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Second Mission Analysis Report of the Scientific Support Action to the German Hightech Strategy 2025

Zooming in:
Translating missions into policy instruments

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Contents Page

List of Figures

List of Tables

Abbreviations

BMAS	Bundesministerium für Arbeit und Soziales (Federal Ministry of Labor and Social Affairs)
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMEL	Bundesministerium für Ernährung und Landwirtschaft (Federal Ministry of Food and Agriculture)
BMG	Bundesministerium für Gesundheit (Federal Ministry of Health)
BMI	Bundesministerium des Innern, für Bau und Heimat (Federal Ministry of the Interior, Building and Community)
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMVI	Bundesministerium für Verkehr und digitale Infrastruktur (Federal Ministry of Transport and Digital Infrastructure)
BMWi	Bundesministerium für Wirtschaft und Energie (Federal Ministry for Economic Affairs and Energy)
CO_2	Carbon dioxide
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DKE	Deutsche Kommission für Elektrotechnik Elektronik Informationstechnik in DIN und VDE (German Commission for Electrotechnical, Electronic & Information Technologies of DIN and VDE)
DKFZ	Deutsches Krebsforschungszentrum (German Cancer Research Center)
DKH	Deutsche Krebshilfe (German Cancer Aid)
EFI	Expertenkommission Forschung und Innovation (Commission of experts for Research and Innovation)
ESF	Europäischer Sozialfonds (European Social Fund)
FONA	Forschung für nachhaltige Entwicklung (Research for Sustainable Development)
GAK	Gemeinschaftsaufgabe Agrarstruktur und Küstenschutz (Joint Task “Agriculture and Costal Protection“)
GRW	Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftsstruktur" (Joint Task “Improvement of the Regional Economic Structure“)
HTS 2025	Hightech Strategy 2025
HEI	Higher Education Institute

INNO-KOM	Innovationskompetenz (Innovation competence)
ISI	Institute for Systems and Innovation Research
LiSyM-Krebs	Systemmedizinisches Forschungsnetz zur Früherkennung und Prävention von Leberkrebs (Systems medicine research network for the early detection and prevention of liver cancer)
MAR	Mission Analysis Report
MIS	mission-oriented innovation system
MOIP	Mission-oriented innovation policies
NaRess	Nationale Plattform für Ressourceneffizienz (National Platform for Resource Efficiency)
NDK	Nationale Dekade gegen Krebs (National Decade against cancer)
NTC	Nationales Tumorzentrum (National Center for Tumor Diseases)
R&D	Research & Development
R&I	Research & Innovation
RES:Z	Ressourceneffiziente Stadtquartiere (Resource-efficient urban districts)
RUBIN	Regionale unternehmerische Bündnisse für Innovation (Regional entrepreneurial alliances for innovation)
SME	Small- and Medium-sized Enterprises
STI	science, technology and innovation
TRL	Technology Readiness Level
UBA	Umweltbundesamt (German Environment Agency)
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
WIR!	Wandel durch Innovation in der Region (Change through innovation in the region)
ZIM	Zentrales Innovationsprogramm Mittelstand (Central Innovation Program for SMEs)

Executive summary

This second Mission Analysis Report (MAR2) zoomed into the design of four selected missions (Combating Cancer, Reducing CO_2 emissions in industry, Circular Economy, Ensuring good living and working conditions throughout the country) of the German Hightech Strategy 2025. It explores how mission goals are linked to policy instruments, with the aim to understand how mission goals translate into activities. For this purpose, this report – based on publicly accessible information[1] – developed mission-specific impact pathways that describe the anticipated pathways for goal achievement and explored how different instruments contribute to the postulated mission goals.

Providing an in-depth report for the four missions under study, the analysis revealed a number of good practices and generated several key insights. First of all, the findings emphasize the need for a comprehensive strategy process, translating mission goals into specific bundles of policy instruments. The difficulty to delineate mission-specific instruments in most of the missions creates multiple obstacles for implementing and communicating the achievement of missions. Whereas the analysis identified a number of thematically relevant instruments, the complementarity and comprehensiveness of these instruments in relation to the postulated goals often appears to be limited. We therefore urge for a more systemic approach both regarding the strategic development of missions and of the actual mission implementation to capture the diverse links between mission instruments and mission goals as a prerequisite for the success of the missions.

Secondly, the analysis shows that the missions under study in most cases do not yet fully unleash the potential of MOIP regarding actor and resource mobilization. Apart from single exceptions, we primarily observe resources provided by federal ministries. For fully exploiting the potential of MOIP, a clear and compelling mission narrative and goals are necessary that allow for processes that effectively contribute to committing stakeholders from the very beginning of a mission.

Thirdly, cutting across the different missions under study, we found a strong dominance of R&D funding, whereas other instruments tend to be absent. While being the backbone of MOIP, the shift towards a more transformative approach requires the involvement of a broader range of instrument types to achieve the postulated goals. Moreover, considering the variety of instruments, thematic priorities and different modes of policy development, we emphasize the need for a more comprehensive approach of managing the

[1] This analyses report is based on publicly available information (**last updated on 18.June 2021**) derived from ministerial resources (such as https://www.hightech-strategie.de)

instrument mix that reaches beyond the thematic link to a topic, thereby ensuring the integration of instruments. Without actively managing the instrument mix and considering ways how to align instruments with goals, there is the risk that instruments remain a loosely connected bundle of activities that insufficiently leverage potential synergies.

Regarding research on MOIP in general, this report revealed the need for a more systematic approach towards the study of instrument mixes. Whereas the reference to policy mixes is popular in the context of MOIP, the discussion about its applicability remains underdeveloped. The analysis demonstrates the need for further discussion of issues such as the role of policy layering, the delineation of mission-specific instruments, the multidimensionality of instruments and the interplay of different instruments to make these concepts usable for MOIP.

1 Introduction

1.1 Project goal

The Hightech Strategy 2025 (HTS 2025) is the central political agenda of the German Federal government to direct the country's research and innovation policy to address key societal challenges, among others, related to health and aging society, regional development and sustainability. It comprises twelve missions, jointly organized by several federal ministries and coordinated by the Ministry of Education and Research (BMBF).[2] Mandated by the BMBF, the Fraunhofer Institute for Systems and Innovation Research ISI provides scientific support to the HTS 2025.[3] The project has twofold goals: First, it provides evidence-based scientific policy consultation for the implementation of the current Hightech Strategy. Secondly, by offering in-depth insights into selected missions and their diverse instruments and approaches, the project supports the development of a framework for measuring the impacts of mission-oriented policy approaches (MOIP).

As part of its scientific support mandate, Fraunhofer ISI is tasked to produce consecutive Mission Analysis Reports (MARs), in order to analyze the developments of missions in-depth. Since missions within a single policy framework may reveal considerable variation with regard to the goals, priorities and understanding of goals (Wittmann et al. 2020a), the analysis focuses on selected HTS 2025 missions that can be considered as representative for the four different ideal types of 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 behavior).

This report extends the work of the first Mission Analysis Report (MAR1, Wittmann et al. 2020b) by shifting the focus away from the location of a mission in their socio-technical system towards the instruments directed towards goal achievement. Thereby, it draws

2 For more information on the HTS 2025, see https://www.hightech-strategie.de/en/index.html

3 For more information on the project, see https://www.isi.fraunhofer.de/en/competence-center/politik-gesellschaft/projekte/htf2025.html

on a series of expert workshops and interviews, as well as the analysis of official policy documents and academic literature.

1.2 Findings of the first Mission Analysis Report

From an analytical point of view, it is important to differentiate between challenges during the formulation phase, and challenges during the implementation process of complex policies (cf. Kroll 2019). A first step is the translation from a societal challenge into a specific mission. This process of goal formulation of missions is embedded in a distinct political and institutional context shaping the character of a mission. This ranges from questions of stakeholder involvement during the process of goal definition to questions about agency and capacity. The first Mission Analysis Report (MAR1) took a problem-centered approach to improve our understanding of the overall system of the missions under study, their goals and location of the mission within the socio-technical system

To locate the missions into a broader context and capture the context-dependent nature of both the formulation and the implementation of missions, it analyzed the formulation of mission goals (or the translation of challenges into policy goals) and explored how missions are embedded into specific economic, social, political and institutional contexts. For the empirical analysis, we applied a system mapping methodology to all missions under study. With the support of several topical experts, we approached the overall socio-technical system including the main topics, context factors, and actors in order to identify the scope a mission could potentially address. The mapping exercise proved valuable to understand the goals of the missions in relation to the corresponding challenges, but also to depict the boundaries of missions. In this context, the mapping helped to disentangle the key priorities of each mission and identifying those aspects of the socio-technical system that are not or only partly considered by the missions.

The analysis found that the missions under study set goals in relation to specific grand societal challenges. However, the stronger the emphasis on transformative change, the stronger the need for inter- and intra-departmental coordination and the need to think policies in a broader frame beyond science, technology and innovation (STI) policies. In this regard, there remains the challenge that in some missions one could observe that newly formulated missions and long-standing existing policies run in parallel to each other or are cutting across each other, instead of explicitly integrating them as part of the mission. Despite the definition of quantitative goals in some cases, the overall intentionality of missions suffers from a number of ambiguities and insufficient translation into workable concepts, nested structures of goal formulation, etc. The observation of an overly unspecific mission definition may not only hamper the ability to trace the impacts of a mission, but also affect the implementation process itself.

1.3 Aim of the second Mission Analysis Report

In contrast to MAR1 focusing on the location of missions within the socio-technical system, the present second Mission Analysis Report (MAR2) aims for a more detailed understanding of the dynamics and activities that translate mission goals into policy activities. By "taking stock" of the instruments employed to achieve the mission goals this report shifts the focus towards the policy design of the selected four missions and the question how goals are translated into activities.

Thereby, this report seeks to understand whether missions are designed in a way that creates favorable conditions for goal achievement and are supported by adequate policy instruments. To this end, this reports develops impact pathways describing the intended ways of goal achievement and assembles an inventory of policy instruments contributing to these goals. Whereas a comprehensive analysis of the instrument mix of individual pathways or an in-depth study of instruments is beyond the scope of this report, it constitutes a first attempt to map mission goals against the background of policy instruments.

1.4 Structure of report

Having outlined the key motivation of this second Mission Analysis Report (MAR2), the following chapter discusses the conceptual foundation for analysis. In particular it outlines the analytical tools of impact pathways and an instrument inventory as key elements for the analysis of mission design. The four subsequent empirical chapters apply the framework to the four missions under study, exploring how mission goals are supported by policy instruments. In the concluding chapter, we synthesize the insights from the empirical chapters, providing an assessment of the overall mission design process of the HTS and the instrument mix, discuss conceptual aspects related to the analysis, and highlight new insights for the study of mission-oriented policies in general.

2 Research Design

This section prepares the ground for the subsequent empirical chapters, analyzing the mission design of the four selected missions of the HTS 2025. For this purpose, we first discuss the concept of impact pathways to understand in detail how activities are supposed to contribute to the desired dynamics and impacts. Secondly, we present a template for an inventory of mission instruments that can systematize the different activities of a mission and serve as an analytical framework for studying the instrument mix within specific pathways and of the mission as a whole.

2.1 Impact pathways

The first key element to analyze the design of missions is to identify impact pathways describing how missions aim to achieve the postulated impacts. These impact pathways provide insights how mission inputs shall contribute to the anticipated impacts of a mission by describing the different steps along the way.

Thereby, from the perspective of mission-owners/policy actors, we ideally assume a "causal chain" (Gregory 2004, p. 300) of events which enables an analyses and re-construction of the mission design. Even though the term mission owner might suggest the existence of a central superior figure (e.g. a unit in a ministry; lending agency) that is responsible for every aspect of the mission, we urge to use it as a cipher for those actors that are actively involved in the realization of the mission through the definition of goals and their involvement in coordinating the mission activities.

Therefore in our understanding mission owners are able to shape the priorities of a mission by committing their activities/efforts to the mission goals. This sets them apart from actors that have no agency in the implementation, but are mobilized by the mission owners during the process of realizing the mission (or are engaged in activities that may contribute to the postulated goals but are not subordinated to the mission governance).

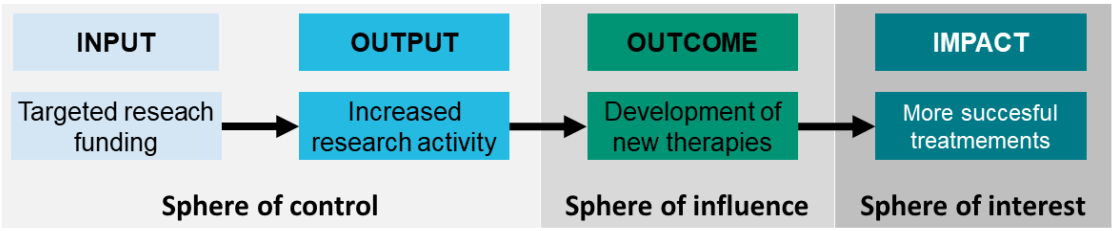
Pathways describe a stylized way of the mission development over different stages (following the established Input-Output-Outcome-Impact scheme) that in later stages can be used for tracking the development of mission contributions over time with adequate indicators. At the same time, they serve as a useful tool for understanding and assessing ex-ante the mission design by providing a framework for systematizing the activities and resources (policy instruments) that serve as inputs to the missions. Are pathways supported by adequate inputs and if yes, how are different inputs combined to contribute to the achievement of the postulated goals?

Drawing on the framework proposed by RIPATHS (Griniece et al. 2020) we distinguish between four main structuring elements of impact pathways that also reflect the varying degree of control of the mission owners (ibid., p. 6):

- Inputs: Policy Instruments/resources and activities by mission owners aiming to facilitate the emergence of the desired impacts.
- Outputs: Immediate results from resources/activities that are under control of the mission owners and therefore like inputs belong to the sphere of control.
- Outcomes: In contrast to outputs, outcomes are only in the sphere of influence as their immediate control is limited, as they result from the interaction of stakeholders and the outputs.
- Impacts: The overarching impacts that are to be achieved, being conditional on the outcomes and the interactions with the overall socio-technical system constitute the sphere of interests.

Figure 1 provides an example for a hypothetical pathway that focuses on the provision of research funding, using the example of the mission on combating cancer. Mobilizing research funding dedicated to a specific topic (input) is assumed to stimulate research activities in this field, a dynamic that belongs to the sphere of control of the mission owners. In contrast, the uptake of these insights leading to the development of novel therapies cannot be directly influenced by mission owners, as these depend on a wider set of factors. Finally, the development of new theories can contribute to the main sphere of interest of impact assessment - societal impacts like a higher success rate of treatments.

Figure 1: Example of a pathway



Source: Own elaboration based on Griniece et al. (2020)

There are several important reflections regarding the usage of this concept. First of all, pathways can be considered as a tool to disentangle the complexity of missions, by breaking down the inner dynamics of mission realization into distinct dynamics. Key drivers in any way are the inputs provided by the mission owners, however, the materialization of impacts depends on the interaction of outputs with potential users and the overall socio-technical system. Accordingly, missions are assumed to consist of multiple pathways, that may interact (most likely at the output/outcome level) or contribute to a shared

goal. Secondly, despite the reliance on an I-O-O-I logic (input-output-outcome-impact), the pathways are not considered to represent linear logics but allow for feedback loops, wherever necessary. Thirdly, while playing an important role for investigating the impact of missions, pathways are also an important tool for understanding the design of a mission. In particular, they prepare the ground for investigating the contribution of individual instruments: Are all pathways covered with adequate instruments and if yes, how do instruments complement each other?

Ideally, the consideration of impact pathways provide orientation on how to reach the intended mission goals by the use of (the right) resources (policy instruments). When developing pathways during the process of mission formulation and mission design in an iterative way by linking inputs and outputs (results) closely with each other (e.g. through strategy workshops, making use of expert/scientific support and effectively involving the perspectives of stakeholders), coherence and a fit between mission goals and invested resources can be increased. However, considering the fact that missions of the current HTS have already been developed and the implementation has started, the approach adopted for MAR2 is the retrospective reconstruction of pathways and therefore served as an analytical tool. For this purpose, we draw on the understanding of mission goals outlined in MAR1 (Wittmann et al. 2020b) and official missions documents (BMBF 2018, 2019) to develop – in cooperation with thematic experts from Fraunhofer ISI – plausible impact pathways that reflect the approach of missions to realize the outlined goals.

2.2 Inventory of mission inputs

The second key element for analysis in this MAR2 is a comprehensive inventory of mission instruments. As mission instruments we define all those policy instruments[4] and activities managed by mission owners (responsible ministries and administrative agencies alike) that are implemented to achieve the goals of a mission. Consequently, mission instruments are outward directed to the relevant socio-technical system, excluding the coordination activities among mission owners also referred to as governance mechanisms. This forms the foundation for understanding the match between mission goals and inputs mobilized by mission owners, exploring whether all identified pathways are covered with appropriate means and if yes, how complementary instruments are. Given the fact that pathways were retrospectively developed by the research team, also the assignment of instruments to specific pathways is based on the assessment of the scientific support action.

4 Policy instruments are the "set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (cf. Vedung 1997, p. 21).

Whereas there have been attempts to assess the fit between goals and inputs against the background of MOIP, our analysis differs in some way. In contrast to Hüsing et al. (2017), our perspective is broader including also inputs besides research funding, thereby increasing the number of potential dimensions for analysis. We assume that MOIP introduce directionality to the research of innovation process and complement it with a wider set of instruments to steer this development (Kuittinen et al. 2018, pp. 12–13). A limitation of this perspective is that it is not possible to systematize or directly compare inputs with regard to budget size or TRL level as proposed by Hüsing et al. (2017). Alternatively, we propose to capture the character of inputs by a wider range of descriptors focusing on the target groups, their link to thematic priorities of the socio-technical system identified in the MAR1 report, and their input type.[5] The inventory hence assembles the following information on identified instruments:

Table 1: Template for inventory of instruments

Overarching category	Category	Description/further details
Instrument name	Name of the overarching program family	In German, if applicable, for instruments that are part of larger program/strategy
	Name of instrument	In German
Link to pathways	Association with mission pathways	Indication whether instrument is relevant for a certain pathway
Characteristics of instrument	Type of activity	Classification of the instrument building on to Hufnagl (2010) that distinguishes three main types of instruments (distribution, regulation, information) with several subtypes.
	Actor responsible for instrument	Name of actor in charge of implementation/execution of instrument
	Duration/temporal dimension	Start and end date of the instrument
	Budget	In million EUR, where applicable
	Target group	Short description of main target group (e.g. research, SMEs, civil societies, municipalities, etc.) of the instrument
	Thematic priority	Reference to relevant topics identified in system mapping in MAR1, as instruments may address a certain topic more broadly or only cover certain facets of it.
	Focus of the instrument:	Description of the main goal and priorities of the instrument

5 Depending on mission specifics, additional categories might be necessary.

Building on the distinction between distribution, regulation and information by Hufnagl (2010) we rely on the following sub-categories to systematize policy instruments.[6] Among distribution we follow the distinction between direct and indirect (subsidies, tax reductions, allowances) distribution with different sub-types. For direct distribution we distinguish between institutional support (financing of existing or new organizations/research institutes/etc.) and project support (financing targeted towards thematically oriented activities and projects, including early financing). Among the category of regulation, Hufnagl subsumes two main types of instruments: systemic management (support for strategic alliances, clusters and cooperation networks), regulatory measures (adjustment of laws, regulations, and rules). Finally, informational instruments can be grouped into transfer of knowledge (awareness raising for a topic through publications, events or other forms of coverage), policy expertise (support for decision-making such as foresight activities, technology assessment, evaluations, benchmarking, audits etc.), and discursive instruments (creation of fora for discussion, advice and exchange).

While there is no generalizable blue-print for the analysis of the fit between instruments and mission goals along the pathways, we expect that there are a number of dimensions particularly relevant for investigation that are inspired by the research on policy mixes (cf. e.g., Rogge and Reichardt 2016; Kivimaa and Kern 2016). However, in the end, the analysis of instrument mixes both at the mission and the pathway-level is strongly context-dependent, so that the following points only provide a rough orientation:

- Coverage: This is the most straightforward dimension inquiring whether a pathway is supported by relevant instruments. The absence of relevant instruments for a pathway renders it unlikely that the anticipated effects materialize due to the absence of adequate inputs.
- Linkage: Moreover, it is important how instruments relate to the specific pathways. Firstly, this refers to whether the instruments directly or indirectly contribute to a specific goal, e.g. by defining specific beneficiary criteria. Secondly, instruments may address an issue comprehensively or focus on selected aspects of it. For example, the development of new solutions may be thematically open or focus on some areas that are considered as particularly important. In this context, the system mapping conducted in MAR1 provides a useful orientation for the possible topics to be covered. Thirdly, to gain a better understanding of how instruments are aligned with the priorities, it can be worthwhile to investigate their temporal dimension. Instruments may have been designed specifically in the context of the mission or are previously existing policies that were adjusted for the purpose of the mission. Depending on this, the focus assessing the fit might vary, drawing attention rather to the context of instrument

6 It may be possible that instruments combine features of different instrument types, such as support programs for a dedicated topic that can be addressed by clusters/research alliances. In these cases we rely on the main motivation in order to classify the instrument.

development (e.g. stakeholder involvement) or the question of how adjustments were carried out (e.g. access criteria; supporting criteria, budget, etc.)

- Instrument mix: Depending on the kind of problem to be addressed, different mixes of distributive, regulative, and informational instruments might be necessary. Aiming to achieve behavioral changes, for example, it might be insufficient to rely on distributive instruments alone, as these should be accompanied by awareness raising information instruments. Moreover, coordination between different types of instruments may be more complex the more different actors are contributing to the same pathway.

2.3 Underlying assumptions and limitations

At the same time, this MAR2 report rests on a number of assumptions and decisions that need to be kept in mind. First of all, the inventory focuses on activities and instruments that are officially linked to the mission and are subjected to the governance arrangement of a mission. In contrast, other policy instruments that relate to the mission in a wider context are considered as dynamics shaping the overall context. While these might be considered as important to understand the overall dynamics in a chosen socio-technical system and for impact assessment, they are beyond the control of mission owners and therefore cannot be considered to directly contribute to the mission efforts.

Secondly, as missions may develop over time (Janssen et al. 2020, p. 10), the inventory can only constitute a snapshot at a certain point in time, while further inputs may be added to a mission at a later phase. The empirical basis for this reports are the official documents on the Hightech Strategy 2025 (BMBF 2018, 2019), the website for the national decade against cancer (NDK), and feedback from involved ministries (until end of 2020). A list of identified instruments was submitted to the units in charge of implementation for verification during this process. Consequently, the identified instruments should neither be treated as an exhaustive nor permanent list. For the purpose of the analysis, the research team decided - wherever possible - for a fine-grained perspective, focusing on individual funding schemes instead of large umbrella programs.

Thirdly, this MAR2 report focuses on understanding the overall instrument mix and its link to the mission goals. Thereby it aims to "take stock" of existing dynamics and attempts for a first mapping of instruments against the background of impact pathways. However, a comprehensive analysis of the instrument mix for each individual pathway, an analysis of the definition process of individual instruments, and policy layering or refurbishing of different past and present policies and activities (cf. e.g., Hacker 2004; Thelen and Streeck 2005; Kern and Howlett 2009; Mahoney and Thelen 2010) is beyond the scope of the analysis.

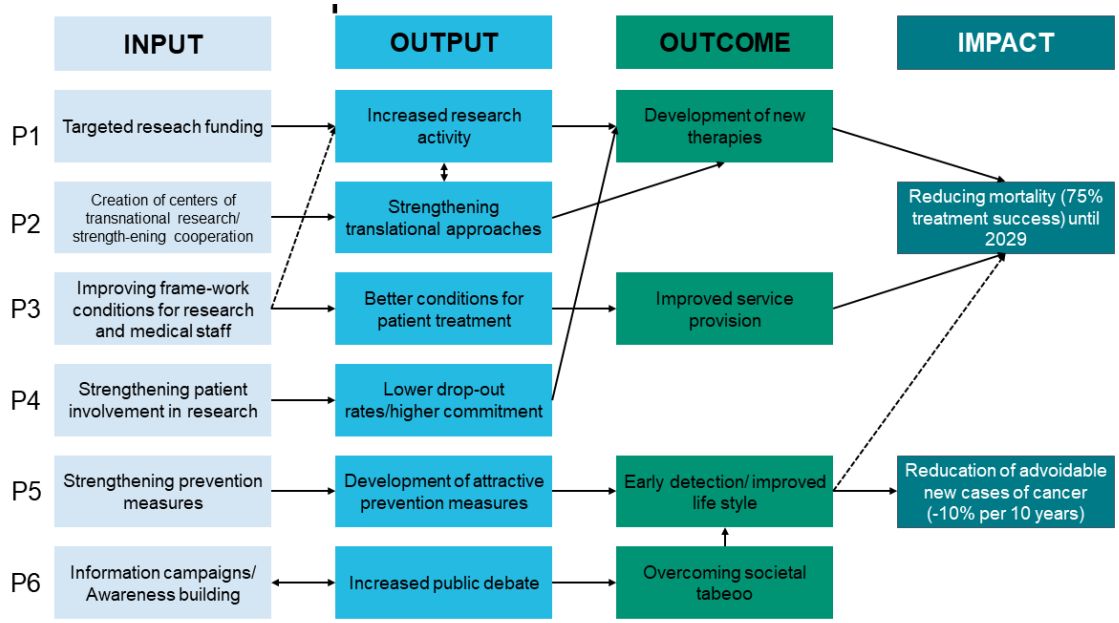
3 Mission: Combating cancer

Section written by Florian Wittmann, Tanja Bratan

3.1 Overview of relevant pathways

The mission on Combating cancer has five goals postulated in the joint declaration of the National Decade against Cancer (NDK), with two main quantified goals and three goals contributing to the overarching goals of improved treatment and cancer prevention. We have identified six distinct pathways to achieve these goals (see figure 2). Whereas two of them are focused on prevention, aiming to reduce new cases of cancer by 10% every ten years, the remaining four pathways approach the challenge of combating cancer from the treatment side, aiming to achieve a 75% success rate of treatments until 2029. While pathways can generally be categorized according to the main types of goals they aim at, nonetheless there are several connections between them. For example, patient involvement may be closely linked with awareness raising campaigns to serve the promotion of prevention measures. Moreover, at the level of outputs/impacts, an increase of early detections that is facilitated through prevention measures may contribute to reduce the overall mortality rate.

Figure 2: Impact pathways for the mission on combating cancer



Source: Own compilation

The following sections present the individual pathways and provides an overview over relevant instruments associated with the described pathways. An overview of the presented aspects can be found in table 2. The insights from different pathways are discussed in the concluding sections.

3.1.1 Target research funding for the improvement of treatment (P1)

The first “classical” STI pathway focuses on the provision of adequate resources to improve research activities to develop new therapies that increase treatment success. The provision of new research insights might act as a positive feedback effect, stimulating additional research activities. It is mainly addressed by BMBF research programs that are listed below as the instruments associated with this pathway.

- Funding line (62 million EUR) for clinical studies that seek to improve treatment, diagnosis and prevention of cancer. While the line is principally open to other areas as well, the majority of the currently funded research projects (9/13) is linked to the treatment of cancer. This input also contributes to the pathways of strengthening patient involvement, translational medicine and prevention.
- Initiation of a new funding scheme for research clusters on tumor heterogeneity that was inspired by the results of the working group of the NDK on unresolved issues of cancer research. The funding scheme emphasizes the importance of translational research and requires a link to clinical perspectives.
- Reserving parts of the funding scheme "Digitale FortschrittsHubs Gesundheit" for a project funding for one project that aims to improve the usage of patient data for research activities in line with the goals of the NDK.

The inputs that are all newly designed instruments (2019-2021) for research funding that emphasize different aspects and approaches related to treatment and research (clinical studies, usage of patient data for research, specific topic of tumor heterogeneity). All of the instruments fall into the responsibility of the BMBF, implying a high level of internal coordination.

3.1.2 Providing faster access to novel developments through strengthening translational research (P2)

This pathway is also closely related to research activities and patient involvement (P4), aiming to accelerate the uptake of new insights and bringing them into practical use. Being affected by the previous pathway (research funding) and the pathway focusing on improving framework conditions, it supports the development of new therapies and can

improve the efficiency of pathway P1. At the same time, the development of new therapies generates additional opportunities for translational research, taking up novel developments. The pathway is covered by the following instruments:

- Funding for clinical studies aimed at providing new insights for patient treatment.
- Research scheme for tumor heterogeneity emphasizing the need for a clinical perspective
- Foundation of new location of the National Center for Tumor diseases combining research activities and treatment and thereby contributing to translational research
- Establishment of DKFZ-Hector Krebs-Institute focusing on research for personalized therapies.

In most instances, those inputs serve the goal of research for problem-solving (P1) or infrastructure building (P3), while at the same time promoting a translational approach and taking into account the clinical perspective in funded projects. Thereby, the promotion of a translational approach is embedded into other activities. All of the instruments implemented are fairly new, presumably ensuring a high congruence with the goals of the NDK.

3.1.3 Improvement of infrastructure (P3)

Another pathway we identified based on the goals of the NDK is the improvement of the overarching framework conditions for research and service provision for patients under treatment. Regarding this pathway, we identified two main inputs contributing to its fulfilment:

- Foundation of new location of the National Center for Tumor diseases in order to strengthen research activities and particularly translational research that can spillover to patient treatment.
- The foundation of the privately funded DKFZ-Hector Krebs-Institute for research on personalized therapies against cancer.

The measures undertaken focus on improving research infrastructure and treatment by the creation of research institutions. Consequently, the measures focus on strengthening research capacities through creation of new centers. In contrast, there are no measures reported to improve the general framework conditions for research and treatment in general that might unleash immediate effects on patient treatment beyond the geographical focus of these Centers.

3.1.4 Improving research results through patient involvement (P4)

The final pathway in the field of improved treatment is also related to accelerating the research process. Through strengthening the involvement of patients in the research process, it seeks to create favorable conditions for the research process in order to improve therapies and incorporate patient needs. Like with translational medicine, there is no input dedicated exclusively to patient involvement, but rather addressing this goal alongside the contribution to other pathways in an indirect manner. In particular the goal is addressed by:

- Funding scheme for clinical studies that indirectly seeks to promote patient involvement through two mechanisms. Firstly, the involvement of patient representatives as part of the committee reviewing project applications. Secondly, definition of application criteria that require patient involvement in the foreseen studies.
- Making use of a newly designed funding schemes, the goal is achieved indirectly through funding regulations. For the remaining inputs we are not aware of a similar requirements.

3.1.5 Reducing new incidences of cancer through prevention (P5)

The strengthening of prevention measures represents the main pathway towards the postulated goal of reducing (avoidable) cases of cancer. It builds on an improvement of prevention measures, particularly earlier detection and adjusted lifestyles (output), to reduce risk factors, which consequently should lead to a long-term reduction of new cases. The following inputs were identified as relevant for the pathway:

- Research network for early detection and prevention of liver cancer,
- Research funding for the prevention of intestinal cancer in young and future generations,
- Organization of cancer prevention week by DKH/DKFZ, aimed at promoting healthy lifestyles,
- Research funding for clinical studies: Three of the 13 funded projects in the first phase of the funding scheme focus on questions related to prevention and early detection.

The inputs can be categorized into two groups. On the one hand research funding (1,6,7) that supports research on causes of the emergence of specific types of cancer and finding appropriate ways for preventing them. On the other hand, input 8) focuses more on behavioral change through providing information and promoting a healthy lifestyle. However, at the current state there might exist a gap with regard to inputs addressing the intermediary level that focuses on promoting different types of screening/early detection

mechanisms and other complementary instruments like regulatory means to strengthen prevention and/or creative incentives for a changed behavior. The current approach strongly focuses on financing research activities on selected types of cancer (6, 7) that were identified as pivotal by the working groups. Overcoming societal taboos and information deficiencies around cancer through information and awareness raising (P6)

Besides the strengthening of prevention measures (P5) we identified another pathways related to prevention according to the goals of the NDK. Stimulating the public debate on cancer aims at breaking societal taboos and spreading knowledge around the topic, and ultimately removing psychological barriers that hamper the effective realization of prevention measures. This pathway contains a positive feedback effect, implying that a more vivid societal debate also opens up more opportunities for awareness raising. As the main contributions the following instruments were identified:

- Online dialogue of the NDK: besides gathering inputs from civil society and their perspective on combating cancer, the survey constitutes a way of bringing the topic to public debate.
- Creation of a cancer prevention Centre by DKH/DKFZ in Heidelberg with an information Centre for citizen.

Whereas both of the instruments are aligned with the goals of the pathways, it needs to be discussed to what extent these activities are suited for contributing to promoting a wider societal debate. For instance, the online dialogue primarily relied on respondents being directly or indirectly affected by cancer, thus does not target the broader range of citizens where awareness raising would bring the highest benefits. Overall, the measures seem to be targeted towards an "interested audience" that might differ from the general audience that might be necessary for stimulating a public debate.

Table 2: Inventory of instruments for the mission on combating cancer

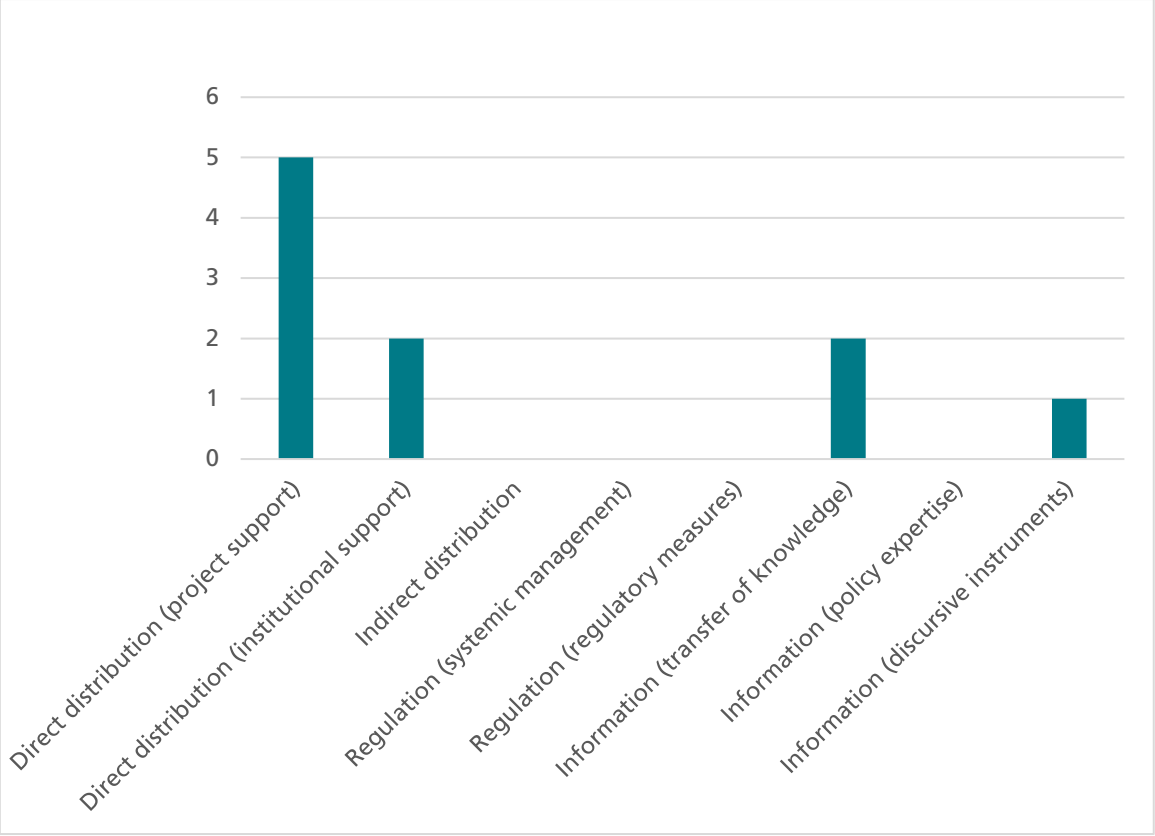
No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
1	Rahmenpr. Gesundheitsforschung	“Praxisverändernde Studien“	X		X	X	X		Direct distribution (project funding)	BMBF	2019-2029	62	Research	Prevention, diagnosis, therapy, aftercare	Clinical studies
2		„Tumorheterogenität, klonaler Tumor-Evolution und Therapieresistenz“	X		X				Direct distribution (project funding)	BMBF	2021-	n/a	Research	Therapy	Research funding for exploring the heterogeneity of tumors and development of personalized treatment approaches
3	Medizininformatik-Initiative	“Digitale FortschrittsHubs Gesundheit“	X						Direct distribution (project funding)	BMBF	2020-2023	n/a	Research	Therapy	Funding of at least one project aligned with NDK goals, focus on improving usage of patient data for research (treatment)
4		New locations for NTC		X	X				Direct distribution (institutional funding)	BMBF	2019-2025	13mio (per Center)	Research/ health infr.	Therapy, service provision, diagnosis	Two additional locations for the National Center for Tumor diseases
5		DKFZ-Hector Krebsinstitut		X	X				Direct distribution (institutional funding)	DKFZ/ Hector Found.	n/a	2.5 (Hector foundation, per year)	Research/ health infr.	Service provision, therapy	Creation of a new Center focusing on personalized treatment/translational activities

No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
6		Research network („Früherkennung und Prävention von Leberkrebs (LiSyM-Krebs)“)					X		Direct distribution (project funding)	BMBF	2020-2023	n/a	Research	Diagnosis	Creation of research network for exploring causes and developing better approaches for prevention and early detection of hepatic cancer
7		Research networks (Prävention von Darmkrebs in jüngeren und künftigen Generationen					X		Direct distribution (project funding)	BMBF	2021-2029	n/a	Research	Primary and secondary prevention	Research networks to improve prevention measures for intestinal cancer
8		Prevention week (1st/2nd edition)					X		Information (Transfer of knowledge)	DKH/ DKFZ	2019-2020	n/a	Civil society	Primary prevention	Event aimed at creating awareness for prevention
9		Online dialogue of the NDK						X	Information (Discursive instruments)	NDK	2020	n/a	Civil society	Patient involvement	Survey on needs regarding combating cancer
10		Cancer prevention center						X	Information (Transfer of knowledge)	DKFZ/ DKH	2020-	25	Research/ health infr. /civil society	Patient involvement, primary prevention	Creation of new Center for prevention/information provision for citizens

3.2 Summary and discussion

Having identified six specific pathways targeted towards two overarching goals (improved treatment, avoidance of new cases of cancer), this chapter explored how goals and instruments relate to each other. Overall, the analysis identified a total of ten different instruments, with some of them addressing multiple pathways simultaneously. All of the identified pathways are associated with relevant inputs that can be expected to contribute to the postulated goals, though the degree of fit may vary. The mission reveals a strong orientation towards incentive creation through direct distribution (project support for research funding, institutional support for creation of new research centers). Half of the instruments are linked to research funding (cf. figure 3).

Figure 3: Types of instruments (Combating cancer)



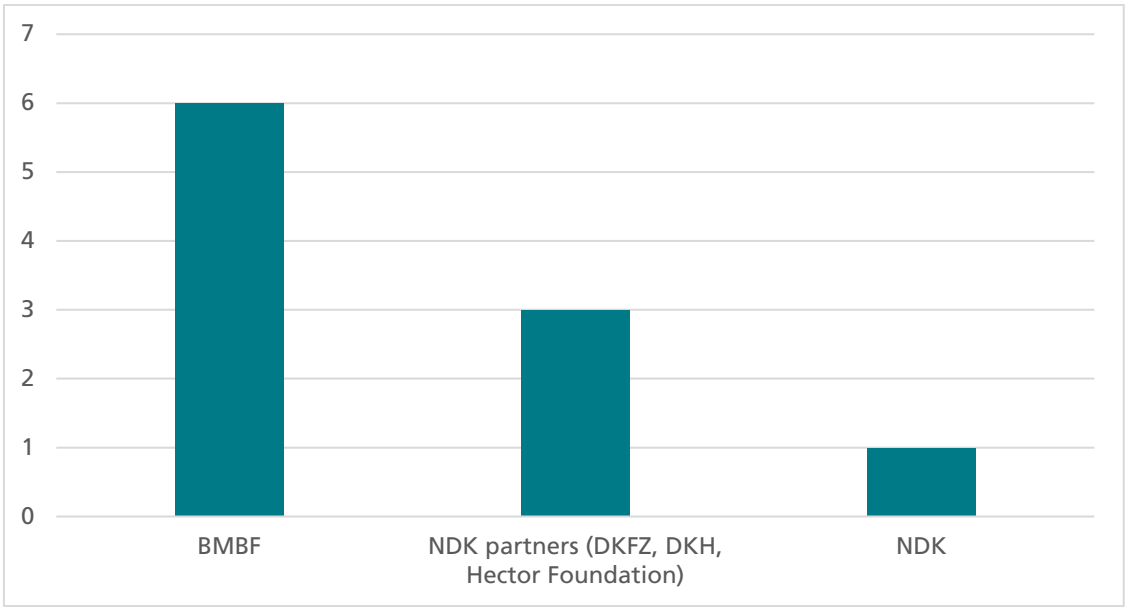
Source: Own compilation

All inputs can be considered fairly new, being developed in the context of the NDK (and partly even inspired by the output of the relevant working groups. Thereby, this mission avoids the problem of policy layering or insufficient alignment of existing policies with newly formulated goals that characterizes other missions in the HTS 2025. At the same, as the area of combating cancer is an established field with a plethora of on-going activ-

ities and actors involved (cf. MAR1, Wittmann et al. 2020b), there are many inputs shaping the dynamics in the socio-technical systems beyond the mission inputs that can be also considered as relatively small regarding their budget in comparison to the corresponding socio-technical system. From this perspective it remains open, whether including additional existing instruments into the governance of the mission (and aligning them with mission goals) might strengthen the capacity of the mission to promote sustainable change.

Despite the large numbers of supporters of the NDK – based on publicly available documents – inputs are provided by few actors. BMBF, DKFZ, DKH, Hector Foundation are responsible for the ten identified instruments/inputs that contribute to mission achievement). In contrast, the remaining actors so far contributed indirectly to the mission, by providing input through the working groups that have been used to define new priorities and programs. Whereas the involvement of the Federal Ministry of Health in the mission governance contribute to a coordination of activities of instruments beyond the realm of the mission (e.g. in the National Cancer Plan), the analysis could not identify any dedicated instruments that belong to the mission and are managed by the Federal Ministry of Health (BMG). While this rather clearly delineated "division" of labor reduces the need for coordination between different instruments and actors, the mission at the instrument level might not yet unleash its full potential for mobilization (cf. figure 4). The strong focus on distributive instruments triggers also questions to what extent these activities will provide the opportunity for mobilizing additional stakeholder inputs.

Figure 4: Number of instruments by actor (Combating cancer)



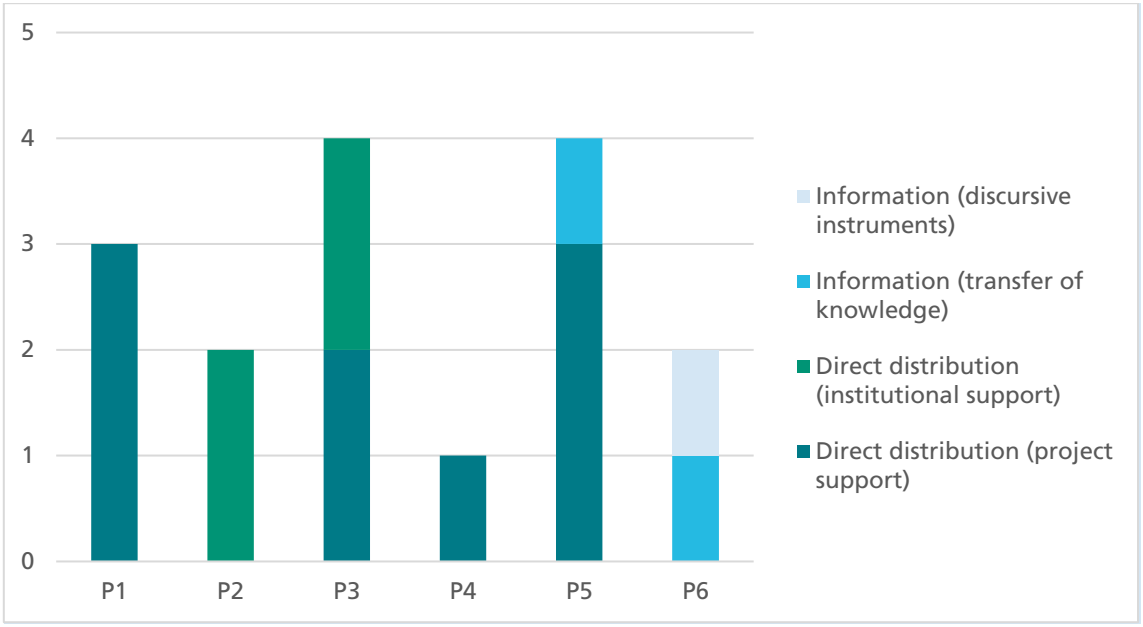
Source: Own compilation

With regard to the scope of activities, in many pathways one can see a targeted approach focusing on a specific problem (certain type of cancer), mostly through research-oriented funding. This prioritization of certain topics is rooted in recommendations of the working groups, suggesting a close alignment between priorities and activities of the NDK that has to be welcomed. In contrast, civil society primarily comes in with regard to prevention activities and service provision is addressed rather indirectly.

While all the activities can be associated with one or more specific pathways, the analysis revealed that there are currently few systemic instruments and inputs reaching beyond Research and Development (R&D) activities (cf. figure 5). This might be particularly relevant for the pathways focusing on preventions, where the scope of undertaken measures is rather narrow and might not unleash the desired dynamics leading to behavioral change and higher acceptance for prevention measures.

Moreover, while all pathways are associated with relevant instruments, the capacity of the instrument mix for achieving sustainable change might be limited in some cases. This particularly applies to patient involvement that is only indirectly approached – at this stage – by one research funding line 1). In this context it remains to be seen whether the design spills over to other programs to make patient involvement more sustainable.

Figure 5: Types of inputs for different pathways (Combating cancer)



Source: Own compilation

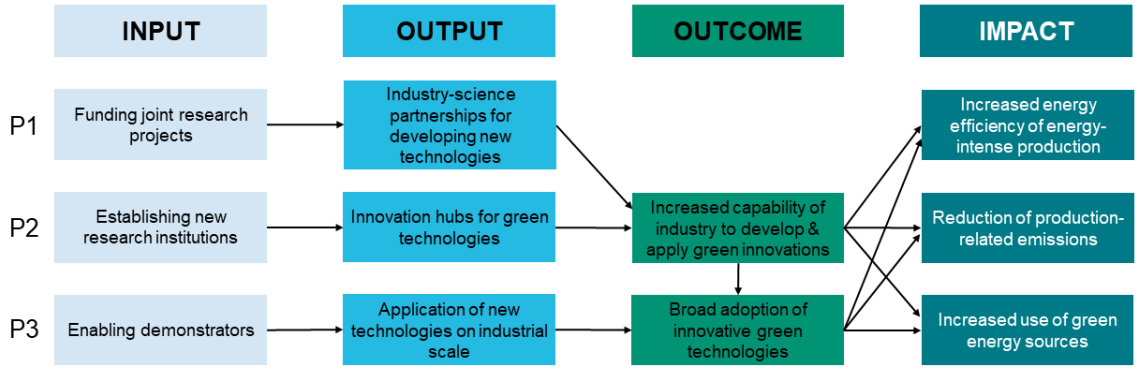
4 Mission: Achieving substantial greenhouse gas neutrality in industry

Section written by Florian Roth, Marlene Arens and Clemens Rohde

4.1 Overview of relevant pathways

The Hightech Strategy 2025 sets out two main goals for the "greenhouse gas emission reduction in the industry" mission. On the one side, as the name suggests, the mission aims to contribute to the greenhouse neutrality of Germany's industry sector by the year 2050. At the same time, the mission also serves to secure and foster the international competitiveness of Germany's economy. Our analysis finds three distinct pathways entailed in this mission that address different central topics relevant for achieving greenhouse gas neutrality in the industrial sector that we have identified as part of MAR1. In how far the different pathways primarily serve the first or the second goal of the mission (emission reduction vs. international competitiveness) is difficult to be judged based on the available documents.

Figure 6: Impact pathways for the mission on reducing CO_2 emissions in industry



Source: Own compilation

The remainder of this section, presents the individual pathways and provides an overview over relevant instruments associated with the described pathways. An overview of the instruments can be found in Table 3.

4.1.1 Research funding for green technologies (P1)

The first pathway aims to foster the development of innovative green technologies to reduce industrial CO_2 emissions by supporting and triggering different kinds of collaborative research endeavors. This includes financial funding for mid- and long-term projects

that are expected to technological innovations that help to reduce emissions due to the energy carrier used, so called energy-related emissions, as well as process-related emissions which are an issue in many industrial processes like steel and cement production. Specifically, it aims to bring together scientific and private-sector actors to collaboratively develop new materials, processes, and methods. While this pathway may involve funding for basic research, a strong emphasis is on applied research endeavours that are hoped to be an important stepping stone for transforming the industrial sector towards greenhouse gas neutrality in the upcoming years. Several of the inputs that are part of the HTS 2025 seem to follow this pathway:

- The framework program "Research for sustainable development" (FONA) of the BMBF entails several instruments in support of technological innovations for solving the challenge of greenhouse gas neutrality (which is one of the main goals of FONA). To mention here is the funding line "KlimPro-Industrie", which addresses process-related emissions in so-called hard-to-abate industries. It provides funding for innovations from technology readiness level (TRL) 1 to 5. The research program "material science for energy transition" supports the development of new materials that are hoped to enable the production and storage of hydrogen and other green technologies that play an growing role in the German industry. Further, the funding initiative "Future-ready energy grids" enables research in the field of network operation management, network planning, transmission and distribution technologies. The outcomes of these research activities are supposed to contribute to a secure energy supply for industrial end-users as the energy mix is expected to change in the forthcoming years. Finally, the funding scheme "KMU Innovativ" is specifically geared at small and medium size enterprises. Among different elements, in includes several incentives to participate in research projects to develop greenhouse gas-reducing technologies and processes for industrial processes.
- The funding program "Dekarbonisierung in der Industrie" (Decarbonization in the Industry), funded by the BMU and organized by the "Competence Center Climate Protection in energy-intense Industries" (KEI) and the UBA, provides funding for a broad range of projects that aim to reduce process-related emissions. This includes the development of green production processes, innovative combinations of existing processes as well as new climate-neutral replacement products. Eligible are single companies, private-sector consortia as well as public research organizations.
- Many programs under the scheme of FONA are also part of the 7th Energy Research Program, led by the BMBF. For example, the so-called "Kopernikus Projects for energy transition" are listed as parts of both programs. The Kopernikus projects aim to foster research collaborations between academia, industry and civil society. One of the topical foci of the Kopernikus program are innovations to reduce energy-related emissions, for example though hydrogen technologies, or to increase the flexibility of energy-intense industrial facilities for synchronizing their demand with fluctuations on the side of energy suppliers.

4.1.2 Establishment of new research institutions (P2)

A second pathway relates to the long-term conditions of successful R&I activities. It is geared at setting up new research institutions that form kinds of innovation hubs for the development and application of green technologies. These new institutions do not directly aim at the development of specific technological innovations, but instead try to foster new collaborations of public and private sector partners that in turn are expected to speed up innovative processes in the context of greenhouse gas neutrality. Our analysis found several new research centers that are aligned with this pathway to increase Germany's innovate capacities for the sustainability transition:

- The Competence Centre on climate change mitigation in energy-intensive industries (KEI) in Cottbus, funded by BMU, serves as a Think Tank for generating new ideas and connecting different actors from academia, industry and civil society. Further, the KEI functions as an executing agency for the BMU, managing the "Decarbonization in Industry" funding program mentioned above.
- The Institute for Low-Carbon Industrial Processes, operated by the German Aerospace Center (DLR), conducts several applied research projects on the reduction of production-related CO2 emissions, mostly together with the Brandenburg University of Technology Cottbus-Senftenberg (BTU). Topics include, among others, the decarbonization of steel production using renewable "green" hydrogen as a reducing agent or the production of synthetic solid reducing agents from biomass.

4.1.3 Enabling demonstrators for green solutions (P3)

Implementing new sustainable innovations on an industrial level not only means to overcome technical challenges, but also involves many political and regulatory challenges. The mission involves several instruments for translating scientific knowledge into practical use, to address and ultimately overcome challenges in controlled environments and demonstrate its viability. The mission encompasses several inputs that provide funding for diverse measures to scale up the diffusion of available green technologies. We identified the following instruments as relevant for the pathway:

- Reality labs offer a valuable safe space to test innovative methods, products and processes under realistic conditions. The 7th Energy Research Program, funded by the BMWI since 2019 includes several reality labs. Their purpose is to test innovative approaches on a local or regional scale under realistic conditions.
- In *Carbon2Chem* the Max Planck Society, the Fraunhofer Society, different universities, as well as eight industrial companies are working collaboratively on large-scale facilities to convert smelter gases into primary products for fuels, plastics, or fertilizers. A central part of the project is a pilot plant in Duisburg, commissioned in 2018. Complementary to Carbon2Chem are the projects MACOR and Bewise that follow similar

aims, but focus on new smelting methods. All three projects are funded under the 7th Energy Research Program and FONA.

- The NANOSYM project is also part of the 7th Energy Research Program and at the same time of FONA. Its aim is to lay the basis for the production of synthetic fuels on the multi-ton level in Germany. It brings together 31 different actors from industry and applied research. In autumn 2020, a demonstrator production was officially opened in Munich as part of the project.
- Another instrument for getting green innovations to the industrial scale is the Environmental Innovation Program, funded by UBA. Already for over forty years, the program specifically supports demonstration projects that fulfil high ecological, but also economic standards. Currently, it includes around 90 different projects related to climate change mitigation and also provides funding demonstrator projects.

Table 3: Inventory of instruments for the mission on achieving substantial greenhouse gas neutrality in industry

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
1	FONA	"Materialforschung für die Energiewende"[7]	X			Direct distribution (project support)	BMBF	2013-2015	90.1	Research	Energy efficiency, production-related emissions, energy-related emissions	Energy efficiency in buildings, Hydrogen production and storage, fuel cell technology Photovoltaics, Wind energy, power plant technology, Geothermal energy, Hydropower
2		"Förderinitiative Zukunftsfähige Stromnetze"[8]	X			Direct distribution (project support)	BMBF, BMWi	2013-2018	150	Research institutions. enterprises	Energy-related emissions	Network operation management, network planning, transmission and distribution technologies
3		"KlimPro-Industrie"	X			Direct distribution (project support)	BMBF	2021-2029	71	Research, industry	Process-related emissions	Funding for industry-led research projects (TRL 1-5), also funding for networking activities

[7] Also part of the 6th Energy Research Program.

[8] Also part of the 6th Energy Research Program.

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
4		KMU-innovativ: Energieeffizienz und Klimaschutz	X			Direct distribution (project support)	BMBF	2020-2023	n/a	SMEs	Energy efficiency	Systemic technologies, processes and services for energy efficiency, climate-relevant cross-sectional technologies for climate protection, products for adaptation to climate change, climate-friendly services and management processes for rural areas.
5	Umweltinnovationsprogramm	Förderrichtlinie "Dekarbonisierung in der Industrie"			X	Direct distribution (project support)	BMU	2021-2024	2000	Energy-intensive industries	Energy-related emissions, process-related emissions	Climate protection, decarbonization, industry
6		Kompetenzzentrum Klimaschutz in energieintensiven Industrien (KEI) - Cottbus		X		Direct distribution (institutional support)	BMU	2020-2023	n/a	Energy-intensive industries	Process-related emissions	Foundation of a competence center for the development of low-carbon industrial processes and technologies for turning coal power plants into storage power plants

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
7	7. Energieforschungsprogramm der Bundesregierung	Kopernikus-Projekte für die Energiewende[9]	X			Direct distribution (project support)	BMBF	2016-2025	400	Industry, research, civil society	Energy-related emissions	Development of technologies for achieving climate goals. Developing solutions for dealing with fluctuations in the electricity system due to increase of renewable energies.
8		Reallabore der Energiewende			X	Direct distribution (project support)	BMWi	2020-2026	600	Industry, research	Energy-related emissions	Sector coupling and hydrogen technologies, Large-scale energy storage in the power sector, Energy-optimized quarters
9		Carbon2Chem[10]			X	Direct distribution (project support)	BMBF	2016-2024	139	Industry	Process-related emissions	Research into how valuable starting products for fuels, plastics or fertilizers can be obtained from the gases produced in steelmaking.
10		MACOR/Bewise[11]			X	Direct distribution (project support)	BMBF	2017-2023	9	Industry	Process-related emissions	Research into the decarbonization of the steel industry, focs on new smelting methods

9 Also part of the FONA funding scheme.

10 Also part of the FONA funding scheme.

11 Also part of the FONA funding scheme.

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
11		NaMoSyn[12]			X	Direct distribution (project support)	BMBF	2019-2022	24	Industry	Energy-related emissions	demonstrator project for synthetic fuels for diesel and gasoline engines.
12	Strukturentwicklung in den Braunkohleregionen	Creation of DLR Institute		X		Direct distribution (institutional support)	BMWi	2019-	57	Research	Process-related emissions	Creation of research institution focusing on emissions in hard-to-abate sectors (e.g. steel, aluminum, cement)

[12] Also part of the FONA funding scheme.

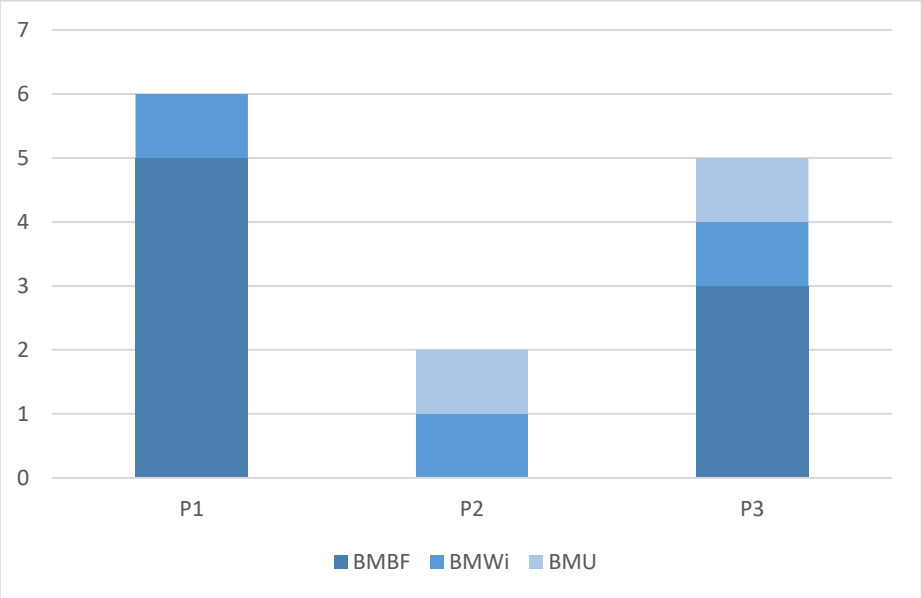
4.2 Summary and discussion

Our analysis found twelve specific instruments to lower the greenhouse gas emissions of the German industry sector, while fostering its long-term international competiveness. As laid out in the relevant strategic documents, the mission towards greenhouse gas neutrality of the German industry sector puts a strong emphasis on the development of green technologies on the one hand, and a broad and timely application of these technologies on the other. To this end, the mission on CO_2 emissions in industry builds on close collaborations between research institutions and industry partners to work on industrial production methods that are able to reduce greenhouse gas emissions, especially in the so-called hard-to-abate industries, such as steel and aluminum production, or the cement industry. The mission appears to be based on the assumption that a mix of institutional and project funding will increase the capability of the German industry to develop and apply green innovations. Further, it aims to stimulate specific targeted R&I activities connected to single green technologies, such as hydrogen technologies or integrated energy systems. The feasibility of these technological innovations is shown in reality labs and demonstrator projects that represent a kind of intermediary step before a broad, industry-wide adoption of new technological methods that either increase the energy efficiency of energy-intense production processes, reduce the amount of production-related emission and/or increase the use of green energy sources. This way, the three pathways are closely interlinked, as the research-centered pathways P1 and P2 are supposed to feed directly into the market-oriented pathway P3. Together, these impacts are hoped to ultimately lower the greenhouse gas emissions of the German industry sector significantly.

In how far current policy instruments match these pathways is generally hard to tell based on the available data. In the context of mission implementation, the HTS 2025 and its progress report (BMBF 2018, 2019) mainly refer to some of the government's largest R&I funding schemes for academia and industry actors, such as the 7th Energy Research Program or the framework program "Research for sustainable development" (FONA). In addition, the progress report of the HTS and the HTS website enumerate a couple of projects within these funding schemes. For example, the project "Carbon2Chem" is listed, which is part of the FONA program as well as of the 7th Energy Research Program. At the same time, both these programs entail many other projects with apparent links to the goals of industrial greenhouse gas reduction that are not specifically listed as part of the HTS. Based on the available information, it appears that most of the mission's resources flow into the funding for specific research projects (P1). But also demonstrator projects (P3) receive considerable funding, since new production facilities in hard-to-abate industries (e.g. steel furnaces) typically cost many millions or even billions of Euros and consequently absorb considerable shares of R&I funding. Finally, the mission also

includes instruments to establish new research institutions (P2). While no precise budgetary numbers are available, the instruments on this pathway certainly account for a much smaller share of the mission's resources, compared to P1 and P3.

Figure 7: Number of instruments/strategies by actor (Achieving substantial greenhouse gas neutrality in industry)



Source: Own compilation

The funding for the instruments mainly is provided by federal ministries, yet some instruments build on a substantial co-financing from the side of industrial partners to ensure their commitment and increase the leverage of public funding. Overall, three federal ministries are involved in the mission: The BMBF is in charge of eight instruments, the BMWi is responsible for three instruments and the BMU for two instruments (see figure 7). Remarkably, only one instrument, the funding initiative "Future-ready energy grids", is jointly organized by the BMBF and the BMWi. The HTS does not include specific instruments to improve coordination and bridge ministerial silos. Rather, coordination between these actors mainly takes place through other institutions, such as the 'Cabinet Committee on Climate Protection', which serves as the central governance instrument for coordinated climate action of the German government. Reflecting the mission's ambition to support research institutions and industry partner to join forces, developing and implementing green technologies, many instruments include elements for stakeholder involvement, mainly representatives of large companies or industry associations. In contrast, other potential stakeholders, such as consumer organizations or environmental groups are rarely involved. For example, the HTS progress report (BMBF 2019) names the "Forschungsnetzwerk Industrie und Gewerbe" (research network industry and trade) as an

example of a productive collaboration of the private sector, research, science policy and society, yet social stakeholders beyond the affected industries appear to play a rather marginal role in the network's activities.

5 Mission: Creating sustainable circular economies

Section written by Miriam Hufnagl and Katrin Ostertag

5.1 Overview of relevant pathways

The mission *creating sustainable circular economies* displays several main sub targets that should lead to closing the loop of production and consumption. The main aim is to link "economic growth to sustainability goals and achieve a 30 per cent increase in overall raw material productivity by 2030 compared to 2010" (BMBF 2018, p. 22). Given the nature of this complex undertaking the HTS 2025 outlines the political will to "work with industry, science and consumers" (ibid.). Prior to discussing pathways and associated policy instruments as a result of studying this mission, three general observations are worth mentioning since they limit the validity and meaningfulness of our analyses:

Firstly, possibly due to the fact that fostering and ultimately realizing full circularity would result in a major shift of business practices and a deviation from the growth paradigm of modern capitalism, the description on how this shift will be facilitated via policies of this mission is rather vague, whereas the motivation is emphasized quite strongly: "Together with all those involved, we want to press ahead intensively with the transformation of the traditionally linear economy into a resource-efficient circular economy" (BMBF 2018b, p.22). The introduced policy instruments and cooperation schemes however, more often than not, lack a clear outline on how they will substantially contribute to achieving this systemic goal.
Secondly, linking different societal subsystems by applying STI policies that – among other benefits – foster scientific progress and knowledge transfer in general is of utmost importance for systemic transformation, nonetheless the facilitation of circularity through strong regulatory measures is the real game changer in years to come. How these different dimensions could be integrated and combined more systemically has not been outlined yet by the federal government.

Which takes us to the third general observation: several large scale strategies and programs with different levels of ambition, regulatory and financial effects (or existence as a tool of information/knowledge sharing) are part of this mission and it proves difficult to disentangle their concrete contribution (instruments) to successful mission orienta-

tion/accomplishment. We already outlined the heterogeneity of some of these large initiatives in the MAR 1 (Wittmann et al. 2020b)[13]: among others namely ProgRess, FONA and the associated research concept "Resource Efficient Circular Economy", the Environmental Innovation Program by the BMU, the Raw Materials Strategy lead by BMWi and the Bio-economy Research Strategy jointly presented by BMBF and BMEL.

As outlined above the mission on "Circular Economies" (CE) has the overarching quantified goal to "achieve a 30 per cent increase in overall raw material productivity by 2030 compared to 2010" (BMBF 2018b, p. 33). Several encompassing qualitative aims complement this goal and are closely related to raw material productivity, namely "to achieve a decoupling of economic growth from resource consumption, a significant reduction in greenhouse gases, waste and environmental pollution, and less dependence on imported raw materials" (BMBF 2018, p. 33).

We have identified seven distinct pathways to achieve the goal of circularity by four different impacts (see figure 8).

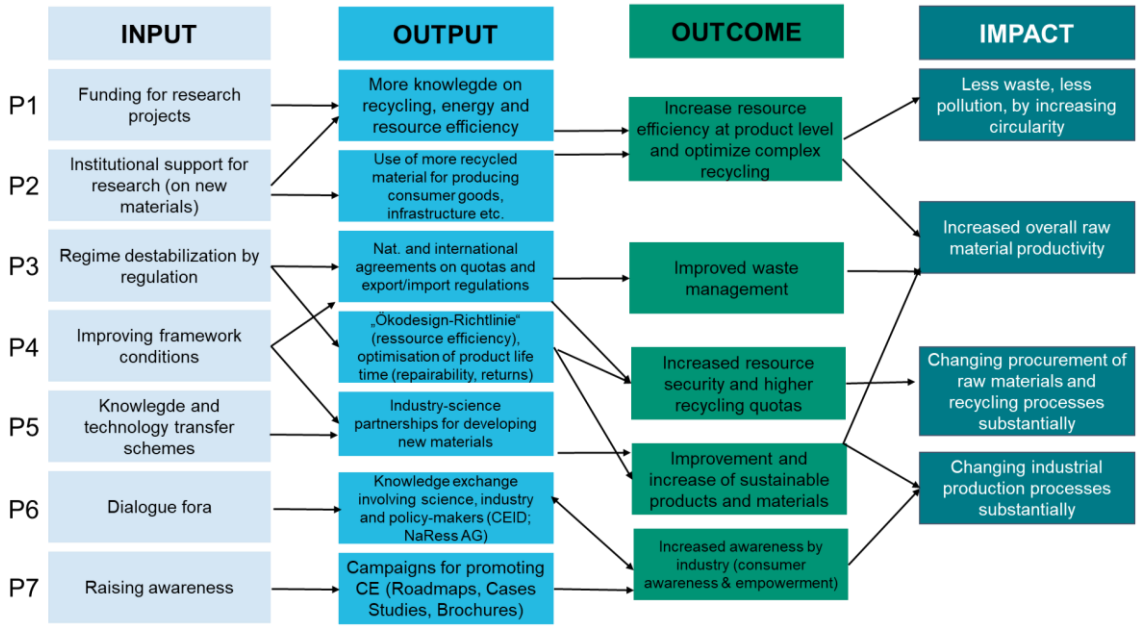
- Less waste, less pollution by increasing circularity
- Increased overall raw material productivity
- Changing procurement of raw materials and recycling processes substantially
- Changing industrial production processes substantially

As these outcomes and figure 8 generally show, there can be several interconnections between different pathways (and the associated policy instruments).

The following sections therefore present the individual pathways and provide an overview of policy instruments associated with the described pathways from an analytical point of view. For a general overview of the policy measures as listed in the official documents of the Hightech Strategy 2025 please refer to table 4. The insights from different pathways are discussed in the concluding section.

13 "The German Resource Efficiency Programme (ProgRess) can be identified as the center piece of the mission apart from STI-related initiatives. The German Federal government has set itself the goal of increasing total raw material productivity by 1.5 per cent per annum by 2030 and through this support the principle of circular economy. This corresponds with the objectives of the sustainability strategy and contributes to the implementation of the European Circular Economy Strategy (Europäisches Paket zur Kreislaufwirtschaft von 2015) and the Climate Protection Plan 2050. Furthermore the new edition of the Raw Materials Strategy of January 2020 (lead BMWi), highlights circularity as a contribution to securing the raw material supply for the German industry. Increasing total raw material productivity means decoupling economic growth from resource consumption, significantly reducing greenhouse gases, waste and environmental pollution and reducing dependence on imports" (Wittmann et al. 2020b, p. 45).

Figure 8: Impact pathways for the mission on creating sustainable circular economies



Source: Own compilation

5.1.1 Funding for research on products and processes (P1)

This pathway is associated with funding for research activities that aim to solve a specific problem in the area of new materials (focus on products or components like recycled materials) or optimizing material processes (routines and digitalization tools for production or use of materials in certain sectors e.g. construction, building). The resources we associate with this pathway are mostly bound to classic competitive project funding schemes which are provided by BMBF, BMU and BMWi. The framework program FONA (research for sustainable development, third edition) is the most prominent initiative with dedicated funding schemes for STI related aspects of CE (with a focus on recycling, improving the use of critical raw materials and technologies for resource efficiency). A sub-program of FONA is BMBF's own research concept on Resource-Efficient Circular Economy[14], which includes several funding programs associated with the mission:

- Innovative Product Cycles (ReziProK): 25 collaborative research projects with partners from industry, science and users to develop innovative solutions for business models, design concepts and digital technologies required to prolong or intensify product use, expanding refurbishing / remanufacturing and close production cycles (in diverse material fields like plastic, concrete or steel, electric vehicles or consumer products like communication devices or clothing).

14 Running from 2018-2023, with a total budget of 150 mio. €.

- Construction and Mineral Material Cycles (ReMin) provides funding for collaborative projects on research and development of new technologies, products and processes that contribute to more circularity in the construction industry (with a particular focus on mineral material cycles).
- Transnational cooperation scheme ERA-NET ERA-MIN 2 and 3 (research and innovation program on raw materials for the sustainable development and the circular economy) which "aims to improve synergy, coordination and coherence between regional, national and EU funding in the raw materials sector by (...) improving the use of human and financial resources, the competitiveness and the environmental, social, health and safety issues of raw materials operations through supporting of transnational, excellent and translational R&I activities."[15]
- The funding scheme Plastic recycling technologies (KuRT) targets the development, improvement and promotion of "new and existing plastics recycling technologies (...) (while) at the same time ensure their integration into the entire value chain in the sense of closed-loop recycling. Intelligent utilization concepts for plastics, improved logistics and collection as well as high-quality use of plastic recyclates should enable a significant increase in the actual recycling or recyclate use rates for plastics."[16] The thematic focus lies on packaging, construction products, electrical and electronic equipment, vehicles and commercial waste.
- KMU-innovativ, the BMBF scheme supporting SMEs willing to carry out applied research, was extended with a module on "resource efficiency and climate protection". This scheme is targeted at SMEs which want to establish efficiency technologies and work in the areas of resource and energy efficiency, climate protection as well as sustainable water and land management. Since KMU-innovativ offers more thematic modules like material science and IT and communication technology it might play an even a bigger role to foster CE apart from the dedicated new module.
- Furthermore the BMWi is active in the field and established the Technology Transfer Program Lightweight Construction (Technologietransferprogramm Leichtbau). This program is promoting a faster and improved knowledge and technology transfer in lightweight construction across different sectors and industries taking different kinds of materials and life cycle assessments into account. Lightweight construction is identified as a driver of innovation for sustainable and resource-saving economic practices and can therefore contribute to the achievement of climate protection goals.

15 Cf. https://www.era-min.eu

16 https://www.fona.de/de/massnahmen/foerdermassnahmen/recycling-kunststoffe.php, own translation of the main thematic aspects supported by KuRT.

- Applied research to foster circularity is also targeted by the BMELs Support Program on Renewable Resources (Förderprogramm Nachwachsende Rohstoffe[17]) which focusses on five core topics like raw material plants from agriculture, forestry and aquatic biomass, biogenic residues (waste with recycling potential, by-products) and ways to environmentally friendly produce bio-based products and bioenergy sources.

The fact that different ministries are responsible for quite a variety of support instruments on research for solving challenges around circularity and further comprehensive strategies have been published like the National BioEconomy Strategie and Raw Materials Strategy, proves that it is a topic that has been taken up in many policy areas. Whereas this is generally a positive development, the compilation of policies in the HTS 2025 appears rather eclectic. If and to what extend this uptake has been coordinated between the different ministries (topical division of labor or at least information sharing) to avoid policy layering or contradictory action, cannot be said.

An additional result of our analyses regarding research funding is the fact that supporting dedicated research projects and consortia investigating the elimination of barriers in innovation through consumer behavior by social and economic research about knowledge, acceptability and practicability of CE concepts and processes is a blind spot of the mission.

5.1.2 (Institutional) Support for research (on new materials) (P2)

This pathway is associated with the support of fundamental research on new materials reflected in institutional as well as project based funding. Mostly carried out at publicly funded higher education institutions (HEIs; institutional funding) by qualifying students, PhDs and postDocs through teaching and carrying out research projects in the disciplines of material science, biochemistry and associated fields these kind of activities are

17 This initiative is one example representing the third general observation on the entanglement of several large scale strategies and programs: "The program is based on the objectives and guiding principles of the National Sustainability Strategy and the Bioeconomy policy strategy, as well as other strategies and programs such as the Energy Research Program, the Forestry Strategy 2020 and the Bioeconomy 2030 research strategy, and the German Resource Efficiency Program" (BMEL 2015, p. 4).

also very close to applied research (P1) and the translation into practical use (P5).[18] We therefore conclude that the following initiatives explicitly associated with the mission are relevant for this pathway:

- The Research Concept on Resource-Efficient Circular Economy (sub program to FONA): whereas it generally focusses on the overall system of economic product cycles and raw materials (application), some of the supported activities also contribute to this pathway since they are connected to basic research. ReZiProk, for instance, is one of these core activities as part of the research concept.
- The National Bioeconomy Strategy, since 2020 a combined research and policy strategy, jointly published by BMBF and BMEL, presents possible frameworks and a large diversities of topics associated to circular economy and bioeconomy. There is an emphasis on focusing future research funding on several "building blocks", with "biological knowledge as the key to the bioeconomy" (BMBF and BMEL 2020, p. 5) which clearly refers to excellent basic research in this regard.

5.1.3 Regime destabilization: decoupling of economic growth from use of resources (P3)

The motivation of introducing P3 with a view to circularity appears self-evident: in order to alter existing structures of the socio-technical system considerable transformative elements and policy instruments are necessary, therefore this mission qualifies as a Transformer Type 1 mission[19]. To move " ahead intensively with the transformation of the traditionally linear economy into a resource-efficient circular economy" (BMBF 2018, p. 22) a swift regime change in many sectors and the willingness to leave existing paradigms by industry (and consumers) is ultimately necessary. Therefore the modus operandi of some of the associated policy instruments should be guiding this paradigm shift by firm regulation and possibly de-incentivize actors that stick to the old routine or promote those which *come full circle* with their businesses. With a view to the officially documented policy mix in the HTS 2025, mainly ProGress III, under the auspices of the BMU and the associated environmental agency (Umweltbundesamt), works towards guiding stakeholders to decouple economic growth from the use of resources.

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[18] Additionally a lot of the advances in the field of new materials stem from activities at large scale research infrastructures for instance photon science facilities with particle accelerators and experimental stations; these fully funded tools for research (as diverse as synchrotrons or digital infrastructures for big data processing) are not directly associated with the HTS 2025 mission but integral parts of research organisations (e.g. Helmholtz, Max-Planck) and together with HEIs these institutions built the base for the majority of scientific insights contributing to a possible roll out of circularity in the future (the National Bioeconomy Strategy makes no explicit reference, but implicitly urges to foster excellent basic science whenever focusing on the research contribution to bioeconomy).

[19] Cf. Wittmann et al. 2020b, 7ff.

As documented on the BMU website[20], ProgRess is based on the following four guiding principles: 1. Combining ecological necessities with economic opportunities, innovation focus and social responsibility; 2. Considering global responsibility as a key guide of national resource policy; 3. Making economic and production practices in Germany less and less dependent on primary resources; developing and expanding the circular economy; 4. Securing sustainable resource use for the long term by guiding society towards quality growth.

These principles are addressed by 118 single (mostly voluntary) policy instruments with (possibly) various contributions to CE and emphasize digitalization as a key driver for resource efficiency. With hindsight to the predecessor programs ProgRress I and II it is argued that "in principle, the mixture of voluntary measures and regulatory law has proved successful" (BMU 2020, p. 17, own translation). Regarding the development towards circularity a five point plan should guide towards less plastic and more recycling, with the main pillars: "Avoiding superfluous products and packaging, making packaging and other products more environmentally friendly, strengthening recycling, using more recyclates, avoiding plastics in biowaste, international commitment to combating marine litter and handling plastics sustainably" (BMU 2020, p. 50, own translation). The document outlines 16 (proposed) measures in a dedicated chapter (5.2.5.) for circular economy like (selected examples): readjust and further develop product stewardship, support market actors in setting quality standards for testing, cleaning and repairing, facilitate in-kind donations from the trade, develop standardization and certification systems for recyclates, prevent third-country free riders in the sale of electrical appliances/batteries via online platforms/fulfillment centers and strengthen dismantling and recycling of wind turbines. ProgRress III is a very comprehensive program that also incorporates concrete regulatory measures. Important examples are

- the amendment of the Circular Economy Act (KrWG)
- an update of the federal waste prevention program with the participation of the Länder (AVP) (ibid., p. 17)
- the transposition of the Waste Framework Directive (Directive 2008/98/EC on waste, amended by Directive 2018/851/EU) into national law (ibid., p. 50, own translation)

If regulatory instruments that are part of ProGress III will initiate and support a true regime change as intended by P3 is unclear and beyond the scope of this Mission Analyses Report. The uncertainty is mostly rooted in its voluntary character, as officially outlined:

20 https://www.bmu.de/en/topics/economy-products-resources-tourism/resource-efficiency/overview-of-german-resource-efficiency-programme-progress/

"ProgRess III is a political program in which the German government presents its ideas and plans for the sustainable use and protection of natural resources. ProgRess III is the guiding principle for future consideration of resource efficiency in various policy areas. Its impact does not come about directly, but through measures that support companies and the population in behaving in a more resource-efficient manner. Regulatory and financial policy measures outlined in ProgRess are to be discussed and decided upon in the relevant procedures. ProgRess III thus does not predetermine specific legislation, e.g. on the law governing the circular economy." (BMU 2020, p. 9, own translation)

5.1.4 Improving framework and cooperation conditions (P4)

P4 focuses on providing and securing (critical) raw material supply for the German industry (in the long run) and good cooperation conditions with supplier countries. It seeks to unleash positive economic effects by possibly stabilizing the (demand and) supply of critical materials such as rare-earth elements in connection with a more advanced focus on performance standards relying on the relevant environmental, health and safety guidelines. The core initiative for this aspired sustainable improvement of framework conditions is the Raw Materials Strategy of the Federal Government, which consists of a policy mix of regulatory and financial instruments but also shares strategical insights and guiding principles of Germany acting as a market player worldwide. Just to mention one example: to stabilize the framework conditions public authorities may de-risk investment for commodity projects abroad for financial institutions/investors by providing untied financial credits (Garantien für ungebundenen Finanzkredite (UFK)) to buffer economic and political risks (BMWi 2021b).

5.1.5 Translation of knowledge into practical use (P 5)

With a view to circularity the goal of P5 (accelerating the translation of scientific knowledge into practical use) is shared by all the policy instruments mentioned in P1, with the most dedicated features being:

- ReziProK: this initiative fostering cooperative research projects on a variety of innovative product cycles is supported by the dedicated networking and transfer project RessWInn. The aim is to "support the establishment of cross-project issues that are discussed in forums and workshops. [...] the research approaches and results are discussed in the funding measure and in the respective value-added chains – with the involvement of further stakeholders from the economy, politics, science organizations, environmental and social interest groups – and the dissemination of results is supported."[21]

21 https://innovative-produktkreislaeufe.de/Projekte/Transfervorhaben+RessWInn/_/ResWInn_Flyer_engl_online.pdf

- ReMin: targeting the construction industry ReMin focuses on investigating possible solutions for closing mineral material cycles through new design concepts, innovative building products and supporting the improved utilization of mineral material flows such as construction waste, mining residues, ash, dust or slag. The current 17 ReMin joint research projects are supported by the integration and transfer initiative called TReMin.
- Plastic recycling technologies KurT: as part of FONA this initiative supports innovative research to promote new and existing plastic recycling technologies and improve and evolve their routines whilst ensuring their integration into the entire value chain in terms of circularity at the same time. The financial support period last from 2020-2025 and features the following core strands: a) further development of innovative marketable processes for chemical and raw material recycling to provide resources for the chemical industry, b) further development of material and raw material processes with regard to quality and purity of recyclates, quality assurance, flexibility and economic efficiency of the processes, c) innovative sorting solutions for plastic waste and further approaches to increase utilization efficiency, d) concepts, technologies and industrial demonstration for the joint recycling of plastics and value-added inorganic additives, d) new approaches to stimulate demand for or use of post-consumer plastic recyclates, e) design-for-sustainability concepts.[22]
- Technology Transfer Program Lightweight Construction (TTP LB under the auspices of the BMWi) offers five transfer oriented program lines: 1) technology development to strengthen the German economy in lightweight construction incl. digitalization and automation, 2) CO_2 savings and CO_2 sequestration through the use of new construction techniques and materials, 3) CO_2 savings through resource efficiency and substitution, 4) Demonstration and proof-of concept projects, 5) Standardization.[23]

The portfolio of projects driven by a problem-oriented perspective on different branches, sectors or logistical challenges of "translating knowledge into use" contributing to P5 seems quite elaborate. There are two aspects, however, that are key to achieving *closing the loop* of production and consumption in the long run that are not answered by the HTS 2025 mission CE framework yet: 1) how can we assure that the output of "industry-science partnerships for developing new materials" (and corresponding processes for recycling and reuse) from joint project work is sustainable and spillover effects to other businesses and branches will be fostered even after support actions like RessWInn are completed? 2) How do insights of those projects feed back into the policy making process in terms of regulation (setting standards and norms for production processes) with real impact? Answering these questions is of utmost importance due to the systemic nature of

22 https://www.fona.de/de/massnahmen/foerdermassnahmen/recycling-kunststoffe.php

23 https://www.bmwi.de/Redaktion/DE/Artikel/Technologie/technologietransfer-programm-leichtbau.html

CE and the crucial but limited impact of STI policy on the overall success (see introduction to this case study).

5.1.6 Dialogue fora for expertise, standardization, awareness (P6)

This pathway focusses on the process of knowledge generation by facilitating fora for debate between academics, industry, social interest groups as well as authorities responsible for standardization and regulation (for a variety of aspects like material use, energy efficiency, production processes and consumer protection). While this pathway might have a more distinct focus on the exchange of scientific insights regarding other missions, the inherent systemic perspective of circularity (with a focus on industries) makes it necessary to include diverse stakeholders very early on. Because circularity also touches upon aspects beyond the responsibility of the federal government and takes into account regional and local public services, like communal waste management, the wider scope of representatives in the below mentioned (expert) commissions and working group is absolutely crucial. The following fora are dedicated to increase the cross-sectoral debate:

- Progress III (please refer to P3 for a more detailed description): an essential element of the implementation process of ProgRess is the National Resource Efficiency Platform (NaRess), with currently 47 members including eleven federal ministries, two Bundesländer (Hamburg and Hessen), associations representing businesses and trade unions (e.g. DIHK, BDI, Bitkom), environmental (e.g. BUND, NABU) and consumer protection (e.g. VZBV) as well as municipal umbrella organizations (e.g. Deutscher Städtetag). Besides knowledge exchange the platform's purpose is to monitor the implementation and further development of ProgRess. In parallel, the Round Table "Resource Efficiency in the Construction Industry" – under the auspices of the Federal Ministry of the Interior - is also running as a separate forum.
- Additional dialogue fora are the conferences of the Resource Efficiency Network (NeRess) and the National and European Resource Forums (NRF and ERF). Particularly NeRess is a well-established opportunity for cross-departmental exchange on the operational level and qualifies as a networking activity for authorities; invited speakers enrich the regular meetings. Furthermore policy makers at the federal and state agencies regularly exchange information at working level via the "Resource Efficiency Competence Pool". In 2015 the Resource Efficiency Working Group (LAGRE) was established to engage political stakeholders on a higher level and include all Bundesländer and the federal authorities in debates on "resource efficiency" primarily to work towards a consensus in the Umweltministerkonferenz (UMK).
- The institutional funding of the VDI Kompetenzzentrum Ressourceneffizienz GmbH is motivated by the political willingness to establish a player that serves as a one-stop-shop for SMEs with pressing questions around CE regarding recommendations on

change management, standardization and awareness building by providing a data repository and digital platform for exchange and expertise including hands-on advice and accessible information formats such as video clips.

- ACATECHs Circular Economy Initiative Deutschland (CEID) – a merger of experts representing 50 different institutions – can be seen as a tool of collective intelligence for gathering information and guidance. Around 130 experts are analyzing framework conditions for the successful implementation of circularity focusing on the areas of "packaging", "batteries for emobility" and "business models for circular economy in general". The analyses will feed into a "circularity roadmap for Germany".

Since the main target of P6 is the creation of favorable conditions for knowledge creation (research), diffusion, solution seeking for applicability and acceptance of circularity (exchange with industry and the public), it is closely associated with P7: raising awareness for circular economy as a concept and process (see below).

5.1.7 Raising the awareness for Circular Economy as a concept and process (P7)

The core aim of P7 is to nudge and affect public awareness with regard to a) information about mission content, b) mobilization of stakeholders to support the targets and the associated policy instruments and c) support awareness building to legitimize MOIP and lead to success through public support. This pathway is closely connected to P6 (dialogue fora for expertise, standardization, awareness). Whereas P6 provides the room for debate, P7 can be seen as the "public relations" and outreach side mobilizing for the mission aim to work with industry, science and consumers altogether.

Even though the concept of circularity raises a lot of public attention and the willingness of citizens to question the current routine of "extract-make-and-dispose" is growing, the mission on circular economy has not yet put a focus on the elimination of barriers in innovation through consumer behavior. Many promising aspects that might raise the awareness of consumers and would need to be communicated broadly if applied through regulatory measures are mentioned in ProGress III but cannot be associated to P7 yet, since their implementation status is unknown. The relevant instruments to support P7 are therefore all featured in P6. However, ACATECHs Circular Economy Initiative

Deutschland (CEID) and the services of the VDI Kompetenzzentrum Ressourceneffizienz GmbH are particularly suitable to contribute to raising the awareness for CE[24].

24 One initiative, which is not featured in the mission, on raising the awareness of citizen for reducing waste and keeping resources in the loop is, for instances, the public relations campaign of the BMU from 2019 "Wertschätzen statt Wegwerfen – Konzepte und Ideen zur Abfallvermeidung" ("Appreciation versus discard – concepts and ideas for waste avoidance: https://www.bmu.de/publikation/wertschaetzen-statt-wegwerfen/ which is a practical "how to guide" for citizens, businesses and municipalities.

Table 4: Inventory of instruments for the mission on creating sustainable circular economies

No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	P7	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
1	Prog Ress: Deutsches Ressourceneffizienzprogramm III	ProgRess III			X	X		X	X	Regulation (Systemic management)	BMU	2020-2023	n/a	Different actors/ stakeholders, level of federal states and municipalities	material development and product design; consumption models; waste management;	118 single instruments with (possibly) various contributions to CE
2		NaRess (Nationale Plattform Ressourceneffizienz)						X	X	Information (policy expertise)	BMU; BMWi	2020-2023	n/a	Different actors/ stakeholders, level of federal states and municipalities	Please refer to ProGress	Advice body on ProgRess topics: NaRess combines 40 institutions (federal ministries, business, environmental and consumer protection associations, trade unions, municipalities, two representatives of German states)
3		Förderprogramm "Nachwachsende Rohstoffe"	X				X		X	Direct distribution (project support)	BMEL	2015-	85	Enterprises, research institutions, municipalities; societal/non-profit organizations	Production processes	Supporting the further development of sustainable bio-economy and creating new opportunities and perspectives for Germany as an industrial location and for the development of rural regions.
4		Technologietransferprogramm Leichtbau	X				X			Direct distribution (project support)	BMWi	2020-2030	300	Enterprises, research institutions, munici-	material development and product design	Promoting the establishment of lightweight construction as a driver of innovation for sustainable

No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	P7	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
														palities; societal/non-profit organizations		and resource-saving economic practices. Improving technology and knowledge transfer into concrete products and services to promote the broader industrial application of lightweight construction
5		KMU-innovativ: Ressourceneffizienz und Klimaschutz	X				X			Direct distribution (project support)	BMBF	2019-2021	n/a	SMEs	material development and product design	Support for SMEs to develop new products and services (for others) which can reduce external environmental effects or resource consumption
6	FONA	Forschungskonzept "Ressourceneffiziente Kreislaufwirtschaft"	X	X						Direct distribution (project support)	BMBF	2019-	150	Enterprises, research institutions, municipalities; societal/non-profit organizations	material development and product design; production processes	Focus on the overall system of economic product and raw material cycles. After energetic usage or disposal, the main priority lies on establishing product and component cycles that prolong the time of use.
7		Ressourceneffiziente Kreislaufwirtschaft "Bauen und mineralische Stoffkreisläufe" (ReMin)	X				X		X	Direct distribution (project support)	BMBF	2018-2024	n/a	Enterprises, research institutions, municipalities; societal/non-profit organizations	material development and product design; production processes; waste management	Promoting the expansion of circular economy. Special focus on the construction industry with its high demand for raw materials and at the same time large amounts of extractive

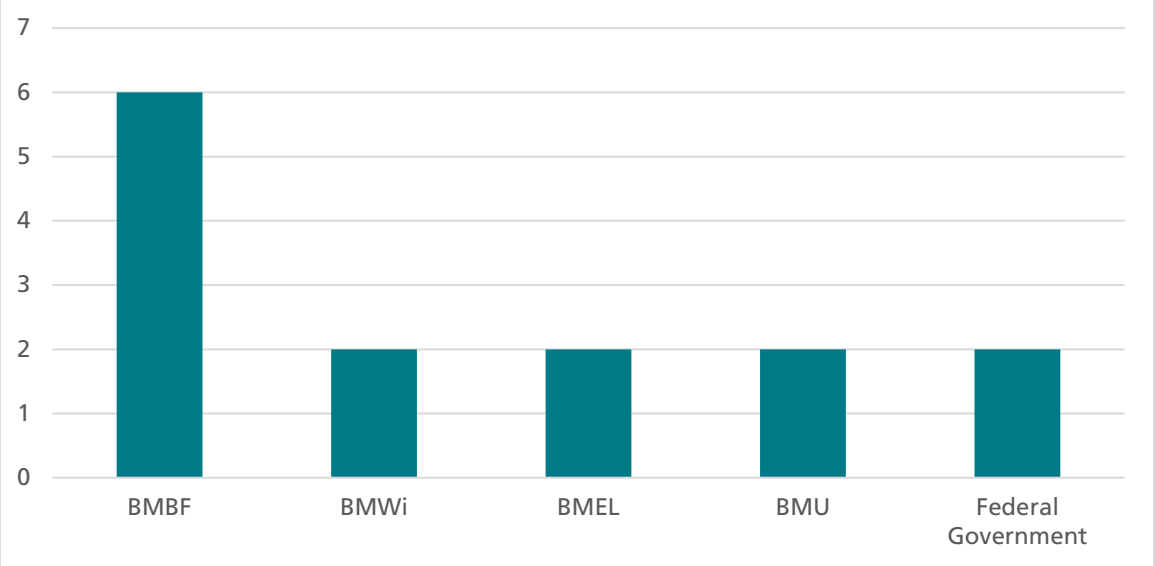
No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	P7	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
																waster in form of construction waste.
8		ERA-Net ERA-MIN 3 und ERA-MIN 2021	X						X	Direct distribution (project support)	BMBF; EU Countries	2021-2025	19.5	Enterprises, research institutions, municipalities; societal/non-profit organizations	production processes; waste management	The aim is to contribute to the implementation of a resource-efficient recycling economy and to expand the high-quality recycling of metallic and mineral raw materials
9		Ressourceneffiziente Kreislaufwirtschaft Innovative Produktkreisläufe (ReziProk)	X	X			X		X	Direct distribution (project support)	BMBF	2019-2022	30	Enterprises, research institutions, accompanying RessWInn project by DECHEMA	material development and product design; production processes; waste management	Aims at closing product cycles by promoting the use of recyclates, extending or intensifying product use, improving the recyclability of electric vehicles, optimizing and expanding remanufacturing.
10	ACATECH (Institution)	Circular Economy Initiative Deutschland (CEID)						X	X	Information (policy expertise)	BMBF	2019-	n/a	institutional support ACATECH; Reports for a mixed audience	Consumption models	Conditions for a circular transformation and assessment of CE potential (Roadmap for Germany); pilot studies for new value chain networks for batteries and packaging Circular business models and digital technologies as drivers of innovation.
11		Kreislaufwirtschaftsgesetz			X				X	Regulation (regulatory measures)	Federal Government	2012-	n/a	Enterprises; municipalities	consumptions models; waste management	The purpose of the Act is to conserve natural resources and to ensure environmentally sound management of waste.

No.	Prog. family	Input	P1	P2	P3	P4	P5	P6	P7	Type of activity	Actor	Duration (start/end)	Budget (mio. EUR)	Target group	Thematic priority	Short description
12		Gesamtstrategie Bioökonomie (National Bioeconomy Strategy)	X	X	X		X	X	X	Direct distribution (project support)	BMBF; BMEL	2020 (revised strategy coming research and policy strategy)	n/a	Research institutions, SMEs, large enterprises	material development and product design; consumption models; waste management	Strategic outline (support transformation from an economy based on fossil resources to a bio-based economy. Contribution to SDGs, areas such as food, health, wellbeing, affordable and clean energy, decent work or sustainable consumption and production (target: 2030).
13		Kompetenzzentrum Ressourceneffizienz				X		X	X	Direct distribution (institutional support)	BMU	2015-2019	n/a	Enterprises, research institutions, municipalities; societal/non-profit organizations	material development and product design; consumptions models; production processes	Development of instruments and working tools for the assessment and presentation of resource efficiency potentials, especially in SMEs.
14		Rohstoffstrategie der Bundesregierung	X			X	X		X	Regulation (systemic management)	Federal Government	2020 (revised strategy, 2010)	n/a	Enterprises	consumptions models; production processes; waste management	Ensuring secure, responsible and sustainable raw material supply. Special consideration of ecological, economic and social aspects of sustainable development. Protecting the environment through efficient usage of raw materials and low use of primary raw materials.

5.2 Summary

We identified seven specific pathways which possibly contribute to achieving the four impact goals "less waste, less pollution by coming full circle", "increased overall raw material productivity" and "changing procurement and recycling processes" as well as "changing industrial production processes substantially" (see figure 8). The majority of the policy instruments of the mission "creating sustainable circular economies" (roughly 70%) fall into the category of financial inputs (direct distribution for project or institutional funding); the categories regulation (forms of systemic management and firm regulation) and information (policy expertise and discursive debates) are equally often represented (remaining 30%). The documented contribution to the mission is provided mostly by the BMBF, followed by BMU, BMWi and BMEL (see figure 9) but as some examples indicate throughout this case study (e.g. the Environmental Innovation Program by the BMU), the federal government and different ministries certainly already do more to support CE.

Figure 9: Number of instruments/strategic program by actor (Creating sustainable circular economies)



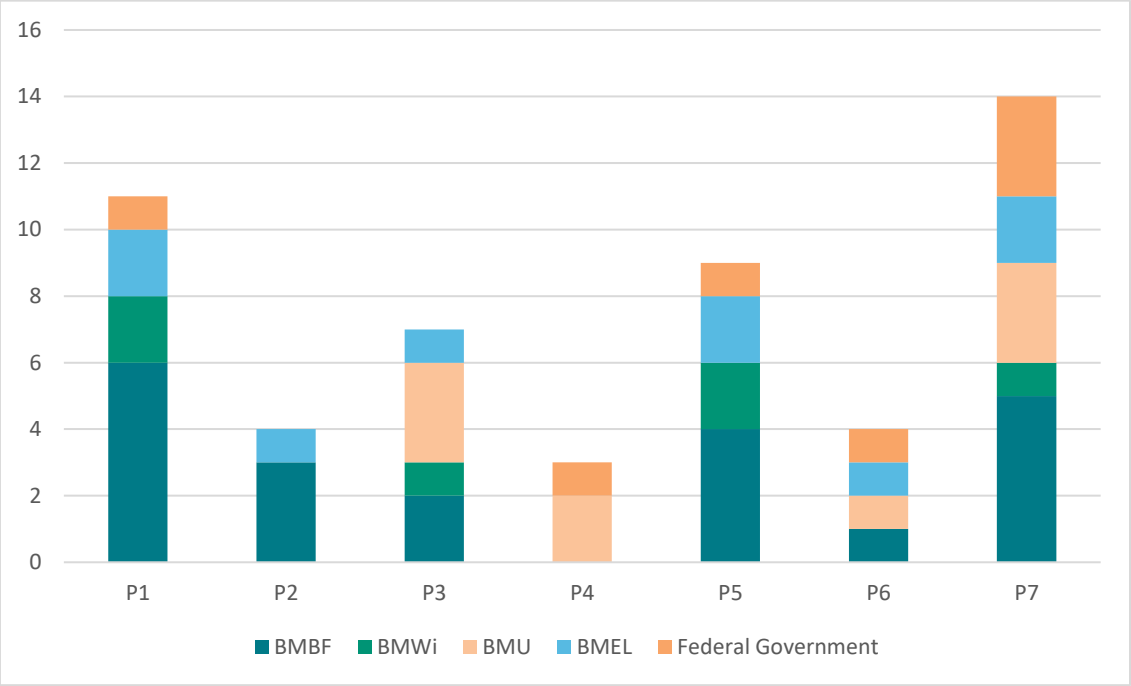
Source: Own compilation[25]

As indicated in table 4 quite a few instruments have been introduced after 2018, which points to a rather dynamic policy development and the fact that circularity is a topic of high political attention. In some cases, we observe that initiatives have been updated (e.g. in the case of ProgRess (III) or the FONA related instruments), which we

[25] Please note that NaRess is analysed as a single policy instrument in the text and figures below, here it's seen as part of ProGress. This explains variation in overall instruments throughout this chapter.

acknowledge as a positive development. However, with a view to coordinative efforts of "burden sharing" and topic related division of labor 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 (please see figure 10 for an overview of the number of instruments by actors and pathway).

Figure 10: Number of instruments/strategic programs by actor and pathway (Creating sustainable circular economies)



Source: Own compilation

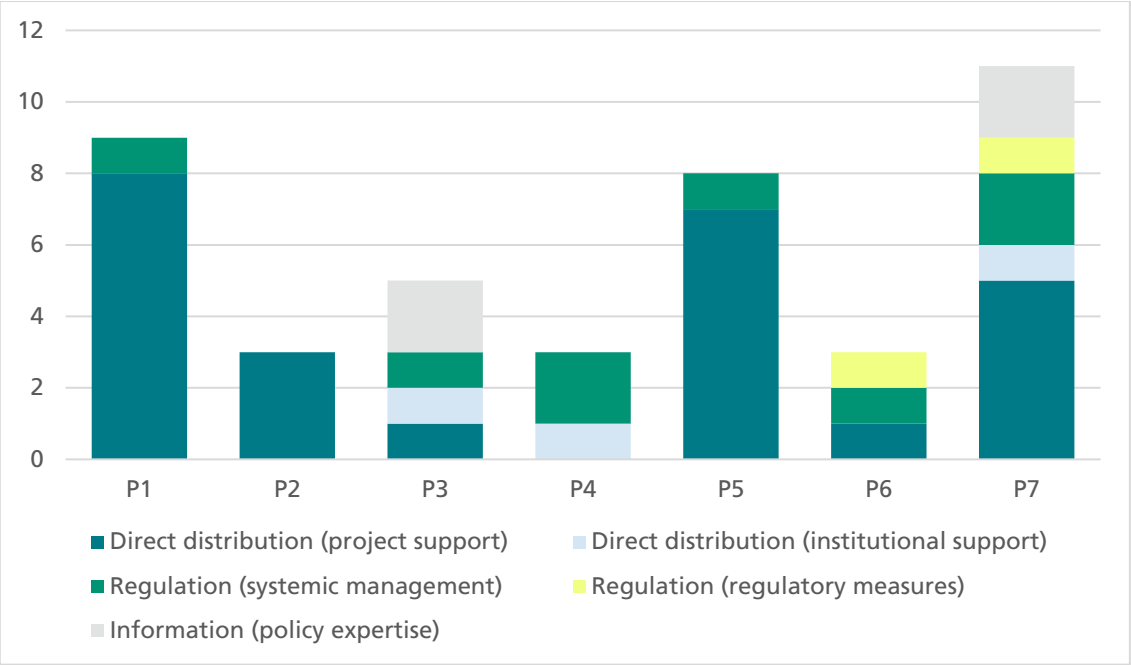
Considering the fact that the mission sets out to change "economies", several socio-technical systems need to be addressed and transformed – an undertaking that has so far not been championed by any state, thus the ambitious agenda of the German CE mission is a quest addressing a worldwide challenge. The seven pathways we associated to address these challenge all tie in with the major goal with different foci: fostering research (P1 and 2), changing framework conditions and orientation (P6 and 9) and supporting the practical application of research insight and raising awareness for circularity (P3, 7 and 10), as summarized in the overview below

- Funding for research on products and processes (P1)
- (Institutional) Support for research on new materials (P2)
- Regime destabilization: decoupling of economic growth from use of resources (P3)
- Improving framework and cooperation conditions (P4)
- Translation of knowledge into practical use (P5)

- Dialogue fora for expertise, standardization, awareness (P6)
- Raising the awareness for Circular Economy as a concept and process (P7).

Figure 11 illustrates the possible contribution of different types of policy instruments to the seven pathways. However, since this figure only portrays the outlined policy instruments mentioned in the HTS 2025 on a meta-level, we need to acknowledge that it might be misleading with regard to the whole "mission picture". Quite a few regulatory measures are embedded in larger programs like ProGress III for instance. But it does serve the purpose of illustrating the overall impression as published in the HTS.

Figure 11: Types of policy inputs for different pathways (Creating sustainable circular economies)



Source: Own compilation

One part of the mission that is prominently documented in the coalition treaty 2018 and the HTS 2025 itself is not yet in place: the National Research and Innovation Strategy for Resource Conservation Technologies (Nationale Forschungs- und Innovationsstrategie für Ressourcenschutztechnologie). Currently, Working Group 4 of NaRess is engaged in a well thought out stock taking of the relevant support landscape ("Förderlandschaft Ressourcenschutztechnologie"[26]) supported by Projektträger Jülich and the VDI

26 The detailed work plan (October 2020 - June 2021) of the NaRess Working Group 4 (AG 4) collecting and discussing the current policy instrument portfolio ("Förderlandschaft Ressourcenschutztechnologie") can be found here: https://www.re-source.com/wp-content/uploads/2021/03/ZRE-2020-2020-12-FI-Foerderung_DE_NaRess-AG-4.pdf

Zentrum Ressourceneffizienz. With a view to fostering the concept and roll out of circular economy in Germany progress regarding this National Strategy quite possible throughout the next legislative period (2021-2024) is quite probable.

While we generally welcome and appreciate the many instruments and strategies fostering CE in Germany, the diversity of policies and complexity of the landscape is difficult to grasp. Obviously, the HTS 2025 flags out important initiatives, but as mentioned above the federal government and different ministries undertake much more to foster different aspects of circularity which have not been documented as part of the mission (e.g. Umweltinnovationsprogramm[27] by the BMU does not appear as a vital part). A "stock taking" of all policy measures that possibly work towards the mission CE might therefore be stimulated in the near future to identify possible gaps and serve as an indicator for more effective, systemic and strategically sound mission orientation.

One neglect seems to correspond with a lack of attention for P 7: since a key feature of MOIP is the facilitation of systemic solutions and, at best, a societal consensus on how to bring about the desired transformative change, fostering public awareness and support seems crucial. However, with regard to the latter there should be no false expectations of the mission on circularity about the associated policy mix fostering societal change altogether. We would like to encourage a more systematic appreciation, integration and uptake of for instance decentral initiatives of citizens and municipal stakeholders that target CE (even on a small scale like repair cafes, second-hand-shops, Unverpackt Läden) to foster a culture of co-creation between authorities and society to successfully endorse the mission aim of integrating industry and civil society in the process of CE.

27 https://www.umweltinnovationsprogramm.de/ueber-uns

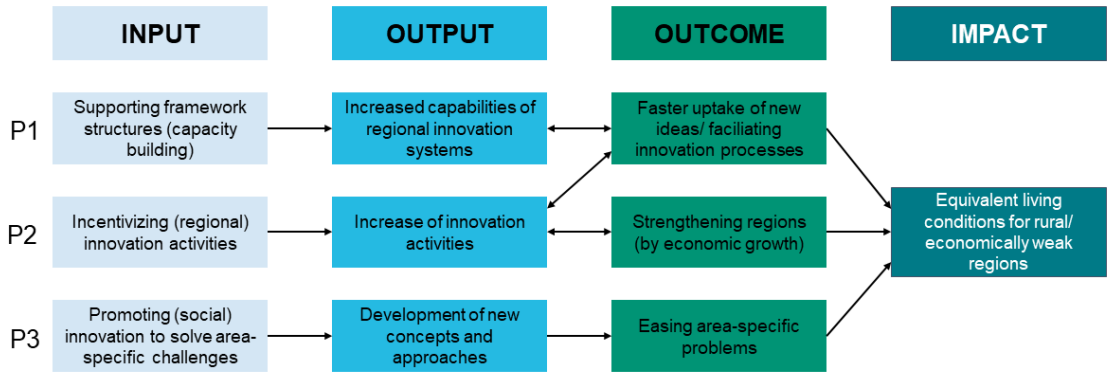
6 Mission: Ensuring good living and working conditions throughout the country

Section written by Florian Wittmann, Andrea Zenker, Thomas Stahlecker

6.1 Overview of relevant pathways

The mission dedicated to ensuring equal living conditions focuses both on supporting innovation in economically disadvantaged and rural areas. As outlined in MAR1 report (Wittmann et al. 2020b) these spatial categories in many, but not all cases overlap. Given the multi-faceted character of the phenomena, there is no quantitatively defined mission goal that proposes specific benchmarks to be achieved. For the purpose of this report, we identified three key pathways that can be plausibly assumed to contribute to the overarching goal through a strengthening of innovation activities, framework conditions of regional innovation systems, and activities to provide solutions to area-specific problems. Especially between the first pathways, there exist strong interactions that may reinforce their dynamics (see figure 12).

Figure 12: Impact pathways for the mission on ensuring good living and working conditions throughout the country



Source: Own compilation

One peculiarity of this mission is its cross-cutting character with regard to the national framework program for regional development (*Gesamtdeutsches Fördersystem*) that subsumes more than 20 federal programs under its umbrella. Focusing on research and innovation activities it does not only cross-cut the overarching program but also individual instruments. While only one program family (Innovation and structural change, BMBF) given its central position for the mission is enlisted as a separate contribution, documents from the coordination board do not entail information about the remaining programs of

the *Gesamtdeutsches Fördersystem*.[28] For the purpose of the analysis, we focused on individual programs entailing at least a partial focus on research and innovation activities.[29] However, it should be noted that this list is not exhaustive and only represents the perspective of the scientific support action.[30]

The remainder of this section presents the individual pathways and provides an overview over relevant instruments associated with the described pathways. An overview of the identified instruments and their key characteristics aspects can be found in table 5.

6.1.1 P1: Accelerating the uptake of new ideas and innovation processes through strengthening of regional innovation systems

The first pathways is linked to capacity enhancing activities that seek to provide the foundation for a faster uptake of new developments and innovative approaches, thus aims at improving the framework conditions of innovation in the field of research and economy. Therefore, it is closely aligned with P2 that deals with generation of new ideas and approaches. The following inputs are contributing to this pathway:

- The program family "Innovation and structural change" by BMBF (RUBIN - Regionale unternehmerische Bündnisse für Innovation; WIR! – Wandel durch Innovation in der Region; Region.innovativ) that seeks to promote the formation of new and deepening of existing regional alliances dealing with innovative topics and approaches. Particularly in the case of *WIR!*, an instrument that has a strong component of system management, the creation of regional alliances is a key driver to shape favorable regional conditions for innovation.
- ESF Bundesprogramm "Zukunftszentren": Creation of so-called "Zukunftszentren" for supporting digital transformation processes of (mainly) SMEs in Eastern Germany
- Besides the BMBF program family "innovation and structural change" the mission entails other research and innovation-centered policies from the large platform Gesamtdeutsches Fördersystem. This includes e.g. the program family “Unternehmen Region” (the predecessor of "Innovation and structural change" that is supposed to be replaced by it in the future) and EXIST-Potentiale that seek to strengthen a spin-off culture at research institutes. Furthermore, the BMWi-led program *ZIM* and parts

28 At the same time, some of the instruments on their website explicitly highlight that they contribute to the German Hightech Strategy 2025.

29 This refers mainly to those activities being linked to research and innovation (cf. https://www.bmwi.de/Redaktion/DE/Downloads/G/gesamtdeutsches-foerdersystem-fuer-strukturschwache-regionen.pdf?__blob=publicationFile&v=8).

30 Moreover, the activities of the program for structural change in coal regions might alter the policy landscape over time.

of the *GRW*-scheme (innovation cluster) might contribute to the development of regional eco-systems through facilitating alliances around specific topics.

One key focus in this context is the creation of regional alliances of different actors in order to develop and strengthen the regional profile. This makes it also difficult in many instances to clearly delineate instruments between P1 and P2, as especially the newly created program family "Innovation and structural change" seek to combine these goals. In contrast, *EXIST-Potentiale* and the ESF Program Zukunftszentren focus more on dissemination of knowledge and expertise through existing institutions. The instruments are characterized by a focus on economically weak regions and target the domain of economy and innovation.

6.1.2 P2: Strengthening regions/economic growth through strengthening innovation activities

Being closely related to P1, a second pathway focuses on strengthening innovation activities to spur economic growth and development. Among the contributions to this pathway, we identify the following instruments

- The program family "Innovation and structural change" by BMBF (RUBIN - Regionale unternehmerische Bündnisse für Innovation; WIR! - Wandel durch Innovation in der Region; Region.innovativ) that seeks to promote the formation of new and deepening of existing regional alliances dealing with innovative topics.
- Within the *Gesamtdeutsches Fördersystem* there is a number of instruments focusing on enhancing innovation activities, mainly in SMEs. Above all, this includes INNO-KOM and ZIM (BMWi) as well as parts of the GRW scheme that focus on supporting innovative activities of enterprises (particularly SMEs)

Within this pathway there exists a dual structure of inputs. On the one hand the rather newly designed instruments by the BMBF that are linked to alliance/cooperation building, relying primarily on direct distribution (project support) or systemic management. On the other hand, the BMWi-led instruments that are rather focused on individual enterprises, often entail allowances supporting innovation activities and build on long-standing policies that experienced revisions over time. Similar to P1 its instruments are focused only on economically weak areas and a distinct topic for equivalent living conditions (economy & innovation).

6.1.3 P3: Easing area-specific problems through innovative solutions

The third pathway takes a different approach aimed at providing innovative solutions to area-specific. It thereby exhibits a broad variety with regard to the spatial focus as well

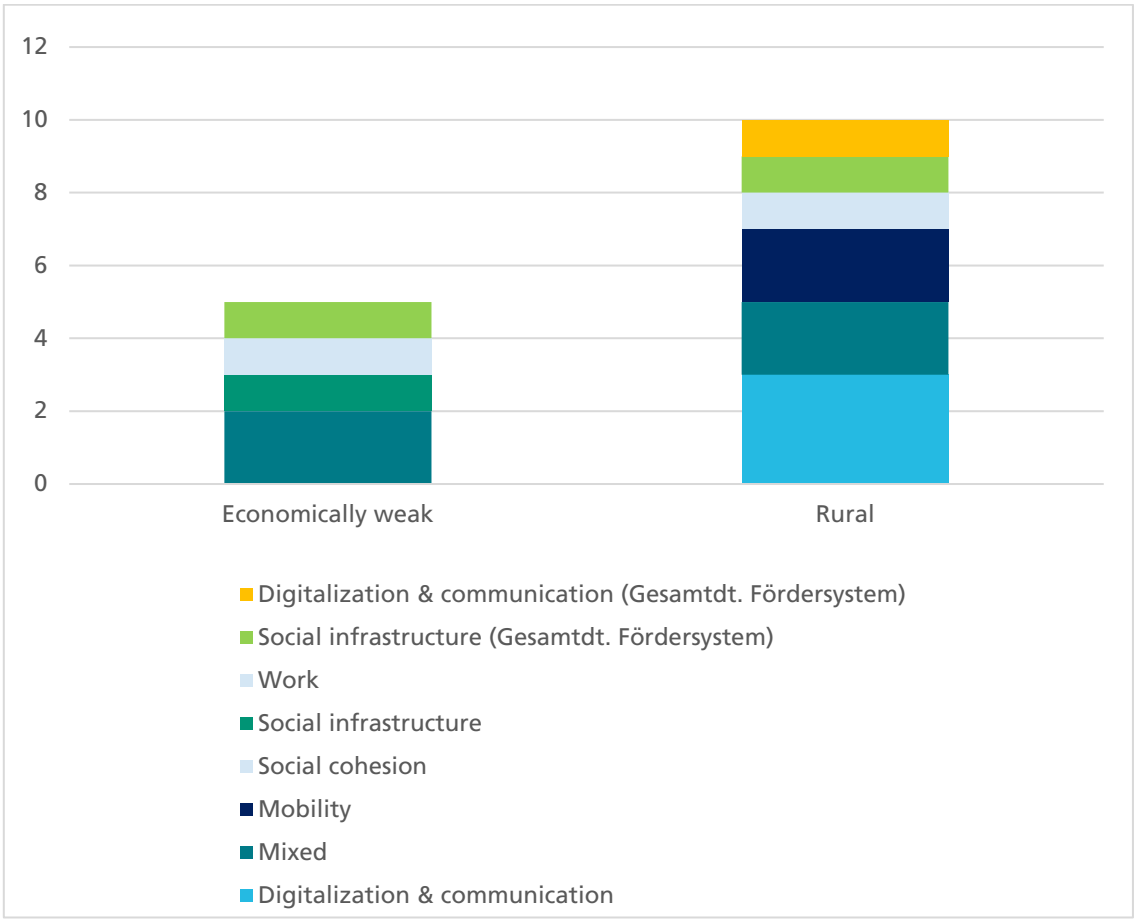
as with thematic priorities. The following inputs are considered as relevant for this pathway:

- WIR! - Wandel durch Innovation in der Region: support for new cooperations between research, industry and civil society for alliances to develop a regional innovation profile, including social innovation and innovations for health care provision.
- Region.innovativ: promoting and deepening of regional alliances around municipalities for addressing new research and development topics with applications centered on thematic issues (circular economy, work conditions).
- Ressourceneffiziente Stadtquartiere RES:Z: support of model projects in selected municipalities for the for development and application of new concepts for sustainability.
- Zukunft der Arbeit - Innovationen für die Arbeit von morgen, comprehensive support program ranging from research to translation activities.
- Among the contributions of the *Gesamtdeutsches Fördersystem*, especially, the BMBF program *Kommunen Innovativ* that focuses on model projects of regional developments stands out. Moreover, there is a number of additional programs that entail links to innovative solutions, most prominently the funding scheme for rural/coastal areas (GAK) with its integrated rural development priority and *Stadt.Land.Digital* that focuses on the development of new strategies in the field of digitalization.
- Stadt-Land-Plus: support for Spatially integrated applied research alliances for the development of innovative solutions (housing, circular economy, value chains), funding is not targeted to economically weak areas.
- Region gestalten, Research and model projects focusing on developments of rural areas.
- Research funding for the project *Mobilität im ländlichen Raum* aiming to develop plans for mobility solutions in rural areas.
- InitiativeSozialraumInklusiv, funding scheme focus on knowledge exchange among stakeholders in the context of disability.
- Smarte LandRegionen, Land.Digital: support for model projects in rural areas with focus on different types of beneficiaries (counties, local alliances).
- Ländliche Räume in Zeiten der Digitalisierung, research funding for projects dedicated the effects of digitalization in rural areas.
- Land.Mobil, Model projects devoted mobility issues in rural areas.

Whereas the majority of these programs originated in temporal proximity to the mission or experienced a modification/revision, at least the program *Zukunft der Arbeit* was set up considerably prior to the start of the mission. In consequence, it remains questionable to what extent its contribution can be considered as a product of the mission, even though

there is some continuation in form of overarching programs. Whereas of the listed instruments five are targeted (to varying degrees) towards economically weak areas, ten are directed towards rural areas (see figure 13). While sum five of the six topics of the socio-technical system that were identified in MAR1 (Wittmann et al. 2020b) are covered (with economy & innovation being represented in the previous pathways), the analysis does not reveal a clear picture with regard to the main thematic priorities of the instruments (though, for example, digitalization & communication/mobility are only addressed in rural areas). However, it needs to be noted that among the 16 instruments identified there is a considerably number of instruments that focus on model projects thus possess a rather small budget.

Figure 13: Thematic priorities of instruments in pathway P3 (Ensuring good living and working conditions throughout the country)



Source: Own compilation

Table 5: Inventory of instruments for the mission on ensuring good living and working conditions throughout the country (grey shaded-cells indicate elements of the Gesamtdt. Fördersystem that were considered as relevant for the mission by the team of the scientific support action)

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/ end)	Budget (mio. EUR)	Target group	Spatial focus	Thematic priority	Short description
1	Innovation & Strukturwandel (also part of Gesamtdt. Fördersysetm)	RUBIN - Regionale unternehmerische Bündnisse für Innovation	X	X		Direct distribution (project support)	BMBF	2019-	600 (until 2024)	SMEs; research	Econ. weak (GRW)	Economy & Innovation	Strengthening innovation capacity of SMEs & networks for for creation of regional value chains (Preference for hightech Strategy areas)
2		WIR! - Wandel durch Innovation in der Region	X	X	X	Regulation (systemic management)	BMBF			Different stakeholders	Econ. weak (GRW)	Mixed (No specific priority)	Establishing new cooperations for developing regional innovation profiles
3		Region.innovativ	X	X	X	Direct distribution (project support)	BMBF			Municip. with mixed partners	Econ. weak (GRW)	Dependent on call	Focus on new research and development topics for (existing) regional alliances
4	FONA	Ressourceneffiziente Stadtquartiere RES:Z			X	Direct distribution (project support)	BMBF	2019-2024	25 (until 2022)	Municipalities	Econ. weak (partly)	Social infrastructure (sustainability)	Support for for development and application of new concepts/model projects for sustainable development
5	FONA	Stadt-Land-Plus			X	Direct distribution (project support)	BMBF	2018-2025	43,3 (until 2023)	Urban-rural areas	Rural	Mixed (No specific priority)	Spatially integrated applied research alliances for the development of innovative model solutions
6		Zukunft der Arbeit - Innovationen für die Arbeit von morgen			X	Direct distribution (project support)	BMBF	2014-2020	211	Research alli(SMEs)	Econ. weak (ESF)	Work	Funding focused on changing working environments (
7	Bundesprogramm ländliche Entwicklung	Smarte LandRegionen			X	Direct distribution (project support)	BMEL	2021-2025	25	Counties	Rural	Digitalization & communication	Model/demonstration projects for digital solutions in rural areas (digitalization)

No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/ end)	Budget (mio. EUR)	Target group	Spatial focus	Thematic priority	Short description
8		Land.Digital			x	Direct distribution (project support)	BMEL	2020-2023	11	Municip., counties, enterprises universitie)	Rural	Digitalization & communication	Model/demonstration projects for digital solutions in rural areas
9		Land.Mobil			x	Direct distribution (project support)	BMEL	2019-2022	6.5	Stakeholders in rural areas	Rural	Mobility	Model projects devoted mobility issues in rural areas
10		Ländliche Räume in Zeiten der Digitalisierung			X	Direct distribution (project support)	BMEL	2020-2023	3.1	Research institutions	Rural	Digitalization & communication	Research projects focused on effects of digitalization
11		Region gestalten			X	Direct distribution (project support)	BMI	2020-2023	20 (2019-2020)	Different stakeholders	Rural	Social cohesion	Research and model projects focusing on developments of rural areas
12	Forsch.-prog. Stadtverkehr	Forschungsvorhaben Mobilität im ländlichen Raum			X	Direct distribution (project support)	BMVI	2018-2020	0.2	Mobility networks at county level	Rural	Mobility	Research projects developing implementation plans for mobility in rural areas
13		ESF Bundesprogramm "Zukunftszentren"	X			Direct support (institutional support)	BMAS	2019-2022	38	SMEs	Econ. weak (ESF/East-Ger.)	Economy & innovation	Creation of Zukunftszentren for supporting digital transformation processes of (mainly) SMEs
14		InitiativeSozialraum-Inklusiv			X	Information (discursive processes)	BMAS	2018-2021	0.22 per year	Soc. stakeholders (disability)	Rural	Social Cohesion (Inclusion)	Focus on disability, knowledge exchange and conferences
15	Gesamtdt. Fördersystem	Unternehmen Region	X			Regulation (systemic management)	BMBF	1999-2022	>2,000 (whole period)	Enterprises, research, civil society	Econ. weak (GRW)	Economy & innovation	Regional alliances for innovation (to be replaced by Innovation & structural change)

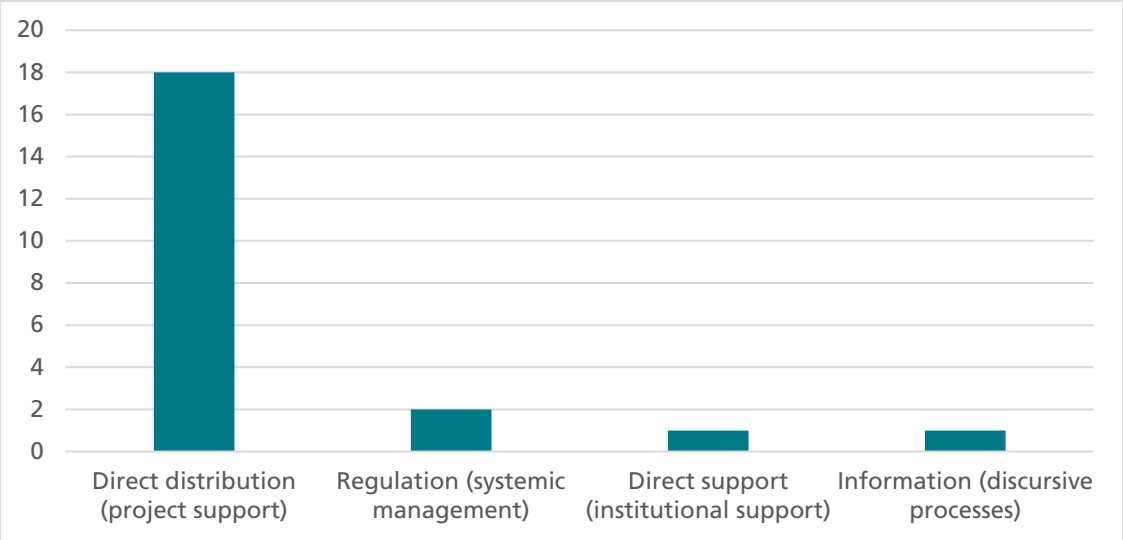
No.	Prog. family	Input	P1	P2	P3	Type of activity	Actor	Duration (start/ end)	Budget (mio. EUR)	Target group	Spatial focus	Thematic priority	Short description
16		INNO-KOM		X		Direct distribution (project support)	BMWi	2017-n/a	71 (2019)	SMEs, research institutes	Econ. weak (GRW)	Economy & innovation	R&D support for SMEs through cooperation with research institutes
17		Kommunen innovativ (also part of FONA)			X	Direct distribution (project support)	BMBF	2016-2024, revised 2020	10 (per call)	Municipalities, research, civil society	Econ. weak (GRW, pref.)	Social infr., sustainability, digitalization	Model projects centered around topics of local development around different topics
18		ZIM	X	X		Direct distribution (project support)	BMWi	2008-, revision 2020	555 (2019)	SMEs	Econ. weak (GRW, pref.)	Economy & innovation	Support scheme for medium-sized enterprises for innovative solution as individual projects or for alliances
19		EXIST-Potentiale	X			Direct distribution (project support)	BMWi	2018-2023	n/a	Research institution	Econ. weak (GRW, ov.)	Economy & innovation	Strengthening of founding/start up culture at research institutes
20		GRW (Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur")	X	X		Direct distribution (project support)/Regulation (syst. managm.)	BMWi, reg. gov.	1969-, revision 2020	n/a	SME, public beneficiaries	Econ. weak (GRW)	Economy & innovation	Only selected parts of support scheme, e.g. focusing on support for innovative activities in SMEs or innovation clusters
21		GAK (Gemeinschaftsaufg. Agrarstruktur und Küstenschutz)			X	Direct distribution (project support)	BMEL, reg. gov.	1969-, rev. 2029	n/a	Municipalities	Rural	Social infr., social cohesion	Support for Integrated rural development (2020-2023)
22		Stadt.Land.Digital			X	Direct distribution (project support)	BMWi	2019-n/a	n/a	Municipalities	Rural	Digitalization & communication	Development of new strategies for digitalization

6.2 Conclusions

Having identified three pathways for the mission (with P1 and P2 being closely linked to each other) this chapter has investigated whether pathways and instruments match each other. The section outlines some of the key insights, turning first to the overall character of instruments, actor mobilization and focusing more specifically on the instrument mix. In sum, the analysis has identified a considerable number of instruments, particularly when differentiating and investigating in greater depth the involvement of individual programs that are subsumed in the *Gesamtdeutsches Fördersystem*. Similar to the other missions, there is a strong focus on creating incentives through direct subvention, running mainly through the support of selected projects and activities or allowances supporting selected activities (see figure 14).[31] The existence of systemic management is primarily driven by the existence of the BMBF program "*WIR! – Wandel durch Innovation in der Region*" that is cross-cutting pathways and focuses on the creation of regional alliances incorporating different types of stakeholders.

The majority of these instruments emerged or was revised in the wake of the emergence of the new Hightech Strategy, however, in some cases the projects were ending shortly after the beginning of the mission (Zukunft der Arbeit, BMBF; Forschungsvorhaben Mobilität im ländlichen Raum, BMVI). In these cases, it remains an open question to what extent the results of these instruments actively contribute to the mission.

Figure 14: Types of instruments (Ensuring good living and working conditions throughout the country)

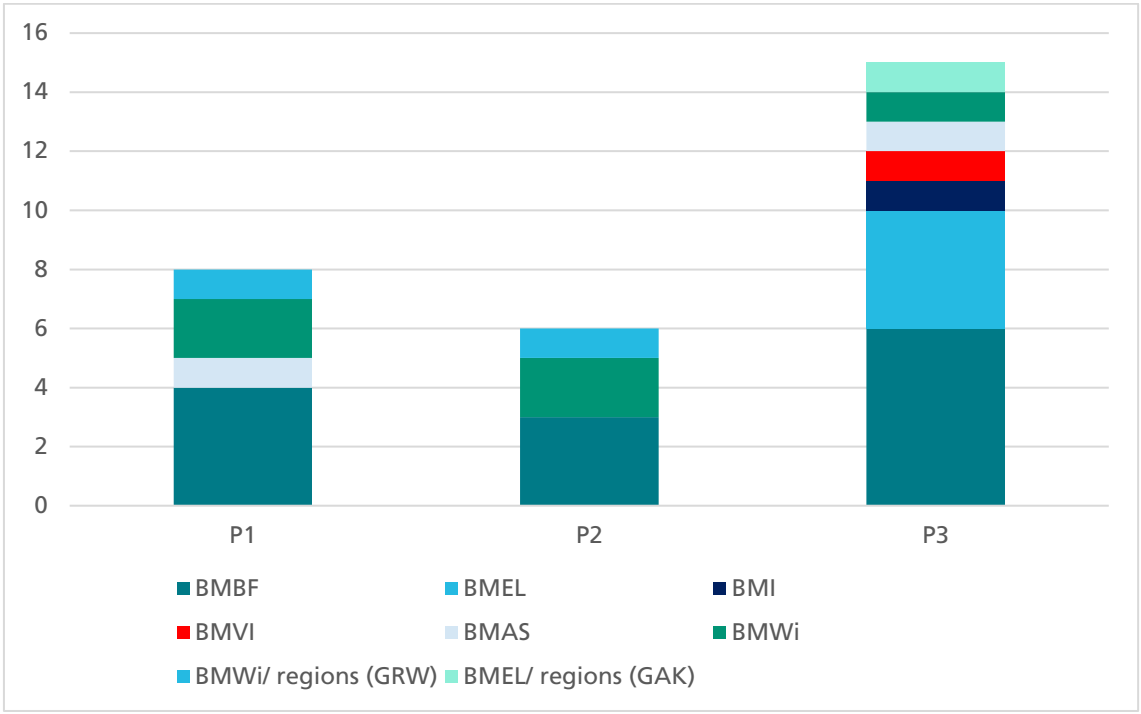


Source: Own compilation

31 However, it has to be noted that in some instances instruments combine features of systemic management and direct/indirect support.

Turning to the perspective of actor mobilization. In case of the two pathways focused on economically weak regions that aim to strengthen innovation capacities and generating new innovations, there seems to be a moderate involvement of different actors, centering around the BMBF with its flagship policy (innovation & structural change) and the BMWi (see figure 15). In contrast, the pathway of providing solutions to area specific projects is the most diverse, combining inputs from a variety of different actors. Taking a closer look to the spatial preferences of these instruments, one can see that especially instruments tackling specific problems of rural areas are coming from different ministries, whereas economically weak areas are mainly targeted by instruments implemented by the BMBF. Besides the partial involvement of instruments of the *Gesamtdeutsches Fördersystem* with elements of innovation & research (federal-regional cooperations in GAK, GWR), actor mobilization seems to focus on Federal ministries and does not include a wider range of actors that provide inputs for mission realization.

Figure 15: Number of instruments by actor and pathways (Ensuring good living and working conditions throughout the country)



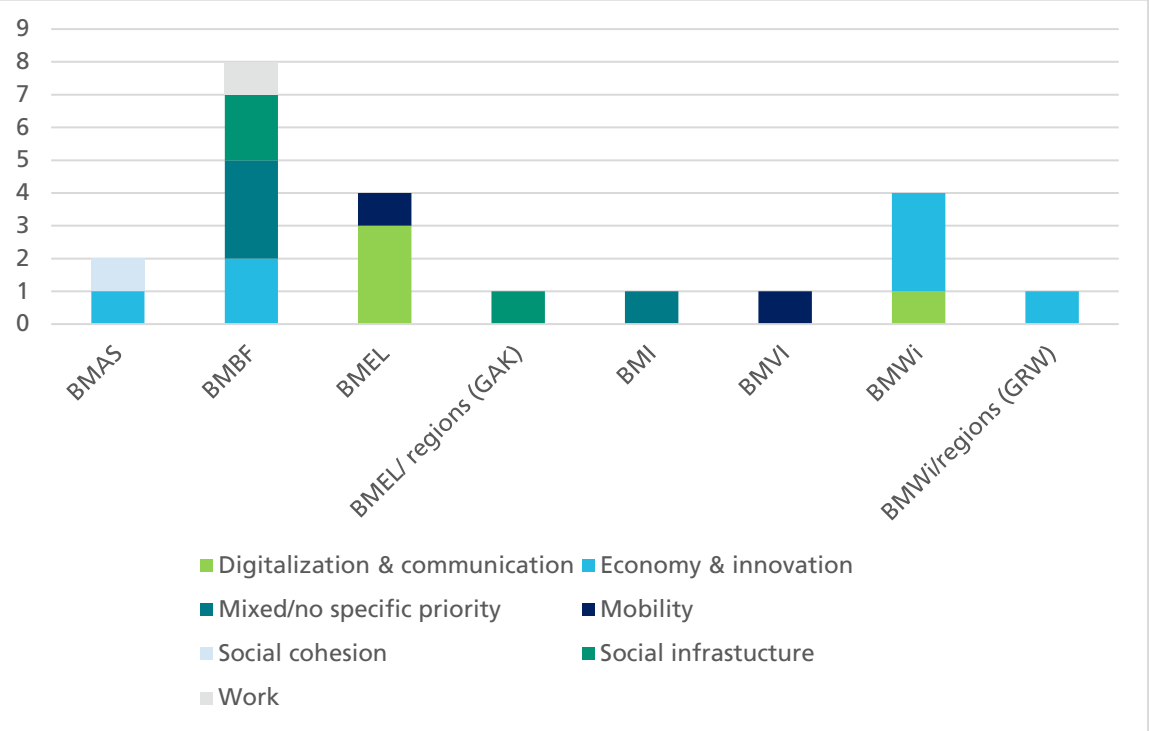
Source: Own compilation

From the perspective of resource mobilization, it is moreover difficult assess the overall contribution or the budgets dedicated to individual pathways. Besides the fact that several instruments are cross-cutting pathways, especially the fact that many instruments only exhibit a preference or favorable conditions for economically weak regions, makes

it difficult to understand the contribution in quantitative terms from an ex-ante perspective, and might require an analysis of actually funded projects.[32]

What is noteworthy is the strong presence of funding dedicated to model projects, particularly in P3, implying that many of these instruments are accompanied by a rather small budget (cf. table 5). Whereas these instruments provide the opportunity for experimentation and exploring new solutions, a key question from a long-term perspective is to accumulate and systematize the insights from different projects to inspire future instrument development on a larger scale. The mission might provide a useful arena for this endeavor, as different ministries are in charge of the instruments – also cross-cutting key topics of equivalent living conditions (cf. figure 16).

Figure 16: Actors and thematic priorities (Ensuring good living and working conditions throughout the country)



Source: Own compilation

Moreover, there are two noteworthy observations with regard to the employed instruments that deserve attention and can be considered as integrating activities across pathways and mission within the HTS 2025. First of all, some of the instruments are clearly

32 A recent report (BMWi 2021a) suggests a percentage between 51% and 100% of the instruments under study were allocated to structurally weak regions in 2020.

cross-cutting pathways contributing to different goals simultaneously (above all the programs from "Strukturwandel & Innovation" that can be considered to be a key reference point of the mission. Secondly, the mission given its comprehensive and cross-cutting character also reveals considerable links to other missions at the instrument level. A good example in this context is the program *Region.innovativ* (BMBF) that issued topic-specific calls that were focused on circular economy and working conditions in modern times.

7 Summary of conceptual and empirical insights

The second Mission Analysis Report (MAR2) "zoomed in" for a better understanding of the design of the four selected HTS 2025 missions. In particular, it explored how mission instruments link to mission goals, aiming to understand how mission goals translate into dedicated activities and instruments. For this purpose, it relies on two main tools: In a first analytical step, the development of impact pathways describing the way missions are supposed to achieve their goals based on official program documents. These pathways allow to decompose the complex dynamics of missions into several streams of action and purposeful sub-targets. While preparing the ground for developing appropriate indicators for measuring the progress of a mission in the long run, the pathways are a useful tool for an ex-ante assessment of the fit of instruments with mission goals. In a second step, an inventory of policy instruments connected to each mission was assembled, as the collection of instruments on the website of the HTS2025 proved insufficient for a thorough analysis and varied in scope and depth across missions. Therefore, the team of the scientific support action identified relevant inputs, drawing on official documents and publications related to the HTS2025 as well as insights from exchange with representatives of administrative units in charge, wherever possible and necessary.

There are, however, some caveats that should be taken into consideration. Firstly, it should be noted that MAR2 provides a first attempt of systematizing and analyzing the mission design. We neither deliver a comprehensive policy evaluation of individual missions, nor aim to evaluate/assess individual policy instruments. Instead, this analysis provides solid insights into the complexity of individual missions by focusing on policy instruments. Secondly, as requirements for instrument mixes change over time (Edmondson et al. 2019), the analysis may only constitute a snapshot at a certain point in time, as missions may change and develop (Janssen et al. 2020).

This final section summarizes the key insights from the case study of the four selected missions (Combating cancer, Reducing CO_2 emission in industry, Creating sustainable circular economies, Ensuring good living and working conditions throughout the country). Following the approach of MAR1, we structure the summary along three main points:

- Insights with regard to the **empirical case of the HTS 2025** and the missions under study, deriving context-specific policy recommendations
- Reflections on the **methodological approach**, indicting insights that need to be taken into consideration for the **development of a framework for impact assessment**
- Insights that are of relevance for **research on MOIP in general**

7.1 Insights and recommendations for the missions of the Hightech Strategy

This first sub-section summarizes the key empirical insights of the four missions under study and seeks to derive recommendations for the implementation of the HTS 2025 and subsequent strategies. Besides the provision of good practices from the HTS 2025, it discusses key insights along several dimensions that build on the case study and the comparison of instruments across different missions. The key results are summarized in table 6.

7.1.1 Coverage

A first key aspect for understanding the mission design is the question to what extent the identified instruments match with the impact pathways that were developed for each mission (see section 2 for a detailed description of the concept of pathways and the inventory of mission activities). While generally finding evidence that all the pathways are covered by instruments, the analysis revealed the difficulty to clearly identify and delineate instruments contributing to the mission goals. Even though different official sources like the website of the HTS 2025, the *Bundesbericht Forschung und Innovation 2020* (BMBF 2020), the HTS 2025 (BMBF 2018) and its progress report (BMBF 2019) offer compilations of policy instruments that are linked to specific missions, to our knowledge there are no established and comprehensive overviews of all the instruments and measures that "pay into" reaching mission goals for most of the missions. **While acknowledging that a delineation of instruments that are relevant for a mission is complex, we strongly encourage adopting a more systematic approach for mission implementation that captures policies (policy instruments) contributing to the mission in an encompassing overview (inventory) that covers all policy areas and ministries involved from the very beginning. From our perspective, a constantly updated inventory of mission instruments is a key prerequisite for the efficient implementation of missions and ensuring the required directionality. This also requires a clear delineation of instruments and activities that despite thematic similarities are not part of the mission.**

In this regard we would also like to reiterate our recommendation from MAR1 regarding the need for a strategic formulation process: "a sound strategic process translating the formulated goals into a comprehensive concept and workable plan of activities and priorities is pivotal to strengthening the missions and ensuring the commitment of all actors towards a common goal" (Wittmann et al. 2020b, p. 70).

At the same time, an inventory can help to enhance actor mobilization and communicate/showcase the effects of the mission more clearly. In this regard, the initial strategy document on the Hightech Strategy and the progress report (BMBF 2018, 2019) often describe missions, their goals, and inputs in an enumerative way, leaving room for interpretation. In the case of circular economy, for example, differentiated strategies on subareas are featured as prominent instruments, however it is hardly possible to distinguish specific instruments against the background of strategic plans (e.g. Bioökonomie Strategie) or an entire catalogue of proposed measures (e.g. ProgRess; Rohstoffstrategie). The same applies to the *Bundesbericht Forschung und Innovation.* Its structure does not allow to flag out the contribution of missions in a clear manner. **A possible solution might be regular status reports informing about the development of specific missions that could strengthen both internal cooperation and coordination processes while improving external visibility at the same time**.[33]

7.1.2 Linkage

Closely related to the observation of a lack of a systematic inventory of instruments, the analysis revealed the existence of multiple ways how instruments can contribute to mission goals, reflected by the different relationship with the pathways. For example, contributions to goals are not necessarily enshrined in the declared goals, but may be enforced e.g. through beneficiary requirements (as involvement of patient representatives as a funding requirement in one instrument in the mission on combating cancer). Moreover, missions are often linked to larger policy platforms/strategies that comprise a large number of different policy instruments (like reference to FONA in the mission on CO_2 emission or circular economy), leaving unclear what parts of these programs actually contribute to a mission. **Therefore, it is necessary to clarify how individual instruments link and contribute to the anticipated developments stimulated by a mission** – a step that can help to clarify the boundaries of a mission and delineate mission-specific instruments. **Otherwise, the mission is at risk of subsuming different thematically-related instruments on a topic that are, however, not necessarily contributing to the specific goals defined in a mission.** Such ambiguities do not only create difficulties for the implementation of a mission but also create obstacles for assessing the impact of missions.

33 The focus in this context should be on clarifying *how* the chosen instruments link to mission goals (see also below) instead of maximizing the number of enlisted instruments.

Table 6: Key insights of analysis

Issue	Observations	Recommendations
Identification of instruments	Lack of systematic and coherent information provided by official documents; difficulty to delineate inputs to missions	Creation of "inventory" of instruments that contribute to mission achievement and are subjected to the governance of a mission
Link of instruments with mission goals	Missions may relate and contribute to mission goals in different ways (program goals, beneficiary requirements, financing preference for a certain group/topic etc.)	Making explicit for individual instruments how they relate to mission goals to improve coordination and communication of mission
Types of instruments	Strong reliance on incentive creation/direct distribution/traditional project funding	Transformative goals might require a broader set of instruments to achieve the postulated goals
Actor/resource mobilization	Only indirect mobilization of other (non-public) stakeholders in most missions	Urge for a cultural shift of burden sharing, possibly more (financial) commitment by industry and mobilization of other stakeholders (good practice Top Sectors NL)
Origin of instruments	Mission combines existing with newly designed instruments	Adjustments of existing policies will be a common phenomenon for MOIP, however, adjustments will be necessary to adjust policies with mission goals
Instrument mix	Lack of integration of at instrument level towards a shared goal	Making use of potential of missions by strengthening the focus on synergies between different instruments pushing towards a shared goal by integrating efforts and treating instruments as connected

7.2 Instrument types

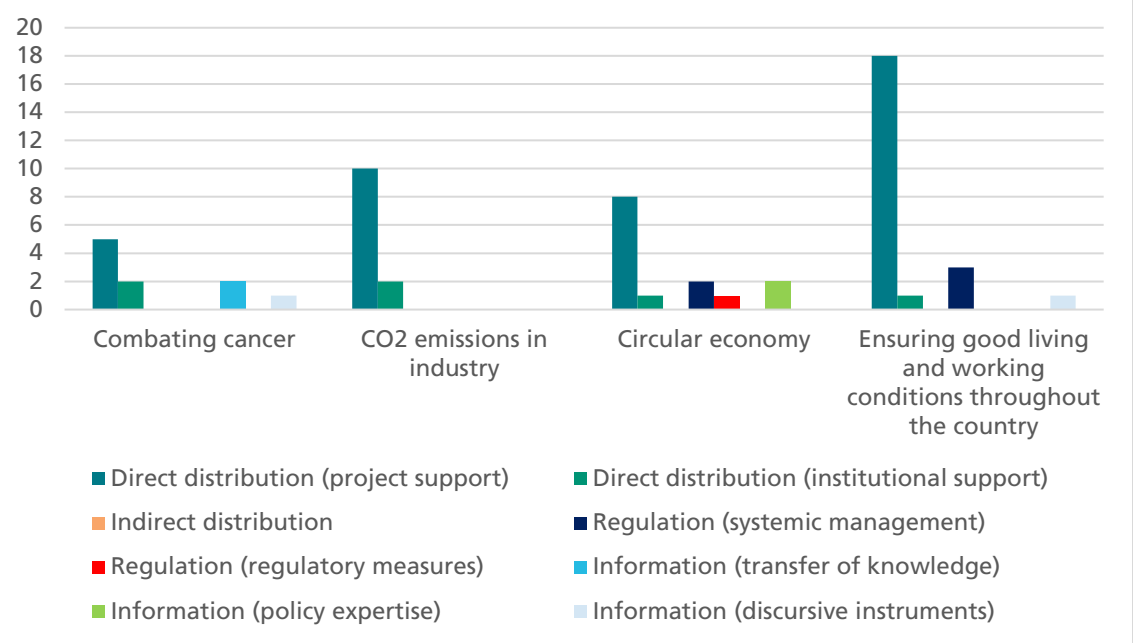
Looking at different types of instruments employed, across all missions the identified instruments primarily fall into the type of distributive instruments, in the form of research funding (see figure 17). Whereas this finding is not surprising against the background of the understanding of the HTS 2025 as the central research and innovations strategy of the federal government, the application of other types of instruments is strongly limited.[34] While this analysis does not allow inference about the leverage of individual instruments, the overall composition of instrument types illustrates the relative weight of Research and Innovation (R&I) compared to other forms of intervention. Moreover, informational

34 For a similar finding from a comparative country study see Larrue (2021, p. 63).

instruments appeared to play a rather small role and are limited in their scope, compared to larger funding schemes that were dominating in the cases under study.

While there is no blueprint for an ideal instrument mix, especially for missions aiming for transformative and behavioral change, the reliance on a broader mix of instruments will be necessary to achieve the desired effects. In sum, complementing conventional R&I policies with a more balanced mix of instruments to achieve the desired effects lies at the center of mission-orientation. Thus, it is recommended to ensure that future processes of mission design consciously incorporate policy instruments that reach beyond the confines of conventional R&I funding and support.

Figure 17: Type of policy instruments for missions under study (classification according to Hufnagl 2010; for missions on CO_2 emissions in industry/circular economy the data contains policy strategies and policy instruments)



Source: Own compilation

7.2.1 Actor and resource mobilization

Regarding actor and resource mobilization, the cross-mission analysis reveals a relatively clear image. The majority of inputs related to the missions are provided by Federal ministries, above all the BMBF as the key actor across all missions (see figure 16). There is some evidence that missions mobilized and incorporated external resources, such as expert advice and strategic intelligence, fostered knowledge transfer and engaged in meaningful discourses with other public actors at different institutional levels, stakeholders and the general public. However, in the future, significant efforts need to be made to

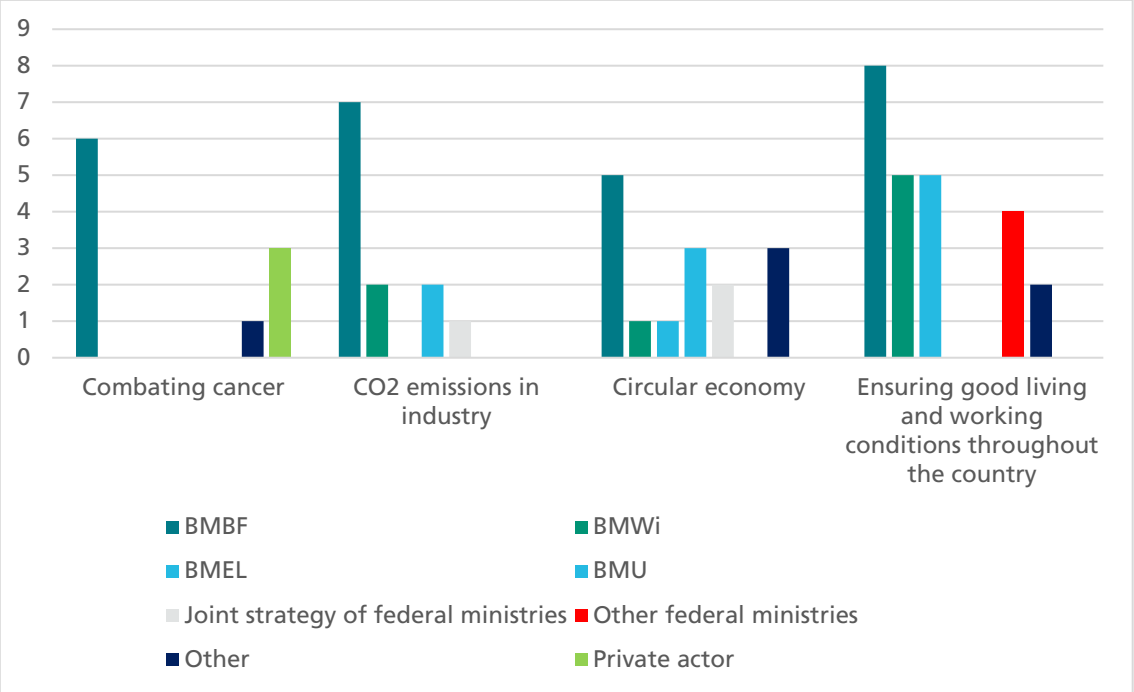
ensure that shared responsibility in terms of financial contributions, capacities and joint ownership is developed.

So far we could identify instances of 'information sharing' amongst stakeholders at different stages of implementing the missions and related to single instruments, indicating patterns of neo-corporatism in the missions of combating cancer (working groups of NDK), circular economy (e.g. NaRess Working Groups) or reducing CO_2 emissions. These observations imply a rather strong top-down orientation in many of the missions with most actors beyond federal ministries being mainly funding beneficiaries. Thus, a **key challenge is to strengthen actor involvement and actively encourage a wider range of actors to contribute their resources to gain the necessary momentum.**[35] **In order to achieve this, a clear and compelling mission narrative and goals are necessary. In consequence, this calls for processes that effectively contribute to committing stakeholders from the very beginning of a mission.**

A good example for successful mobilization in this context can be found in the Netherlands. At its Knowledge and Innovation Convenant (2020-2023) the 30 involved stakeholders promised a total resource mobilization of annually almost 5 bln EUR, of which 42% were supposed to come from non-public sources (Janssen 2020, p. 21).

35 These aspects are strongly encouraged by the advisory board to the HTS 2025 (Hightech Forum 2021) and by the EFI Commission (EFI 2021).

Figure 18: Mission inputs per actor (for CO2 emissions/Circular economy the data includes policy strategies)



Source: Own compilation

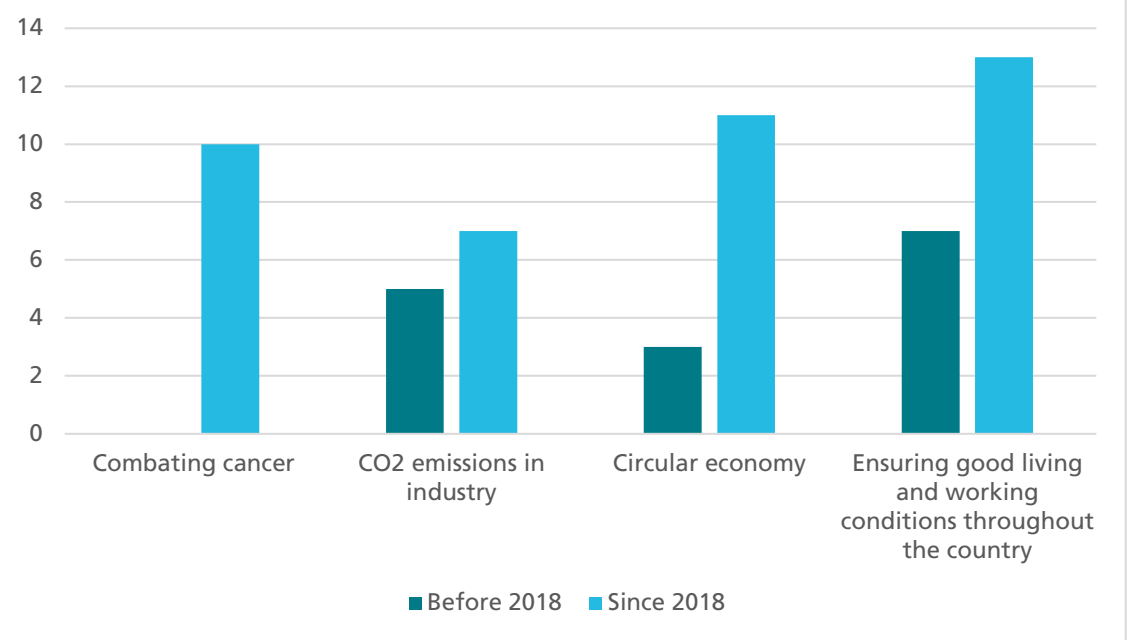
7.2.2 Origin of instruments

Another relevant aspect for the mission design is the origin of instruments. As Larrue (2021) notes, in many instances missions build upon existing structures. Depending on their origin, the link between an instrument and the mission's goals can vary considerably. Figure 19 categorizes inputs whether they originally emerged before 2018 or were adopted afterwards. A rather heterogeneous image in this regard is revealed for the missions under study. The mission on combating cancer, for example, with a rather small number of instruments, relies exclusively on newly designed activities and policy instruments. In contrast, the mission on ensuring good living and working conditions that is linked to longstanding political issues, exhibits a combination of newly developed instruments that emerged in the wake of the mission, and policies pre-dating the mission.

Policy layering has been a prominent feature of STI policies for decades. Consequently, the reliance on existing instruments may be a fast and efficient way for the design of MOIP. However, effectively integrating a long-standing instrument will require efforts to align it with the specific goals of a mission. This calls for a critical reflection of the role of evaluations (of policy instruments) and the prac-

tices of (and potential for) policy learning since the modification and possible adjustments should be rooted in a systematic reflection on the successful implementation so far.

Figure 19: Temporal origin of mission inputs



Source: Own compilation

7.2.3 Instrument mix

So far we focused on individual instruments, but the question of how different instruments interact with and complement each other is more complex. Whereas a comprehensive analysis of the mix within pathways was beyond the scope of this report, the case studies provided a glimpse into the different instrument mixes that potentially could contribute to achieving the mission goals. In many instances, the identified instruments revealed a diverse picture with regard to target groups, intervention levels or thematic priorities, making it difficult to identify the way these activities interact with each other – a fact that points to the difficulty of clarifying which instruments actively contribute to a mission.

From our perspective, the instrument mixes for MOIP should not be seen as a collection of thematically connected instruments or sub-strategies, but as a set of policies jointly contributing to the mission goals, complementing each other (cf. Larrue 2021). MOIP do not only require a high degree of coordination at the strategic level, but also an alignment of individual instruments across ministerial responsibilities towards a shared goal, with missions being more than the sum of

subsumed instruments.[36] For mission design it is therefore of utmost importance to not only clarify the connection of individual instruments with mission goals, but also enable synergies between instruments to fully unleash the potential of missions. A good practice in this regard are the attempts of the Dutch Mission-oriented Topsector and Innovation Policy to provide an annual portfolio analysis of instruments and monitoring of on-going activities (Janssen 2020, p. 32).

A second observation is that in some of the missions (e.g. Ensuring good living and working conditions throughout the country) there was a high share of pilot projects. **While pilot projects provide the opportunity for experimentation and exploring possible solutions, it is key that the insights gained are subsequently incorporated and allow for a further improvement of the mission. If missions emphasize this approach, they should from the very beginning aim to ensure that insights feed back into the mission implementation and allow for the scaling-up of promising solutions in the future.** Otherwise, there is the risk of loosely coupled instruments that do not provide sufficient leverage for achieving the mission goals.

7.2.4 Good practices

Finally, we observe a number of good practices within the HTS 2025 with regard to mission design that might be valuable examples for future implementation. First of all, we found multiple examples of instruments that simultaneously contribute to different pathways. One example from the combating cancer mission is the funding scheme "*Praxisverändernde Studien*" which, besides promoting research for therapies and prevention, brings in additional application criteria that strengthen the involvement of patients. In a similar vein, the program family "*Strukturwandel & Innovation*" in the mission on good living and working conditions combines a strengthening of innovation capacities with the development of innovative ideas and approaches, both aiming to strengthen economic development and solving area-specific problems.

Secondly, the mission on combating cancer provides a good example on how to integrate stakeholder involvement, mission design and ensure a high degree of actor mobilization. Two of the instruments in this mission (research projects) were developed based on the results of the working group of the NDK. Besides using the expertise of the working groups, we see particular value of such approaches for the mobilization of stakeholders

36 A view that is also strongly support by and advocated for by the EFI Commission in its current report: “The implementation of missions requires not only coordinated R&I policy measures, but also a coherent policy mix across all policy areas. The policy approach of MO consequently results in a variety of requirements for policy coordination at the operational level.” (EFI 2021, p. 43, own translation).

and highlighting the importance of their contributions. In this context, a project website, as of the NDK, might be a useful way to showcase the achievements and activities of a mission and thereby can create incentives for participation for different actors. Another example for this kind of commitment of heterogeneous actors can be found in the mission of circular economy. The NaRess Working Group (consisting of 40 different institutions including federal ministries, representative of some Länder and industry organizations) of ProgRess works jointly towards a strategy fostering "Ressourcenschutztechnologie". Additionally, many aspects of norms and standardization as a source for resource efficient innovation have to be clarified and DIN, DKE and VDI[37] have been mandated to provide their expertise (Normungslandkarte).

Last but not least, there even exist possibilities for creating synergies between different missions through the design of instruments (cf. also the reference to meta-level coordination of missions in MAR1). The program *Region.innovativ* within the mission on ensuring good living and working conditions provides a good example for this. While aiming to contribute to regional development goals, two of the project calls were dedicated to topics that are addressed as missions in the HTS 2025: circular economy and concepts of new work.

7.3 Reflections on the methodological approach

This report aimed for a first "taking stock" of existing missions and their instruments, exploring the overall fit of instruments with mission goals and priorities. This section highlights some of the key insights from a methodological perspective, providing guidance for the development of a framework for impact assessment of MOIPs.

First of all, the question of mission design is cutting across the spheres of policy coordination and policy implementation that characterize MOIPs (cf. Larrue 2021). Among the dimensions provided by Larrue, particular fundability (mobilization of public and private resources), policy mix consistency and partly also intensity (decision-making mode for instruments) and novelty (coordination of activities to allow for experimentation) were relevant factors for assessing the mission design. This ties in with the fact that mission design should not be perceived as static, but acknowledge that mission instruments and their composition may evolve over time. Therefore, a repeated assessment of the fit between mission goals and instruments employed may turn out as necessary when trying to assess the impacts of MOIP.

37 Deutsche Institut für Normung (DIN), Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (DKE) and Verein Deutscher Ingenieure (VDI).

Secondly, a key challenge remains the understanding of the way how instruments contribute to certain pathways and how they interact with other instruments. As outlined earlier, there is no straightforward way for systematizing their interplay, as this might take place at different levels: thematic priorities, TRL-levels, relevance/leverage of instruments. Therefore, we argue that a qualitative perspective is needed for investigating the interplay of different inputs. The system mapping approach outlined in MAR1 (Wittmann et al. 2020b) in this regard can help to better understand how instruments relate to the overall socio-technical system and the priorities within the respective mission. Especially for more complex missions that entail a higher number of instruments per pathway, the analysis can become relatively complex. In consequence, it may be necessary to involve additional sources like expert interviews or conduct separate ex-ante evaluations for individual pathways, as a simple comparison of budgets might be insufficient. Valuable insights might also be provided by a more explicit focus on the process of developing new programs (e.g. through stakeholder involvement etc.).

Finally, depending on the timing of the investigation, the analysis might both entail ex-ante and ex-post elements. From the perspective of mission implementation, it is also insightful to review the fit ex-post (cf. Hüsing et al. 2017). This may include, for example, a focus on the selected projects and activities in order to explore to what extent the instruments triggered the desired dynamics and how sustainable these changes have been. For example, in the Netherlands, a permanent monitoring of projects granted is foreseen (Janssen 2020, p. 32).

7.4 Insights relevant for research on MOIP

Besides the rather technical results and the case-specific insights for the German HTS 2025, the insights of this analysis also contribute to research on MOIP in general. This section formulates some of the key insights that might inspire research on MOIP by pointing to open question and gaps in literature.

First of all, the analysis confirmed the argument that missions are usually not designed "from scratch" but are embedded in a context of existing policies and instruments (Larrue 2021, p. 9). This has profound implications for the study of MOIP as these will be characterized by different modes of institutional change, such as layering or refurbishing of different past and present policies and activities (cf. e.g. Hacker 2004; Thelen and Streeck 2005; Kern and Howlett 2009; Mahoney and Thelen 2010). Limiting the opportunity of mission owners to freely design mission interventions, this fact underlines the need for a distinct perspective that takes into account the different ways existing instruments can be aligned (or remain unchanged) in order to serve the specific goals of a mission. In their study on the Dutch case, Janssen (2020, p. 22) finds that the focus was

less on the creation of new instruments, but rather attempts to strengthen the coordination and linkage between existing instruments. Therefore, the focus on "newness" of MOIP should not overshadow the fact that many policies have already been in place before, but are likely to necessitate conscious adjustment and modification in order to explicitly contribute to the mission goals and ensure the required directionality that characterizes MOIP.

This aspect also closely ties in with the difficulties to delineate mission instruments from other instruments and activities in the socio-technical system. Our approach to focus on activities and instruments related to the mission owners closely resembles the work of Wesseling and Meijerhof (2020) who distinguish between a mission arena and a wider mission-oriented innovation system (MIS). In order to assess the potential impact of MOIPs, however, it is key to understand to what extent the instruments employed by the mission arena succeed in mobilizing actors in the wider socio-technical system. These dynamics can be considered to differ from the analysis of internal implementation and coordination procedures and are located at the anticipated outcomes of the impact pathways.

Next, the analysis revealed that there were plenty of cases where instruments were directly and indirectly contributing to different pathways at the same time. This observation stands in contrast to the argument that policy instruments might not address multiple goals (Tinbergen 1952). However, Howlett and Rayner (2013, p. 173) highlight, Tinbergen's work has been often misinterpreted, as Tinbergen himself did argue that in complex situations often a mix of instruments is required. At the same time, while the concept of policy mixes has been developed further by various authors (Ossenbrink et al. 2019; Kivimaa and Kern 2016; Rogge and Reichardt 2016), it remains an open question to what extent it is desirable to have instruments serving multiple goals simultaneously. While the idea to closely link and align different pathways is promising, there might exist a number of pitfalls. This includes a higher level of policy/coordination complexity, potential challenges to react to changing environments without giving up the contributions to other pathways and the analytical difficulty to explore (quantitative) contributions to different pathways, as effects might be interconnected.

The reference to an instrument or policy mix has been popular in the literature dealing with MOIP (Janssen et al. 2020; Wesseling and Meijerhof 2020; Hekkert et al. 2020; Amanatidou et al. 2014). However, as Larrue (2021, p. 63) notes the character of policy mixes is more narrow, compared than many common understandings of policy mixes (cf. Rogge and Reichardt 2016), focusing on a top-down selected set of coordinated instruments. Consequently, we see the need for greater conceptual clarification on how to make the concept of policy/instrument mixes usable for the study of MOIP.

In this regard, this report particularly highlights two questions: First of all, how to systematize and analyze the interplay of instruments in a context of MOIP? Departing from the assumption that different missions are driven by different dynamics, this report argues that it is important to shift the focus from the instrument mix of a mission as a whole (see e.g. Larrue 2021, p. 65) to instrument mixes at a lower level – represented by the different impact pathways that characterize a mission. Decomposing missions into different impact pathways can contribute to a reduction of complexity for analysis and provide a better access to understanding the interplay of different instruments.

Secondly, little is known about the appropriate instrument mix. While there has been an emphasis on more systemic instruments (Smits and Kuhlmann 2004; Daimer et al. 2012), it remains unclear to what extent "traditional" STI instruments such as research funding need to be accompanied by other instruments, particularly those that aim at the destabilization of existing regimes (Kivimaa and Kern 2016). While the reliance on more coercive instruments may only be a second choice by policy makers (Doern and Wilson 1974), different types of ambitions for mission realization (Wittmann et al. 2020a) will require different **instrument mixes**.

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