5 Reaching Net zero: Do mission-oriented policies deliver on their many promises?

Mission-oriented innovation policies are increasingly popular as a policy response to meeting net-zero targets. They have clear objectives and measurable targets, promote broader co-ordination of policy plans across administrative silos, and better integrate various support instruments across the different stages of the innovation chain than more traditional and fragmented policy approaches. These policies remain unproven, however, and early indications suggest they lack sufficient scale and reach to non-STI policy domains to have wide-ranging impact. The challenge remains to move these initiatives from effective co-ordination platforms to integrated policy frameworks that mobilise and align a wide range of actors. Overcoming many of the barriers – including administrative and legal rules, accounting structures and governance models – requires changes that are far beyond the reach of STI authorities alone and will need significant political support.

Key messages

- A growing number of countries are experimenting with mission-oriented innovation policies (MOIPs) to help them reach net-zero targets. Most of these have only been launched recently and have yet to demonstrate their differential impact with respect to more traditional and fragmented policy approaches. Providing evidence of their contribution to long-term objectives in a timeline compatible with short- to medium-term political cycles is, however, a challenge for most net-zero missions.
- This chapter uses a "theory of change" policy framework to track the effects of 83 net-zero missions, from their specific design features to their contribution to achieving net-zero. It shows that net-zero missions produce some of their expected outputs and outcomes and in most cases, represent a marked improvement over traditional science, technology and innovation (STI) policy mixes. However, they are not yet well-suited to producing the needed transformative changes to achieve net-zero.
- Net-zero missions entail a co-designed agenda, a dedicated governance structure and finally, a tailor-made and integrated policy mix. Compared to traditional policy mixes, net-zero missions are characterised by:
    - Stronger orientation, with clearer objectives and measurable targets related to GHG emission reduction – although only a few correspond to expected specific, measurable, achievable, relevant and time-bound (SMART) goals. Such initiatives are characterised by co-developed strategic agendas that are directly associated to financial resources and implementation modes, which is rarely the case in other strategic frameworks.
    - Broader co-ordination of policy plans across administrative silos, bringing together the authorities in charge of research and innovation policy, and the "owners" of the challenges they tackle – for instance, the policy and regulatory bodies in charge of transport or environment. To date, however, budgets are not commensurate with the transformative objectives of net-zero missions and originate almost exclusively from public authorities in STI.
    - Higher integration of various support instruments across the different stages of the innovation chain, from supporting research to skill strengthening and, for some of them, market deployment through price-based mechanisms and public procurement. A significant value added of net-zero missions is their result orientation, which leads mission partners to integrate societal needs and demands at different stages of the mission life cycle.
- Building on these early results and learning from good practices, net-zero missions will accomplish their transformative potential if they can find a way out of two common traps:
    - The "STI-only trap": despite displaying some systemic features, most net-zero missions remain focused on supporting research and innovation, are led by STI authorities and draw almost exclusively on STI funds.
    - The "orientation trap": so far, most net-zero missions have had success in defining strategic agendas and setting up governance structures. Evidence of joined-up implementation remains rarer and limited.
- The MOIP theory of change presented in this chapter should be further developed and translated into decision-support tools to facilitate public policy experimentation and adaptive, real-time policy learning.

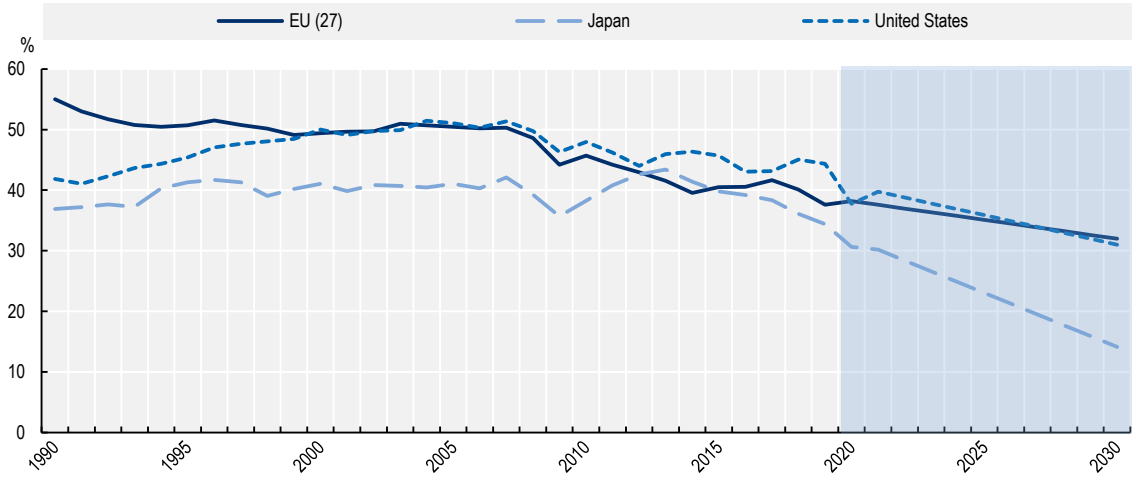
Introduction

Current STI policy and governance frameworks are unfit to help deliver sustainability agendas

Despite technological progress that has helped lower the costs of low-carbon technologies and increase their performance in areas such as buildings and transportation (IPCC, 2022[1]), it is increasingly clear that "change as usual" is no longer an option to tackle systemic societal challenges such as climate change. While 33 countries and EU Member States have set net-zero targets, mostly for 2030 and 2050, to attempt to limit global warming to 1.5˚C by the end of the century, at the current rate of emission reduction, countries are not on the path to meet their international commitments for 2030 (Figure 5.1). Furthermore, in the unlikely case that all countries will implement their 2030 pledges and continue at the same pace, recent simulations show that global warming is likely to reach about 2.7°C by 2100 (IPCC, 2022[1]).

Figure 5.1. Gap between GHG emissions and 2030 national targets for selected countries, 1990-2020, and linear projections 2021-30

In percentage of GHG emissions



Note: Annual difference between GHG emissions and NDC 2030 target is calculated by subtracting target estimates from GHG emissions each year. The figure shows the annual difference as a percentage of GHG emissions in each year. GHG emissions levels are aligned to the scope and unit of NDC targets, including the coverage of sectors, gases and global warming potential factors (GWP). Emission levels are therefore not directly comparable across countries. Projections are based on the trends observed during the last five years for each series of data; emission data for China, – which are increasing rapidly – are not regular enough to allow projections.
Source: OECD (n.d.), International Programme for Action on Climate, Climate Action Dashboard, https://www.oecd.org/climate-action/ipac/ (accessed on 3 March 2022).

StatLink https://stat.link/ht4rfx

Many countries are trying to translate their net-zero commitments into concrete actions, which requires immediate decisions (Jeudy-Hugo, Lo Re and Falduto, 2021[2]). However, climate actions to date fall significantly short of what is necessary to achieve these targets (Lebling et al., 2020[3]). Recent OECD work highlights the marked levelling out of concrete climate policy measures across OECD countries, particularly innovation-related policies (Criscuolo, Dechezleprêtre and Cervantes, 2023[4]), (Kruse et al., 2022[5]). International Energy Agency (IEA) data demonstrate a clear flattening of public expenditures for research, design and development (RD&D) for low-carbon technologies as a percentage of gross domestic

product since around 2010 (IEA, 2022[6]). This trend coincides with a slowdown of patenting in low-carbon technologies (Criscuolo, Dechezleprêtre and Cervantes, 2022[7]).

Despite announcements regarding the increasing proximity to climate tipping points (OECD, 2022[8]), multiple pathways to limit global warming to 1.5°C are still available. These pathways correspond to various mitigation approaches, with different combinations and timelines for the development and diffusion of social and technological innovations (IPCC, 2022[9]). Both the diffusion of currently available technologies, and new advances and scale-up of those still in laboratories or at the demonstration stage, can help achieve the 2030 emission-reduction targets (IEA, 2022[10]). However, these will need to be combined with behavioural, regulatory, political and social changes. Changes in a wide range of domains, involving different communities on multiple levels, will have to co-evolve in conjunction towards similar objectives to allow such co-ordinated systemic transformation.

In past decades, however, policies have mainly consisted of individual policy instruments targeting specific market failures (Mazzucato, 2018[11]), for instance by raising the level of private R&D, supporting feasibility or strengthening the knowledge base. This "one objective – one policy instrument" framework has resulted in a fragmented policy and governance landscape that has exacerbated co-ordination problems. Without a framework to co-ordinate different modes of intervention, these dispersed policy mixes are ill-suited to bring about the systemic changes required to ensure the transition to net-zero (OECD, 2021[12]), (Hynes, Lees and Müller, 2020[13]).

A wealth of "mission-oriented" systemic policy experimentations

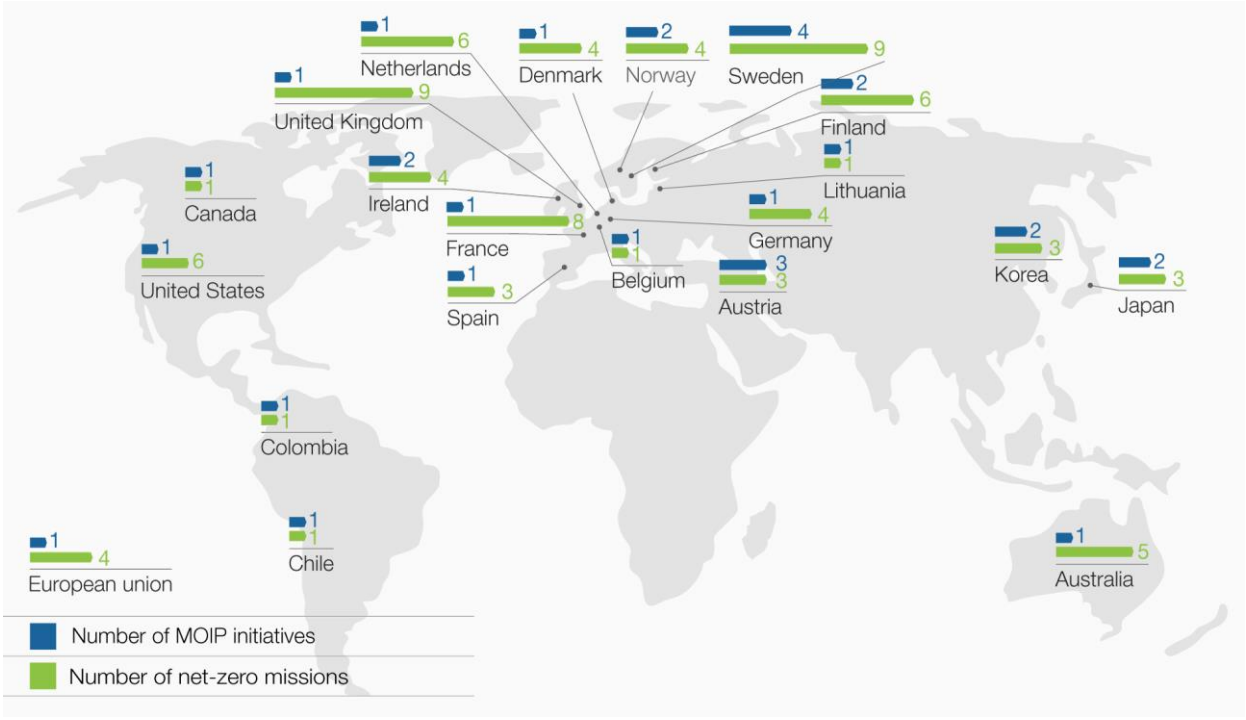
Acknowledging the limitations of current policies to address "wicked" challenges such as climate change, several countries are piloting systemic policy approaches that promote (to various degrees) cross-governmental, cross-sectoral and multidisciplinary collaboration in STI policy formulation. These initiatives consider linkages between issues that are generally treated separately within different "silos" to address a specific challenge. In Norway, a country where many sectoral ministries and their agencies have responsibility for their own STI policy, three agencies have since 2016 gathered their respective instruments to fast-track the development, testing and deployment of new green energy solutions in a single integrated scheme (Pilot-E). In France, the "Investments for the Future" programme (PIA)[1], initiated in 2010, was redesigned in 2020 to focus on specific technology areas through integrated support across all stages of the innovation chain, from exploratory research to market deployment. Each of these so-called "acceleration strategies" has its own strategic agenda, budget and governance structure, with a dedicated inter-ministerial co-ordinator. In the United States, several agencies have been created to emulate the "Defense Advanced Research Projects Agency (DARPA) model", where a co-ordinated portfolio of projects are proactively managed to solve complex energy or health-related challenges (among others). In the energy area, the systemic dimension of these initiatives was enhanced in 2021 by integrating various relevant programmes and agency schemes into "Energy Earthshots", which adopt an "all-R&D-community" approach to addressing complex challenges such as affordable grid storage for clean power and low-cost clean hydrogen. Under different forms, systemic policy experimentations occur in many European countries, in Asian countries and in Australia.

While these initiatives vary in terms of focus, scope and design, they have in common the goal of promoting proactive action across disciplinary, sectoral and administrative silos to address collectively a challenge too complex to be solved by any individual measure. They have generally been gathered under the "MOIP" label, a concept that has attracted a great deal of attention from policy makers and analysts. OECD defines MOIPs as a "co-ordinated package of policy and regulatory measures tailored specifically to mobilise STI in order to address well-defined objectives related to a societal challenge, in a defined timeframe". These measures may span different stages of the innovation cycle, from research to demonstration and market deployment; feature a mix of supply-push and demand-pull instruments; and cut across various policy

fields, sectors and disciplines (Larrue, 2021[14]). Using this definition as a reference, the OECD has identified 83 net-zero missions in 30 MOIP initiatives implemented in 20 countries (Figure 5.2).

Figure 5.2. Map of MOIPs and their net-zero missions

An increasing number of countries have engaged in systemic policies to reduce GHG emissions



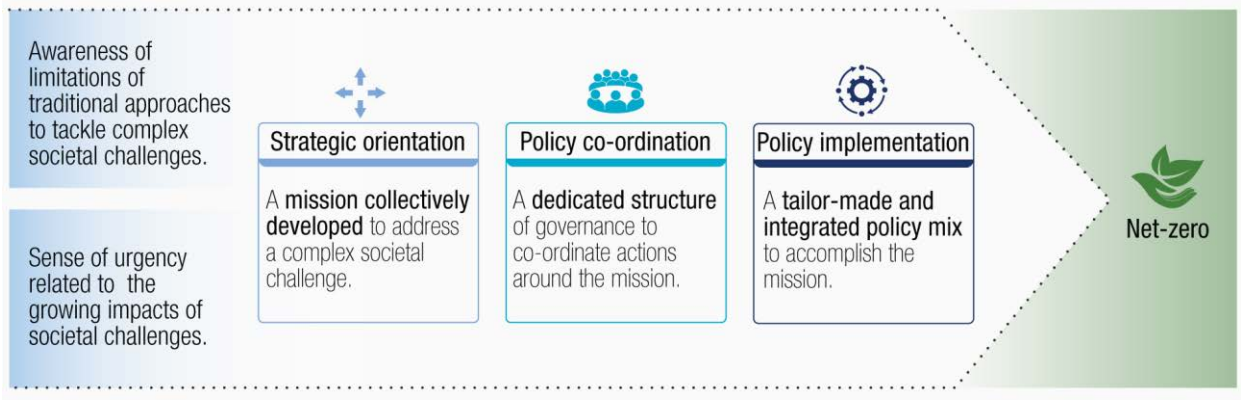
Note: For instance, Ireland currently operates two MOIP initiatives which include a total of 4 missions. The list of MOIP initiatives, as well as their net-zero missions, is available at: https://www.oecd.org/sti/inno/Online%20list%20of%20NZ%20missions.pdf.

This definition relates to an ideal type that can be characterised by three main features:

1. *Strategic orientation*: the main objective of MOIPs is to develop and set well-accepted objectives regarding a complex challenge to be addressed, to lay the foundation for targeted and co-ordinated collective action. While MOIPs are still often wrongly characterised as top-down, their objectives can only be defined by involving and reaching a consensus among a wide array of public and private stakeholders.
2. *Policy co-ordination*: MOIPs co-ordinate the strategies and plans of various public authorities in charge of different components (e.g. knowledge, technologies, funding, skills, regulations, markets) that are essential to reaching collectively agreed objectives. These public authorities belong to different policy fields (such as research, innovation and different sectors that "own" the societal challenges, including energy, mobility and health) and different levels of governance. Co-ordination arrangements are negotiated in different types of governance bodies at the strategic and operational level, as well as at the level of the overall initiative or specific mission.
3. *Policy implementation*: MOIPs are implemented through a comprehensive mix of policy interventions and various initiatives to support a range of activities (from research to market launch and the acquisition of required skills) deliberately designed to achieve their objectives. For the most part, these policies do not substitute, but rather build upon and co-ordinate pre-existing policy interventions to tackle a specific challenge.

All national innovation systems include many components that perform various functions pertaining to these three dimensions (e.g. a hydrogen strategy, a cross-ministerial committee and a collaborative programme). The main novelty of the MOIP approach resides in the proactive and intentional integration of these components within a dedicated common institutional framework to tackle a selected challenge. Concretely, a MOIP is a "platform for collective actions" that articulates, for each selected challenge, a collectively developed agenda; a dedicated structure of governance for taking (and monitoring the effects of) common or mutually consistent decisions; and a tailor-made, integrated policy mix (Figure 5.3).

Figure 5.3. MOIPs as an integrated framework to steer, co-ordinate and implement collective action toward net-zero



Can MOIPs help countries implement the sociotechnical changes needed to transition towards net-zero?

MOIPs are reaching a critical pivotal time. While most of these policies are still at an early stage, there already exists strong political demand to demonstrate results, not only because these initiatives are more visible, but also because they have raised high expectations and sometimes have larger budgets. However, knowledge about the extent, the means and the conditions under which MOIPs produce the expected impacts is still limited.

Although it is impossible to assess the effects of initiatives that established a goal for 2030 or beyond and have been in existence for only two or three years, a first step is to validate the policy approach itself: to what extent – and why – is a MOIP approach justified in comparison to existing strategic and policy frameworks? In other words, legitimising the adoption of a MOIP approach requires capturing the benefits of their systemic dimension to orient and co-ordinate plans, and take action.

A theory of change of net-zero missions has been developed to this end that sets out the causal relationship between net-zero missions and their expected outputs, outcomes and impacts (Box 5.1 and Figure 5.4). This theory is used to analyse the database of 83 net-zero missions and 20 in-depth case studies[2]. It also structures this chapter, providing insights on the contribution of net-zero missions to three expected outputs, followed by three expected outcomes[3]. The chapter concludes by highlighting two traps that net-zero missions will need to overcome if they are to fulfil their promise.

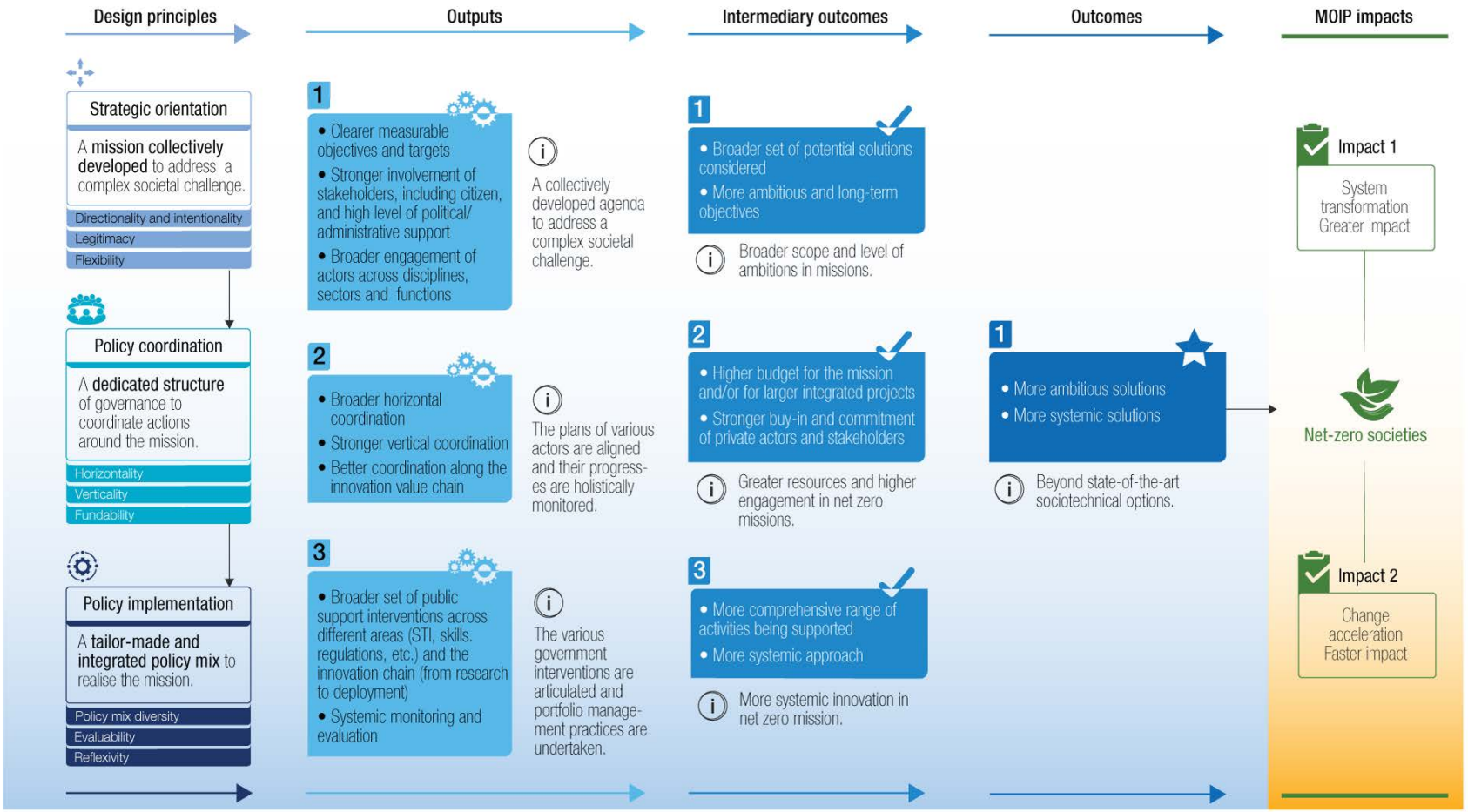
Box 5.1. A theory of change of net-zero missions

The OECD has studied and categorised the different designs of MOIPs, as well as analysing and benchmarking their main processes through cases studies (Larrue, 2021[15])[4]. However, there exist almost no evaluations of these policies that could provide evidence of whether they meet their ambitious objectives. Building upon previous work on MOIP design, it is necessary to develop a "theory of change" for MOIPs that will surface the causal relationships between the problems they tackle and their desired goals, inputs, outputs, outcomes and impacts (Janssen et al., 2021[16]), (Hekkert et al., 2020[17]). In its most general understanding, a theory of change is a set of beliefs about how change happens (Church and Rogers, 2006[18]).

In the case of MOIPs, the theory of change seeks to capture their *additional* effects on top of those produced by existing fragmented policy instruments, as they build upon and integrate existing policies. The legitimacy of this policy approach, therefore, depends on successfully passing a stringent double test: not only must they accomplish their missions, but they should do so more effectively and more efficiently than would have been the case without them, or they should fulfil missions that are beyond the reach of traditional approaches.

The net-zero theory of change (Figure 5.4) describes how MOIPs are expected to produce their impacts, in direct relation to their characteristics. It starts with the MOIP "design principles" as formalised in previous OECD work (Larrue, 2021[15]) and presents the expected causal relationships to outputs (i.e. the previously mentioned collectively developed agenda, dedicated governance structure and integrated policy mix), outcomes and intended impacts. Building on the distinction between acceleration and transformative missions (Kuittinen, Polt and Weber, 2018[19]), it is possible to distinguish two main types of impact – system transformation and change acceleration..

Figure 5.4. The theory of change of a net-zero mission: From MOIP design principles to net-zero achievements



What are the outputs of net-zero missions?

In direct relation to their design principles, MOIPs are expected to deliver three policy outputs: a collectively developed strategic agenda, a dedicated governance structure to co-ordinate actions towards this agenda, and a consistent package of policy and regulatory interventions to implement the mission. This section questions each of these outputs successively. Table 5.2 summarises the results of these missions.

Table 5.2. Synthesis of the main outputs of net-zero missions

Outputs

Net-zero mission effects	Main results
A) Collective development of a strategic agenda to address a complex societal challenge	
Clearer measurable objectives and targets	Missions have enabled clearer goals to be set than in traditional programmes, although few correspond to the expected "SMART" goals. Only half of these goals have clear targets. Strategic agendas allow "continuous directionality" and complement mission objectives in a context of high uncertainty and contestation. In stark contrast with traditional strategies and roadmaps, strategic agendas are directly associated with mission budgets, co-ordination structures and modes of implementation, increasing their influence on interventions.
Higher level of political/administrative support	Missions are political by nature, owing to normative goals related to societal impacts. Broad national missions attract more attention from politicians and high-level administrative levels, which strengthens their legitimacy but can add pressure to obtain early results.
Broader engagement of stakeholders	Strategic agendas are developed by a wide range of actors from different communities, increasing their ownership of the mission and subsequent engagement.
B) Alignment and holistic monitoring of various actors' plans	
Broader horizontal co-ordination	Almost all net-zero missions subject to a case study have significantly expanded the scope of co-ordination between different actors across the government structure. Leadership is assumed by the STI authorities that have launched the mission. Cross-sectoral co-ordination is the main challenge of net-zero missions, generating significant transaction costs in the largest and most integrated missions.
Stronger vertical co-ordination	Most net-zero missions are led by national (or EU) authorities; some include local authorities in their governance. Local authorities are involved in many mission activities to enable demonstrating solutions and their early transition to market. A few net-zero missions are implemented at the regional level, particularly in the context of the new generation of EU Smart Specialisation Strategies.
Better public-private co-ordination	Missions complement (and often benefit from) the existing public-private STI concertation platforms. They add a well-targeted purposive framework and ensure a more direct link to policy interventions.
C) Articulation and management of a portfolio of activities	
Broader set of public support interventions across different areas	All net-zero missions are bundled under a common strategic and governance framework featuring different types of interventions, from R&D grants to skill formation or advocacy. Only a few missions include policy instruments that support the market deployment of current or new solutions. Net-zero missions allow co-ordinating public support for different aspects of systemic solutions.
Broader set of public support interventions across the innovation chain	Several net-zero missions map and connect the various support instruments across the different technology readiness levels, with a view to providing more continuous support to different stages of the innovation chain.
Novel systemic monitoring and evaluation approaches	There is a pervasive perception among mission partners that new evaluation methodologies and processes are needed to evaluate this approach, but very few MOIP evaluations have been undertaken to date, and they do not significantly depart from traditional STI policy evaluations.

Develop collective and strategic agendas to address societal challenges

Mission objectives and targets

MOIP objectives can take various forms. In theory and ideally, a mission's objectives are operationalised by measurable targets (Mazzucato, 2018[11]). In practice, only around half (46%) of the net-zero missions identified have set targets. In some cases, targets and objectives can be combined in a "mission statement" encapsulating in a short – and if possible inspirational – formulation an ambitious result to be attained in a precise timeframe. These statements serve as "entry points" and "identifiers" to the mission.

> The Japanese Moonshot Programme has nine Moonshot goals covering various societal challenges. For instance, Moonshot Goal 5 aims for the "creation of industry that enables sustainable global food supply by exploiting unused biological resources by 2050."
>
> In the United States, the Hydrogen Earthshot has formalised its main objective as the "1 1 1" goal, i.e. the objective of "reducing the cost of clean hydrogen by 80% to USD 1 per 1 kilogram in one decade".

Regardless of the form these objectives take, programme managers claim that their missions set clearer and more inclusively developed goals than do the usual programmes and schemes developed by their organisations. In other words, the goals are formulated to be more impactful (i.e. to "deliver" a result), rather than simply focusing on inputs or immediate outputs (i.e. to "do" something). As one programme manager put it, "Usually the goal is to do something, here the goal is to deliver something". Against this backdrop, all activities are geared towards the desired outcomes. Even in the most research-intensive mission, the intended results are the heart of the projects and a cornerstone of research activities. These clearly enunciated objectives also act as a "focusing device" and a reference point for interactions between the different actors all along the innovation chain, and across the various involved communities.

Missions set common objectives in uncertain and contested environments

Setting clear objectives at the outset is not limited to adopting "good project management practices". The goals – and when they exist, the targets that accompany them – enshrine the results of negotiations on the objectives. They also reflect hypotheses regarding the evolution of sometimes uncertain variables (e.g. carbon and energy prices, availability of raw materials, geopolitics, capacity to overcome scientific and technological bottlenecks, evolution of users' perceptions and preferences) that influence these sociotechnical options, and their even more uncertain results on the state of the world. The mission therefore appears as a locus of debates, providing a platform for public-private, cross-ministerial and inter-sectoral negotiations, with direct consequences on public intervention. These debates are essential when it comes to choosing long-term futures that directly affect people's well-being. In this light, focusing only on scientific and technological uncertainties would diminish missions' social and political complexity, and underestimate the underpinning power conflicts and disagreements that are important drivers of their implementation (Wanzenböck et al., 2020[20]). While modern innovation systems offer many instances where these negotiations can take place (such as committees, industrial associations and unions), the specific added value of missions is that they integrate mission orientation, co-ordination and implementation in the same institutional space. The mission formalises and renders directly "actionable" the results of the negotiations. The different actors can directly refer to the ensuing actions to strengthen their positions. And the government can tie its financial commitment to achievement of the mission's objectives, in order to defend choices that incorporate certain social values which may not always be aligned with the individual interests of companies or other stakeholder groups.

The development of objectives requires significant information and knowledge to strengthen their underlying hypotheses. However, some missions do not have a dedicated budget and therefore rely on the capacity and resources of specific actors, potentially reducing the acceptability of the results regarding controversial issues. Furthermore, very few missions use formal foresight approaches to support the

formulation of objectives, despite their potential to capture broad sociotechnical issues.[5] In most cases, a mission's strategic agenda is defined using technology road-mapping techniques rather than a full-fledged foresight exercise.[6] This reflects, in part, countries' limited experience of using foresight in policy making. Moreover, foresight exercises take time, and the missions are often under high political pressure to start functioning as soon as possible. Another reason for the limited use of foresight is the narrow techno-centric scope of many net-zero missions.

> It took more than a year for the French authorities to develop the "clean hydrogen Acceleration Strategy". This time was used to conduct preliminary studies to calibrate and strengthen the legitimacy of the targets; run extensive consultations to assess needs; and issue calls for expressions of interest to identify potential solutions and project partners, and negotiate common objectives with them despite a wide diversity of views and interests. As a result, the mission deliberately includes some strong choices that exclude certain options. For example, the strategy focuses only on clean hydrogen for applications where battery storage technologies are ill-suited (hence mainly heavy vehicles), which would be produced with electrolysers plugged into the electricity network. The mission objectives also include clear choices regarding the type, capacity and distance of the electrolysers to the application site.

The mission-oriented strategic agendas and roadmaps act as collective action frameworks

In several cases, the objectives are not the starting point but rather a first result of the mission itself. Many missions start with broad objectives, priorities or "mission areas". The first step of the mission is to develop or refine the objectives, most often embedding them in a strategic agenda or roadmap. The five EU missions,[7] for instance, started with five broad mission areas and a mandate for groups of high-level specialists in each area (the mission boards) to first devise a strategy featuring objectives and targets (the mission board reports) and then a plan (the implementation plans). These loose directional elements do not really aim to set a clear orientation, but rather incentivise and facilitate the formation of large partnerships, wherein public and private actors jointly set attainable objectives and develop the collective strategy to meet them. This is particularly true of ecosystem-based MOIPs, which start with a call for strategic agendas, followed by the selection and implementation of some of these agendas.

A strategic agenda almost always complements a mission's initial objectives and targets to ensure the directionality and consistency of its different activities. These agendas (under different denominations and formats) are key to the expression of top-down and bottom-up dynamics. While governments still play a strong role at the political stage of setting the mission's objectives and targets, it is almost always the stakeholders who develop the strategic agenda which maps the different pathways towards fulfilling these objectives. What differentiates these mission-oriented strategic agendas from traditional strategies is that they are developed, implemented and monitored in an integrated way, allowing the strategic agenda to become the authoritative framework for action. In several missions, some components of the strategic agendas are directly used to develop the call for proposals; they can also be used on a regular basis to monitor progress on the different activities against the roadmap and identify gaps in the mission.

> In the Netherlands, the implementation of the "Carbon-free Built Environment" mission under the Mission-driven Top Sector and Innovation Policy (MTIP) is guided by four multi-annual mission innovation programmes (MMIPs) covering different sub-areas. The MMIPs include not only the activities to be performed but also the map of public financial resources deployed across the entire innovation chain, from fundamental and applied research to pilots and demonstrators. The call for proposals for the implementation of the mission are *directly based on* these MMIPs (some calls include copy-pasted text from the initial mission document). Since all the 25 top sectors' missions have developed such MMIPs, they are also used to identify and strengthen synergies among them.

While strategic agendas are never binding and there is no "stick", peer pressure among the mission partners in the broad governance bodies can exert a significant influence on possible opportunistic behaviours by the different partners.

An underlying condition for the effectiveness and legitimacy of strategic agendas is that they should be both directional and flexible. They must be a "living document" that evolves regularly to adapt to new internal and external conditions. In this regard, some missions, such as the Danish Green Carbon Capture Storage or Utilisation (CCSU) mission or the Japanese Moonshots, have established procedures to revise their strategic agendas every year.

Missions' net-zero objectives interact with a broader set of objectives

An analysis of the main rationales for net-zero missions shows that the objective of combating climate change is always intertwined with other environmental, economics or health ambitions. This analysis is useful in highlighting how countries frame their arguments for missions, what aspects they showcase as the most important, and what they believe missions can help them achieve.

All net-zero missions aim by definition to tackle climate change by reducing GHG emissions;60% link their aims to wider environmental objectives and 54% to economic impacts (e.g. creating jobs). For instance, Australia's Commonwealth Scientific and Industrial Research Organisation's (CSIRO) mission to end plastic waste aims to reinvent the way plastic is made, processed and recycled to stop it from entering the environment. Some missions clearly enshrine the expected economic impacts in their main objectives and targets. Further, while not always officially emphasised, strengthening national competitiveness and creating new jobs always feature among the missions' rationales.

> The German High-Tech Strategy (HTS) 2025, implemented during the 2017-21 legislative period, aimed to "Make Germany into the leading supplier and market for electromobility" by defining and following concrete missions, particularly the mission to "Develop safe, networked and clean mobility".
>
> Korea's mission The Alchemist "Low-cost carbon dioxide (CO_2)-free hydrogen production facilities" aims to "Develop fundamental technologies and processes for mass-producing cost-effective and eco-friendly hydrogen in order to secure the leading position of Korea in global market in hydrogen car production and energy production".
>
> The first of the six objectives of the French acceleration strategy for industry decarbonisation is to "Ensure the emergence of a competitive French offer of decarbonisation solutions for industry".

These diverse objectives primarily reflect the multidimensional and systemic nature of societal challenges. They are also related to the mission process itself. To engage a wider range of policy sectors, the initial mission champions have to negotiate the mission objectives, and take onboard new goals and targets. One of the main intrinsic trade-offs of missions is this balancing between ensuring a broad range of partners on one side, and directionality and consistency on the other. Ensuring the effective participation of sectoral ministries and agencies in the mission – not only in terms of time and attention in meetings, but also of financial and technical assistance – requires it to include objectives that are consistent with their mandate. The resulting bargaining between different policy sectors creates a risk of diluting the mission.

A diversity of challenges is also the norm at the level of MOIP initiatives, with around three-quarters of MOIP initiatives combining net-zero missions with missions related to other societal challenges (most often related to health, but also to food security and ageing). The high prevalence of such diversified multi-mission initiatives suggests that policy dynamics – i.e. the desire to explore a new type of policy approach – have a strong influence on the adoption of this policy approach, together with the imperative of tackling climate change and other societal challenges. This is related to the fact that STI authorities – which have a functional, rather than sectoral or thematic, mandate – lead almost all MOIPs.

Align and monitor various actors' plans

Missions gather a broad range of policy sectors around common objectives

It is now well-accepted that complex societal challenges, such as GHG emissions reduction, require broad cross-sectoral co-ordination, a fact that underpins the rationales for adopting a mission-oriented policy approach. Policy fragmentation greatly hinders the capacity of innovation systems to respond adequately to wicked societal challenges, such as those included in the 2030 Agenda for Sustainable Development (OECD, 2019[21]).

Almost all net-zero missions represent a significantly expanded scope of co-ordination between different public policy actors. These missions gather around the table not only the public authorities in charge of research and business innovation, but also some relevant sectoral ministries and agencies. This co-ordination takes place primarily in dedicated governance bodies with various advisory, decision-making or monitoring roles. In the larger mission-oriented policy initiatives, these groups can be replicated at different levels (political, strategic and operational).[8]

> The EU Climate-Neutral and Smart Cities mission (Cities Mission) is led by two high-level managers from the Directorate-General for Environment and the Directorate-General for Research and Innovation. Besides the leadership, several groups and committees – notably the "mission owners groups" at working and director levels – co-ordinate actions between the 12 directorates more or less directly involved in the mission. This is said to have significantly reduced the number of overlaps between different directorates' activities related to cities. The mission's mode of governance is new, as climate neutrality has traditionally been addressed by different parts of the European Commission (transport, energy, urban planning, etc.). The "EU Cities" mission provides a legitimate authority at the systemic level (a "climate neutrality interlocutor"). The mission also supports cross-sectoral co-ordination aspects within each of the selected 100 cities, which are asked to develop and sign a "Climate City Contract" (CCC) between the different city partners. These contracts include an overall net-zero transition plan across all sectors (energy, buildings, waste management and transport), together with related investment plans. This holistic co-ordination is an essential component of the common guidelines and requirements that cities must follow in developing these contracts. The CCCs embed and officialise the systemic dimension for each city participating in the mission.

STI public authorities champion all net-zero missions

STI public authorities in charge of research or business innovation policy have initiated all 30 MOIP initiatives that include net-zero missions. They are undoubtedly "champions" of mission-oriented policies, experimenting and arguing for this new policy approach to tackle societal challenges featuring an unprecedented level of urgency and complexity.

In-depth fieldwork for 20 of those net-zero missions shows that almost all have provided an institutional space and concrete platform for cross-ministerial co-ordination. However, STI public authorities lead the missions, finance them and provide the bulk of policy instruments to implement them. Sectoral ministries and public agencies are "at the mission table", which allows more informed and holistic decisions. To date, however, they have barely committed their own financial resources to the collective endeavour. In other words, while the co-ordination of net-zero missions is broad and extends beyond the public authorities in charge of research and innovation, the missions' budgets remain largely confined to "STI funds".

Cross-sectoral co-ordination faces many costs and challenges

The OECD study shows that cross-sectoral co-ordination is not only one of the main expected added values of MOIPs, but also one of the main practical challenges. This is confirmed by a recent survey of mission practitioners and stakeholders, who rank "silo effects" as the highest risk for a mission's success (OECD and DDC, 2022[22]). This is not new: holistic co-ordination has been acknowledged as a key weakness of national innovation systems, as highlighted in all OECD Reviews of Innovation Policy and

confirmed by other types of STI policy assessment at the thematic, regional or initiative levels. Almost all point to the core issue of co-ordination between public authorities in charge of research and those responsible for business innovation. However, the upswing in societal challenges (such as global warming) has broadened the scope of co-ordination to include other sectoral policy and regulatory administrations with closely related mandates (the "challenge owners"). While mission-oriented policy is seen as a possible response to this new imperative, in many countries, it occurs in a context where previous challenges related to the functioning of the innovation system and economic growth remain unresolved.

When fully applied to broad missions, the governance of the mission involves a number of meetings and numerous items that must be collectively decided by a wide set of actors. It is therefore necessary to strike a "sustainable" balance between the benefits of co-ordination on the one hand, and transaction costs on the other. While net-zero missions are almost all very recent, some have already started to readjust this balance. In the Netherlands, the MTIP has been praised for its very comprehensive governance structure, which allows co-ordinating a wide range of actors across 2 main axes (with 9 top sectors and 25 missions) at different levels (high-level/political and operational) in several governance bodies (e.g. mission teams, top sector teams, programme advisory groups to support MMIPs and transversal teams across several missions) (Janssen, 2020[23]). However, several actors involved in this policy have pointed to a growing "mission fatigue" owing to the high number of meetings of these bodies. The policy is now being reformed to simplify this governance structure and increase its efficiency.

As is traditionally the case in cross-sectoral co-ordination, bringing a large set of actors to the negotiation table is only the first challenge. A second challenge is for each representative in mission governance bodies – especially those in "non-core", often sectoral, departments – to engage colleagues in mission activities, share information and possibly commit funding. The mission competes for time and resources in administrations that would not normally be involved in such activities as they are not traditionally considered central to their sectoral mandate. Some of these actors, who act not only as contact points but also as "ambassadors" for the mission within their administration, struggle to engage the leaders of related programmes and activities in the mission, and convince them to commit resources.

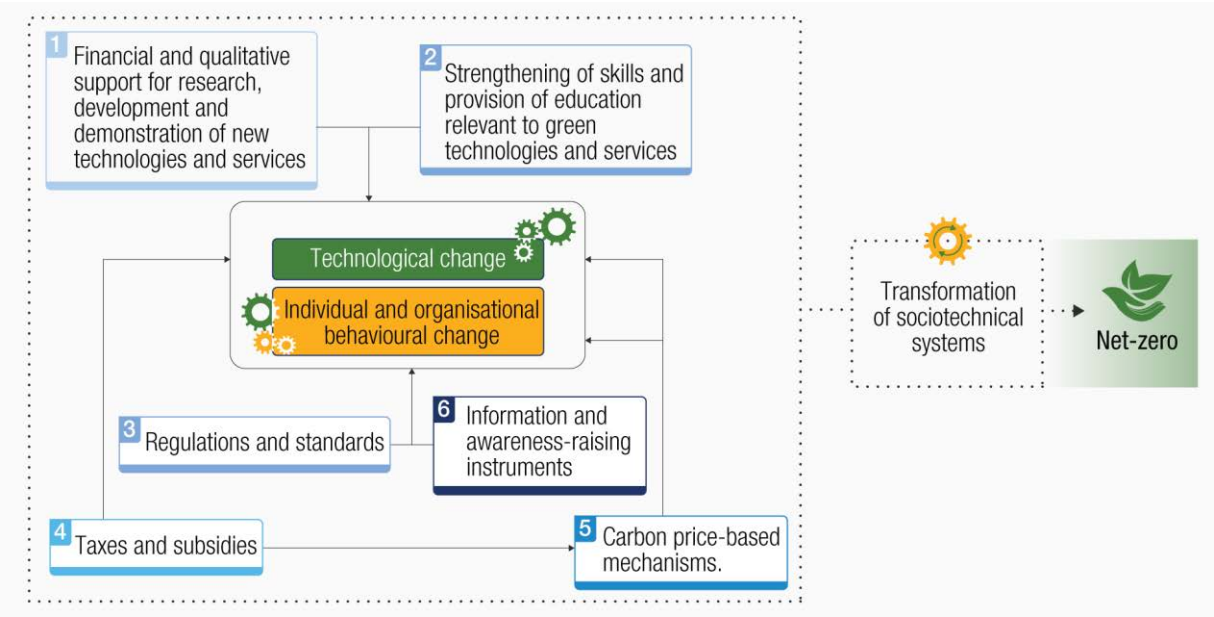
Delivery and management of a portfolio of activities

Different types of public support interventions need to be integrated to fulfil the mission

As outlined in the OECD definition of MOIPs, missions involve a package of policy and regulatory measures (Larrue, 2021[14]). In almost all cases, missions do not create new instruments, but integrate existing ones in a coherent bundle to meet their objectives.

It is widely acknowledged that the societal transformation that conditions the achievement of net-zero will require a combination of different types of interventions for any given sociotechnical option (D'Arcangelo et al., 2022[24]). The different interventions can be categorised under six different types, as shown in Figure 5.5.

Figure 5.5. Different types of public interventions to support the transition towards a net-zero society



Although net-zero missions vary greatly in terms of scale and scope, they always combine several of these intervention types under a common strategic and governance framework. Grants for research and innovation activities remain one of the main policy instruments for channelling mission funding to project partners. They are, however, accompanied by a wealth of other measures designed to support (among others) specific projects, competence or excellence centres, regulatory reforms, competitions and prizes, demonstration sites, training or communication, and awareness-raising activities. For example, the UK industry decarbonisation missions dedicate specific actions to skill strengthening. The Danish CCSU mission performs studies to better understand and shape public acceptance of these technologies. Several missions, such as the Finnish Growth Engine "Green E2", support the emergence of new ecosystems around the mission, which constitute "interest groups" that help promote the necessary regulatory reforms.

An important rationale for integrating complementary instruments is to provide continuous support across the different stages of the innovation chain, from R&D to market deployment. Pilot-E in Norway is one such initiative where the three agencies in charge of research and research-based innovation (Research Council of Norway), innovation and demonstration (Innovation Norway), and early-market deployment of energy technologies (Enova) have teamed up to provide a one-stop-shop for sustainable energy projects, such as green ships (Larrue, 2021[15]).

Although they integrate a wider set of policy instruments, very few missions currently include instruments to support mass deployment of the newly developed solutions. The French clean hydrogen acceleration strategy, for instance, compensates early adopters for the higher price of clean hydrogen. This allow managing and monitoring within a common strategic framework the balance to be struck, and the complementarities to be exploited, between research for new solutions and market introduction of available ones.

Levels of integration vary significantly among missions

An important distinction between missions is not only the range of these instruments but their level of integration, i.e. the extent to which decisions regarding their implementation follow the commonly developed strategic agenda and are collectively monitored. Some missions can be loosely integrated in

this respect, with the mission acting as a common heading for all relevant activities falling under its remit. This was the case for the missions of the former German "Hightech" strategies (2009-21), which were categorised as "umbrella missions" by (Wittmann et al., 2021[25]).

MOIPs are generally less integrated at the implementation level than at the orientation and co-ordination levels. In many cases, the funding and implementation of activities belong to specific agencies, which use their own portfolio of instruments in keeping with the orientations and guidance decided at a higher governance level.

What are the outcomes of MOIPs?

MOIPs are expected to build upon their three main outputs discussed above (i.e. strategic agenda, governance structure and policy package) to essentially "aim higher", benefit from more resources and engagement from all partners, and explore more systemic solutions. The extent to which net-zero missions contribute to these three outcomes is assessed in this section and synthetised in Table 5.3.

Table 5.3. Synthesis of the main outcomes of net-zero missions

Outcomes

Net-zero mission effects	Main results
A) Broader scope and level of ambitions in missions	
Broader set of potential solutions considered	The scope of the mission is a matter of important debate to strike a balance between the benefits of 'open' missions (characterised by neutrality and exploration) and more narrowly defined missions (characterised by directionality and integration between different mission activities). Few missions are open, and some are evolving towards more narrowly defined and directional missions.
More ambitious and long-term objectives	Most missions have set objectives geared towards impacts in 2030 and 2050. The differences in different missions' levels of ambition are difficult to assess.
B) Greater resources and higher engagement in net-zero missions	
Higher and longer-term funding	Missions generally benefit from longer-term funding compared to traditional research and innovation schemes. Funding is only informally earmarked for missions in the long run, but public funding announcements tend to generate some pressure for public authorities to commit the promised resources. Net-zero mission budgets mainly originate from STI public authorities. Few sectoral public authorities have committed additional funding to achieve the missions. There is limited financial innovation in leveraging public funding to attract private funding (through blended finance, equity funding, etc.)
Stronger buy-in and commitment of private actors and stakeholders	There is strong engagement of stakeholders in developing the strategic agenda. Insufficient information on private-sector financial contributions to conclude on mission leverage effect.
C) More systemic innovation in net-zero mission	
Better integration of the demand and impact dimensions	Connection to needs and demands is one of the aspects most frequently raised as a novelty of net-zero missions. Net-zero missions provide various means to articulate demands at different stages of the mission life cycle, from mission definition to mission evaluation.
More comprehensive and consistent range of activities	Net-zero missions allow a wider and more consistent range of activities, from basic research to deployment, capacity-building, communication and advocacy. Proactive portfolio management practices in missions are necessary to reap the systemic benefits of missions but require significant resources, new skills, and new rules and procedures in ministries and agencies.

Broader scope and level of ambitions in missions

There exists a need to strike the right balance of openness

The scope of a mission is one of the most difficult factors to comprehend conceptually and handle in practice. One reason for this is the apparent paradox at the core of the mission principle: missions must be open to all solutions for a given objective, but the framing of the objective itself greatly influences the range of potential solutions. The scope of options greatly varies according to the positioning of the mission's objective in the "problem tree", from a totally open mission ("solving climate change") to narrower missions addressing the issue of emissions in certain areas, and even within specific technologies.

In theory, the only specific mission objective that would not restrict the range of potential solutions would be "to achieve net-zero by 2050", without any mention of any sector or technology that might hinder actors from helping to find net-zero solutions within the framework of their own capabilities and experience. Another rationale for mission openness is that a narrow scope can create doubts about the mission's neutrality. When support increasingly targets a more narrowly defined problem, the "level playing field" can be altered (Boon and Edler, 2018[26]).

In practice, several factors conspire against overly "open" missions:

- Relevance: some strategic narrowing-down of the problem allows a better alignment with national priorities (themselves related to international commitments), as well as greater coherence with a country's research and industry systems. While these criteria could, in theory, be integrated ex post when selecting the projects, rather than ex ante when specifying the problem, in practice, this would generate inefficiencies both for the project partners and the policy makers.
- Commensurability: a mission's objective must be aligned with the available national financial resources and capabilities. A small innovation system will struggle to pursue a net-zero mission with the necessary scale and scope to cover several emission sectors (e.g. agriculture, industry and transport). Of course, this does not preclude using more traditional policy instruments to support innovation in emission reduction in other sectors. In most countries, however, the mission approach, which involves significant budgets and transaction costs, will need to be reserved for areas where the problem is particularly acute.
- Consistency of the option portfolio: an overly open mission could result in a set of options that are too dispersed to work synergistically. Reaping the expected benefits of integrated activities within a mission requires some degree of proximity (either through similarities or complementarities) between the different options proposed to solve its objectives.

In practice, "open" missions do exist. For example, the "Towards net-zero" mission of CSIRO in Australia focuses on advancing net-zero technologies to the point of demonstration, without specifying what those technologies should be. What is particularly interesting is that the earliest open missions have already learned from their experience, and are now evolving towards (or will be replaced by) a less open, more strategic definition of their objectives. This is notably the case with the Swedish strategic innovation programmes and "Challenge-driven Innovation" schemes.

Choosing the right scope of missions is, therefore, a matter of striking the right balance. Some pilot "multi-mission MOIPs" have been experimenting with various scopes.

> Science Foundation Ireland (SFI) has debated how to determine the "right" scope for the missions under its new "Challenge Research" programmes. The agency has deliberately launched missions with varying degrees of openness to draw lessons on this key issue. The Zero Emission Challenge, for instance, was very open as it aimed to "Support interdisciplinary teams to develop disruptive solutions that accelerate progress towards net-zero greenhouse gas emissions in Ireland by 2050". It attracted a project to create a carbon-neutral, resilient dairy farm ("Farm Zero C", the winning project at the end of the competition), as well as projects on the recycling of lithium cobalt batteries or new solar panel technologies. Other missions were more narrowly

> defined, such as the Food Challenge or the Plastics Challenge. Some further specifications allowed fine-tuning the degree of openness: the Zero Emission Challenge was open to all solutions to reduce GHG emissions, but a specific "bonus" of EUR 1 million (euros) was announced for projects that would succeed in developing CO_2 removal technologies

Another way in which missions manage their degree of openness is through stage-gate funding and other procedures that take a gradual approach to problem resolution (such as calls for expression of interest). A mission can start with broad objectives to "test" the potential ecosystems and explore different pathways, some of which will be selected and expanded at later stages. In these missions, the more systemic aspects are developed within the projects that make it to the final stage.

Open exploratory research is placed inside or outside missions

The scope of options can vary depending on the types of activities supported within a given mission. Missions often pursue in parallel different generations of technologies to fulfil staged objectives, often related to GHG-reduction commitments for different time horizons (2030 and 2050 in most cases) Mission co-ordinators usually emphasise that they try to remain more open and flexible with regard to the scope of solutions under investigation for future technologies, as they require more exploratory research.

While such an approach can appear to be in line with the "common wisdom" of research management, it has implications for the design of the mission. Since the focused and integrated features of the mission-oriented framework are less suited for exploratory research, then it may be better placed either outside the mission or in a specific sub-programme with its own operating principles and governance, although still directed towards mission goals.[9] In both cases, regardless of whether exploratory research is positioned inside or outside the mission, it is essential to set up institutionalised linkages between these upstream activities and the mission's "core" development, demonstration and deployment activities. Concretely, this involves periodical progress reviews of these activities, and subsequent critical decisions as to which avenues should be terminated, redirected or integrated into the mission plan.

> Within the French Acceleration Strategies, exploratory research is conducted in the Priority Research Programmes and Equipment (PEPRs) which are attached to one or several acceleration strategies to support them. PEPRs function as "upstream sub-programmes", embedded within the acceleration strategies but with their own operating principles, budget and structure of governance. This provides PEPRs with a significant level of freedom to investigate new uncertain basic research avenues that could lead to new solutions to the acceleration strategies' objectives. The PEPR "Support innovation to develop new low-carbon industrial processes", which is attached to the industry decarbonisation acceleration strategy, covers technology-readiness levels 1-4 through breakthrough research on (for instance) the storage and valorisation of CO_2. The PEPR has a budget of EUR 70-80 million out of a total budget of EUR 610 million. The results, and the new information and opportunities originating from the PEPR, are discussed in the context of the mission "Task Force" (the mission's operational governance structure), and therefore in an inter-ministerial setting. This is hardly the case in more traditional programmes, where exploratory research is connected to authorities in charge of R&D, but rarely to other actors located at later stages of the innovation process.

Greater resources and higher engagement in net-zero missions

Missions attract longer-term funding

All missions with formal targets related to GHG reduction targets have set their final mission deadline for 2030 or 2050, in line with their country's international CO_2 reduction commitments. While administrative budgeting processes and political cycles do not allow securing budgets until these deadlines are reached, the analysis of the missions' funding horizon shows that they generally benefit from longer-term funding compared to traditional research and innovation schemes. Among the net-zero missions for which information is available, a majority (61%) are funded for more than four years on average, with 38% of these receiving funding for more than six years. For purposes of comparison, OECD analysis of

competitive research-funding schemes shows that the majority of research awards are granted for a period of three to five years, although there are reports of increasing grant durations in more recent funding schemes. Financial support awarded for longer durations (seven years or more) is most often directed at ”excellence centres” with lower application numbers or is associated with institutional funding (OECD, 2018[27]). The comparison with EC-OECD STIP Compass data confirms this result: about 45% of public research grants and 34% of business R&D grants have a funding duration above three years.[10]

Since most funding organisations (ministries, agencies) are still subject to an annual budget cycle, multi-year funding is most often only announced (or in the best case earmarked), but not appropriated. However, even if non-binding, they are announced publicly, and therefore usually represent fairly reliable budget commitments that reduce the level of uncertainty of the partners and stakeholders involved in the mission, allowing them to plan ahead and set more ambitious and long-term objectives. Missions are too recent to allow assessing whether they can withstand several budgetary restrictions, such as those experienced after the 2008 financial crisis. The likely tightening of budgets in coming years, owing to the difficult economic conditions related to the COVID-19 pandemic and Russia’s war against Ukraine, will be their first robustness test.

Most missions’ budgets remain in the range of large-scale climate R&D programmes, but are better integrated

Sixty percent of the mission initiatives assessed in the OECD study had budget information available.[11] The most frequent annual budget ranges were EUR 1-20 million (23 missions, 50%) and EUR 20-200 million (12 missions, 26%).

As for other policies, the diversity in mission budgets owes primarily to overall differences in the size and level of development of country STI budgets. Another important factor in determining budget ranges is the scope of the mission. Large systemic missions, such as those defined in an overarching mission-oriented strategic framework, feature a wide number of programmes that are relevant to the mission. This was the case of the former German HTS mission, “Achieve substantial greenhouse gas neutrality in industry (‘GGNII’)”, which had an annual budget of EUR 6.25 billion. However, the budget figure alone can be somewhat misleading in such cases as the mission’s overall budget is the aggregation of different funding sources, and the influence of these “umbrella programmes” on the different budgets falling under the mission is unclear.

A mission’s budget envelope correlates with its content. Notably, the few missions that also support the market deployment of new solutions generally require far greater budgets than missions focusing on research. As mentioned earlier, this is the case for France’s “clean hydrogen” and “industry decarbonisation” acceleration strategies, whose respective budgets of over EUR 1 billion per year are largely allocated to providing price-based incentives for adopting new (more costly) technologies. On the other end of the spectrum, the Irish “Zero Emissions Challenge” research programme, which aims to include the demand dimension in its research activities but remains focused on R&D, has an annual budget of EUR 1.5 million.

Public funding data are not readily available for comparable initiatives, but comparing selected examples of climate change-related research and innovation “programmes” provides some meaningful orders of magnitude.[12] This comparison shows that (“non-mission-oriented”) thematic programmes in renewable energy, CCSU or sustainable transport technologies have budgets in the EUR 5-100 million range, as it is the case for most missions.

However, here again the comparison should be treated with caution, as some of these programmes might be closer to the level of MOIP initiatives (which often include several missions) than that of individual missions. Annual funding levels of whole MOIP initiatives are actually higher, ranging from EUR 11 million

for Pilot-E in Norway to over EUR 1 billion for the UK Industrial Strategy Challenge Fund (EUR 1.3 billion) and the Dutch mission-driven "Topsector" policy (EUR 1.4 billion).[13]

While the comparisons above are imperfect, they tend to suggest that the funding envelopes available to net-zero missions, while significant, remain somewhat in the same order of magnitude as more traditional large climate-related research and innovation programmes.

However, further investigations should also be performed at the level of the projects and activities within missions. It often happens that the financial support provided for given activities or projects is greater than what it is in traditional project funding. For instance, more targeted joint action between the three agencies involved in Norway's Pilot-E scheme makes it possible to fund a smaller number of large consortia. The Dutch MTIP is also one of the very few cases where a specific instrument has been specifically created to complement the mission policy mix. Specifically, the "Mission-oriented research, development and innovation" scheme supports multidisciplinary consortia that undertake projects combining various technological and non-technological sub-solutions, including activities related to their commercialisation and societal acceptance (Janssen, 2020[23]).

Besides funding levels, an important dimension is the nature and composition of mission budgets. Many missions do not have a dedicated budget and are funded by different funding sources. This is confirmed by the survey of mission practitioners and stakeholders performed by the OECD Mission Action Lab and the Danish Design Center (OECD and DDC, 2022[22]). While the bulk of funding comes from national actors, most missions receive funding from multiple sources, showing a "scattered image of funding resources". Furthermore, around one-third of respondents consider that "aligning resources across government or organisations" is the biggest financial challenge, ahead of the mismatch between investment and strategic mission objectives, the lack of risk capital and high-risk, high-reward investments, and the lack of targeted resources.[14] This is especially the case for the larger national missions, despite some notable exceptions.

> The budget of the French clean hydrogen acceleration strategy is an order of magnitude higher than past funding of hydrogen RD&D, notably due to the support provided to market deployment. The increase is from around a few hundred million euros in the last 10 years to over one billion euros per year for the acceleration strategy. Furthermore, during the French "Investments for the Future" programmes (*Programmes d'investissements d'avenir* [PIA]) 1 to 3 (from 2010 to 2020), the budgets used to be integrated by sectors of intervention (e.g. higher education, business innovation, technology transfer) and/or broad sectors (transport, energy). With the adoption of the "acceleration strategies" in the PIA4, the budgets now target each strategy, covering different industries and stages of the innovation chain. This makes it easier to co-ordinate the plans of different actors, mobilising and staging various actions or sectors as required, in accordance with the progress made.

Contrary to what might be expected from experimental and ambitious initiatives, missions have not been supported by financial innovation. To a large extent, funding sources remain traditional, without recourse to equity funding, blended finance or other types of public-private financial partnerships. Innovative public procurement is also seldom used, despite some early prototypes. Attracting funding at the right scale to additionally support the mass deployment of novel solutions will require finding new ways to fund missions at a time when public budgets are under pressure.

The leverage effect of missions will be essential to determine their success

Uncertainty around the unfolding of net-zero pathways, and consequently the development of the mission strategic agenda or roadmap as a "living document" in many missions, requires some degree of financial flexibility. Firm long-term financial commitments from public authorities must be in place, while still preserving a significant margin for changes to adapt to new internal and external developments. However, this can prove difficult due to existing rigid public budgetary and accounting rules. One workaround is to commit a portion of the announced funding and earmark another portion to be awarded under certain

conditions, notably the ability to form a wide and solid partnership that gathers the necessary capabilities and resources to meet the mission objectives. A more common solution is to use a gated funding model, where projects must achieve pre-determined assessment milestones to progress to the next phase and receive the associated instalment.

> In the Danish CCSU Innomission, 40% of the budget is not included at the start (compared to 10% usually), but rather earmarked for allocation to the selected partnership over five years. The main condition for the allocation of this funding is the proven ability of the partnership to attract new relevant activities and partners. To do this, the partnership may need to face administrative and legal issues.

Mission funding should therefore be considered from a dynamic perspective. Ultimately, a mission's success depends on the funding it is able to attract, using the governance and policy frameworks it has built with its initial budget: some mission managers view the initial budget of their missions, in almost all cases originating from the leading STI authorities, as "seed money". Given the transformational objectives of net-zero missions, the finance needed to scale up the sociotechnical solutions that have been developed are vastly higher than their endowment at the outset. Some missions have invested in developing a "map" of potential funding sources that could be mobilised as the mission's strategic agenda unfolds. To date, however, few missions have been able to secure significant financial commitments beyond the initial STI funding. The EU "Climate-neutral and smart cities" mission has set up an innovative procedure to label cities that comply with some criteria established collectively in order to ease their access to complementary funding.

> The initial EU Cities mission budget (EUR 360 million over 2021-23) originates only from Horizon Europe. To date, no other directorates have committed or even earmarked funds for the mission. This initial budget is mainly dedicated to setting up the overall framework for developing and normalising the process to be followed by the 100 participating cities to become "smart and climate-neutral", and supporting the cities in implementing this process through the Mission Platform. The platform provides participating cities with the necessary expertise and assistance for developing and implementing their CCCs, as well as financial and technical advisory services to develop a tailor-made investment plan to access public and private funding. A key component of the mission's leverage effect consists in awarding a "Mission label" to selected cities that have signed a CCC. This label aims to "unlock synergies with other programmes" by facilitating the creation of targeted funding opportunities in other EU funding programmes (not least the European Investment Bank and the European Regional Development Fund). Cities are invited to refer explicitly to their mission label in their award procedures (calls for proposals, prizes, etc.). It is also expected that in the second phase of the mission starting in 2023, when the vast majority of CCCs are in place, linkages will be established to calls for proposals under other EU funding programmes. Labelled cities could receive privileged access to some relevant EU calls or additional "points" in the award criteria under these calls' evaluation process. The Council of the European Union, in its "Conclusions on European missions" adopted in June 2022, proposed that this labelling procedure be used for other EU missions in the context of calls for proposal outside Horizon Europe, in order "to facilitate the construction of missions' portfolios, to increase the visibility of the related initiatives and to gather their results" *(Council of the European Union, 2022[28])*.

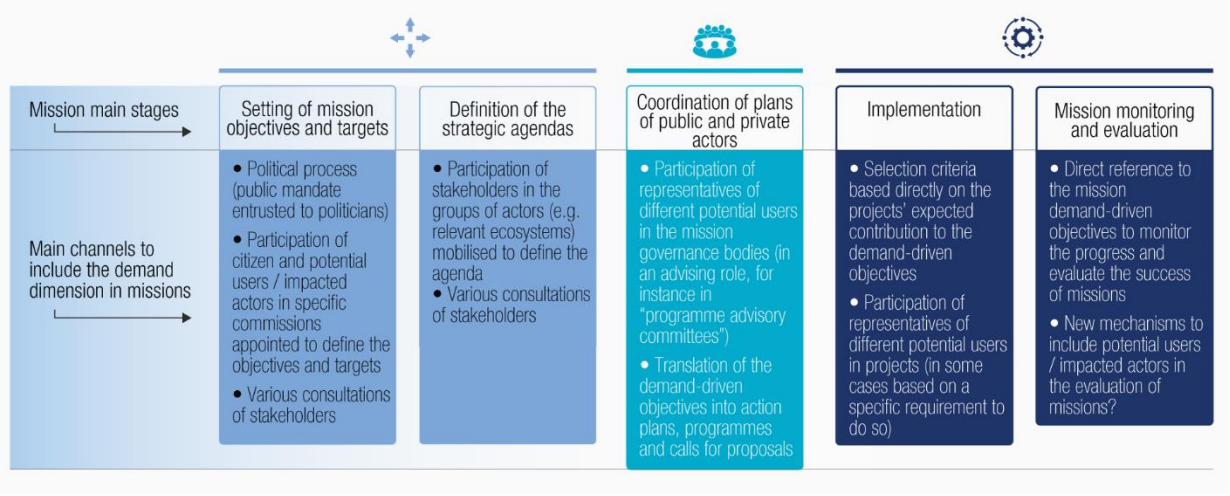
More systemic innovation in net-zero missions

Needs and demands are articulated throughout the mission's life cycle

Although different types of STI policies have made progress in the way they identify the needs and demands to be addressed, and how they use these to calibrate their objectives and design, the demand conditions are still not given full consideration when designing the policies to support missions (Boon and Edler, 2018[26]). The systematic review of net-zero missions in this chapter draws a less negative picture of missions. It finds that in many cases, the missions tend to be effective platforms for demand articulation in the specific context of systemic and complex societal challenges.

The mission's demand-driven nature is one of the aspects most frequently highlighted as a novelty of the mission-oriented policy approach. There exist various means to articulate demands in missions at different stages of their life cycle, from mission definition to mission evaluation (Figure 5.6).

Figure 5.6. Integration of the demand dimension in net-zero missions at different stages of the mission lifecycle



During their early stages of definition, missions use different ways (e.g. consultation workshops and platforms, committees and studies) to determine and integrate the interests of society and various stakeholders' views.[15] Through these various channels, the demand and use dimensions are embedded by design in mission objectives and targets. While the mission targets can be sometimes politically driven (as for the 25 missions of the Dutch MTIP), in many missions, the development of the strategic agendas is the main channel for integrating the demand and use dimensions. This is especially true for ecosystem-based MOIPs. In these initiatives, large communities of actors coalesce to develop an agenda that is consensual enough to reconcile the interests of the broadest part of the ecosystem, and ambitious enough to maximise the chances to be selected by public authorities for implementation.

The governance of the mission can also serve as a channel to connect more continuously to the potential user community and various interest parties. Although these co-ordination structures most often involve representatives from various public authorities, the presence of sectoral ministries or agencies can help integrate the use dimension in missions. Again, ecosystem-based MOIPs are an exception, as their governance structure features large representation from the ecosystem itself. Some of the largest overarching mission schemes can also have a dedicated advisory body, comprising stakeholders and experts with strong consultation mandates.

During the course of implementation, some missions – even the most research-intensive – have integrated policy support into the upstream and downstream stages of the innovation chain at the project level.

> In the Irish net-zero mission ("Challenge Research" programme), project applicants are strongly encouraged to include users in the proposal. While this is not compulsory, it is clearly recommended. Even during the so-called "seed phase" (first phase in the programme's stage-gate funding), SFI promotes interactions between the "challenge teams" and potential "solution beneficiaries" so that they can test whether their ambitions are realistic, and also navigate non-technical issues relating to challenges (e.g. stakeholder engagement) and solutions (e.g. barrier identification). A "societal impact champion" is nominated for each project, to provide a strong societal perspective for team members as they develop their solution, and build relationships between scientific researchers and their stakeholders and beneficiaries.

> In addition, SFI strives to identify and map the "impact actors" related (in a broad sense) to the various applications and use of the technologies being developed, and support connections between the researchers involved in the mission and these organisations. SFI strongly encourages the mission teams to engage with these actors so that they better understand the challenges and start building connections. This has a significant acceleration effect, bringing projects closer to the market and impact. SFI also organises "meet and greet" events with investors, to familiarise researchers with their way of thinking.

Missions support a more comprehensive and consistent range of activities

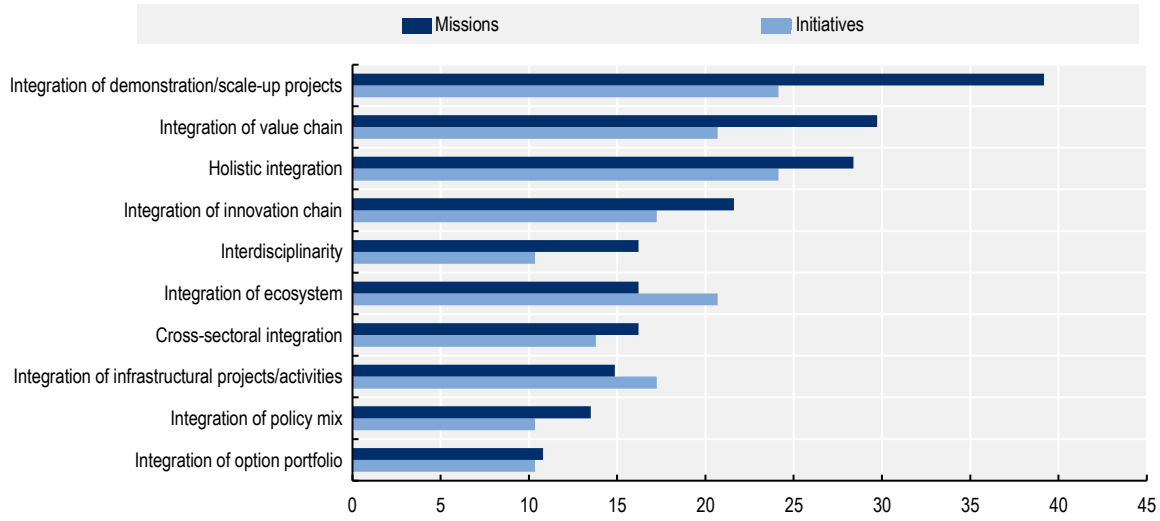
Depending on a mission's objectives, its tailor-made policy mix supports a wide range of activities, from basic research to deployment, capacity-building, communication and advocacy. However, the added value of the mission approach does not only reside in the diversity of activities it covers, as more traditional initiatives like large-scale programmes or clusters may also cover a wide spectrum of activities. Rather, the mission enables greater consistency in the pool of projects geared towards achieving its objectives and often guided by a specific strategic agenda.

> The Atmosphere and Climate Competence Centre (ACCC) is a Finnish flagship programme that aims to mitigate climate change by increasing forest and soil carbon sequestration, and improve global air quality. The ACCC consortium brings together three universities and one research institute, and over 40 key stakeholders. The mission sustains a diverse array of activities, which run the gamut from education, research and impact programmes, to engagement and citizen science, and solution development and prototyping. Among these activities, the Verified Climate Safety initiative verifies climate neutrality based on observation systems; the GlobalSMEAR initiative integrates 1 000 atmospheric-earth system stations to provide data from various ecosystems around the world; the Citizen Science Initiative allows the general public to contribute to problem definition, data collection and analysis in climate science; the Initiative for "Safer Climate" works at the intersection between civil society, academia and art; the Climate University develops climate change and sustainability education in higher education; and ACCC Impact Week promotes dialogue between earth system scientists and society stakeholders interested in the co-creation of science-based solutions for climate change and air quality.

Most (if not all) net-zero missions illustrate the additionality of the mission approach, compared to traditionally more fragmented policies, when it comes to designing and directing a consistent pool of activities towards a shared goal. It is therefore worth delving further into the subject and attempting to debunk this notion of portfolio consistency and determine what type of complementarities are expected in the various missions. Figure 5.7 provides such an analysis, using an ad hoc typology of the announced rationales for integrating activities within missions.

Figure 5.7. Breakdown of net-zero MOIP initiatives and missions by scope of integration

In percentage of MOIP initiatives and missions



Note: MOIP initiatives are the overarching MOIP frameworks that "host" the missions. For instance, the Dutch "Mission-driven Topsectors" programme has 25 missions, while the United States Department of Energy has launched 6 Energy Earthshots.
Source: Authors' own calculations based on authors' desk reviews.

StatLink https://stat.link/idze6x

First, around 40% of the missions included in the OECD study also target demonstration and market deployment phases. This shows that the net-zero missions' scope extends beyond R&D and seeks to better bridge the demonstration or scale-up stages, ensuring continuity. Second, almost 30% of missions aspire to connect together different segments of the value chain. Third, the most frequent type of integration in net-zero missions is "holistic integration" (28%). As already noted, missions introduce in a systemic way various forms of activities into their remit by including social, legal, behavioural and educational aspects.

Some net-zero missions add new formal criteria to traditional criteria for selecting activities (e.g. team excellence, relevance and experience) in order to capture each project's expected contribution to the mission's objectives. However, this new approach is still in its infancy, and there are few precise comparative studies on the different ways of assessing the "fitness" of a mission portfolio within a given project.

> The four EU missions – all of which aim directly or indirectly to reduce GHGs – represent a step change in the way the projects are selected in framework programmes. As stipulated in the Horizon Europe Implementation Strategy *(European Commission, 2020[29])*, mission evaluation modalities will be designed to ensure the selection of a coherent portfolio of projects. The plan is to proceed via two-stage calls, first, by evaluating the intrinsic quality of each individual proposal submitted and second, by identifying high-quality proposals that work together to maximise the expected impact of the portfolio as a whole. The evaluation committees will have more flexibility to adapt to a mission-oriented approach. For instance, Article 26 of the Programme regulation stipulates that the "evaluation committee may rank the proposals having passed the applicable thresholds according to their contribution to the achievement of specific policy objectives, and may also propose any substantial adjustments to the proposals in as far as needed for the consistency of the portfolio". Actions are also encouraged before a call (e.g. using an expression of interest mechanism) to support the building of a consistent portfolio. Another novelty is the tailor-made approach for selecting projects, which will vary from mission to mission to take into account each mission's inherent characteristics.

Missions encourage hands-on portfolio management

The implementation of such portfolio approaches calls for a change in established practices, not only to select projects according to mission objectives and strategic agendas, but also to manage the projects and complementary activities more proactively and strategically. These so-called "portfolio management practices" originate from large-scale projects in the public and private sectors (notably in defence and aeronautics), and entered the realm of STI public policies through the DARPA agency and, later on, DARPA-like agencies (Wallace and Rafols, 2015[30]). As documented by a voluminous literature, portfolio management in these agencies is greatly predicated not only on the rare combinations of competencies among the programme staff, but also on the conditions offered to them within their agencies (notably in terms of support resources, empowerment and autonomy) to allow them to perform active project management (Azoulay et al., 2018[31]).

Many MOIP initiatives adopt such proactive and hands-on portfolio management practices and engage in frequent interactions with mission partners, including during the calls for proposals. This is less the case of the ecosystem-based MOIPs, whose success depends more on co-operation among the wide range of ecosystem partners in the framework of a co-developed strategic agenda than on the competencies and prerogatives of a key individual co-ordinating their actions. In these missions, such as the Finnish Growth Engine "Green E2", significant funding (sometimes the whole budget) is dedicated to supporting the formation and structuring of the ecosystem partnership, and providing resources for its "orchestration". Similarly, the "Swedish Innovation Platform for Textile Sorting" also dedicates one stage (Stage 2) of a three-step stage-gate funding process to stakeholder collaboration.

While it is difficult to quantify, several mission managers emphasised that proactive portfolio management calls for significantly greater resources than traditional practices. They also mentioned that these practices are often hindered (or in some cases made impossible) by organisational procedures – and in Europe, by R&D state aid rules that require a fair treatment of project applicants to ensure a level playing field among potential beneficiaries.

Conclusions

Applying a theory of change, this chapter has provided the first comprehensive analysis of the additionality of MOIPs in helping countries meet their GHG emission-reduction pledges, building on a purpose-built database and in-depth case studies of net-zero missions. Although further work is needed to finalise the analysis of this rich material, the chapter has identified key strengths and weaknesses, and possible future evolutions of net-zero missions.

Most net-zero missions produce many of their expected results. In most cases, they represent a marked improvement over traditional STI policy mixes. They allow different mixes of – and a stronger focus on – common objectives and strategic agendas, broader co-ordination of policy plans across administrative silos and higher integration of various support instruments across the different stages of the innovation chain. However, these improvements will not be sufficient to scale up and deploy these innovations on a massive scale. Net-zero missions focus on technological innovation. In essence, they remain led by STI authorities, relying almost exclusively on STI policy interventions and budgets. While sectoral policy and regulatory authorities have a hand in the mission structure of governance, and can share information – and to some extent, influence – decisions, they have not yet contributed their own resources and programmes to the mission. To bring about the transformative changes needed to achieve the goal of net-zero (as opposed to simply reducing overlaps and speeding up technological innovation), net-zero missions will require investments of a far greater scale and scope. They will also need to balance, align and accompany the mass deployment of these innovations with solutions to promote social and behavioural changes, which is prerequisite for reducing GHG emissions rapidly and significantly.

The success of net-zero missions will depend on their ability to expand beyond STI programmes and budgets (the "STI-only trap") and move from co-developed strategic agendas to joined-up action (the "orientation trap"). Encouragingly, recent existing experimental and pilot mission initiatives with significant reflexive activities have already generated important learning, and are starting to move away from these traps.

The MOIP "STI-only trap"

Net-zero missions are broader in scale and scope that traditional programmes, but remain focused on more or less narrowly defined "technological innovation". While mission managers often claim that social innovation is as important as technological innovation in their mission – and far more prominent than in other STI initiatives – the social components are mainly limited to advocacy, information and communication campaigns, as well as various studies at the individual and societal levels to prepare technology scale-up and market transition. Given the importance of combining both types of innovation, the transformative potential of these missions remains unclear. This is consistent with other studies, such as the study on the missions of the former German HTS 2025 during the 2017-21 legislative period, which showed that stakeholder involvement remained limited in the mission formulation process to traditional research and innovation actors, thus not fully realising its transformative potential (Roth et al., 2022[32]).

Even in the broader and most ambitious missions, a closer scrutiny of leadership and financial commitments shows that in practice, they are also funded strictly with "STI money" and pertain to programmes with an STI mandate. For instance, the EU "Soil" mission plans to focus its actions on specific communities, including land managers, citizens, consumers and companies (European Commission, 2021[33]). Stakeholders need to be mobilised far beyond the scope of STI, which raises the question of whether the Horizon Europe research and innovation framework programme is the best location to "host" such ambitious objectives. At the EU level as well as in countries, the funding of activities "beyond STI but with STI money" has already generated some concerns among researchers who usually benefit from these programmes.

These observations raise the question of where missions aiming to transform sociotechnical systems to achieve net-zero should be anchored in government structures. The three main options are STI public authorities (research and/or innovation), "challenge owners" (sectoral authorities) or centre-of-government (president, prime minister or cabinet offices). Although this does not apply to all national institutional settings, positioning the MOIP leadership "above ministries" seems relevant, to raise their level of ambition and broaden their systemic scope beyond STI authorities. This option is also more compatible with integrated multi-year budgets originating from different sources (including centralised budgets and "common pots") across policy fields. It is also important to strengthen high-level political buy-in and citizen ownership of ambitious net-zero missions. A few countries with longer experience of this policy approach – such as Sweden, where missions lie within the research and innovation agencies – have tried to "elevate" missions to a higher and broader level of governance, although with mixed results. The French missions (the acceleration strategies), which are led by an autonomous agency attached to the prime minister's office, with strong support from the president and a dedicated budget covering a broad systemic portfolio of actions over different generations of sociotechnical solutions, offer a different model of institutionalised missions. Countries have not yet been sufficiently innovative in institutionalising missions. Novel options to steer, govern and possibly manage large systemic missions still need to be designed and experimented on different levels across government structures. Options include a dedicated agency linked to several ministries, a large public-private partnerships/platform or an autonomous organisation with foundation status.

The MOIP "orientation trap"

Most missions have been successful at setting legitimate and powerful objectives and targets, as well as a widely shared systemic strategic agenda to fulfil their objectives. Each mission has set up dedicated holistic governance structures, under which a range of policy makers from different sectors align their plans and monitor their actions against the mission's strategic agenda. However, whether the strategic agenda actually influences collective decision-making on budget allocation and policy implementation is less clear.

In ecosystem-based missions, which are less directional and empower partners to define their own agendas, a significant share of resources are dedicated to forming the ecosystem and various partnerships by supporting networking, co-ordination and orchestration. Nevertheless, the large financial resources necessary for R&D, and especially scale-up and market take-up, are provided through traditional instruments that sometimes fall outside the sphere of the mission's holistic decision-making and influence. In the large national missions, the link to implementation can also be lessened, due to loose co-ordination in expansive and diluted "umbrella" missions.

Beyond the issue of missions' influence on public policies, their implementation will depend on their ability to mobilise the private sector, which will need to provide huge resources to fund and engage as a key change agent in sustainability transitions. While policy makers and analysts in this phase still focus on public funding and cross-ministerial co-ordination, the ultimate test of missions will be whether they can garner contributions and financial commitments from private businesses and investors. Thus, missions also need to innovate in the way they are funded. Innovative financial models for missions, including public-private partnerships, blended finance options and equity financing, should be investigated and tested to increase and broaden the scope of funding. These new financial models would be combined with new targeted policy instruments and comprehensive funds for solution scale-up and market deployment.

Learning by mission orientation

MOIPs are still in their infancy and limited in number. Among the MOIPs that have been identified in the climate change area, an overwhelming majority were launched between 2018 and 2020. Furthermore, 'early' MOIPs, which were developed even before the policy concept itself gained salience, are not only less numerous but also more remote from the 'ideal' MOIP type.

These often experimental and pilot initiatives with significant reflexive activities have already generated important learning, and continue to evolve. In Germany, the missions of the former HTS 2025, which were criticised for their weak directionality and loose co-ordination, will be followed by the 'Future research and innovation strategy'. This new strategy will feature dedicated governance structures which will materialise the mission-specific goals, establish milestones and assess their achievement through continuous monitoring, as requested by the advisory High-Tech Forum prior to its dissolution. In Austria, the mission-oriented thematic programmes "Building of tomorrow", "Mobility of the Future" and "City of Tomorrow" will be taken over by (or embedded within) four national directional and cross-ministerial missions. In Ireland, the SFI Challenge Research programmes will benefit from the funding and institutional dynamics of the Irish Recovery and Resilience Plan, expanding and "deepening" their mission-oriented approach within the newly created "National Challenge Fund". The latter will be characterised by greater directionality to allow a more consistent and interrelated project portfolio. The Dutch mission-driven "Top Sector" policy will also be improved to render it more strategic and efficient.

These are only a few initiatives, and more work remains to be done to make missions "fit" to support the transition to net-zero. This process will require significant monitoring and evaluation frameworks to develop adequate methodologies and processes that can not only assess their results, but also capture the added value and weaknesses of their mission-oriented features.

Transitioning missions to their next stage in order to escape the "STI-only" and "orientation" traps mentioned above will also depend on making changes to their underpinning environment. Missions often

"stall" not because they are ill-designed, but because they come up against ministries' and agencies' mandates, administrative and legal rules, accounting structures and governance models that cannot easily adapt to the mission approach (Aagaard, Norn and Stage, 2022[34]). Changes at this level are far beyond the reach of STI authorities alone, and will require significant political support and active engagement. There is also a need to make relevant changes within the public administrations themselves, such as adapting incentive structures, procedural rules and practices (e.g. rules governing calls for proposal, selection criteria, project management and reporting) to the requirements of missions, and strengthening the relevant resources and skills (e.g. portfolio management).

Finally, future evaluations of MOIPs related to climate change (and other areas) should investigate and incorporate the system-level benefits provided by missions. Some of the new practices and mindsets generated by the adoption of a mission-oriented policy approach have structural effects at a higher level. In Norway, for instance, the positive experience of cross-agency co-operation in Pilot-E and other "Pilot X" schemes has paved the way for two types of initiatives. First, the revised STI national strategic framework now includes two new high-level and systemic missions (Larrue and Santos, 2022[35]). Second, the four main agencies involved in supporting research and innovation activities have reached a broader co-operative agreement.

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Notes

[1] The “Programme d’Investissements d’Avenir” (PIA) is now included in the “France 2030” recovery plan

[2] The list of net-zero missions in the database is available at: https://www.oecd.org/sti/inno/Online%20list%20of%20NZ%20missions.pdf. Synthetic information on each case study is available at: https://www.oecd.org/sti/inno/Online%20list%20of%20NZ%20missions%20case%20studies.pdf.

[3] The format of this chapter provides insufficient space to lay out the whole analysis of the different contribution claims of net-zero missions, and do justice to the rich material collected through desk research and interviews. The chapter focuses on selected components of the theory of change. The full analysis and results will be presented in the forthcoming report.

[4] The strengths and weaknesses of MOIPs by type are presented in detail in (Larrue, 2021[15]) and are summarised in the annex available at https://www.oecd.org/sti/inno/Online%20typology%20of%20MOIPs.pdf.

[5] For instance, the European Commission engaged in a multi-year foresight analysis in five mission areas to strengthen reflexivity in the policy preparation process (European Commission, 2021[36]).

[6] Technological road-mapping is a normative tool that makes detailed projections about future technological developments and their socio-economic impacts. Foresight, on the other hand, is a “systemic” exercise that analyses the long-term impacts of STI developments in order to contribute to “better-informed policy decisions” (Pietrobelli and Puppato, 2016[37]).

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

[8] The different mission co-ordination structures are analysed in (Larrue, 2021[14]).

[9] This type of research is often referred to as “use-inspired basic research” in Stokes’ quadrant model of scientific research (Channell, 1999[38]).

[10] Team calculation based on data retrieved on 20 September 2022 for 289 policy instruments with the grant duration question filled in the STIP Compass database, in the same countries with net-zero missions covered in the OECD study (https://stip.oecd.org/stip/).

[11] Not all policies and their respective missions had their budgets readily available. In order to develop a budget range for individual net-zero missions where possible, the individual mission funding was taken either “as is” (if explicitly given) or (if necessary) extracted from the overarching policy initiative, and divided by the years in the mission’s individual funding horizon. A simple conversion into euros was then made to ensure that values were comparable across currencies.

[12] Information retrieved on the STIP-Compass Net Zero Portal, an inventory of 289 STI policy initiatives for reaching net-zero (https://stip.oecd.org/stip/net-zero-portal).

[13] Information retrieved on the MOIP Online Toolkit (https://stip.oecd.org/moip/).

[14] 36% of the 131 respondents consider that “aligning resources across government or organisations” is the biggest financial challenge, ahead of the mismatch between investment and strategic mission objectives (34%); the lack of risk capital and high-risk, high-reward investments (31%); or the lack of targeted resources (28%) (OECD and DDC, 2022[22]).

[15] The different means of stakeholder engagement in mission definition were systematically reviewed in the previous OECD MOIP report (Larrue, 2021[14]).