the general framework conditions, the respective state of play related to regional RIS3 processes and the resulting strategies, as well as policymakers' assessment related to the process of implementing smart specialisation strategies in their regions. For the 2013 survey, more than 500 potential respondents could already be identified. In 2014, with more knowledge gained about the full teams working on RIS3, the baseline population could be extended to nearly 1000. In 2013, more than 70 of the targeted addressees completed the questionnaire in full and more than 130 answered notable chapters of it. In 2014, the respective figures were similar with 80 full and 160 partial responses. Overall, the resulting coverage can, in both cases, be considered significant given that there are about 200 regional or national entities in charge RIS3 strategies in total.

To deepen the collection of information in France and Germany, 14 telephone or personal interviews were performed, from which 9 were taking place in Alsace and Baden- Württemberg. The interviews were based on semi-structured guidelines lasting between 45 and 75 minutes. The aim was to reach a better understanding of complex aspects needed for the interpretation of the collected data through the online survey.

Furthermore, the interviews performed in the Upper Rhine area were targeting more specifically the issue of cross-border cooperation.

Germany and France in the context of smart specialisation

Overall, the survey underlined that both Germany and France have comparatively similar systems of governance and political traditions when compared to other European countries as far as S3-related processes are concerned. These findings were deepened by the specific interviews in Alsace and Baden-Württemberg. On both sides of the Rhine River, the framework conditions in terms of political priorities, human resources and specific competencies can be considered to be rather supportive, and also the degree of socioeconomic development in 2013 was comparatively advanced in both national states.

Equally, the process of conceiving and implementing smart specialisation strategies cannot be considered as 'revolutionary', but rather as following the trajectories of political strategies developed beforehand. As the empirical study showed, both Alsace and Baden-Württemberg are encompassed in countries in which the perceptions and potential benefits of smart specialisation processes are not radically different at the national level (Kroll et al., 2014).

Regional innovation governance and policy in Alsace and Baden-Württemberg

As a consequence, it seems necessary that the analysis takes a closer look at the bordering regions of Alsace and Baden-Württemberg and their existing, pre smart specialisation innovation policies. The decision to focus the analysis is mainly to be found in the fact that the level of interactions between the two regions is quite unique at European level. As earlier research has shown, strong economic relations can be observed as well as some innovation policy-related connections, even though the national boundary continues to play a dividing role (Koschatzky, 2000). This situation is reinforced to a certain extent by historical and cultural links, i.e. cultural proximity.

On both sides of the Rhine, from Karlsruhe to Strasbourg and Basle, the Upper Rhine Valley constitutes a core region of Europe that has produced various cultural and technological revolutions and remains a very innovative region and a strong scientific area with a relative weight comparable to Belgium, Austria or Denmark (Héraud, 2012). The specificity of the Upper Rhine area, and maybe its strength, is its polycentric metropolitan nature: linguistic and institutional variety, together with a very old common culture (Héraud, 2011), may constitute a laboratory for S3 application. Against this background, it might provide a 'living lab' to improve the understanding of policy dynamics and complexity.

Alsace

On the French side, Alsace remains influenced by a long tradition of centralised governance, even though regional autonomy (decentralisation) has increased progressively in the past three decades. At the same time, in terms of innovation policy, the French situation can be seen as very specific. While up until the 1990s, the French innovation system was characterised by a centralist, interventionist philosophy ('technological Colbertism' Larédo & Mustar, 2001), today, it is undergoing profound transformations, coupled with new actors, regulations and frameworks, as well as new ways of implementing priorities (Héraud & Lachmann, 2015).

Since France is at the cross-roads between centralisation and decentralisation, its governance system is now very complicated and variable, involving several levels of regional/local actors and national/European institutions and policy frameworks. Unlike in German federal states, the legal distribution of roles is fixed, and as a result, complex multi-level/multi-actor processes in the design and implementation of policies can be observed (Mueller et al., 2009).

The principle of regional equity, if not equality, has also shaped a distinctive French response to the needs of a competitive, international knowledge-based economy. Networks and clusters of scientific excellence, rather than the concentration of resources per se, have become preferred policy tools, demonstrating equality of opportunity to compete for science resources, if not equality of outcome. This reflects a more gradual evolution in French policy towards equity rather than equality as a precondition for competitiveness: "equity represents a means of striving for equality within the reasonable limits of efficiency" (Baudelle & Peyrony, 2005, p. 109). Baudelles and Peyrony note a changing regional development paradigm in which competition between territories is no longer seen as a zero-sum game, a position supported by the rejection of the notion of 'compensatory solidarity' by the most modern and progressive localities. The recent development of S3 strategies at regional level in France must be analysed and understood in the light of this specific context.

As in other French regions, the smart specialisation agenda did not come as a substantial novelty in terms of strategy and implementation, since all French regions had to develop (on request of the European Commission) so-called strategies regionales d'innovation (SRI) between 2006 and 2009. This process had to follow guidelines ('Methode Prager') which already constituted a form of smart specialisation process.

Baden-Württemberg

The situation on the other side of the Rhine is quite different since – unlike France – Germany is a Federal state. In Baden-Württemberg, innovation policy has a long tradition, and stakeholder participation has been an important element of policy making for many years. In general terms, Baden-Württemberg has set up discussion groups comprising private sector as well as research institutes' representatives since the mid- 1980s. In 1992, moreover, the regional government implemented the 'Future Commission Economy 2000' which recommended the implementation

of an 'Advisory Council for Innovation' which, under the name 'Innovation Forum', operated from 2002 to 2005.

Along similar lines, the Enquete Commission 'Situation and prospects of medium-sized companies, in particular family-owned companies' was set up in the late 1990s. While there is, thus, a long and robust tradition of public consultation, innovation-related aspects have typically been featured only as one topic among others. Instead, most regional forums have focused on SME-specific issues in a broader sense. Expert hearings were another approach adopted to deepen the understanding of the topic. Additionally, best practices from other German regions and abroad were collected.

Further dialogue processes were also introduced in connection with Baden-Württemberg's cluster policy in 2007 coinciding with the establishment of the regional 'Innovation Council', a broad-based committee uniting 50 persons from leading companies, scientific institutes, culture, sports, media, community, churches, trade unions, chambers of commerce, industry and handicrafts and associations. Its recommendations, published in 2010, were based on an underlying study that described economic and technological perspectives for Baden-Württemberg until 2020, based on empirical evidence and expert assessments. The recommendations carved out a number of domain-type 'future fields': sustainable mobility; environmental technologies, renewables and resource efficiency; health and care; and ICT. Later, these were complemented by 'growth fields' outlined in the 2011 coalition agreement: aerospace, creative industries, logistics and key enabling technologies (Bündnis 90/Die Grünen BW & SPD BW, 2011).

In responding to the smart specialisation agenda promoted by the European Commission, Baden-Württemberg could put together existing elements as a coherent strategy that, in an inter-ministerial effort, was finally published in mid-2013 (Ministerium für Finanzen und Wirtschaft BW, 2013). Moreover, Baden-Württemberg decided to go one step further and develop a concrete implementation tool at the sub-regional level, i.e. the RegioWIN competition. This action calls functional regions at NUTS 3 level to develop bottom-up strategic approaches towards regional innovation. During its first phase until autumn 2013, the regions were asked to develop a strategy concept. In case of a positive jury vote, the candidate regions were invited to further elaborate their regional development concepts and draft projects. After a second positive jury vote, concrete projects and support measures may be implemented from 2015 onwards.

An S3-related congruency at cross-border level?

The main point resulting from the interviews with policymakers (on both sides of the Rhine) about S3-related activities is that Alsace and Baden-Wurttemberg currently show some common features in terms of innovation policy.

Starting in 2011, a dialogue-oriented policy action associating regional companies, chambers of commerce, worker unions, networks and policymakers was introduced in Baden-Württemberg. This dialogue became a central element of the economic and innovation policies of the Land (Ministerium für Finanzen und Wirtschaft BW, 2013).

Baden-Württemberg's dialogue-based policy approach, since 2011 has comprised (1) the general economic dialogue (economic exchanges with chambers, unions or associations, etc.) which embraces (2) dialogues in sectors or branches (such as automotive, health industries, information and communication technologies, creative industries, logistics, aerospace, mechanical engineering), (3) theme-oriented dialogues (for instance concerning skilled labour, vocational training or related to clusters) and (4) regional dialogues (Ministerium für Finanzen und Wirtschaft BW, 2013).

On the other side of the border, since the development of the Alsatian regional innovation strategy 'Oser innover, être ouvert au monde, Faire des choix' (Région Alsace, 2009), substantial progress has been achieved through the smart specialisation rules of action. Changes are not only observable on the level of involved stakeholders (a higher share of regional companies is included) but also on the governance and the operational levels. The strategy development follows more strongly a bottom-up philosophy than in previous periods. During the process of conceiving the strategy, Alsatian policymakers specifically paid attention to the interchapter of emerging markets for regional firms and the specific regional competences.

Synthesising strategy documents in both regions and also referring to regional experts' assessments lead to the conclusion that the process of strategy conception according to the 'smart specialisation' rationales are based on important previous developments and strategies. In terms of joint strategy building across the French-German border, (joint) smart specialisation seems to play an important role as an instrument generating opportunities for strengthening existing cross-border ties and relations in innovation policy. So far, information exchanges have played the most important role. However, the process of conceiving S3 strategies was run in both

regions independently, i.e. without setting explicit coordination mechanisms in place. Aligning strategies in region-specific fields of specialisation may offer opportunities for future collaboration and, ideally, lead to joint research and innovation efforts in the Upper Rhine region. Following an analysis of specialisation fields in Alsace and Baden-Württemberg, some potential fields of congruency can be identified between the two regions.

The following table depicts the three main areas of congruency in terms of common specialisation that are: (i) green economy; (ii) sustainable mobility and (iii) health (to be understood in a broader meaning). Moreover, it is possible to detail these areas into seven more specific fields (see Table 6).

The previous chapter has shown that the cross-border system formed by Alsace and Baden-Württemberg is a case of an intermediate situation between 'weakly integrated' and 'strongly integrated' (cf. Figure 10). In other words, the two regions can be (at best) considered as exhibiting complementarities that are also reflected in the respective S3 strategies. However, going a little further two questions arise: (i) which existing policy mechanisms might – at least partly – explain this evolution? (ii) What could be done in the future, in terms of governance, to foster this evolution?

Concerning the first question, one important policy mechanism has been the cross-border project called RMT and TMO (Region Metropolitaine Trinationale du Rhin superieur, Trinationale Metropolregion Oberrhein, http://www.rmtmo.eu/). This bottom-up initiative of the concerned regions (Alsace, a large part of Baden, a small part of Palatinate and North-West Switzerland), agreed by the national states, targeted a strategic convergence of four 'pillars': politics, economy and science as well as civil society. The self-organised activities of the scientific pillar have proven to be particularly efficient. A very original initiative has been the organisation of a cross-border call for research proposals co-financed by regional money and Interreg EU funds. This smaller sized local 'Framework Programme' was very popular among research labs of the Upper Rhine area, leading to numerous excellent proposals and several funded projects. Another cooperation instrument designed by the RMT and TMO academic community is an annual cross-border meeting called 'Dialog Science'. It is nevertheless important to stress the fact that such a set of initiatives is no coincidence in the Upper Rhine area which has a long tradition of

institutional creativity including cross-border international agreements like Oberrheinkonferenz, Oberrheinrat, Eurodistricts and, specifically for the academic community, the EUCOR federation of five universities founded in 1989 – which now claims to be 'the' university of the Upper Rhine and is de facto the core of the RMT/TMO scientific pillar – as well as the cross-border cluster Biovalley connecting local companies to academic labs. In such a context, there are clear indications that the S3 strategy of each part of RMT and TMO (particularly Alsace) just reflects what has been set up for decades by political will and bottom-up initiatives – often supported by the European structural funds. Therefore, the role played by the EU policy through its new S3 concept was, in this case, just to accelerate an existing systemic integration process. Is it old wine in new bottles?

A. Green economy
1. Sustainable energy production
2. Energy efficient buildings
3. Circular economy and water-related issues
B. Sustainable mobility
4. Optimisation of combustion engines
5. Hybrid- und electric vehicles/Sustainable mobility systems and services
C. Health and wellness
6. Administration, infrastructure and E-Health
7. Innovative treatment processes and new drugs

Table 6: Areas and fields of congruency between Alsace and Baden-Wurttemberg

The second question is about facilitating closer cross-border ties for the future in terms of innovation policy. This issue is clearly linked with intra-regional coordination (Baier et al., 2013) and multi-level governance (Crespy et al., 2007). In the case of Alsace, for instance, the specific process of systemic integration across the Rhine is strongly linked to the degrees of freedom of the regional government and its perimeter (cf. Trippl, 2010). The present institutional evolution of French regions will certainly impact the evolution of the cross-border system: French regions will have more competencies, but they must share the new powers with urban agglomerations.

Strasbourg in this case will play an increasing role. Furthermore, the new perimeter of the region will include Lorraine and Champagne- Ardennes. Thus, further cross-border regional innovation policies could/should focus on finding common grounds between the different parts of the cross-border region. The work could/should start from the identified areas of potential joint-specialisation (Table 1) and further transfer the good practices of existing cross-border collaboration to other sectors and areas of the economy. Facilitating knowledge transfer, promoting cooperative network formation and stimulating (the exploitation of) related variety between the different parts of the cross-border region and the respective regional innovation systems should be a key aspect in this process. Existing bridging organisations and intermediaries have an important role as the catalysts of this development (cf. Jauhiainen, 2014; Lundquist and Trippl, 2013; Trippl, 2010).

4.5 Conclusion

In this paper, we attempted to provide new insights into the meaning and implications of the concept of smart specialization (S3) by examining the case of two border regions that can be considered as progressively entering an integration process of their innovation systems.

Conceptually, a review of the original smart specialisation literature underlines that the emphasis of the proposed paradigm shift is in fact much more on the 'smart' process than on the 'specialisation' outcome. In other words, the concept's early advocates aimed to propose a new way of handling both political and real-world complexity through collective discovery among economic and societal actors. Recognising distributed intelligence, diverging interests and the complexity of agency in the political sphere, administrations were encouraged to initiate entrepreneurial processes of discovery which, in the public domain, mirror processes by which companies orient themselves on the market. Firms, researcher, consultants and administrations were meant to conceive visions for development. Thus, the progressive discovery of the specialisation options and final choice of priorities would from the onset involve those actors who would later pursue these specialisations through actual entrepreneurial or other action. Importantly, it is this idea of an open and self-dynamizing process that was genuinely new to the concept.

That said, this paper suggests that, in some regions, such processes have in fact already been in place for many years – and exploited for many purposes, among them cross-border collaboration. For the case of two regions of the Upper Rhine Area, this paper illustrates how processes of joint discovery emerged both within the regions themselves and in cross-border collaboration long before the formal RIS3 agenda (and ex-ante conditionality) of the European Commission had ever been announced. Partly, this was triggered by previous European policies such as the local INTERREG Programme, it was initiated through own, strategically oriented initiatives of regional actors and administrations. Along partial congruences of the factual specialisations of both regions, several instruments were developed to coordinate efforts across the formally delineated support systems of both regions. Examples include a crossborder cluster in biotechnology (Biovalley), a university network (EUCOR), collaborative political initiatives (RMT/TMO), as well as cross-border institutions at local (Eurodisctrict) and regional (Pamina) levels. All of those were efforts to not only manage but leverage and smartly exploit complex policy frameworks as well as actor constellations in a given framework – preceded by discourse, exploration, negotiation and, ultimately joint decision making.

Hence, a spirit of smart specialisation existed years before the name was branded, so that its final institutionalisation in European support policy merely reinforced existing trends. At the same time, it can be observed that the recent formal requirement to draft smart specialisation strategies and set up related governance mechanisms added in fact quite little to existing dynamics, as the two administrative processes were very weakly linked in practice. Not least, this was the case, as the ex-ante conditionality was by both administrations primarily seen as a formal requirement to respond to, rather than as an impetus to openly and informally explore joint futures with partners from neighbouring regions. Thus, the formal obligation to rethink and declare their specialisation policy in the RIS3 context remained little more than additional step in a long run discovery path, and a less cross-national one on top of that. Nevertheless, an 'Upper Rhine identity', cognitively constructed through past actions, became an implicit part of both regions formal activities. Shared visions have existed for years and were inevitably reflected both processes, even if these remained formally separate. In that sense, the independent formal processes of smart specialisation succeeded – as they involved actors who already have a vision and projects for their territory and engaged them in relevant discussions about future options and actions, including cross-border ones.

Hence, this study suggests that, if there is enough congruence and shared visions in a cross-border area, individual actors will naturally find their interest in collaborating across the border around specific projects and lobby for support for this in their respective environments. Consequently, the main political task is to support informal processes of exchange and, indeed, entrepreneurially minded, joint discovery between partners from both regions. More so even than regions, cross-border areas are situated in a complex environment of multi-level opportunities and obstacles that have to be acknowledged and assessed in mutual consultation to take action accordingly.

From a more general point of view, the paper suggests that joint smart specialisation, via common research and innovation efforts, can be an effective instrument to strengthen existing cross-border ties and relations in innovation policy. Hence, cross-border regions and organisations should fully explore opportunities that lie in informal joint discovery to better leverage the prevalent complexity of political, administrative and, more generally, funding systems. Therefore, recommendations for future policy making in this field were derived as (1) the identification of areas of joint specialisation, (2) the transfer of good practices, (3) the facilitation of knowledge transfer, (4) the promotion of network formation and (5) the exploitation of positive differences (related variety).

However, further comparable research is needed to confirm whether the experiences gained from the case of the Upper Rhine can be applied to other cross-border contexts. Accordingly, more research on the effectiveness (success and failure) of cross-border science, technology and innovation policy tools as well as past and present processes of joint discovery will be needed to identify the measures best suited to various types of cross-border regions.

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5 Governing varieties of mission-oriented innovation policies: A new typology

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[66] https://www.uu.nl/sites/default/files/uu_workshop_summary_isi_draft.pdf Workshop report, last access 25.09.2024

5.1 Introduction

Research and innovation policies are increasingly linked to addressing grand societal challenges and the concept of new mission orientation ((Kuittinen, Skov Kristensen, et al., 2018; Kuittinen, Unger, et al., 2018; Mazzucato, 2018a, 2018b; Robinson & Mazzucato, 2019). This turn has led to the emergence of a variety of policy initiatives at supra-national (European Union (EU) Missions), national (Top Sectors, Netherlands; Cancer Moonshot, USA), and sub-national levels (The Circular Flanders Initiative, Belgium; Clean Air London, UK) with different goals, ambitions, and ranges of scope (Kuittinen et al. 2018b; Larrue 2021; (Wanzenböck et al., 2020)). While some missions follow a classic mission understanding, focusing on technological breakthroughs in the tradition of 'putting a man on the moon', others go beyond this, aiming for the transformation of whole socio-technical systems. This growing diversity of activities subsumed under the headline of mission-oriented innovation policies (MOIPs) has created difficulties for systematic analyses, comparisons, and assessments.

This article seeks to enhance the comparative and systematic empirical analysis of missions by proposing a novel framework. By providing a typology of missions based on their level of transformative ambition and the challenges in the implementation process of the associated instruments as key sources of the variance of missions, we aim to narrow the gap between the conceptual debate on mission orientation and current policy practices in this field. In particular, we emphasize the challenges for the governance of missions that have only recently triggered attention (Grillitsch et al., 2019; Larrue, 2021).

These challenges, which so far have only rarely been addressed in the literature, are often due to the fact that MOIPs cut across established responsibilities and aim to mobilize different and more diverse actors. This governance-oriented perspective allows us to derive four ideal types of missions, nested in the broadly used distinction between transformer and accelerator missions (Kuittinen, Unger, et al., 2018). These ideal types serve as deductive interpretations on how mission narratives and the assigned policy instruments pursue the associated mission goals. In our view, these types are particularly necessary to lay out further variances of missions either emphasizing scientific-technological solutions (accelerator) or including socio-institutional transformation (transformer).

To demonstrate its usefulness, we apply this typology to the German Hightech Strategy (HTS) 2025 as an illustrative case study. The 12 missions of the HTS exhibit a great variety in terms of underlying approach to the mission and its implementation structures. Our analysis shows that examples of all four types of missions can be observed, drawing a nuanced picture of MOIPs in Germany. Making use of the insights of this case study, we are able to obtain a list of potential challenges linked to different mission types.

This article contributes to existing research on MOIPs in particular and research and innovation policies in general in several ways. First of all, it adds to the debate about the characteristics of MOIPs by shifting the focus from a problem-oriented description towards an understanding of the implementation processes and governance structures. Second, we believe that the proposed typology can contribute to disentangling the diversity of MOIPs and serve as a useful tool for a systematic study and comparison and the evaluation of impacts. Moreover, it can support policymakers by fostering learning and providing guidance for the design process by stimulating reflection about the intended mission and its nature.

The structure of the article is as follows. First, we provide a review of the main specificities for MOIPs and their implications. Next, in Chapter 3, we outline a novel framework to systematize the characteristics of missions. In Chapter 4, this framework then is applied to the 12 missions of the HTS 2025 as one of the most current initiatives in the field of MOIPs. To conclude, we discuss the insights gained from the empirical application and outline possible avenues for further research.

5.2 State of the academic debate on the variety of MOIPs

MOIPs intend to direct research and innovation activities towards societal needs[67]. As such, MOIPs are nested in the on-going paradigm shift in research and innovation policy towards addressing the so-called grand challenges of our time[68], such as environmental pollution, climate or demographic change. Unlike its predecessors, which mainly targeted market and systemic

[67] For changes in the discourse and the shift from a perception of problems towards challenges, see Kaldewey (2018) and Kallerud et al. (2013).

[68] See https://era.gv.at/object/document/130. last access 25.09.2024

failures (Braun, 2008) and followed a more narrow focus on fostering the distinct domains of science, technology, and innovation (STI), the new paradigm in research and innovation policy seeks to find solutions for transformative system failures (Daimer et al., 2012; Lindner et al., 2016; Weber & Rohracher, 2012). According to Kuittinen et al. (2018b: 31) MOIPs are characterized as 'ambitious, exploratory, and ground-breaking in nature, often cross-disciplinary, targeting a concrete problem/ challenge, with a large impact and a well-defined timeframe' and imposing directionality for innovative solutions (similar (Mazzucato, 2018b)).

Applying a mission-oriented approach in STI policy is not new. However, in contrast to earlier generations of mission-oriented policies, which were predominantly centred on R&D and aimed at a clearly defined technological objective such as the US-American Apollo Project (Foray et al., 2012) current mission orientation focuses on societal problems, which are characterized by higher levels of complexity. In consequence, they more often than not require systemic approaches and transformative change, thereby involving and affecting numerous sectors, political/institutional levels and stakeholders.

Thus, this new generation of MOIPs necessitates the coordination and cooperation of actors across established responsibilities, a plea that has been raised by scholars for quite some time to allow for more systemic policymaking anyway (Braun, 2008; Daimer et al., 2012; Lindner, 2012; Smits & Kuhlmann, 2004) and foster strategic policy learning capacities (Borrás, 2011, 2019).

5.2.1 Current approaches of systematizing MOIPs

So far, there have been several attempts to make the concept of MOIPs empirically applicable and useful for the assessment and enhancement of innovation policies. In the following, we take stock of different approaches aimed at systematizing the empirical diversity of missions. First, originating from the new understanding of MOIPs, scholars investigated the degree of mission orientation in policies. The second strand mainly looks at the underlying challenges that MOIPs aim to address, and the level of societal contestation around the challenges at hand. The third approach primarily focuses on the actor constellations at play, specifically during the implementation phase of the policy process. Finally, the fourth approach combines several

characteristics, such as the motivation, means, and scope of missions to identify ideal types of missions.

During the early 2010s, scholarly debates emerged on the entrepreneurial spirit of the state in taking risks to foster innovation (Mazzucato, 2016) and its possible responsibility as an orchestrator of systemic change (Daimer et al., 2012). A general plea for a bold new mission orientation that addresses societal challenges that 'require technological, behavioural, and systemic changes' was put forward (Foray et al., 2012; Mazzucato, 2016). Accordingly, the question of directionality and linking innovation policies with societal challenges and sustainable transformation goals was up for debate. In a similar vein, scholars raised the question to what extent current policies actually meet the baseline of mission-oriented innovation (Mazzucato, 2018b). From this perspective, Kuittinen et al. (2018) analysed 132 policy initiatives under the headline of MOIPs, finding that the degree of mission orientation of current innovation policies varies considerably across countries and policies. In their analysis, they find missions with a narrowly defined scientific/technological focus (so-called accelerator missions), side by side with broader missions, aiming at a transformation of existing systems and often addressing societal problems (the so-called transformer missions).

Second, MOIPs have been perceived through the lens of the underlying problems. Wanzenböck et al. (2020) have offered a framework to position missions according to the level of societal contestation of the underlying problems and the anticipated solutions to which the missions are connected. This framework allows for understanding the current position and development of a mission, as discourse constellations can change over time, e.g. through public debate or new technological developments. The authors identify several policy pathways that can lead to the desirable state of alignment: a (1) problem-led, experimental pathway, (2) an open, fundamental research knowledge creation pathway, and (3) hybrid, co-evolutionary pathway.

A third related strand of research has emphasized the implementation process of missions and the underlying actor constellations as a crucial factor for understanding the diversity of MOIPs. The framework by Larrue (2021) serves, on one hand, to classify policies according to their main purpose (strategic orientation, policy coordination, or policy implementation) and, on the other hand, lists a comprehensive set of functions that are supposed to shape the implementation of MOIPs. Based on these dimensions, Larrue identifies nine different types of policy initiatives, ranging from international frameworks (e.g. EU missions in Horizon Europe) and cross-sectoral

policies (e.g. German Energiewende) to agency-based programmes (e.g. Defense Advanced Research Projects Agency (DARPA) in the USA). Grillitsch et al. (2019) in turn incorporate insights from transition research, arguing that the complexity of implementation is particularly driven by four dimensions: directionality, experimentation, demand articulation, and policy coordination and learning. However, their framework is primarily focused on the implementation as such and does not reveal systematic insights into the variation across MOIPs.

Finally, an empirically oriented approach to classify different policies has been put forward by Polt et al. (2019), using the established distinction between accelerator and transformer missions to inductively systematize the insights of more than 100 case studies. Observing differences with regard to the motivation (aspirational vs. problem-driven), the intention (understanding vs. solution), the definition of a target/the scope (well- vs. ill defined), and the means (technological vs. socio-institutional), they identify four types of missions:

(1) Science missions (e.g. US Cancer Moonshot – fundamental/basic research with high uncertainty)

(2) Technological missions (e.g. Concorde, Apollo mission – specific goal with a strong focus on technological/scientific solutions)

(3) Transformative missions (e.g. German Energiewende –aiming at systemic change)

(4) Umbrella missions (e.g. German HTS – comprehensive long-term policy frame).

5.2.2 Key insights from literature review

Whereas each of the previously discussed approaches sheds light on certain characteristics of mission-oriented policies, we believe that there is a need for an understanding that synthesizes the different aspects. Before turning to the development of a framework in the following chapter, we outline several key requirements forming the foundation for the novel framework: a clear delineation of conceptual levels that distinguishes between missions and political strategies, a more comprehensive understanding of complexity that treats challenges during the implementation as a distinct category, and finally, an approach that does not presuppose mission orientation but acknowledges that missions emerge in a specific institutional and political context.

First of all, we suggest focusing on the classification of individual missions instead of whole strategies. Whereas the aggregation of the latter rests on the assumption of homogeneity, individual missions can be seen as the intermediary level between overarching strategies and single policy instruments. In essence, missions can be conceptualized as translations of challenges into solvable problems (Mazzucato, 2018a; Robinson & Mazzucato, 2019). Most of the existing research on MOIPs tends to focus on the strategic level despite the fact that particularly national strategies are often comprised of very heterogeneous missions and also contain meta-aspects not associated with any mission at all (e.g. fostering a highly skilled work force or the basic funding of research organizations and infrastructures). The internal diversity and topical fragmentation of such 'umbrella missions' (Polt et al., 2019), therefore, makes both aggregation and comparison difficult, as they may contain different missions with different levels of granularity addressing different types of problems. Moreover, the macro-level perspective on strategies may overlook the relationship between individual missions, whether they are, for instance, complementary to each other, or rather focus on different types of grand societal challenges.

Second, while the new generation of MOIPs is associated with transformative goals, existing typologies provide little guidance on this dimension. Treating transformative missions as a uniform category makes it difficult to differentiate between missions at the high end of complexity. At the same time, transition research in this context has highlighted that transformative change might be driven by different pathways (Geels & Schot, 2007) pointing to differences within this category. Subsequently, an improved understanding of mission types should reflect variation within the category of missions with a transformative agenda.

Third, following the argument put forward by Larrue (2021), we suggest to amend the focus on the complexity of underlying challenges with much more direct attention towards the implementation of missions that is a source for complexity itself. The high degree of intended directionality coming along with mission orientation plays a more pronounced role of state actors in formulating these goals via strategic and systematic approaches in the first place and, consecutively, actively steering towards these goals (Schot & Steinmueller, 2018) by implementing suitable measures and 'setting clear targets and milestones and the development of approaches to assess progress' (Wittmann et al., 2020, p. 74). However, since the state neither plays a uniform role (Borrás & Edler, 2020) nor is a unitary actor, this necessitates governance

mechanisms bringing together different institutions and interests at different levels and creating the need for new means of coordination and cooperation beyond established policy areas and bureaucratic silos (Arnold et al., 2018; Boon & Edler, 2018; Mazzucato, 2018b; Robinson & Mazzucato, 2019; Smits & Kuhlmann, 2004; Weber & Rohracher, 2012). Moreover, actors and actor constellations are often changing over time, increasing the complexity of governance (Hekkert et al., 2020). At the same time, directionality may fuel the emergence of conflicts between different actors with their distinct own interests and agendas, thereby entailing higher degrees of politicization of innovation policy than previously (Botthof et al., 2020). Consequently, the role of governance that can be understood as 'purposeful efforts to guide, steer, control, or manage (sectors or facets of) societies' (Kooiman, 1993, p. 2) is of key importance in order to achieve the changes aspired by mission-oriented policies. In the following, we draw on Borrás and Edler who define governance as the

> '[...] way in which societal and state actors intentionally interact in order to transform ST&I systems, by regulating issues of societal concern, defining processes and direction of how technological artefacts and innovations are produced, and shaping how these are introduced, absorbed, diffused and used within society and economy.' (Borrás & Edler, 2014, p. 14)

This definition is particularly useful in our context as it presents a holistic view on directionality regarding the transformation of socio-technical and economic systems. In addition, the definition explicitly emphasizes actors' purposeful attempts to influence decisions, associated processes, and framework conditions to achieve certain ends, a main pattern of reflexive governance (Lindner et al., 2016). Finally, we urge for an empirically based or 'realist' perspective on missions that takes the actual missions as the decisive analytical reference rather than normative conceptions about the character of types of problems and solutions. While there has been a semantic shift towards mission-orientation in many countries, actual changes in the form or content of policies cannot be presupposed (Daimer et al., 2012). Policy design is shaped by a path-dependent process, resulting in a layering of policy instruments and making it difficult to clearly delineate different generations of policies (Arnold, 2019). Moreover, a primarily problem-oriented perspective on missions might overlook the various translation processes that are inherent to MOIPs and lead to highly divergent approaches to address similar challenges (Edler & Salas Gironés, 2020 for a more general perspective beyond missions see Howlett et al., 2017;

Kroll, 2019). Missions are not taking place in a political vacuum but are embedded in a specific societal and institutional context (cf. also Goggin, 1990; Mayntz, 1982; Ringeling, 2005), leading to different priorities and assumptions on how to solve a given problem. This has been also indicated by Wanzenböck et al. (2020), who argue that perceptions of solutions and problems can vary across different contexts. As a consequence, a specific solution might be more contested in one country than in another. Given this background, missions may only address a certain part of a challenge or may be complemented by other missions addressing the same overarching societal challenge (European Commission, 2017; Larrue, 2021). For example, the reduction of waste might be both achieved through changes on the side of production (through new technologies), changes in consumer behaviour or different combinations thereof.

To address these requirements in existing MOIP literature, subsequently we provide a comprehensive classification that is clearly linked to the level of individual missions and acknowledges the different sources for variation across actual missions. It pays particular attention to implementation, since trying to understand MOIPs without the interplay of public and private actors and the inherent challenges, we would fall short to grasp different kinds of complexity.

5.3 A new typology of MOIP

This chapter sets out a novel typology for understanding the diversity of MOIPs by complementing existing typologies with the dimension of governance requirements. Following the insights from the previous chapter, it focuses on individual missions instead of comprehensive political strategies. Moreover, it takes a clearly empirical or 'realist' approach, as it emphasizes the importance of the implementation process and governance of MOIPs rather than relying solely on the underlying problems that the missions are *supposed* to address. From this perspective, variations between types of missions follow different narratives and therefore result in different understandings and approaches (e.g. focus on science and focus on changing production patterns) to address the underlying challenges. We acknowledge that the realization of MOIPs is characterized by multiple translations from the underlying societal challenge towards desired impacts (Wittmann et al., 2021). Following Kroll (2019, p. 637)), we understand translation 'as a process of ideation, negotiation and decision-making that is driven and

governed by multiple actors'. This perspective generally adds valuable insights for MOIPs that typically cut across different thematic areas and institutional responsibilities and also ties in with our proposed focus of the new typology on governance requirements (e.g. cross-sectoral coordination). This chapter proceeds as follows. First, it outlines how the three key steps of the translation process of missions are linked to the variety of missions. We argue that missions differ first with regard to the motivation (problem- vs. solution oriented), second with regard to the mission approach to achieve the desired outcomes (relative importance of STI), and, finally, they differ in their mode of implementation (complexity of governance). Building on the description of variations across missions, we derive a set of ideal types of missions exhibiting different configurations with regard to the aforementioned characteristics. Taking the multiple translation processes as a starting point, we observe three sources for the variation among missions.

Step 1—Mission definition: First, the process of narrowing down the scope from a societal challenge to a dedicated mission that addresses (part of) the challenge can be grasped by different notions of the mission definition, i.e. understanding the underlying motivation. Drawing on Polt et al. (2019), missions vary with regard to motivation (aspirational vs. problem-driven) and intention (understanding vs. solution). Focusing on the driving factor behind missions, we subsume these two aspects, distinguishing between problem and solution-driven mission goals. Whereas missions being driven by a certain problem aim for a comprehensive understanding of the underlying problem and yet have to find a solution for the problem, solution-driven missions rely on an already identified solution for a specific problem. From this perspective, problem- and solution-driven approaches can be also considered as the intermediate steps in the framework of Wanzenböck et al. (2020) where convergence of views have been achieved either for the problem or for the solution.

Step 2—Mission design: Second, missions often vary with regard to how their goals are translated into policy actions. Depending on the perception of different types of failures to be addressed (Weber & Rohracher, 2012), obviously different approaches and instruments on how to reach the postulated goals are chosen (cf. Rogge et al., 2020). Polt et al. (2019) highlight that missions may be approached by scientific-technological or socio-institutional means. Whereas these perspectives are not mutually exclusive, we consider that missions may vary with regard to the extent STI policies are complemented with a wider range of inputs, such as social innovation (Botthof et al., 2020), reflecting the different assumptions for goal-achievement. Furthermore,

we need to acknowledge that missions, just like any generation of policy intervention before, are a legacy and combination of past and present policy instruments (Hufnagl, 2010; Rose, 1990) and therefore results of the frequently cited processes of layering, drift, conversion, replacement, and exhaustion (Béland, 2007; Rayner & Howlett, 2009; Thelen & Streeck, 2005). In this light mission design poses an additional challenge since diverging ideas and perceptions on the system (components) that require transformation (Kuhlmann & Rip, 2018) might furthermore be confronted with the limited outreach or scope of distinct STI policies that, therefore, need to be complemented.

Step 3—Mission implementation: The final step relates to the complexity of mission implementation. Being potentially closely linked to mission design, it analytically constitutes a distinct dimension. This is well illustrated by the example of a vaccination (cf. USAID, 2018): the science part in a vaccination programme might be of limited complexity, while the logistics of distributing the vaccination can be a considerably larger challenge requiring the cooperation of multiple actors in a difficult environment. In consequence, by looking at the implementation process separately we are able to derive a more pronounced understanding of the complexity of the actual roll out of MOIPs. The complexity of implementation arises along several lines and levels, which requires a critical reflection of the role and performance of public and private actors who should bring about the desired change ((Borrás & Edler, 2020; Braun, 2008; Edler et al., 2003; Flanagan et al., 2011; Lindner, 2012; Matthews, 2011) connected to the missions and the emerging requirements for governance and implementation (Kuhlmann & Rip, 2018; Weber & Rohracher, 2012). Given the complexity of this aspect, we only can approximate it in general terms, focusing on its key constitutive elements. In particular, missions may impose the coordination and cooperation between public and private actors at different levels, creating the need for aligning activities both horizontally and vertically (Weber & Rohracher, 2012). Moreover, an alignment is necessary at the intervention level (ibid.), ensuring that different types of interventions push towards the shared goal (Rogge et al., 2020).

These three steps of translation processes (definition/ design/implementation) may help to characterize the varieties of MOIPs that can be observed in practice[69]. However, while

[69] In Chapter 6, the article: From mission definition to implementation: Conceptualizing mission-oriented policies as a multi-stage translation process, investigates this observation in more depths.

constituting analytically distinct categories/levels of policymaking is beneficial for the analysis of MOIPs, it should be noted that empirically these translation processes are not performed in isolation from each other (Wittmann et al., 2021). Particularly with a view to the (relative) role of STI in MOIPs and the implementation process, broadening the sectoral approach and instrument mix will—on average—imply a more complex actor configuration, compared to a policy that remains within the confines of STI policy alone. In consequence, some combinations of characteristics might be more plausible than others.

As discussed above, mission implementation is a key parameter of the empirical diversity of missions. The established distinction between accelerator and transformer types (Kuittinen, Skov Kristensen, et al., 2018; Polt et al., 2019) falls short of capturing this diversity that—to our understanding—seems crucial, both conceptually and practically. To close this gap, we propose to extend the established dichotomy and introduce sub-types for both transformer and accelerator missions, to account for differences in the implementation and specify missions more comprehensively. A more detailed analysis and understanding of mission implementation pinpoints to the gradual differences of the underlying motivation that lead to missions in the first place and ultimately to the policy instruments chosen (to address the mission goals particularly with a view to the aspired degree of transformation). It allows us to shed more light on the variation within the transformer type of mission, which typically necessitate an ambitious and complex implementation process, instead of considering those just as a uniform category with rather broad goals reaching beyond technological solutions alone (cf. Polt et al., 2019).

In sum, we derive four ideal types of mission that describe different plausible combinations of key characteristics encompassing a distinct understanding about type and scope of necessary changes and the intended approach (cf. Table 7). The identified mission types thereby constitute ideal types, acknowledging that real-world missions may combine different features or fall in-between types. The remainder of this chapter discusses the differences between different types in greater detail, matching types to the previously identified mission characteristics. Within accelerator missions, two sub-types exist (A1, A2). Accelerator Type 1 (A1) departs from a problem-oriented perspective, lacking a defined solution that prioritizes ‘classical’ STI as a means for mission accomplishment. In consequence, such ‘science’ missions impose only limited complexity with regard to mission governance, given the absence of crosscutting responsibilities and the involvement of stakeholders beyond the science sector. In contrast, Accelerator Type 2

(A2) rest on the notion of promoting a certain solution by adjusting structural and institutional constraints, e.g. on the regulatory domain, in order to bring research results into application.

In consequence, the more solution-driven Accelerator Type 2 mission goals typically cannot be accomplished by technological/scientific solutions alone but need to be accompanied by a broader set of instruments beyond research funding and the cooperation of actors from different sectors and domains. This in turn implies a higher demand for coordination by state actors to ensure the desired interplay of actors and successful translation processes.

As discussed in Chapter 4.2. of this paper, transformer missions represent a more transformative understanding of MOIPs. We further differentiate between Transformer Type 1 missions (T1), which are more confined in their scope as they depart from an identified solution, and the more problem-oriented approach of Transformer Type 2 missions (T2), which takes a broader stance, lacking convergence on the desirable solution. For the remaining categories (approach for goal achievement and implementation) the differences are rather by degree than by kind. Reaching beyond traditional STI policy, both T1 and T2 require a comprehensive mix, combining different kinds of policies. However, the depth of anticipated changes can be considered to be more comprehensive for T2 missions that, for example, require a change of behaviour/'behavioural additionality' (Gök & Edler, 2012) or elements of exnovation/destablization policies (Kivimaa & Kern, 2016; Rogge & Johnstone, 2017; Turnheim & Geels, 2012). These different approaches also resonate with the complexity of governance. Taking into consideration the micro-level (end users, population, etc.), T2 missions comprise a wider range of stakeholders compared to T1 missions that deal with key systemic actors on the macrolevel such as industry sectors. Moreover, the composition of the policy mix can be considered to be both more diverse and contested, making the governance of the mission more challenging.

	Accelerator Missions		**Transformer Missions**	
	Type 1 (A1)	Type 2 (A2)	Type 1 (T1)	Type 2 (T2)
Mission definition: underlying motivation	Problem-oriented	Solutions-oriented	Solutions-oriented	Problem-oriented
Mission design: relative importance of STI	High	High	Medium	Medium
Mission implementation: governance requirements	Low	Medium	High	Very high

Table 7: Characteristics of different types of missions (own elaboration).

5.4 Illustrative case: The German HTS 2025

Having outlined a framework for capturing the empirical diversity of missions, this chapter explores the applicability of this framework to the HTS 2025 of the German Federal government as an illustrative case. The HTS 2025 (see Table 8) aims to address different societal challenges, among others, related to health and aging society, regional development, and sustainability. The history of the HTS dates back to the year 2006, when the German federal government decided to launch its first framework to streamline its R&I policies. It aimed to support selected key technologies, including among others, nano-, bio-, and space technologies. The first update of the strategy, the HTS 2020 (BMBF, 2010), saw a shift, from supporting selected technologies towards emphasizing the importance to tackle global challenges. The HTS 2020 was the first strategy that explicitly referred 'to gear research and innovation policy towards a number of central missions [..] (by) defining 'forward-looking projects' (BMBF, 2010).

In comparison, the current HTS 2025 (adopted in 2018), provides a more direct reference to the MOIPs approach by specifying dedicated missions. It comprises 12 missions, (jointly) organized by several federal ministries and coordinated by the Ministry of Education and Research. In this sense, the HTS 2025 serves as a kind of political umbrella for a diverse mix of research and innovation policies of the German federal government. This way, it provides an interesting test case to explore different mission types, along with their specific requirements for governance, in a uniform institutional setting.

Field of action	Topic	Mission
Societal challenges	Health and Care	Combating cancer Digitally networking research and healthcare—for intelligent medicine
	Sustainability	Substantially reducing plastic discharged into the environment Achieving substantial greenhouse gas neutrality in industry Preserving biological diversity Creating sustainable circular economies
	Mobility	Developing safe, networked, and clean Building up battery cell production in Germany
	Urban and rural areas	Ensuring good living and working conditions throughout the country
	Economy & work 4.0	Shaping technology for the people
Germany's future competencies	The technological base	Putting artificial intelligence into practical application
Open innovations and venture culture	Putting knowledge into effect	Finding new sources for new knowledge

Table 8: Overview of the German HTS missions[70]

5.4.1 Operationalization

In order to explore the applicability of our typology to the German HTS 2025, we propose a simple operationalization of the relevant steps and discuss sub-components for the governance dimensions. Especially the final dimension of governance constitutes a challenge, given the fact that missions may evolve over time (Janssen et al., 2020) and that complexity is often rooted in the specific context of implementation and its circumstances. Hence, the suggested

[70] based on BMBF (2018))

operationalization, focusing primarily on quantities instead of qualities of potential challenges for implementation, only provides a first rough approximation. It aims to sketch a rather general approach applicable to different institutional contexts. Table 9 provides an overview on the identified dimensions and their suggested operationalization.

The first two dimensions regarding the underlying motivation and the relative role of STI polices are strongly rooted in existing literature (cf. Polt et al., 2019). They can be captured by a qualitative assessment based on the overarching mission description that can be found in strategic documents. Regarding the motivation, it is possible to assess whether missions are driven by attempts of solving a problem or focus on implementing an already defined solution. In a similar vein, the overarching understanding of how to achieve these changes can be differentiated by missions with scientific/technological innovation as the key driver, in contrast to missions emphasizing a systemic change and thus point to the importance of means beyond STI policies.

Characteristic	**Operationalization**	**Type of variable**	**Related literature**
Underlying motivation	Mission defined by goals vs. problem description	Binary	Polt et al., 2019
Importance of STI	Scientific/technology, innovation as the main driver vs. systemic change (behavioural additionality)	Binary	Gök & Edler, 2012; Polt et al., 2019; Wanzenböck et al., 2020
Governance requirements	Cross-sectoral diversity (state, science, economy, and society)	Additive index (0-4)	Larrue, 2021
	Dimensions of activity (informing, financing, regulating, and destabilizing)	Additive index (0-4)	Hufnagl, 2010; Kivimaa & Kern, 2016; Larrue, 2021; Lowi, 1972; Rogge & Reichardt, 2016
	Number of involved ministries/actors	Categorical variable	Larrue, 2021; Weber & Rohracher, 2012
	Multi-level dimension	Binary	Larrue, 2021; Weber & Rohracher, 2012

Table 9: Dimensions of typology and operationalization (own elaboration)

Regarding mission implementation, we consider four dimensions as relevant, with two of them referring to the governance of missions among public actors and two of them referring to the interaction of public actors with other stakeholders. For the purpose of this illustrative case, we rely on a simple aggregate index combing these four dimensions that were previously standardized to the range from zero to one. Consequently, we attach equal weights to these dimensions, given the absence of a theoretically founded approach for systematizing their relationships in a more complex way. The realization of policies strongly depends on the interplay and cooperation of the multiple external stakeholders from industry, science, and society. The main challenge in this context is to ensure an efficient interaction among all these actors and an uptake of the policy mix.

First, MOIPs aim to mobilize a wider range of actors around a mission topic (and potentially a mission owner, if there is an entity that claims leadership). While a broader range of involved actors may increase the possibilities to mobilize additional resources, it comes at the cost of higher coordination. To capture the range of potential actors, we propose a simple additive index of key players in the mission (state, research/science, economy, society understood as citizens, and formal organizations representing relevant non-economic groups), with more actor groups involved implying higher efforts for coordination.

Second, MOIPs can combine a variety of different policy instruments and activities aiming to facilitate the materialization of desired outcomes. Complexity, therefore, may also increase with the policy mix and the appropriate timing and coordination imposing additional constraints. While a systemic inquiry of instrument mixes is beyond the scope of this operationalization and may evolve over time, we focus on the diversity of measures as a proxy for the necessary efforts to align activities within the mission context. Drawing on Hufnagl (2010) and Rogge and Reichardt (2016), we take the following three types of activities as a starting point:

(1) Informing: supporting the acceptability of technological advancements that address missions or/and facilitate behavioural change among citizens by providing information and making persuasive efforts and also actively gathering information on attitudes and social practices of non-state actors to feedback into the policy process

(2) Financing: direct or indirect support to facilitate/ promote a certain solution be it in cash or in kind. This includes a wide range of benefits ranging from funding for dedicated research

projects or the establishment of new research institutions to public procurement measures for instance

(3) Regulating: adjusting existing regulations to new developments and setting a legal frame for its implementation or even implementing entirely new regulatory frameworks due to technological advances and societal needs e.g. in the sphere of eHealth

Besides these instruments, we include a fourth category, cross-cutting the aforementioned types. Drawing on Kivimaa and Kern (2016), we acknowledge that transformative activities might require the destabilization of existing regimes/systems to unlock the required changes by shifting system statics through weakening existing solutions/ behaviours or supporting their phasing out. Such policies are often redistributive in their effects, producing losers that may oppose the planned changes (cf. Lowi, 1972). Consequently, the existence of each of the four types of instruments results in an increase of the index by one unit, assuming that the combination of all four types constitutes the highest need for coordination.

The second pillar within implementation focuses on the requirement a mission imposes with regard to dynamics within public actors. Due to their cross-cutting nature, missions mostly fall into the shared responsibility of several ministries, and in turn, of numerous administrative units within the involved ministries or even shared responsibilities for implementation at different institutional levels for instance subordinated public agencies or local/regional authorities.

Following the argument of Weber and Rohracher (2012), we focus particularly on horizontal and vertical coordination, as the key dimension of coordination for public actors. With regard to horizontal governance, i.e. public actors at the same level (e.g. ministries) in charge of mission implementation, we propose to rely on a simple quantitative measurement.

Admittedly, this approach is rather schematic, ignoring e.g. the existence of conflicts between ministries governed by different political parties, different bargaining power of individual ministries and even ministers, or intra-ministerial coordination challenges. Nonetheless, a higher number of involved actors can be considered to increase the need for coordination and entails the challenge of different cognitive frames, experiences, etc. (Edler & Salas Gironés, 2020) in its own right. Consequently, we distinguish between four different levels of coordination: the absence of coordination, low (two ministries), medium (three ministries), and high levels of coordination (four or more ministries).

In contrast, vertical governance refers to the possible existence of multi-level structures that affect the implementation of the mission. This may comprise the involvement of regional or local actors, subordinated agencies or interactions with the supranational level. For the purpose of this case study, we distinguish between a need for vertical coordination and the absence therefore, thus relying on a dichotomous coding (yes/no).

Whereas the assessment of the underlying motivation and the assumed role of STI policies can be derived from the mission description and strategic documents, the identification regarding the implementation is more challenging. Assessment might be carried out either by focusing on mission documents alone depicting the perspective of mission owners or a perspective incorporating expert assessments that focus on actual requirements necessary for mission implementation.

In this paper, we pursue a hybrid approach, taking the original strategy document as well as the subsequent implementation report as a starting point (BMBF, 2018, 2019) but incorporating additional insights (expert assessment, insights from workshops with staff responsible for missions at ministries and funding agencies) wherever possible. Based on this empirical basis, the research team rated all 12 HTS missions, using the operationalization described above. Our findings reveal a broad diversity of policies under the strategic umbrella of the HTS 2025 in relation to all three theoretical characteristics. A summary of the assessment can be found in Table 10.

5.4.2 Discussion of results

Table 10 indicates considerable variation across the missions of the HTS with regard to their approach to the mission (goal- vs. solution-orientation; dominance of STI), as well as with the emerging governance requirements. While the association between the latter and the role of STI policies is—as expected—relatively high, missions generally differ with regard to the involvement of key stakeholders, range of (potential) instruments, and the horizontal and vertical coordination. Whereas some missions rely on a narrow horizontal coordination (e.g. combating cancer/open knowledge), others are characterized by the involvement of up to six different federal ministries (e.g. plastic waste).

Mission	Underlying motivation (solution oriented)	Mission approach (dominance of STI)	Sectoral depth (key stake-holder groups)	Types of policy instruments	Horizontal governance (involved ministries)	Vertical depth (multi-level structure)	Agg. Governance requirements
Combating cancer (1)	No	Yes	1	0,5	0,33	1	0,71
Intelligent medicine (2)	Yes	Yes	0,5	0,75	0,33	1	0,65
Plastic waste (3)	No	No	1	0,75	1	1	0.94
CO2 emission industry (4)	Yes	Yes	0,75	0,5	0,66	1	0,73
Circular Economy (5)	Yes	No	0,75	0,75	1	1	0,88
Biodiversity (6)	No	No	1	1	0,66	1	0,92
Mobility (7)	No	No	1	1	1	1	1
Battery cells (8)	Yes	Yes	0,75	0,25	0,33	0	0,33
Good life (9)	No	No	1	1	1	1	1
Technology for humans (10)	No	No	1	0,75	1	0	0,69
Artificial intelligence (11)	Yes	Yes	0,75	0,5	1	0	0,56
Open knowledge (12)	Yes	No	1	0,5	0,33	0	0,46

Table 10: Assessment of individual missions along categories and sub-categories (own elaboration, main categories are grey shaded)

In a second step, we use the obtained values for running a cluster analysis (average linkage, Gower dissimilarity measure for mixed binary/continuous data) to identify clusters of missions with shared characteristics. The obtained groups of missions can be subsequently matched and compared against the ideal types of missions derived in the previous chapter.

The lower part of Figure 11 entails two clusters of missions reflecting key characteristics of the accelerator sub-types. The research-driven mission on combating cancer with its problem-oriented character aiming to support the development of new therapies, early diagnosis measures and a focus on translational research activities to accelerate the diffusion of advances towards patients can be considered as a case of an Accelerator Type 1 Mission. However, we need to acknowledge that the mission should not be considered as a pure type, as it also entails elements implying a broader orientation (e.g. stakeholder involvement through the decade against cancer). In contrast, a number of missions (artificial intelligence, battery cell production,

CO_2 emissions, and intelligent medicine) emphasize a more solution-oriented applied approach and a medium demand for coordination given the often-limited degrees of horizontal coordination, a less complex policy mix or the limited involvement of stakeholders. This is particularly well illustrated by the mission focusing on battery cells involving only two ministries (BMBF and BMWi) and emphasizing the role of financing instruments.

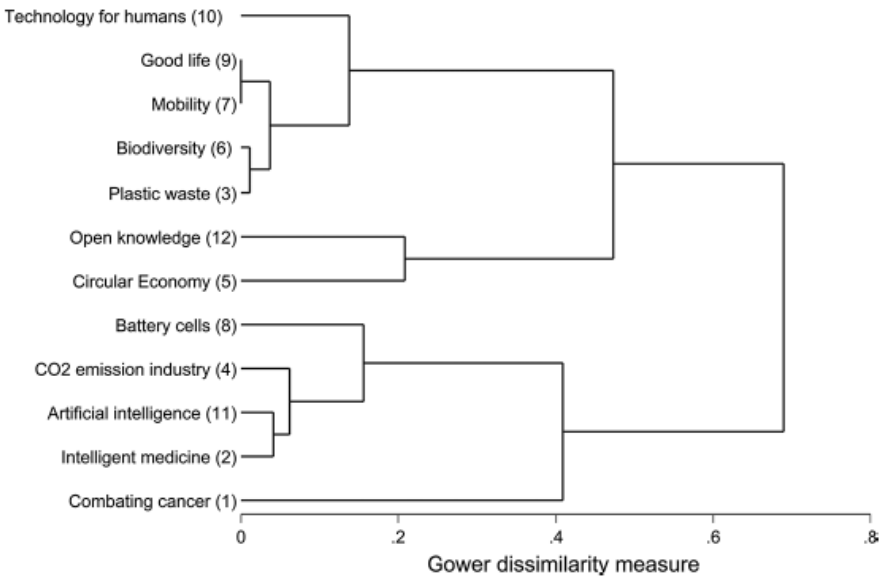

Figure 11: Dendrogram for the twelve German HTS missions (own elaboration)

The remaining two clusters in the upper half of the figure can be considered as transformer missions. The smaller group of open knowledge and circular economy in this context resembles the Transformer Type 1 with its more limited character. This is exemplified by the latter mission, focusing primarily on activities related to producers (manufacturing and branches like the building industry), whereas consumers receive only limited attention. In contrast, the remaining missions open up a more comprehensive perspective emphasizing the role of behavioural changes and potentially encompassing an instrument mix reflecting those goals, like the mission on ensuring good living and working conditions throughout Germany, including activities that seek to facilitate social innovation. The analysis provides several relevant insights.

First of all, it demonstrates the high diversity of missions even within a single strategic framework, such as the German HTS 2025. In this particular context, we find evidence for the existence of missions resembling all of the four previously identified ideal types with a combination of certain characteristics, resting on different assumptions about the underlying problem, appropriate means, and the most adequate way to achieve it. A case in point is the mission on reduction of CO_2 emissions in industry, illustrating the importance of different understanding of missions. The mission puts strong emphasis on technological innovation, which is mostly supposed to happen in collaborations of research institutions and partners in specific energy-intense industries through funding of research and innovation activities. Other stakeholders, for example downstream industries (e.g. car manufacturers, construction companies) or product end users are hardly considered at all, indicating the potentially different approach the mission might have pursued.

At the same time, the analysis turns attention not only to the variation across but also within clusters. For instance, the mission on intelligent medicine aiming to introduce an electronic patient record does not constitute a viable technological challenge, but in turn imposes relatively high coordination requirements regarding different stakeholders and institutional levels that sets it apart from top-down organized missions with a limited instrument mix and potentially lower demands for vertical coordination (artificial intelligence and battery cell production).

5.5 Discussion and conclusion

The illustrative case study found examples for all four ideal types among the 12 missions of the German HTS 2025, highlighting the considerable variation of missions even within a single strategy. While complexity can have its roots in many sources, we believe that the formation of ideal types can help to link mission types with distinct challenges characterizing the realization of missions. Hence, missions are driven by various dynamics, requiring different perspectives both for researchers/policy analysts and policymakers. Whereas coordination and stakeholder involvement is an issue for all mission types, other aspects gain importance for some of the mission types (see Table 11).

Type	Possible means for goal-achievement	Possible obstacles
A1	• Increasing research output and scientific knowledge production in defined area	• Mobilizing and directing research activities • Setting up and implementing problem-oriented instruments • Managing research portfolio with high levels of uncertainty
A2	• Bringing research to application • Creation of new infrastructure • Adjustment of regulatory framework	• Ensuring knowledge/ technology transfer between science/research and enterprises/users by facilitating processes and detection of possible obstacles • Coordination of policy mix containing funding and regulation • Reducing uncertainty/risk for involved actors
T1	• Substitution/ Reconfiguration of existing systems through facilitation of new solutions	• Coordination of complex policy mix in a multi-stakeholder environment • Long-term orientation and strategic planning at the systemic level • Overcoming lock-in and path-dependencies by facilitating alternative solutions
T2	• Substitution/Reconfiguration of existing systems • Phasing out of existing solution/approaches • Change in behaviour and attitudes	• Coordination of complex policy mix and coordination of actors across different levels • Mobilizing and involving civil society • Long-term orientation and strategic planning at the systemic level • Compensation of potential losers of transformation/ managing veto-players

Table 11: Mission-types and possible issues for implementation.

For example, in Accelerator Type 2 missions, a main issue is to ensure the translation of scientific developments into practice by providing an appropriate mix of incentives and framework conditions. In contrast, Transformer Type 2 missions require more emphasis on preventing the emergence of deadlocks and blockades emerging from incumbents and potential losers of changes, alongside the proper coordination of the policy mix that encompasses a wider variety of inputs. Moreover, the involvement of civil society groups and individual citizens gains considerable importance in this type of mission, confronting actors with the need to develop a dedicated and suitable set of instruments.

We assume that the typology can contribute to research and policymaking in multiple ways. First of all, the growing popularity of MOIPs and the empirical diversity of missions raise the need for conceptual clarification. The diversity of missions is cross-cutting different academic debates on MOIPs about underlying concepts, negotiation processes at different levels, the definition of directionality, context conditions, and implementation dynamics (cf. e.g. Janssen et al., 2021; Wittmann et al., 2021). The proposed typology ties the conceptualization of different missions closer to these debates by a process-oriented perspective and provides multiple analytical and conceptual clarifications (level of analysis and actors, and differentiation between transformer missions). Thereby, it emphasizes the importance of the emerging governance requirements, addressing the lacking focus on the implementation dimension in the majority of research on MOIPs (cf. Janssen et al., 2021). The identification of sources of variation along the different stages of MOIPs and the typology building on these contributes to a more finely granulated analysis and understanding of MOIPs, with ideal types and key characteristics providing an orientation point for analysis of individual missions and comparative approaches in national, sub-national, and cross-national settings. Second, identifying specific obstacles for each mission type contributes to a better understanding of the impacts of MOIPs, which so far have only rarely been addressed by researchers and pose new challenges for evaluation (cf. Amanatidou et al., 2014). For example, Arnold et al. (2018) argue that the level of complexity of evaluation depends on the complexity of the problem. In a similar vein, Kuittinen et al. (2018, p. 35) argue that 'mission-oriented R&I initiatives should be evaluated against criteria adapted to their objectives and the problems they target', rejecting a one-size-fits-all approach. In this sense, the proposed typology hopes to lay the basis for more nuanced analysis and evaluation of MOIPs in future research.

With regard to policymakers, the typology can support expectation management in the definition of missions in conjunction with a better understanding of promising kinds of policy interventions for certain types of missions. For example, a Transformer Type 2 mission relying on a narrow target group and the reliance of STI funding alone will face difficulties to achieve its goals. Instead, it will require a broader and multi-faceted mix of instruments reaching beyond STI that also targets measures towards individuals/civil society.

In this context, the ideal types can be regarded as an orientation point, helping to make the often-implicit assumptions about missions explicit and support the design and implementation

process to unravel the different understandings of actors about transformation and the ways to achieve it. While we believe that this new typology offers practical and theoretical values, we acknowledge several theoretical and methodological limitations. First, as mission goals might develop over time, due to shifting political constellations and priorities, internal learning processes, or changing context factors, the assessment of missions can only represent a snapshot at a certain point in time that is reliant on the accessible sources. Therefore, a repeated assessment of missions might be necessary in order to see whether and how missions evolve (Janssen et al., 2020; Wanzenböck et al., 2020). Moreover, such longitudinal analyses might provide an opportunity to systematically monitor the development of MOIPs and explore the interaction of MOIPs with other factors. Further, while having outlined a first operationalization for governance requirements focusing on the quantification of challenges, we are aware of the limitations of this approach. Translating complex concepts such as policy mixes or actor involvement into quantitative indices can only be an attempt to approximate the full complexity of real-world missions.

Moreover, the proposed operationalization could benefit from additional qualitative indicators. To what extent our framework can be usefully translated to other national contexts or be used for cross-national comparisons needs to be explored in further studies. Generating additional insights from the comparative study of MOIPs could help to refine the operationalization of the dimension of governance, obtaining a more fine-grained understanding of the relationship between the different aspects of implementation requirements. In conclusion, this paper presents a novel analytical framework for the study of MOIPs, identifying four ideal types of missions that extend the existing distinction between accelerator and transformer missions. The key argument is that the turn towards stronger directionality of these policies has substantial implications for the role of the state in this policy domain. Accordingly, the study of MOIPs needs to adjust its perspective and pay more attention to governance, implementation processes, and actor constellations. We thereby go beyond the dichotomy of the state correcting vs. creating markets, taking a closer look at the role of state actors—a blind spot in innovation research only recently addressed by Borrás and Edler (2020).

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6 From mission definition to implementation: Conceptualizing mission-oriented policies as a multi-stage translation process

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6.1 Introduction

In recent years, mission-oriented approaches have attracted considerable attention in innovation policy debates and beyond. Mission-oriented innovation policies (MOIP) aim to effectively address pressing societal challenges and propel forward the transformation of socio-technical systems. While Borrás and Edler (2020) acknowledge that 'demand on the state to develop transformative policies is normatively reasonable' (p.1), Janssen (2021, p. 5) observes a shift 'from policy for knowledge to policy for solutions', which raises high expectations. The Organisation for Economic Co-operation and Development (OECD) recently even admonished the 'over-optimism' about what MOIP can achieve (Larrue, 2021, p. 12), contending that, so far, 'their effectiveness [...] is still to be proven'. Therefore, even though the popularity of MOIP among policymakers and scholars has constantly grown, it seems that the elaborate scholarly debate is not always well-attuned to address the challenges of actual policy-making. In other words, theory is running ahead of practice.

Recent research has defined several key elements of successful MOIP: a legitimate and urgent societal challenge to address, ambitious mission goals, effective measures and coordination structures (Mazzucato, 2018, 2019). However, a conceptual framework that covers all these elements is still lacking. In consequence, discussions have often centred on selected aspects of MOIP, without integrating these perspectives and accounting for the dynamics of MOIP implementation (M. J. Janssen et al., 2021). This chapter aims to address these shortcomings by proposing a process-oriented analytical perspective on MOIP that particularly takes into consideration the different actors and levels of contestation involved.

We argue that missions are shaped by three interrelated but distinct translation processes, related to (1) mission definition, (2) mission design, and (3) mission implementation (cf. Wittmann, Hufnagl, Lindner, et al., 2021). By disentangling the dynamics and exploring their relationships, we present a conceptual framework that serves multiple purposes. First of all, it provides policymakers with a better understanding of the dynamics and pitfalls of missions, indicating critical points in the realization process that require special attention. Secondly, the conceptualization supports researchers dealing with MOIP by integrating insights from policy studies, public administration research and other strands of research and increase analytical clarity and rigor. Finally, conceptualizing missions as multiple translation processes can

contribute to an improved understanding of potential effects and therefore may contribute to better assessing the impacts of missions, an aspect that still needs to be addressed (Amanatidou et al., 2014; M. J. Janssen et al., 2021; Wittmann, Yorulmaz, & Hufnagl, 2021).

The contribution is structured as follows: After this introduction, the next chapter highlights the need for a better understanding of the dynamics of MOIP, focusing on the different actors and contestations. Seeking to enhance analytical rigor, we subsequently argue for a process-oriented perspective on MOIP that manifests itself in multiple translation processes. This provides more granularity, and a more comprehensive picture of the specific choices and challenges involved at each procedural stage. Moving towards an integrated perspective, the following chapter focuses on the interactions between different translation processes. The final chapter summarizes the key insights and outlines the implications for research and policy practice.

6.2 A process-oriented perspective on MOIP

The concept of MOIP bears the promise of shifting Science, Technology and Innovation (STI) policies towards a broad and transformative approach that spans across sectoral policies and addresses grand societal challenges (Kuhlmann & Rip, 2014). As Canter and Vannuccini (2018, p. 845) argue, 'for any policy intervention in this context, it is not so much the intensity of innovation activities that matters, but rather their direction'. This directionality is the defining characteristic of mission orientation. To this end, MOIP seeks to mobilize actors and resources in a cross-sectoral and interdisciplinary way (Lindner et al., 2021). Over the last years, many countries and international organizations have decided to utilize STI policies to realize missions, among others related to climate change mitigation, digital transformation and public health.

In spite of its growing popularity, previous research has pointed to several issues related to MOIP that pose significant challenges for STI practitioners and scholars alike. The main issues relate to the high complexity and ambitious requirements of missions, the heterogeneity of mission types and goals (Polt et al., 2019; Wanzenböck et al., 2020; Wittmann, Hufnagl, Lindner, et al., 2021), unclear boundaries (Hekkert et al., 2020; Wesseling & Meijerhof, 2020; Wittmann, Roth, & Hufnagl, 2020), as well as insufficient governance arrangements and policy instruments (M. Janssen, 2020; Wittmann, Hufnagl, Roth, Yorulmaz, & Lindner, 2021). Whereas the importance of different dynamics and negotiations for missions within 'innovation bureaucracies' (Kattel et

al., 2019), as in public actors striving for positive change, has been acknowledged (Kattel & Mazzucato, 2018; Larrue, 2021; Lindner et al., 2021), a more comprehensive understanding of dynamics characterizing the setup of missions and how these elements relate to each other is still missing.

In this regard we argue in favour of a process-oriented perspective that can help to unravel the different challenges that are commonly associated with missions.

First of all, missions are often perceived from a perspective of novelty, highlighting the differences to earlier generations of innovation policy. This perspective, however, overlooks the starting point of missions. The novelty of the approach does not imply that missions are emerging in a vacuum, establishing a new field of activities that is unconnected to existing policies. Instead, missions usually develop in the context of established policies (Larrue, 2021), debates and practices that shape the context for missions (Edler & Salas Gironés, 2020). In many instances, innovation policies combine characteristics of different generations of innovation policies (Arnold et al., 2019, p. 53) and display policy layering. This implies that in practice, despite the shift towards new mission orientation, missions more often than not rely on established instruments and entail features of existing policies and strategies. Understanding how missions interact with existing policies and instruments is therefore key for the analysis of missions.

Secondly, MOIP are commonly accompanied by a language of cooperation and actor mobilization. Whereas these are important elements, such language may result in overlooking that 'missions emerge as a negotiated outcome between different interests, concerns, and imperatives—they are neither apolitical in their formulation, nor neutral in their conduct' (M. J. Janssen et al., 2021, p. 440). Introducing directionality enforces a politicization of MOIP compared to traditional innovation policies (Boon & Edler, 2018; Breitinger et al., 2021; Hekkert et al., 2020), entailing contestation on cognitive, material and normative grounds as actors may have different understandings, perceptions and interests. The way the emerging issues are addressed shape the outcomes and dynamics of missions in terms of goals, actor mobilization etc.

Thirdly, missions, despite the formulation of goals to be achieved, should not be considered as static policies. Instead, missions are likely to develop over time, thereby being affected by the

specific context and the existing understandings of the underlying problems and possible solutions (Wanzenböck et al. 2020). In this vein "it is essential to understand missions not as rigid policies with linear impact dynamics, but as dynamic and experimental approaches that can evolve over time as new conditions and insights emerge." (Lindner et al., 2021, p. 31).

Fourthly, research has pointed to an enormous empirical diversity of missions. A process-oriented perspective in this regard can contribute to a better understanding of the sources of variety of missions (cf. Wittmann, Hufnagl, Lindner, et al., 2021). Recent attempts to categorize missions advocated for distinguishing between different ideal types of Accelerator and Transformer missions (Kuittinen et al., 2018; Polt et al., 2019; cf. Wittmann, Hufnagl, Lindner, et al., 2021 for a stronger emphasis on governance); the former generally representing cases that 'can be understood as missions that seek to find an answer to a challenge with a relatively confined scope (e.g. Moonshot, research in one particular field), but do not aim for a comprehensive system change' (Wittmann, Hufnagl, et al., 2020, p. 13) whereas the latter transformer type missions more generally 'aim to achieve a comprehensive change affecting a socio-technical system as a whole and are therefore not limited to scientific progress and regulatory changes' (ibd. p. 14). Even within single national frameworks, such as the German Hightech Strategy 2025, very different missions and ways of linking them to societal challenges exist pointing to different levels of ambition, scope, understandings of drivers for change etc.

Finally, the concept of mission orientation in STI policy does not only impose a new type of objective (focused on solving societal challenges, potentially transformative), but also new requirements for policy-making challenging established routines (for a detailed overview see Lindner et al., 2021). An output-oriented perspective in this regard falls short of understanding the underlying dynamics shaping missions. This includes increased need for coordination across different levels, public actors and domains, necessity for legitimization and mobilization of private and public actors, as well as the openness for experimentation, self-reflection and policy-learning.

So far, the complex connections and negotiation processes between different elements of MOIP have received rather limited attention. Acknowledging different perspectives, belief systems and normative assumptions of actors as part of a complex contestation and translation processes might contribute to grasp missions in their complexity and allows to analytically distinguish between different processes.

6.3 Conceptualizing MOIP as multi-stage translation processes

In order to incorporate the different processes of negotiation and contestation at different levels, we propose a conceptual framework of missions as multiple connected translation processes. The concept of translation processes has been coined by Callon (1986) and Latour (1986, 1987), who understand translations 'as a complex process of negotiation during which meanings, claims and interests change and gain ground' (Waeraas & Nielsen, 2016, p. 237). This idea has been transferred to the process of policy-making and program realization, taking into consideration the 'ideation, negotiation and decision-making that is driven and governed by multiple actors' (Kroll, 2019, p. 637). In case of MOIP, various national ministries as well supra-national or sub-regional authorities (regional, local), specialized agencies, representatives of affected industry branches, civil society organizations and other actors may be involved in creating and bringing MOIP into practice.

Kroll (2019) links the idea of translation processes with the concept of multiple, loosely coupled streams of implementation and policy debate, each driven by its own path-dependent logic. This perspective emphasizes the process-character of policies that leads to new impulses 'into an existing path-dependent system of narratives and support policy practices' (ibid. 637) between the level of strategic priority and agenda setting (sphere of high politics/political discourse involving parliament, secretaries of state and high-level ministry officers), the level of thematic orientation ('mission owners' i.e., political administration, ministerial authority, work level ministry officers), and the level of actual implementation (executive level of agencies/implementation of programs).

The translation process approach yields three important insights for understanding MOIP. Firstly, it points to the importance of embedding the analysis in the existing institutional and political context. Secondly, the idea of path-dependency points to the fact that translation processes are connected and in many cases once taken decisions will be costly to reverse (cf. also Diercks, 2019). Thirdly, it reveals the necessity to also take into account policy capacities (Borrás, 2019; Wu et al., 2017) as moderating factors shaping these translation processes. Whereas it is clear that MOIP impose comprehensive capacity requirements on involved actors (Lindner et al., 2021, pp. 12–15), the extent to which these capacities are available shapes the character of missions and influences the translation processes.

Applying the concept of translation processes to MOIP, we claim that MOIP entail three main translation processes along the way from deriving a mission out of a societal challenge to finally implementing policies that deal with this challenge:

Mission formulation: Translation of a societal challenge into a specific mission with dedicated priorities/goals

Mission design: Translation of mission goals into a specific set of instruments, activities and coordination structures

Mission implementation: Translation of mission activities and inputs into concrete actions and effects

The case of the mission on combating cancer of the German Hightech Strategy serves as a brief illustrative example on how we perceive these processes of multiple translations: departing from the underlying societal challenge (aging society, increasing number of cases of cancer) it prioritizes different aspects to tackle this problem (reducing avoidable cases of cancer, better therapies). These goals are subsequently translated into a mission design comprising a set of instruments (funding for cancer-related research; promoting patient-involvement through changes in funding schemes, fostering awareness campaigns advocating for prevention) and a dedicated governance structure (National Decade against Cancer, involving partners and supporters). Ultimately, these instruments need to be implemented to working towards the desired changes (increased participation in early detection measures, more efficient therapies).

Each translation process unfolds at a different institutional arena and is characterized by specific dynamics of negotiations among different actors. This tri-partite perspective builds upon Larrue (2021), who distinguishes between strategic orientation, policy coordination and policy implementation. The proposed framework may add valuable insights for MOIP, which typically cut across different thematic areas and institutional responsibilities and involve a wide range of actors. Conceptualizing missions as multiple translation processes can help to unravel these complex dynamics of MOIP. As Kroll (2019) concludes, this is crucial since the interplay of these different processes shapes the realization and effects of a policy in the end. Therefore, the concept of translation processes can help us to better understand both dimensions of negotiation: within different thematic arenas as well as between different levels of responsibility and power.

In the following chapter we elaborate on the three main translation processes in greater detail, discussing key actors, central issues to contestation, influencing factors and required capacities that are summarized in Table 12.

	Translation process		
	Mission formulation	***Mission design***	***Mission implementation***
Main function	Narrowing down societal challenge to specific mission goal(s)	Choosing an adequate instrument mix/coordination structures fit for purpose to meet the goal(s)	Implementing instruments and activities within the mission
Level	Strategic level	Policy coordination	Policy implementation
Key actors	High-level politics, representatives of responsible ministries, key stakeholders, society	Mission owners, i.e. involved ministerial authority, work level ministry officers	Executing admiinstration, funding agencies, etc.
Issues of negotiation and contestation	Directionality, scope, level of ambition Priority and agenda setting Stakeholder involvement and representation	Actor and resource mobilization/involvement Mix/types of instruments Re-design vs. development of new instruments Co-ordination structures	Administration and implementation of instruments Role of monitoring, flexibility, and learning Role of civil servants
Influencing factors	Ideational frames Political and institutional context Existing public discourses and awareness (urgency, legitimacy)	Ideational frames Belief systems Existing policies & structures Autonomy and power of actors Participating actors	Resources for learning/evaluation Belief systems Administrative cultures
Key capacities	Communicative and knowledge absorptive capacities	Knowledge absorptive and organizational capacities	Organizational and communicative capacities

Table 12: Key characteristics of translation processes

Mission formulation: Translating challenges into goals

While missions and societal challenges are often understood as directly connected, the relationship is actually more complex in practice, as missions only represent a facet of the societal challenge and interpret it in a specific and often selective manner. No mission is equivalent to the underlying societal challenges but prioritizes and weighs certain aspects it seeks to achieve against different priorities and scope. Accordingly, the first translation process means selecting and emphasizing core aspects of societal challenges while also defining boundaries and excluding other aspects related to a societal challenge. Larrue (2021, p. 9) describes this as a narrowing down process that in many instances starts from what he refers to as 'challenge areas' rather than concrete missions.

Whereas the importance of reasonable mission goals has been increasingly emphasized by research (M. J. Janssen et al., 2021; Wittmann, Hufnagl, Lindner, et al., 2021), '[t]he relation between the nature of challenges and the design of MOIPs is still largely unexplored' (Larrue, 2021, p. 34). The process of mission formulation ultimately seeks to answer and cover several core aspects: Which societal challenge should be overcome by the mission? What is the underlying understanding of the problem and its possible solution? What kind of change or transformation by whom is intended?

The process of negotiating mission goals is closely linked to the strategic level of policy-making deciding about priorities of a mission, pointing to the importance of actor constellations and processes as key factors driving mission formulation. However, even if this step is usually associated with some kind of agency of public actors, missions also might be influenced by other key stakeholders to ideally create commitment, joint ownership and create an impetus to achieve the aspired change (transformation) right from the start that may be involved in varying degrees in the formulation process in different functions (input provider, co-creator). Moreover, it triggers questions about the choice of stakeholders contributing to mission formulation and the absorptive and communicative capacity of public actors (Borrás, 2019) to deal with inputs.

Policy literature in general and research on agenda setting in particularly have pointed to the diverse challenges arising in this context that can shape outcomes (Kuhlmann & Rip, 2018; Schot & Steinmueller, 2018). Whereas a broader involvement of actors may increase the legitimacy, ensure a broader mobilization and therefore also increase the possible success of MOIP in

general through joint owner-and leadership, involving a higher number of actors may also lead to a shift in priorities, watering down the ambitions or delay the formulation process. Empirical practice has demonstrated different approaches even within the same national strategy (Wittmann, Roth, & Hufnagl, 2020). The missions of the German High-Tech Strategy, for example, range from a top-down mode of mission formulation by the involved ministries, to a joint declaration of goals by key stakeholders as in the National Decade against cancer in Germany, a main pillar of the mission on combating cancer. A more expert-driven approach has been pursued in the Horizon Europe program of the European Union. In this case, the process of narrowing down mission areas and proposing mission goals has been delegated to mission boards, partly at least in order to insulate the formulation process from political influence (Mazzucato, 2019, pp. 7–8).

A second issue of negotiation is the question of scope, ambition, and directionality of missions. The perception of urgency and legitimacy in society are critical aspects for missions formulating ambitious and comprehensive goals (M. J. Janssen et al., 2020). However, especially MOIPs with transformative goals pose a challenge to rather risk averse authorities to try for 'policy innovations' (Howlett, 2014). As argued by Braams et al. (2021), as a result of an extensive analysis of transition and public administration literature, tasks related to sociotechnical transitions (like most MOIP with a transformative ambition), go beyond established models of public administration. Such far-reaching transformative missions, inhibit considerable costs and redistributive consequences for some stakeholders, resulting in potential opposition to these changes (Wittmann et al. 2021a).

The mission 'Achieving substantial greenhouse gas neutrality in industry' in the German High-Tech Strategy 2025 exemplifies this case. Whereas the mission goals as such are ambitious, forcing substantial changes to be made in the industrial sector, the scope of the mission is limited to only a few industries, mainly related to the production of steel, aluminium and cement. In this context, the mission mainly strives for the development and implication of technical innovations. At the same time, other possible goals, for example related to the demand side of industrial production are beyond the scope of the mission (Wittmann, Roth, & Hufnagl, 2020).

The negotiation of mission goals mainly takes place at the political-strategic level. This means it does not happen in a vacuum, but is embedded in a broader social, economic and institutional context. Edler and Salas Gironés (2020) have demonstrated the importance of ideational factors

in shaping missions across different countries, focusing on the issue of mobility transition in Germany, the Netherlands, United Kingdom. They show that the same overarching challenge is approached in different ways depending on the national context, reflecting country-specific priorities (similar Larrue, 2021).[71] As argued by Wanzenböck et al. (2020) perceptions on the underlying problem and possible solutions may or may not be convergent. This implies that in different context the process of mission formulation may have varying starting points. At the same time, this points to the fact that negotiations processes may feed back into the perception of the overall societal challenge and its understanding. In consequence, mission formulation process may contribute to converging perceptions among stakeholders, shifting priorities already from the very beginning.

Mission design: Translating goals into policy instruments and activities

The second translation occurs when mission goals are operationalized to come up with a set of specific policy instruments. This translation process also entails the development of structures for communication and coordination between the entities in charge of these instruments. In contrast to the process of mission formulation at the strategic level, mission design takes place at a lower level, located in involved ministries and other stakeholders representing different subsystems that are contributing resources to the mission (mission owners). To put missions into actions, an understanding on the instruments and coordination structures that are necessary to achieve the postulated goals is needed. This translation step is centred on the identification, selection and mobilization of resources and inputs and the alignment of these activities towards the earlier defined mission goal or goals. To put missions into actions, knowledge absorptive and organizational capacities (Borrás, 2019) is necessary to manage the process. At the same time, it creates the need for delineating the boundaries of a mission at an instrument-level, defining activities that contribute to the mission goals and are part of the governance arrangement of a mission and those that characterize the wider socio-technical system. Negotiation processes therefore are likely to centre around several aspects.

[71] A similar pattern can be found looking beyond the case of MOIP. Most countries have followed a mitigation strategy in order to address the challenge of climate changing, in effect focusing on reducing greenhouse gas emissions. In contrast, only few countries have adopted a strong climate change adaptation approach. An exception in this regard are the Netherlands, that have a long tradition of adaptation strategies which cover several policy fields, including innovation policies.

First of all, since MOIP are characterized by a broader cross-sectoral approach, they require a high level of commitment from different actors and their readiness to contribute to the postulated goals. A good example in this respect is the way the Dutch Topsector approach was further developed and crafted into the 'Mission-oriented Topsector and Innovation Policy' (MTIP) strategy to create joint owner-and leadership. This included joint agreements on mission contend and funding after all relevant ministries, so-called knowledge partners (e.g. academies, universities) and industry representatives held structured negotiations on common goals and committed resources (M. Janssen, 2020). In contrast, the German Hightech Strategy in most missions relies only on the mobilization of resources of Federal ministries (Wittmann, Hufnagl, Roth, Yorulmaz, & Lindner, 2021).

Secondly, complex policy interventions generally require a bundle of measures as missions are more than a mere compilation of instruments but an integrated mix of instruments. Therefore, missions are supposed to apply a variety of policy instruments that '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' (Larrue, 2021, p. 11). Key questions in this context are what kind of instruments (Hufnagl, 2010) are combined for what purpose, i.e. how the instruments are supposed to contribute towards goal achievement.

Finally, missions come along with the need for establishing coordination structures bringing together actors for different sub-systems and providing the foundation for the governance of the mission. Such organization decisions, similar to autonomy over spending, touches upon power interests of involved actors and their possibility to exercise control over the implementation process (cf. Moe, 1989).

The translation process of mission design may be affected by different aspects: First of all, actors may differently interpret the way of how to achieve to the postulated goals. Edler and Salas Gironés (2020) point to the importance of different policy traditions, beliefs about the role of the state and ownership of a problem. This aspect is closely linked to the understanding of the possible solutions (Wanzenböck et al., 2020) and the possibility that public actors may take different roles in transformation processes (Borrás & Edler, 2020). In particular, it touches upon the question to what extent a mission may go beyond the confines of STI policy and employ additional means such as regulation in order to facilitate the required changes (see e.g.

Expertenkommission Forschung und Innovation, 2021 for a discussion) or as Lascoumes and Le Gales (2007, p. 3) argue, instruments are not purely technocratic but are attached with different societal values and interpretations.

Moreover, missions are rarely built from scratch, but are embedded into an established field of policy measures and activities (Larrue, 2021, p. 9), so that missions are likely to be a combination of past and present policy instruments or are even built around existing policies. Empirical works highlight that missions often rely on previously existing policies that are only selectively accompanied with new instruments (M. Janssen, 2020; Wittmann, Hufnagl, Roth, Yorulmaz, & Lindner, 2021). This ties in with the observation of Rose (1990, p. 263) that 'Policymakers are heirs before they are choosers'. Generally, the input of MOIPs in many instances will be characterized by different modes of institutional change, such as layering or refurbishing of different existing policies and activities just like in previous policy generations (cf. e.g., Hacker, 2004; Thelen & Streeck, 2005; Kern & Howlett, 2009; Mahoney & Thelen, 2010).

Mission design therefore is not only about designing new interventions, but purposefully combining and adjusting existing interventions. Once again, the Dutch MTIP strategy serves as an illustrative case:

'Rather than on adding more instruments to the policy mix, the emphasis in implementing a national MIP has been put on setting up the coordination mechanisms that allows organizations to make better use of available instruments. In this case, 'better' would refer to innovation capacities being mobilized for contributing to solving societal challenges (as prioritized in missions) rather than for yielding innovative output per se.' (M. Janssen, 2020, p. 22)

Mission implementation: Translating instruments into practice

The policy instruments and activities that were developed during the design phase need to be brought into practice in order to move missions towards the anticipated goals. The final translation process therefore focuses on the implementation of this policy portfolio. As noted by Pressman and Wildavsky (1984), policy goals or objectives do not necessarily have to translate into the expected results, but are shaped by the implementation process. The translation process therefore is not limited to questions of efficiency and effectiveness of instruments, but also includes links between implementation and initial goals, the coordination between different policy instruments and activities.

In contrast to the process of mission design that mainly takes place at the level of mission owners, such as involved ministries or stakeholders, the implementation refers to a broader set of actors including funding agencies and 'street-level bureaucrats' (Lipsky, 1980) who are responsible for carrying out these activities. In fact, these administrative actors may perceive goals differently, have their own agenda and may alternate or even sabotage policies during the implementation phase (Brehm, 1997; Kam, 2000) or might be rooted in administrative cultures conflicting with the new requirements (Braams et al., 2021).

Whereas the existence of sufficient capacity at the individual, organizational and systemic level is a prerequisite for sound implementation and coordination of different activities simultaneously (cf. Considine et al., 2014; Wu et al., 2017), MOIP imposes additional new requirements for the actors involved (Lindner et al., 2021) that are likely to become reason of contestation reaching beyond capacity constraints. Missions usually entail a mix of established and new policies, so that the alignment of existing instruments with the newly formulated mission goals is a key aspect of mission implementation. Typically, this requires changes at different levels, for instance adaptation of program goals or new criteria for eligibility, selection and assessment. Yet these changes may not fully materialize in the expected way as actors tend to rely on established routines and ideas that may not be compatible with the new postulated mission goals. Also when new instruments are introduced in the wake of mission design, the implementation plays an important role, since new instruments typically leave significant room for interpretation of actors, which can lead to 'bureaucratic drift' (Shepsle, 1992). Especially the implementation of systemic instruments, which have become increasingly popular (Smits & Kuhlmann, 2004) requires new capabilities of implementing agencies and individual bureaucrats to reach across ministerial pillars and take a broader perspective of the impacts of their policies. In this regard Daimer et al. (2012, p. 184) acknowledge for these instruments 'the need to develop, e.g. new methods to measure new impact types or to mobilise and rethink beliefs, tacit assessments, emotions or behavioural patterns'.

Moreover, MOIP require to think implementation from the perspective of an instrument mix that constantly needs to be adapted and optimized. Due to their complexity, transformative systemic innovation policies have to put a particularly strong emphasis on experimentation and policy learning (Grillitsch et al., 2019; Weber et al., 2021). Such paradigm shifts, however, may be conflicting with risk-averse cultures of administrative actors, which often tend to focus on

minimizing mistakes and failure (cf. Lindner et al., 2021, p. 31). Different understandings on when and how to revise or even terminate unsuccessful instruments and how these insights may feed back into the process of mission design and mission formulation may be a key issue of negotiation of involved actors. Closely related to this is also the increasing demand for formative evaluation approaches to support transformative policies (Magro & Wilson, 2019; Molas-Gallart et al., 2021; Wittmann, Yorulmaz, & Hufnagl, 2021). Whereas such approaches entail the promise to actively support the formulation, design and implementation of missions, they are not only capacity-intense but also may face discussions about the necessary degree of openness and accountability.

6.4 Towards a perspective of interconnected translation processes

In the previous chapters we presented the three main translation processes constitutive for MOIP: mission formulation, mission design, and mission implementation. Each of these involves specific actors, areas of contestation, capacities, and context conditions. While highlighting the analytical value from distinguishing these different processes, we believe that only an integrated view on the entire process provides a holistic picture of the dynamic of MOIPs. Thereby, we acknowledge that missions hardly follow a simple linear logic from design to effect but are rather characterized by multiple interaction and feedback loops between different translation processes resulting in a down- and up-ward logic (see Figure 12). Especially mission design and mission formulation, but also mission design and implementation in many instances might be understood as partly co-evolving processes, reflecting the dynamic character of missions (cf. M. J. Janssen et al., 2021). In this chapter we describe possible interactions, spill-overs and feedback dynamics that may arise from these translation processes.

Mission formulation is closely linked with the processes of mission design and implementation, or as Winter (Winter, 2012, p. 258) argues ‘the roots of implementation problems can often be found in the prior policy formulation process’. The development of a powerful narrative and a well-designed process of mission formulation is a key prerequisite for actor and resource mobilization and therefore can shape mission design and implementation (Lindner et al., 2021). A compelling mission goal may strengthen the legitimacy and therefore enforce a higher commitment of involved actors to contribute to the goals and a broader instrument mix. In

contrast, missions with poorly defined and ambiguous goals may not only limit the ability to mobilize actors for a shared goal but also open room for negotiation and contestation, providing actors with agency to interpret the goals according to their own preferences, resulting in a cascade of the problems traveling down from formulation to implementation. An example in this regard may be the German High-Tech Strategy where weaknesses in the formulation process were considered as a major obstacle for actor mobilization, and policy design (Roth et al., 2021).

In turn, mission formulation processes can hardly be thought of as independent of the feasible options for mission design, implementation and assessment. In other words, if policymakers do not have suitable instruments at their disposal for implementing an ambitious mission in a comprehensive fashion, this certainly feeds back into mission formulation by predefining a level of ambition that can be plausibly reached. In a similar way, long-standing existing policy approaches may shape the understanding of goals and solutions, resulting in missions being centred on these policies.

In a similar way, mission implementation may necessitate an adjustment of goals and mission design, making them more or less ambitious or even altering the character altogether. We contend that the success or failure of specific instruments may feed back into the (re)formulation of mission objectives and instrument mixes. For example, if a policy instrument fails to trigger behavioural change on the society level needed for system transformation (e.g. in the context of decarbonization), mission goals may be cut back retrospectively to fit a more narrow technology-focused, accelerator type mission. In a similar vein, there might occur a narrowing down of the portfolio approach once promising solutions emerge during implementation.

Finally, the effects of MOIPs may feedback in different ways into the process. Positive results may reinforce the positive narrative of a mission and its legitimacy and credibility of intention, strengthen actor commitment and mobilization. Positive results may also contribute to an increasing convergence of perspective of solutions and problems, shifting missions towards a higher level of alignment (cf. Wanzenböck et al., 2020). Needless to say, that besides such virtuous circle, missions may be also affected by a vicious circle of not materializing results that may undermine a mission's legitimacy and decrease actor mobilization, while opening up the discussion about goals or the legitimacy of a mission in general.

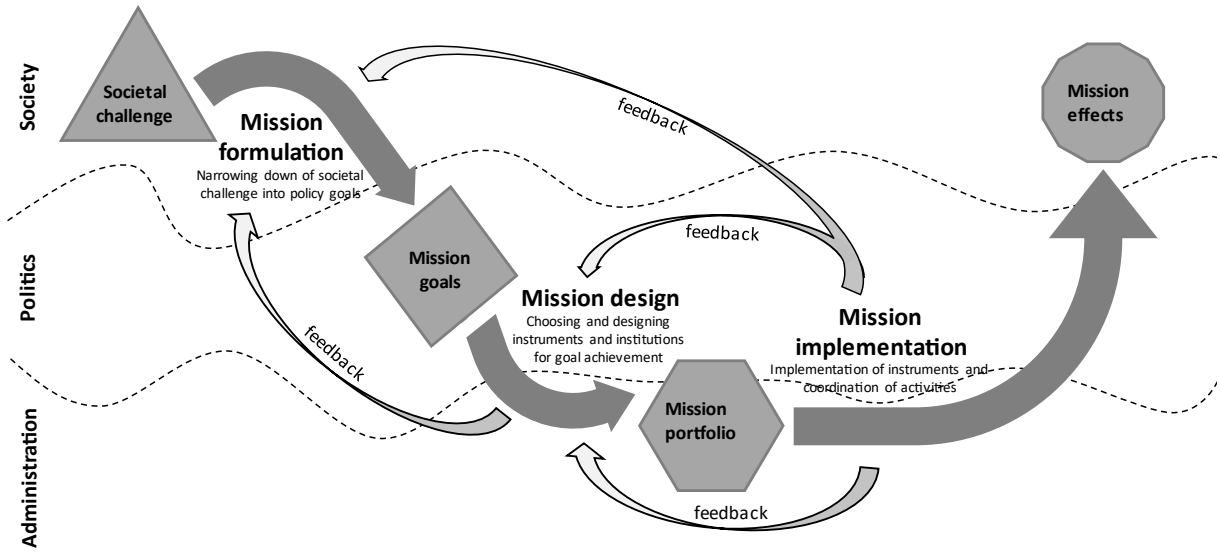

Figure 12: Translation processes and interdependencies (own elaboration)

6.5 Conclusion

This contribution proposed to conceptualize the realization of MOIP as multiple translation processes, starting from a grand societal challenge to implementing policy instruments working towards desired effects of missions. This conceptualization analytically disentangles different steps and dynamics at different levels that characterize MOIP and thereby allows to reduce the complexity of MOIP from a process-oriented perspective. The negotiation processes of actors at different levels directly are associated with the three main translations processes of mission formulation, design, and implementation, but also we perceive them as interconnected throughout the entire process (feedbacks): the results of one translation process has profound implications for the subsequent development. Problems related to the choice of a mission, such as a poor mission definition may also 'cascade' down to the anticipated impact. While this is not to deny that missions may evolve over time, e.g. because of learning processes or external factors, it points to the importance of path-dependencies that influence the developments of missions.

This conceptualization can be considered as particularly useful for different groups including innovation researchers, ministerial authorities/policymakers and actors involved in the impact assessment of MOIP.

First of all, researchers studying the realization and impacts of MOIP this contribution provides an analytical clarification for systematically disentangling the dynamics in MOIP at different levels and identifying the specific dynamics related to them. In doing so, it raises awareness for the importance of path-dependencies in this process, highlighting the need for a comprehensive understanding for the factors shaping MOIP. The process-oriented perspective connects the study of MOIP more closely to the strand of literature of policy studies that can provide useful insights for the different dynamics and processes that characterize complex policies such as MOIP. This includes research dealing with different elements of the policy cycle (cf. Jann & Wegrich, 2017), the debate on the composition of and necessity for systemic instruments (Daimer et al., 2012; Smits & Kuhlmann, 2004; Wieczorek & Hekkert, 2012), policy coordination (Braun, 2008; Lindner, 2012) and reflexive governance (Borrás, 2011; Lindner et al., 2016).

Secondly, the framework can support attempts for assessing the impact MOIP by researchers and possibly the executive administrative. The understanding of missions as multiple connected translation processes can be a useful perspective for addressing the challenges of conceptualizing and measuring the impacts of MOIP (Amanatidou et al., 2014; Hekkert et al., 2020, p. 77; Weber & Polt, 2014, p. 9), as proposed in a recent framework (Wittmann, Hufnagl, Roth, Lindner, & Kroll, 2021). A process-oriented perspective in this context allows to better understand and systematize the different interdependencies between the mission stages and the materialization of impacts. We thereby build on the idea of Kroll (2019), who traces deviations from the anticipated outcomes in EU Regional Policy back to multiple sources that need to be kept analytically apart. He argues that attempts to measure impacts against initial ambitions might fall short of anticipating the process of translation and interpretation in-between, calling for a process-oriented perspective. Otherwise, he concludes,

‘it remains impossible to tell whether an innovation strategy was already flawed in ambition, wrong decisions were taken on thematic areas of action, or if, indeed, one is witnessing a technical failure in the choice of measures.’ (ibid. p. 636)

This contribution points to the pitfalls of a too narrow approach that ignores the dynamics that may affect the materialization of mission effects and ultimately impacts at different stages. A mission undermining the key pillars of the MOIP approach, such as the mobilization of private actors and resources will face considerable challenges from the very beginning. An understanding how the impacts of mission materialize therefore should not depart from mission goals as such but incorporate the process and context of mission formulation into its perspective to adequately capture the context in which a mission emerged. By doing so, it can help to contribute to answering the stronger need for ex-ante evaluation and a different, more formative focus of evaluation (Amanatidou et al., 2014; Teirlink et al., 2011; Weber & Polt, 2014).

Finally, for policymakers our framework clarifies the different procedural steps and point to the specific challenges and pitfalls that relate to each of them. Thereby, it can support the process by making possible consequences of decisions more explicit. Against the background of Larrue's comparative analysis that '[f]ew of MOIP initiatives have set objectives that have the expected mission characteristics: clear, bold and inspirational, with wide societal relevance, ambitious but realistic, targeted, measurable, time-bound and solution neutral' (Larrue, 2021, p. 9) the path-dependency of such decisions outlined in this contribution echoes the call (M. J. Janssen et al., 2020; Wittmann, Hufnagl, Lindner, et al., 2021) for a careful planning of the process from the very beginning.

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7 Conclusion and avenues for further research

The observation that *directionality* and a so-called *normative turn in STI policy* became a prevailing narrative was the starting point of this thesis over a decade ago. This led to investigating various policy practices, which used the leitmotif of more directed STI activities in different policy settings, such as national innovation strategies, smart specialization, and mission-oriented innovation policies. The start, however, was made with the conceptional contribution which introduced the intervention rationale of *orientation failure* and showcased two (systemic) policy instruments.

In addition to the concluding insights of every chapter, the findings of this thesis can be condensed to the following lessons learned below[72]. Further research questions that result from these will be proposed and I present the very first attempts to address them.

But first, the answer to the core question "Is normative change expressed in innovation policy practice?" (see chapter 1.1) can be answered with a definite yes. It can mostly be seen regarding policy formulation and guiding principles in strategies, headlines, and how some policy instruments are conceptualized. In chapter 3 for instance around two-thirds of interview partners (38 or 71,7% of all) mentioned grand challenges (GC) or mission orientation (MO) as a meta-principle of the national strategies altogether. Indeed, over the past decade, the societal discourse and wider expectation of innovation policy as a driver for more sustainable, ethically desirable, and more inclusive technologies gained momentum ("rate and direction"). But formulating policy headlines is one thing - implementing policy instruments and suitable combinations thereof as well as steering and tracking impact and possibly a change in direction the other.

1. **There is a need for different evaluation practices and use of the results**

To provide practical support and guidance for policymakers and evaluators in the above-mentioned tasks, the team of the Hightech-Strategy project, including myself, proposed a formative toolbox approach for MOIP impact assessment (Wittmann, Lindner, et al., 2022; Wittmann, Roth, et al., 2022). To better understand the possible shortcomings of current

[72] Obviously, there are a lot more, but these four are the main insights from the authors point of view including both: further room for empirical investigation and academic debate as well as practical exchange on the topics with policymakers.

evaluation practices against the background of formative ambitions of STI policy, we analyzed earlier approaches and identified the following challenges (Wittmann, Yorulmaz, & Hufnagl, 2021, p.2-4). Even though we tried to anticipate and address them with our own IA approach (see below), all challenges mentioned are “moving targets” in need of more scholarly attention:

- „*Challenge 1: Breadth of scope for analysis and multi-dimensionality of impacts*: The first set of challenges is centred around the question on the key focus of the evaluation. The in-built directionality and orientation towards grand societal challenges reaches beyond traditional perspectives of evaluation by having a considerably wider scope (Amanatidou et al., 2014; Arnold et al., 2018; Edler et al., 2012).

- *Challenge 2: Interconnectedness of dynamics and impacts*: Closely related to this first bundle of challenges, research has pointed to the importance of interconnections and dependencies. See also Rogers (2008, p.32-35) who argues that complexity in evaluation is caused by the existence of multiple actors, the existence of simultaneous or alternative causal strands, the non-linearity of effects and emergent outcomes.

- *Challenge 3: Long-term materialization of impacts:* Another challenge of studies of MOIP and transformative policies is related to the temporal dimension. As Amanatidou et al. (2014, p. 425) highlight, "the long-term approach that is necessary in dealing with grand challenges raises difficulties in attributing impacts to specific policy measures and also clashes with the short-termism of policymaking cycles".

- *Challenge 4: Existence of multiple levels of analysis* - MOIPs entail challenges with regard to the level of evaluation. Kuittinen et al. (2018, p.62-64) emphasize that the realization of impacts in case of missions goes through different phases, moving from the micro- to the meso-/macro-level, making it necessary to distinguish between impact processes and impact levels (an observation we partly tried to address with chapter 6 of this thesis).

- *Challenge 5: New motivations for evaluation and guiding questions* - Moreover, the turn towards transformative changes requires evaluation to provide different perspectives on the motivation, focus, approach and responsibilities (Magro & Wilson, 2019).

- *Challenge 6: Empirical diversity of missions and varying interpretations of mission orientation* - Finally, at an empirical level, there is an increasing diversity of policies that is subsumed under the label of mission-oriented policy“ – an observation that we tried to address with the typology (as presented in chapter 5 of in this thesis)

Acknowledging these challenges, we proposed a modular framework for analysing the dynamics that pave the way for a theory-based and context-specific evaluation approach that can be applied by policymakers or external evaluators alike (see *Figure 13*).

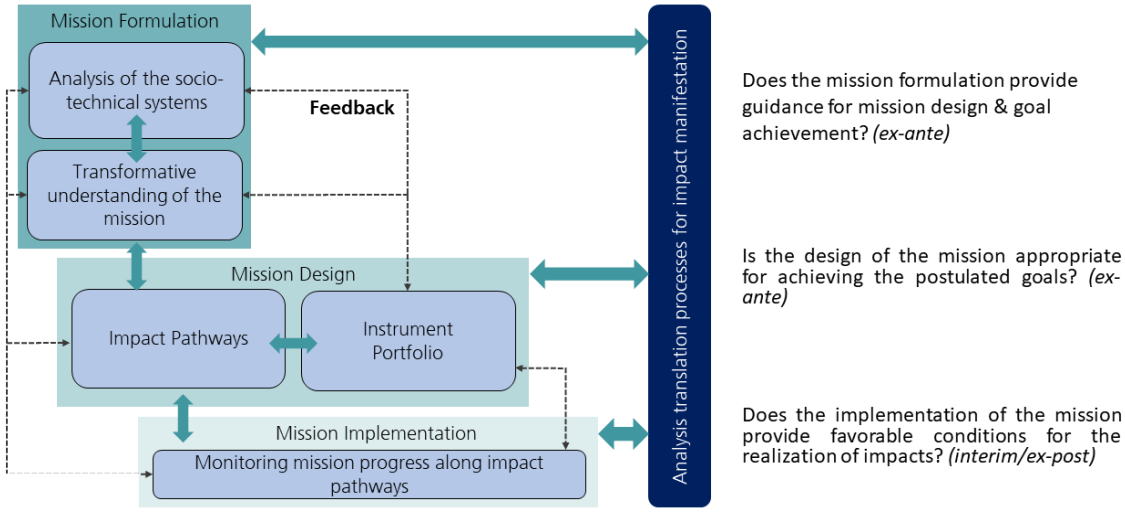

Figure 13: Toolbox elements for different translation processes[73]

Among the key building blocks of the framework are two tasks during the *mission formulation*: mapping the underlying socio-technical system and the definition of the transformative ambition of the mission itself. Furthermore, during the *mission design* phase, we propose drafting impact pathways that describe the anticipated trajectories for change (case studies on how this is practically done see Wittmann, Hufnagl, et al. (2021)[74] Simultaneously it is advised to connect them to the policy instruments already implemented and ideally include the conceptualization

[73] Source Hufnagl et al. (2023, p.3)

[74] With the case study on Circular Economy by Katrin Ostertag and myself

of new ones addressing neglected areas for the mission to be successful (instrument portfolio). The core question of this step is: is the design of the mission appropriate for achieving the postulated goals? In simpler terms: do I have the right tools (e.g. a framed picture, hammer and nails, or paint) to design a beautiful wall, if this is my aim?

The toolbox provides a set of stylized impact pathways that are represented in different types of missions (ibid. chap. 3.4.2, p.30-33). Figure 14 presents 11 pathways we constructed inductively by deciphering MOIP concrete goals and transformative ambitions. The figure furthermore illustrates the connection between these impact pathways and the four ideal types of missions. The link of the ambition of a mission expressed by the pathways and its increasing complexity is depicted by the overlaying circles with Transformer Type 2 encompassing the others, due to the high aspirations about technological progress and the simultaneous goal of behavioural change.

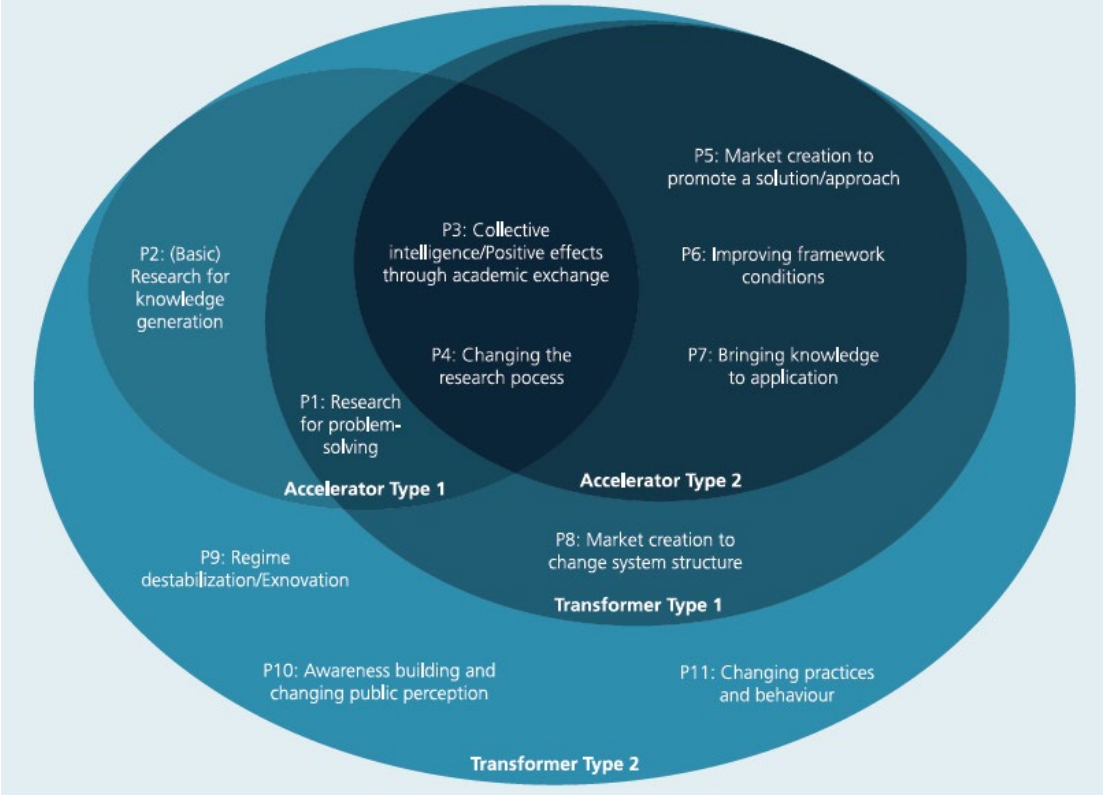

Figure 14: Sets of impact pathways for different types of missions[75]

[75] Source Wittmann, Lindner, et al. (2022, p.11), based on Wittmann, Hufnagl, et al. (2021)

The largely process-oriented pathways are accompanied by a comprehensive and structured catalogue of analytical questions, allowing evaluators a better understanding to analyse the development of missions across the different translation processes, as described in chapter 6. Thus, further learning and improvement to the IA framework would require more empirical application. On a methodological level, the main challenges remain to combine diverse sources of data collection and manage to deal with different analytical levels (instrument mix, processes, responsibility, and agency, etc.). It is important to strike the right balance between a sufficient in-depth perspective on individual activities and instruments (e.g. effects might be less driven by program goals but distinct program characteristics like application regulations) and maintaining a systemic perspective.

However, without sufficient (policymaker) capacity to draw lessons from the insights of monitoring, evaluation, and feedback for the implementation process, efforts are likely to be useless. Since the proposed framework relies on constant exchange and flow of information, capacities need to be built up not only at the level of evaluators to better grasp and improve the complex interplay of different policy instruments and spheres but also about knowledge absorption, organization, and communication are necessary (Borrás, 2019; Borrás et al., 2024) at the responsible authorities (e.g. agencies, ministries, local authorities). Aiming for impact at the systemic level, reaching well beyond the field of STI, has significant implications. For evaluators and STI scholars, for instance, this implies broadening their perspective about sectoral knowledge, different data sources, and the right skills to gather and interpret new indicators beyond the classic canon of e.g. citations, patents, licenses with a view to the wider societal benefit of STI activities (see 4. *capacity building* below).

2. **There is a need to demystify missions, grand challenges, etc. & their expected force for change**

Concerning the composition of missions, the *typology* proposed in chapter 5 and the *translation processes* depicted in chapter 6 might help to foster a better conceptual understanding of how missions could *come into being and function.* However, all academic work so far, including evaluation and impact assessment, has not yet provided conclusive answers as to whether MOIP or other initiatives labelled as transformative innovation policy do have a crucial impact (or are even part of the solution), given the heterogeneity of challenges. As outlined in chapter 3 even OECD experts recently admonished the 'over-optimism' about what MOIP can achieve and

stated that, so far, 'their effectiveness [...] is still to be proven' (Larrue, 2021, p. 12). Whereas the evidence that "Policymakers working in science, technology, and innovation (STI) are facing pressures not just to focus on economic growth and competitiveness but to address contemporary challenges such as global environmental change, growing inequality, and […] socio-economic health crisis" (Ghosh et al., 2021, p.739) is clear, the tools and narratives offered so far to deal with the challenges (as well as the pressure) are rather indistinct. As shown by many cited works throughout this thesis and the document itself, there is a rich body of conceptual work on how to construct adequate policy instruments and policy mixes (Borrás & Edquist, 2013; Kern et al., 2019; Rogge & Reichardt, 2016; Wieczorek & Hekkert, 2012). After a decade of enthusiastic political as well as academic debate concerning MOIP the current state is rather disillusioning, though. MOIP, so it seems, turned from a promising attempt at holistic solutions for society by STI into overloaded "symbolic politics" currently.

The recent *Future research and innovation strategy* (BMBF, 2023) serves as an example of this with headlines either summarising entire policy domains as missions and transformation processes such as "Enable resource-efficient and circular-economy-based competitive industry and sustainable mobility" or remaining as vague as "improve health for all". Generally, one can get the impression that the *new mission orientation* was a misunderstanding between politics and academia right from the start. Why? Because most of the underlying aims of MOIP are much more subject to regulation (in other policy domains) than a question of inventions that are commercialized (innovation) and technological advances. Even though MOIPs are rooted in cross-sectoral problems that cut across ministerial responsibilities and regulatory bodies acknowledgement of this fact and productive processes to deal with this are scarce[76]. To put it provocatively: many STI scholars took the concept of MOIP and transformative innovation policy more seriously than policymakers. A lot of research around these topics is conducted, which does not resonate within the policy arena at all (why that might be the case could be subject to an entire thesis in itself). To add one telling example from the scientific support action of the past Hightech Strategy, my colleague Kathrin Ostertag and myself concluded that the mission of "creating sustainable circular economies" is on the one hand under conceptualized "(…) with a

[76] Sticking with the example from Germany: the newly established Mission Teams might be a first step to deal with this shortcoming https://www.bmbf.de/bmbf/en/research/hightech-and-innovation/future-research-and-innovation-strategy/Mission_Teams/the_mission_teams.html#searchFacets last access 25.09.2024

view to coordinative efforts of "burden sharing" and topic related division of labour between the different ministries we do see room for improvement, particularly regarding the triangle BMBF-BMU-BMWi for real transformative change in the years to come," Wittmann, Hufnagl, et al. (2021, p.46) and on the other far too complex and ambitious:

"Because the mission sets out to change "economies", several socio-technical systems need to be addressed and transformed – an undertaking that has so far not been championed by any state, thus the ambitious agenda of the German CE mission is a quest addressing a worldwide challenge."(ibid.)

One can get the impression the more powerful headlines are formulated, the less change can be verified – a political practice unworthy of the challenges we face today. We need a realistic and feasible combination of policies that foster competitiveness based on products, services, and infrastructure enabling and commercializing transformation at the same time. Many examples of traditional industries from the automotive sector to energy transition show that this ambition – without the political will to support this path of exnovation or re-inventing business models – simply means *squaring the circle*. The concrete plea towards national as well as international bodies such as the EU remains: not to hide behind mission titles but be responsible for pursuing real "transformative missions": which

> "are long-term efforts with limited short-term payback, and which need societal and governance transformations for their successful implementation. But in the long run, they could lead to new ways of governance (suited to 21st-century challenges) and their economic benefits in terms of sustainability and resilience are likely to be very substantial."[77]

Therefore, it is time to break down missions, grand challenges, and transformation processes into more feasible concepts with measurable goals and direct returns for society. This poses new possibilities to find answers to questions such as how can we assess and measure societal transformation? How to measure the impact of policies versus/the power of consumer

[77] As expressed in a viewpoint blog contribution on the 9th January 2024 by Jakob Edler, Mireille Matt, Wolfgang Polt and Matthias Weber for Science and Business: https://sciencebusiness.net/viewpoint/planning-fp10/viewpoint-framework-programme-10-needs-balance-basic-and-applied-research

behaviour? And many more concerns e.g. the role individual and collective actors have to play in supporting change.

3. **There is a need for more knowledge of the recipient's reaction to STI policies**

The thesis dealt primarily with the analysis of policymakers'[78] views and academic reflections on STI policies. A further avenue for research bears the question: How do research institutes and different actors react to the expectation of "solving grand societal challenges"? Technology transfer and innovation (ITT) activities of universities have been subject to research for quite some time ("third mission"). Though, ITT does not necessarily aim at contributing to a solution for a societal challenge but focuses on the commercialization aspects, the potential for funding a startup, etc. The key observation is, that transfer is not always targeted at making the world a better place, and more understanding of and motivation towards focusing research and ITT on social change is needed. One of the main questions is: are today's funding tools appropriate to – not only support – but push recipients toward this cultural shift? And how can this be identified and improved? Chapter 3 illustrates that this question is crucial for actors involved in funding decisions today, as this quote shows *"It´s crucial when looking at a proposal: is the general idea driven by a societal challenge rather than something ordinary just addressed with new words (…)?" (SWE_7: 69)*

One example of this cultural shift concerns specific entities of the research and innovation landscape, namely large research infrastructures (RI). In an article published by two colleagues and me, we revealed that even institutions that are dedicated user facilities of basic science, like particle accelerators, open up to accommodate more societal needs and applied research fostering productive interactions between heterogeneous actors (Kroll et al., 2022).

During the past ten years, a clear shift concerning basic science organizations in performance expectations toward more application and innovation can be seen. This is particularly evident when comparing the processes for selecting RI to be built in Germany. The structured process involving the responsible ministry, parliament, the Science Council (Wissenschaftsrat), and agencies – the so-called roadmap process - that took place in 2013 marked two dimensions as crucial for decision-making a) scientific significance and b) costs:

78 except for some interview partners from local industry chambers regarding chapter 4

> "The Federal Ministry of Education and Research has for the first time carried out a pilot procedure of concepts for research infrastructures into two clearly delineated processes: a science-led and an economic evaluation process. (…) The economic evaluation process involved external experts from business and science (…) all concepts submitted were assessed about the expected costs. A distinction was made between the level of investment costs and the operating costs of each research infrastructure." BMBF (2013, p.3-4)

Around a decade later, the competitive selection - now organized within the so-called prioritization process - already emphasizes the need for broader applicability and exploitation of the RI insights for transfer and societal solutions explicitly right from the start as a core must-have competence (and not nice to have feature). It is prominently illustrated in the very first paragraph of the guidelines:

> **"**Research infrastructures (RI) play a key role in the performance, innovative strength, and international competitiveness of Germany and Europe in science and research, industry and commerce. They contribute significantly to scientific progress, the development of technological excellence, the training of specialists, and the development of solutions for grand societal challenges." (BMBF, 2024, p.4)

This paragraph does not only mention additional possibilities of research infrastructure use besides "enabling science"; it emphasizes and exaggerates the role of these scientific tools such as telescopes, aircraft, digital infrastructures and databases, research vessels, or particle accelerators to push for competitiveness and focus on the translation of basic research insights to solve grand challenges. With the inclusion of the third domain *assessment of the potential for innovation and transfer* in the application process, the decision to reach the shortlist also depends on a convincing concept concerning technology and innovation. In the application, the research organizations in charge are requested to exemplify the RIs (BMBF, 2024, p.9):

- *"Contributions to strengthening Germany as a location for innovation and industry in Europe*
- *Contributions to sovereignty, resilience, and agency of the government*, including the topic of "provision of instructional and orientational knowledge for future provision to politics, legislation, and administration" and "strengthening the digital and technological sovereignty as well as the competitiveness in Europe"
- and *societal effects*, such as

- Contributions to the solution of grand societal challenges and the achievement of the UN Sustainable Development Goals
- Cooperation with civil society and societal relevance
- Transformative potential and contribution to a culture of innovation"

This marks a real paradigm shift and normative turn, regarding the division of labour and core competencies (of non-university actors) within the science system (and would deserve to be considered by STI scholars as a research issue soon). Particularly the fact that digital and technological sovereignty should be strengthened by basic research facilities implies that those do work in applied networks and ideally engage in innovation ecosystems (including industry).

4. There is a need for more capacity building and mobility within the system

The last lesson learned reflects a more personal and pragmatic than academic insight. It is rooted in learnings from the interviews for chapter 3, the interaction with policy practitioners during workshops, case study work during the "Hightech Strategy" project[79] (the origin of chapters 5 and 6), experience during a secondment to the Federal Ministry of Research and Education in 2015-2016 and my work as a manager at the DESY project agency for INTERREG and FP projects: the willingness to leave the own work area (and comfort zone) to enrich one's perspective to gain a little fraction of the often cited *systemic perspective* accompanying the STI communities narrative.

This is related to aspects dominating the current debate on a more refined understanding of individual and collective actors' skills and the need of organizations "to develop new capacities and capabilities that enable them to navigate complexity, foster collaborative ecosystems, and drive systemic change".[80.] Since addressing cross-cutting challenges like climate change calls for different actors' abilities than decades ago this debate is more relevant than ever but somehow remains abstract. As I argue in chapter 3 on page 107 of this thesis: "It is remarkably 'transformative capacity of public sector organizations', that should provide practical policy guidance and, according to Borrás et al. (2023), could be subdivided into the three elements of

79 See also: https://www.isi.fraunhofer.de/en/competence-center/politik-gesellschaft/projekte/htf2025.html last access: 25.09.2024

80 https://tipconsortium.net/capacities-and-capabilities-for-transformative-missions-global-perspectives/ last access 25.09.2024

roles, skills and resources that public organizations can activate and provide for the policy process (Borrás et al., 2023, p. 14). This ties in with the argument put forward by policy advisors as well as scholars: the need for more reflexive governance (Lindner et al., 2016; Voß et al., 2006) to handle complex and 'wicked' problems with suitable policy mixes (e.g. MOIP, sustainable development)." The perspective on capacities and skills, particularly of policy practitioners as individual actors, is - to my understanding – still underexplored but very crucial. So far, the reflection on policy instruments and how evaluation practices resonate within the sphere of policy (and by the individual policymaker) has been categorized as policy learning but is currently rather assumed than empirically proven and analysed. However, the academic debate has explored different kinds of reflexivity already like self-reflection, bridging and integration capacities plus the ability for anticipation and experimentation (Kuhlmann & Rip, 2014; Lindner et al., 2016; Weber & Rohracher, 2012). As Lindner et al. (2016) argued:

> "[…] normative directions for the governance of research and innovation, as widely articulated in missions […] are – by and large – imposed upon the innovation system actors exogenously, and neither their broad acceptance nor their adequacy are a given. With the aim of increasing the sense of 'ownership', legitimacy and eventually societal robustness, we propose to partly endogenise processes of defining and specifying normative directions. Putting increased emphasis on and improving the capacities of reflexive governance will potentially contribute to the discussion and conclusions for STI research and policy strengthening of the innovation systems' input-legitimacy." (Lindner et al., 2016, p.30)

This statement about empowering innovation systems actors as such and possibly strengthening the system's independence from overwhelming external expectation and excessive demand for real transformative change by the STI is plausible. However, the proposed *endogenizing* of the underlying processes seems a practical challenge and research desiderate in itself. Developing normative directions from within also calls for individual topic-specific expertise and training as well as openness for cross-sectoral interactions and compromises. In my point of view, a tiny practical suggestion for this abstract proposal by Lindner et al. for "improving the capacities of reflexive governance" could be individual willingness to enter a different entity for a certain period – say: take a break from a ministry and enter into science management at a research facility or perform work shadowing at a tech company – which could help to increase the

understanding of a different part of the system[81]. This suggestion cannot be realized by a critical mass, but even if only a few individuals might change their workplace and perspective for a limited amount of time it could make a difference. This might help to serve an important purpose for the common good to better align the understanding of authorities and civil servants as well as 'the other side' of academics, researchers and entrepreneurs alike: to better *address the grand challenges of our time with STI* with impactful policies for real change.

7.1 References

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81 Initiatives like the recently introduced "Policy Dialogues Demonstrator (P2D)" program by the EU-SPRI Forum also address the argument put forward here: improved interactions between researchers and policy practitioners: https://euspri-forum.eu/exploratory-initiatives/p2d-policy-dialogues-demonstrator/, last access 25.09.2024

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