Mission-Oriented Research and Innovation

Assessing the impact of a mission-oriented research and innovation approach
Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach

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Manuscript completed in April 2018.

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Mission-Oriented Research and Innovation: Assessing the impact of a mission-oriented research and innovation approach

Final Report

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The authors thank the members for the Expert Board for their valuable feedbacks and contributions: Jos Leijten, Torsti Loiikkanen, Mireille Matt, Nicholas Vonortas, Matthias Weber.
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EXECUTIVE SUMMARY

Context of the study

The European Commission, DG Research & Innovation, commissioned a study on "Mission-based Research and Innovation: Assessing the impact of a mission-oriented R&I approach" to assess the impact of different and alternative mission-oriented research and innovation (R&I) approaches and to provide thereby evidence for the preparation of the future research and innovation Framework Programme (FP9).

More specifically, the purpose of the study is twofold: i) to analyse the concept of mission-oriented research and innovation, by identifying the various approaches and their respective expected benefits, drawbacks and impacts; ii) to perform an impact assessment study on the potential shift of European research and innovation policies towards mission-orientation.

The main findings are:

- There is a plurality of mission-oriented R&I initiatives rather than a singular mission approach or definition and there are scales of mission-oriented R&I initiatives. From this perspective, EU scale R&I missions would be best served in a hybrid model (including or combining accelerator and transformer elements).

- The evaluation and monitoring of mission-oriented R&I initiatives are critical for their success and should not only consider the achievement of or progress towards the specified targets, but also their unforeseen and unintended impacts. Evaluation of ‘portfolio’ of projects oriented together towards the achievement within the same mission is to be preferred over isolated evaluation of individual projects or activities.

- The mission-oriented approach in FP9 has strong potential for weaker R&I systems. It should be designed in a way that it accelerates their reshaping and strengthening while improving their visibility and attractiveness. This is also likely to contribute to tackling the brain drain problems in certain Member States.

- In implementing a mission-orientated approach in FP9, the European Union should as much as possible build upon the instruments and platforms that are already in place, such as the regional Smart Specialisation platforms, in order to ensure that local and regional actors can contribute effectively and consistently to the achievement of the missions.

- In the introduction of a mission orientation into FP9, the European Commission may want to consider adopting a multi-phase approach, whereby the mission-oriented approach will be restricted to few themes in which largely commonly agreed challenges exist in a first (experimental) period.

- The success of mission-oriented R&I initiatives depends amongst others on long historical trajectories, including past R&I activities that have contributed to the creation of knowledge and to the development of specialised capacities. In consequence, if the European Commission intends to give its R&I policy a mission orientation, it should not neglect basic research while placing the main focus on applied research and innovation, as basic research is a pre-requisite for the achievement of the missions.

- Governing structures for missions should include a new constellation of actors, among those who were previously excluded from the management of R&I policy initiatives, while, on the other side, considering new roles for the traditional actors. There is no ‘one-size-fits-all’ structure that should be promoted over the others. It is essential that the governance structures are clear and can rely on high-level political guidance ensuring multi-level coordination. They must additionally present a tailor-made balance between top-down and bottom-up approach, an emphasis on
cross-disciplinary and cross-sector collaboration breaking down the existing unnecessary silos, and give sufficient attention to downstream synergies.

- The policy-mix deployed in mission-oriented R&I initiatives should expand beyond the realm of R&I policy. It must draw on sectoral policy and policy measures fostering both types of demand articulation, i.e. a better match between supply and existing demand, and the orientation of demand towards a selected direction.

- Citizen engagement must be further encouraged to ensure that societal challenges and the societal dimensions of (technological) accelerator-type missions are considered. It could be orchestrated via ad hoc and dedicated structure or via the existing regional Smart Specialisation platform.

The following sections detail the study findings.

**Concept of mission-orientation**

Mission-oriented R&I initiatives, be they private or public, typically are ambitious, exploratory and ground-breaking in nature, often cross-disciplinary, targeting a concrete problem/challenge, with a large impact and a well-defined timeframe. More specifically, they have a clearly defined (societal or technological) goal with preferably qualified and/or quantified targets and progress monitored along predefined milestones. Directionality and intentionality of these initiatives is what differentiate them from other types of initiatives, such as systemic or challenge-oriented policies.

Mission-oriented R&I initiatives tend to be sizeable (in relation to GDP or overall R&I investments by a country). Mission-oriented R&I initiatives are cross-disciplinary by nature and involve several types of stakeholders. They utilise a mix of policy instruments going beyond the mere realm of R&I policies and require horizontal policies cutting across governance levels. Finally, the results, which rely on different technologies, should be applicable to different industrial sectors and social contexts.

The collected empirical evidence sheds light on two additional features of mission-oriented R&I initiatives: they are managed by a clearly identified and empowered governance body which can be held responsible for the achievements of the missions, and they almost always emerge from a sense of urgency that is shared by a wide array of stakeholders.

Mission-oriented R&I initiatives are not a homogeneous group but vary along the aforementioned characteristics. They exist in different degrees on a scale between two ideal-types: the narrowly defined initiatives, aimed at single, well-defined and, the most often, technological objectives (the so-called ‘accelerators’), on the one hand, and the more broadly defined initiatives addressing complex and often societal problems, requiring the transformation of systems (the so-called ‘transformers’), on the other hand. Furthermore, mission-oriented initiatives may require a combination of several projects, which can be mission-oriented but not necessarily all of them. In other words, policy interventions can be partly mission-oriented.

**Assessing the impacts of alternative scenarios for a move of EU R&I policy towards mission orientation**

The impact assessment exercise is the result of a series of research activities that include scoping interviews and meetings with relevant EC services; analysis of the national R&I strategies and funding mechanisms of the EU Member States as well as their official position in regard to the introduction of a mission orientation in FP9; the analysis of 13 past and present case studies; the assessment as to whether the current EU R&I policy has already some grounds for a move towards mission orientation; and, the collection of direct feedback from stakeholders via 34 in-depth interviews, a workshop co-organised together with the European Commission, and an online survey (which resulted in more than 1800 responses from interested stakeholders from all around Europe).
Cross-country analysis and readiness level for move to mission-orientation

By performing extensive desk research and data analysis, the study analysed the degree of responsiveness of the national R&I (funding) systems to a move of EU R&I policy towards mission orientation. Country fiches outline the funding (present and past trends) and R&I policy context in which mission-oriented R&I initiatives are implemented at the national level and draw some preliminary estimation whether these meet basic conditions for shift to a mission-oriented approach. Finally, the primary official position papers on FP9 of all 28 EU countries governments have been considered to acknowledge the expectation about future funding schemes.

No explicit correlation was found between levels of national spending for R&D and challenge orientation. However, most of the Member States (20 out of 28) have already implemented R&I strategies with some degree of challenge orientation. Some of those, probably because of insufficient mechanisms aimed at enforcing this orientation, still have a relatively low government R&D budget earmarked to societal challenges. The R&I strategies of most EU13 Member States do not include any mission or challenge orientation and are instead mainly oriented at strengthening their national R&I capabilities. If the European Commission decides to shift its R&I policy towards mission orientation, it should consider implementing in a way that does not widen the gap between the newest Member States and the older ones. Mission orientation should be instead an opportunity for the countries with less mature R&I systems to accelerate the development of their capacities and increase their attractivity.

Some Member States have already engaged in discussions on mission-oriented R&I, all of them expressing themselves in favour of such a move.

Case studies

The in-depth analysis of thirteen present and past mission-oriented R&I initiatives focus on multiple aspects of their mission orientation. These initiatives all have long trajectories, significant economic, societal or environmental impacts and are heterogeneous in terms of geographical coverage and thematic area. The analysis has been completed mainly based on desk research, expanding the information collected in the mapping phase. In addition, interviews were used to complement the desk research.

All cases show high levels of directionality to solve the targeted challenges, and most of them are also characterised by high levels of intentionality. Along the lines of these two features and by carefully considering the scope of the policy mix applied and the larger role of the demand-side measures and citizens, the study has distinguished the initiatives in accelerator missions and transformer missions. These, however, are not fixed categories with specific characteristics: instead, these are the limits of a range of possibilities, as many accelerator-types of missions can also significantly contribute towards a transformative challenge and solutions supporting a transformation in society and the economy foster technological developments.

In a nutshell, the analysed transformer missions are initiatives involving systemic change implying profound adjustments which may leverage on the role of consumers and end-users. Accelerator missions are different from the former due to their more specific focus on technological developments and their purpose to reach ambitious research and/or technological goals in a fast and coordinated manner. However, as said, most initiatives have elements of both.

The case studies assessed the basic characteristics of mission-orientation of the initiatives.

- They all arise from a clear necessity to solve or mitigate societal challenges, and/or achieve, maintain or reinforce global technological and industrial leadership.

- The initiatives are very different by nature and scale, varying from localised threats, and are strongly rooted in background contextual factors.

- The economic drivers include costs savings, achievement of secure supply of energy, economic growth, job creation and incentives to maintain, achieve and
enhance technological and industrial forerunner position in global scale. The private-led initiatives are typical examples of initiatives that are pushed forwards mainly by achieving market leadership and financial benefits. However, the economic drivers are not exclusively limited to private initiatives.

- The process of defining missions varies also significantly between the initiatives: some were born through the action of niche grassroots movements, others are formalised after an open stakeholder consultation process, while few others are the results of high-level centralised government decisions.

- All the initiatives have an important scale in terms of budget and resources dedicated, which are largely defined by the scope and timeframe of the initiatives.

- The main governing body of the initiatives is typically comprising of national government, but can also integrate public and private stakeholders, such as universities and industries. In general, the executive coordination is supported by high-level political steering involving various administrative levels and count on the contribution of more scientific advisory boards.

- Missions are tightly controlled with rigorous and transparent monitoring systems, that assess the progress frequently and take the necessary measures to maintain the focus of the initiative.

- All initiatives involve communication actions while few only set participative dynamics through which they successfully engage citizens in the design, implementation or evaluation process.

- The policy-measures that are applied to implement the targets of the initiatives can be mainly focused on R&I support or involve policy mix including measures to support supply and demand. The first include R&D grants, public research laboratories and universities and development projects involving industry actors. The second consist in lows and regulations, public procurement, investment subsidies and other measures to be implemented by the public authorities.

- Many of the initiatives are strongly linked to international initiatives (e.g. COP21 Paris Agreements, United National Sustainable Development Goals).

From current EU R&I policy to mission orientation

The ongoing Active and Assisted Living Programme (AAL) and the Strategic Energy Technology (SET) Plan were closely examined for a better understanding of the current EU policy set-up, the extent to which these cases already show features of mission orientation, and the changes that would be needed to shift the current EU R&I policy towards mission-oriented R&I policy.

The two cases highlight the importance of an integral and coherent vision when designing and implementing mission-oriented policy. However, this vision will effectively orient the activities of all relevant stakeholders, only if there is a shared understanding of the challenge to be solved and of the urgency to do so. Furthermore, the vision needs to be translated into clear and quantified goals and milestones that could be adapted to any contextual changes or unforeseen developments, and into the concentration of sufficient resources on a limited number of themes and objectives. Mission-oriented initiatives must be evaluated and monitored consequently against their objectives and goals. Finally, both cases highlight the complexity of an EU-driven mission-oriented approach in policy domains where the EU has only supporting or shared competence.

The foreseen impacts of five policy options

At the heart of this study is the elaboration and comparison of alternative scenarios in order to provide evidence to the European Commission in its decision relative to the introduction of a mission orientation in FP9. This exercise draws on the combined analysis
of all sources of evidence considered in this study: the literature review, the case studies, the online survey, the in-depth interviews with representatives of relevant organisations, and the dedicated workshop organised in collaboration with the European Commission.

The first option is the **baseline**, i.e. how Pillar III and relevant parts of Pillar II currently work under Horizon 2020. The second option is what has been planned in for the work programme 2018-2020, i.e. a *focus area* approach, where these focus areas cut across programmes and priorities, with virtual calls linking together instruments. Due to their similarity, their foreseen impacts have been grouped

- **Foreseen impacts**: The current situation of the Framework Programme should not be radically changed, as the current structure in pillars and functioning of the instruments has proved being capable of fostering cross-sectoral collaboration among different kinds of stakeholders. There are however some critical issues that should be addressed by the European Commission in designing the FP9. An improved version of Horizon 2020 should: i) rationalise the number of instruments, ii) allow citizens to participate into the design of the solutions solving societal challenges, and iii) dispose of enhanced monitoring and evaluation mechanisms.

The last three options all contain the introduction of missions to FP9, under a dedicated pillar combining current Pillar III and parts of Pillar II. However, they differ in respect to the nature of the missions they target.

- **Transformative missions** (‘transformers’): These missions focus and aim to enable and accelerate systemic transformations e.g. through the development and deployment of innovations. They leverage on cross-sectoral policy-mix going beyond traditional R&I policies and should set mechanisms allowing citizens and end-users to participle in the design and implementation of the solutions. Such a bottom-up approach is justified by the breadth of the transformative impact of these societal missions and can be strengthened by an enhanced visibility EU R&I policy may gain. As transformer missions imply systemic changes and therefore need the contribution of a variety of public actors, to improve the vertical coordination between the different layers of decision-making (EU, national, regional and local authorities) becomes a crucial element for success.

- **‘Accelerators’**: These missions concentrate and direct resources and efforts towards the achievement of ambitious scientific and/or technological goals in a faster, more efficient and coordinated manner. They are aimed primarily at providing technological solutions by prioritising research activities and innovations. Their societal and broad economic effects should nevertheless not be neglected, as the targeted scientific and technologic advancements may help improve the competitiveness of sectors and/or industries, or ultimately address societal challenges. In contrast with ‘transformative missions’, the accomplishment of ‘accelerators’ do not require transforming systems. Furthermore, by definition, this kind of missions is more likely to contribute to technological breakthroughs by being more open to failures. Their monitoring mechanisms, governance structure and instruments should consider these specificities.

- **A scenario combining accelerator and transformer kinds of mission** is considered the preferred model to choose for conceiving successful mission-oriented policies. The governance of such missions needs to be flexible, in order to adapt to changeable challenges, and reflexive, to take into consideration critical issues for the purpose of reaching the final goals. This necessitates to balance bottom-up and top-down approaches, being the most appropriate approach to combine a broad overarching societal challenge (transformer) and several technology-oriented

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1 Those which are planned to be governed by missions in FP9, excluding bottom-up innovation actions which will be managed under EIC.
missions (accelerators) in all those domains where technological advances or breakthroughs are essential for solving societal challenges.

Impact measurement and indicators

Because of their very specific nature oriented towards the achievement of societal challenges, the impacts of mission-oriented R&I initiatives cannot be measured like those of traditional R&I policies. Despite changes in the Better regulation guidelines, Impact assessment is currently (and in reality) still dominated by the quantitative measurement of economic and social impacts. Hence, the models on which to draw policy lesson to inform the European Commission, in its process to move its EU R&I policy towards mission orientation, are scarce.

What should be therefore elaborated is an impact assessment methodology that accounts that mission-orientated R&I initiatives produces their effects and have impacts at different stages along a so-called ‘impact pathways’ (from basic research to innovation and diffusion and system transformations) and at multiple levels (micro/individual behaviour, meso/organisation, and macro/systems). A model of impact assessment that take into consideration both dimension will rightfully consider the interdependencies between innovation activities, on the one hand, and production-consumption practices, on the other hand.

The framework will imply a shift towards ex-ante impact assessment which will pay careful attention to the contingencies related to contexts and systems in which the mission-oriented R&I initiatives will be implemented, as well as to policy and funding mechanisms already in place. Given the complexity, uncertainty and ambiguity of the future, the impact assessment framework will need to foresee iterative process.

Ex-post evaluation of mission-oriented policies has the potential to ‘trace back’ (most likely in a case study manner) specific impulses that were in the end strong enough to change the system but would be of limited value as a tool for investment decisions.
INTRODUCTION

This report constitutes the final delivery of the “Mission-based Research and Innovation: Assessing the impact of a mission-oriented R&I approach” study PP-05541-2017, carried out for the European Commission, DG Research & Innovation. This Specific Contract is under the Multiple Framework Contract ENTR/172/PP/2012/FC for 'the procurement of studies and other supporting services on Impact Assessments and Evaluations'.

While the Horizon 2020 Framework Programme for Research and Technological Development is coming to an end, the European Commission, DG Research & Innovation (DG RTD) is preparing the future Framework Programme FP9. For that purpose, it needs evidence on mission-oriented research and innovation (R&I) in order to determine whether such orientation should be adopted and, if so, which approach should be pursued.

Beyond the distinction between the man-on-the-moon type of mission-oriented initiatives and the initiatives targeting systemic transformations, it appears that these initiatives vary to a high degree in accordance with the policy instruments they mobilise, the governance they rely on, the context of their implementation, the sector(s) they target, the technological challenge(s) they must address, the stage of market development, and so on. In sum, there is no unique approach which the European Commission could adopt and pursue in FP9. It furthermore means that different scientific, technological, economic and societal impacts could be expected from similarly different mission-oriented R&I approach.

The European Commission is in the process of investigating which approach would be the most appropriate to generate the expected impacts. Such an investigation needs to rely on strong evidence. For that purpose, the Study conducted a desk research exploring the concept of mission-orientation and the impacts that could be reasonably expected from such approach. Case studies explore past mission-oriented initiatives and flesh out the various impacts that they had. In order to understand what the influence of a move toward mission of EU R&I policy would be, we study the national R&I funding mechanisms of the EU Member States and their level of reliance on European financing. These inputs serve building an analytical framework aimed at comparing the impact of different policy options for mission orientation against a baseline scenario (the current Framework Programme H2020). This exercise relies on data collected via an online survey and interviews with a substantial number of relevant stakeholders.

The present Final Report presents the collected evidence and the analyses that had been performed on this basis. It is structured as follows. Section 1 provides the theoretical background of the study. Section 2 defines the objectives of mission-oriented R&I initiatives. Section 3 explores the national R&I funding mechanisms and strategy in order to assess their potential reaction to a shift of EU R&I policy towards mission orientation. Section 4 provides empirical evidence of the (potential) impacts of mission-oriented R&I through the study of such past initiatives. Based on two illustrative cases, Section 5 defines the baseline scenario against which alternative scenarios of mission orientation will be assessed, and investigates what a shift towards mission orientation of EU R&I policy would require. Section 6 compares the potential impacts of different approach of introducing mission orientation in EU R&I policy. Section 7 discusses the challenges and requirements for assessing and evaluating mission-oriented R&I initiatives, alongside its methodological implications. Section 8 concludes.
1. DEFINING MISSION-ORIENTED RESEARCH AND INNOVATION

Based on the literature and our empirical findings, we define mission-oriented research and innovation initiatives as large-scale interventions aiming for a clearly defined mission (i.e. goal or solution) to be achieved. Missions have an important R&I component, however they are broader (sometimes much broader) than R&I alone and require also other measures to achieve the goals (e.g. regulation). Such initiatives are found predominantly in the public sector, but there are also ones driven by the private sector. Mission-oriented research and innovation initiatives typically are ambitious, exploratory and ground-breaking in nature, often cross-disciplinary, targeting a concrete problem / challenge, with a large impact and a well-defined timeframe.

The main characteristics of these initiatives are:

- A **clearly defined (societal or technological) target**, preferably qualified and/or quantified in terms of an x% reduction or a y% increase, or in more absolute terms (e.g., Malaria eradicated by e.g. 2050).

- The achievement of the mission is defined for a **specific timeframe** and progress should be monitored along **predefined milestones**.

- A large scale. The initiatives mobilise significant public and/or private investments and other resources (infrastructures, human resources, etc.) and their expected societal and/or economic impact should be large. **Large-scale** is not absolute but dependent on the thematic area and the mission specified. Sometimes it is also sizeable in relation to GDP or overall R&I outlays by a country, a sector or a technology area.

- Mission-oriented research and innovation initiatives are **often needed to drive a ‘system’ or ‘transformative change’** and are – due to their ambition – quite often of an explorative and ground-breaking nature either for policy or for markets. Initiatives may be divided into two broad categories depending on the nature of the mission:
  - **Narrow** mission-oriented R&I initiatives aim to achieve a **single well-defined (often, but not exclusively in technological terms) objective** like the Apollo project that aimed to send a man on the moon (not at developing the rocket that sent him).
  - **Broader** mission-oriented R&I initiatives aim at (or implying) the transformation of systems to address wicked (often societal) challenges like climate change and the ageing population.

- Mission-oriented research and innovation initiatives are often **cross-disciplinary**. The initiatives should involve many different technologies (even if some are at the core of the initiative), involve many different actors (research sectors, companies, government, users, citizens inter alia). The solution that they target should be applicable in a variety of industrial sectors and social contexts, and their development requires horizontal policy cut across governance levels.

- The achievement of mission requires
  - the use of a **mix of policy instruments** (i.e. techniques employed by policy makers to complete a policy objective) that is adequately and accordingly coordinated and oriented.
  - a strong commitment from the public institutions, with consistent decree of political approval making public institutions accountable for achieving the mission’s objectives;
• A clear and **empowered governance (structure)** that can be held **accountable** for achieving the results

• A **sense of urgency** that is shared amongst a broad category of **stakeholders**, including citizens.

From the main characteristics that constitute mission-oriented R&I initiatives that we have identified in the proposal and the inception report, many are in common with ‘systemic’ policies in general (e.g. multi-actor/stakeholder involvement, multi-sector perspectives). **The main differentiating feature, though, is the directionality and intentionality (with respect to specific targets) of the policy.** This is what sets mission-oriented R&I initiatives aside from other policies (e.g. from those addressing societal challenges more broadly and as general orientations).

This working definition is used for screening and mapping mission-oriented R&I initiatives and for selecting relevant case studies.
2. MISSION-ORIENTED R&I POLICY OBJECTIVES

The objectives that underpin a move of EU R&I policy towards a mission-oriented approach in the future Framework Programme (FP9) are two-fold:

- Achieving high and visible impact in selected priority areas. The priority areas that the missions should address are major societal challenges and areas where R&I can be a driver for change.
- Better communication to citizens and engaging society in European R&I policy. European citizens should better understand how EU R&I may contribute to solving challenges that are important to them.

The achievement of these both overall objectives at the EU level requires that the following intermediary goals are fulfilled:

- Concentration and better alignment of R&I investment into the mission areas;
- Support the development of innovative solutions to the problems targeted by the mission-oriented R&I initiatives;
- Link missions closely to non-R&I policy and regulatory measures (to facilitate systemic change);
- Adapt the policy instruments to the pursued missions to facilitate their achievement;
- Place more emphasis on cross-sectoral and cross-disciplinary R&I to support missions effectively;
- Accelerate the uptake of innovations by articulating and increasing (public and private) demand for them;
- Improve communication of the goals and impacts of European research to society;
- Engage citizens in shaping missions and R&I policy.

In the following sections, the survey analysis for each of the objectives is presented. In the final report further evidence will be added.

2.1. Objective 1: Concentrate and coordinate R&I investments

A mission-orientation approach in R&I policy implies a selection of specific problems towards which R&I efforts should be directed. Even though multiple (technological) solutions should be tested in order to find out which one is the most appropriate, R&I investments should be concentrated and the existing public R&I funding instruments should be coordinated in order to avoid any unnecessary duplication and dispersion of public money.

Most (73%) of the survey respondents consider the concentration and coordination of R&I investment into the mission areas to have a positive or highly positive potential impact on their efficiency. Especially the coordination and integration of a variety of R&I funding instruments at EU, national and regional levels was considered to have a positive impact (78%) whereas the mobilisation of new private investments through the longer-term perspectives of the missions/commitments scored lower (67%) but was still considered to have a positive impact. 74% thinks that the allocation of a significant proportion of FP budget directed toward mission-oriented R&I projects has a positive or highly positive impact.
Figure 1. Impact of concentration and coordination of R&I investments on their efficiency

Source: Survey data JIIP.

Among the respondents who expressed themselves in favour of a better coordination and integration of existing R&I instruments, most would suggest that such coordination is made between R&I funding programmes operated by the European Commission and those by national and regional authorities and organisations. Coordination with other types of R&I instruments is considered helpful by less than half of the respondents. Similar trends can be observed across the different groups of stakeholders.

Figure 2 Instruments to be further integrated with other research funding instruments

Source: Survey data JIIP.
2.2. Objective 2: Support the development of innovative solutions to the problems targeted by the mission-oriented R&I initiatives

The achievements of missions require the development of solutions which can be radical (especially when the targeted problem is technological) or incremental innovations. Any mission-oriented R&I policy must therefore implement the most appropriate incentives for the conduct of R&I activities.

For most respondents, support given to risky R&I activities (77%), monitoring of R&I projects aimed at ensuring that their outputs contribute to the achievement of the mission goals (68%), and clear go-no-go decisions ceasing projects that do not prove (fast) their relevance and added value (61%) are considering appropriate means to support the development of new products and services for achieving missions.

Less than half of the respondents contend that support to application-oriented R&I activities only have a positive or very positive impact on the development of innovative solutions. However, their share is still superior to the one of those reporting a negative or highly negative impact. Furthermore, private companies are the only category of respondents which mostly consider that exclusive support to application-oriented R&I activities would spur the development of radical innovations for the achievement of mission.

Opinions differ across the different categories of respondents in respect to the impact of clear go-no-go decisions too. Less than half of the responding higher education institutions (48%) do not have a positive opinion on this type of action, whereas the corresponding share is above 50% for all the other category of respondents. However, the share of the higher education institutions with a negative opinion is even inferior.

Figure 3 Impact on the development of (radical) innovations

Source: Survey data JIIP.

2.3. Objective 3: Integrate non-R&I policy and regulatory measures

Because missions target often complex problems (especially societal missions implying systemic transformations), they cannot rely exclusively on R&I policy instruments but should adopt broader policy mixes. The online survey explored the opinions of R&I stakeholders on the composition of these policy mixes.
Public procurement is reported to be the least effective means (beyond conventional R&I policy instruments) to accelerate systemic changes, as only 53% of respondents consider that it could have a (highly) positive impact in this respect. However, it should be noticed that a high 36% share of respondents assess that the impact of public procurement on systemic transformation is neutral, and those who claim that it will have a (highly) negative impact account for 11% only. On the reverse, more than 70% of respondents replied that training and education (at the national and subnational levels) policies, and sectoral policies would have a (highly) positive impact on systemic changes.

Figure 4 Impact on the integration of non-R&I policy and regulatory measures on systemic changes

Source: Survey data JIIP.

2.4. Objective 4: Adapt policy instruments to pursued missions

Not only did mission-oriented R&I initiatives require policy mixes whose realm expand beyond R&I policies, but they also instruments that correspond to the missions and to the problems that need to be solved. In consequence, R&I stakeholders were asked about how those instruments should be selected to contribute to the development of the best solutions to the targeted problems and to have the highest impact possible.

Flexible and generic (i.e. non-prescriptive) policy instruments purposefully chosen are deemed, according to the responses to the questionnaire, the most appropriate to stimulate the development of ‘best solutions’ and to maximise the impacts of supported projects. Almost 90% of respondents desire instruments that they can easily adapt to the size, duration, requirement and funding requirements of their projects. More than three quarters are similarly in favour in being left the choice of the most appropriate instruments to support the projects they carry out. Finally, a reasonable 60% share of respondents contend that non-descriptive work programme with broadly defined topics will help them identify and develop the best solutions, and maximise the impacts of their projects.
All categories of stakeholders are in favour of flexible and purpose-driven choice of instruments to support their project to similar degrees. However, barely more than 50% of private businesses express themselves in favour of non-prescriptive work programmes with broadly defined topics. The same instrument is, on the reverse, supported by more than 60% of higher education institutions and research organisations.

Figure 6 Impact of non-prescriptive programmes on the development of ‘best solutions’ and maximisation of impacts

2.5. Objective 5: Ensure cross-sector and cross-disciplinary approaches

Silos are a factor hampering mission-oriented R&I initiatives. Even those focusing on technological problems and aimed at accelerating the development of new solutions or
technologies needs coordination across academic fields and industrial sectors. Therefore, a move of EU R&I policy towards mission orientation should be accompanied with incentives for cross-sectors and cross-disciplinary R&I projects. **Around 80% of the respondents** agree that calls for projects accordingly designed in the next FP9 will contribute to achieving the missions effectively. The share of those who assessing a highly positive impact of cross-disciplinary calls is even superior to one third.

**Figure 7 Impact of cross-sector and cross-disciplinary approaches**

![Bar chart showing impact of cross-sector and cross-disciplinary approaches](chart)

Source: Survey data JJIP.

### 2.6. Objective 6: Increase and articulate demand

Missions addressing societal and ‘wicked’ problems must foster systemic transformation, which implies the development of new solutions and their large diffusion. Demand-side policy instruments are of key importance in those missions, either for articulating demand and ensuring that the new solutions match existing needs of end-users or for accelerating the uptake of these new solutions by creating or increasing demand for them.

In general, the **favourite option would be to have demand triggering innovation rather than to have demand merely responsive to innovations**. More than 85% of the respondents have positive or very positive views on the involvement of all relevant actors, from research organisations to industry and end-users in the definition of missions and related roadmaps for the implementation. The involvement of end-users in the design and testing of new innovations comes second, while the compulsory integration of key collaborators along the value chain and the alignment of the initiatives to increase the demand for new solutions comes third and fourth in terms of preferences. Still with positive answers having a wide margin over the negatives, a bigger support of the EU to leading users and to the emergence of lead market appears as the least favourite option.
2.7. Objective 7: Communicate to society

In addition to an increased emphasis on the role of demand actors (predominantly for triggering the development of solutions to the targeted problems), mission-oriented R&I initiatives and especially those implying systemic changes should consider further the role of citizens. The basic preconditions for their engagement is to inform them on missions. The survey explores opinions of stakeholders on different means to improve communication on the goals and impacts of European research projects. Communication geared towards an increasing understanding by and interest of citizens, as well as a more extensive use of social media channels collect more than 80% of positive answers.

2.8. Objective 8: Engage citizens

Citizens engagement is a success factor for mission-oriented policies and for transformation of systems that they may requirement for their achievement. The survey fleshes this widely admitted idea out by asking R&I stakeholders at which stage of the mission-oriented R&I initiatives citizens should be engaged.

The survey respondents seem to have similar views on the two given options: about half of them consider positive (if not highly positive) that citizens are involved in the design or the implementation of missions. Private companies, high education institutions and research organisations are less convinced about the benefits of citizens engagement than public institutions. However, the respondents did not consider the two forms of involvement as alternatives: for all categories of respondents the shares of positive, neutral and negative opinions do not change if the two options were taken separately.
2.9. Conclusive remarks

All policy objectives in a mission orientation are supported by most of the respondents to the questionnaire but to different degrees. Cross-sector and cross-disciplinary, communication on research to society, and adaptation of the policy instruments to the pursued missions are the objectives that collect the highest share of positive opinion (between around 75% and 80% of respondents). The support to the development of (radically) new solutions and citizens engagement in the adoption and implementation of missions are thought to be likely to have a negative or very negative impact on mission-oriented R&I by around 10% of respondents. Despite this high share (in comparison to other policy objectives), both options are supported by a majority of respondents (respectively 63% and 53%).
In conclusion, it may be inferred, from the responses to the dedicated survey, that mission-oriented R&D must, most importantly, cut across silos, be flexible in their implementation (with instruments chosen by R&I performers and not limited to the conventional R&I policy instruments) as long as they contribute all to the achievement of the targeted missions, and be communicated.
3. **BASIC NATIONAL CONDITIONS TO MOVE TOWARDS MISSION ORIENTATION**

The decision to orient (parts of) R&I policy towards the achievement of specific missions is foremost a policy decision. However, it may produce its expected effects only if it is well administered and accompanied with appropriate instruments (aimed at adapting the R&I systems, i.e. its governance and funding mechanisms). This section explores such basic conditions at the national level (mostly in relation to R&I funding) for mission-oriented R&I. This approach, despite some limitations, may give some insights on the impacts of an EU-level decision to move R&I policy towards missions could be in case the main other features of national R&I systems remain unchanged.

### 3.1. Methodology

#### 3.1.1. Step 1: Statistics analysis

The analysis of basic conditions for a successful move towards mission-oriented R&I focuses on R&I funding systems and mainly on three indicators:

- **The level of national R&D expenditures** (also known as Gross Domestic Expenditure on R&D, or GERD) **against the Gross Domestic Product (GDP)**. As one essential feature of mission-oriented R&I initiatives is being of ‘large scale’, they are expected to be sizeable in relation to the total government expenditures for R&D, as well as for the national GDP;

- **The contribution of the R&D expenditures from the European Union** e.g. through the Framework Programmes for Research and Innovations (FPs). Countries whose GERD relies to a high degree on EU funding may be more responsive to an EU decision for a move of R&I policy towards missions;

- As mission-oriented R&I initiatives aim at solving specific problems related to wider challenges, the **share of government R&D budget earmarked to societal challenges** could be considered as an indicator of whether national government have been already attempting to orient the R&I activities that they finance. Societal challenges are mostly associated with environment, energy and health\(^2\). However, correlations between the degree of challenge orientation of government R&D budgets and mission-oriented R&I should be considered with caution.

As these R&I funding indicators must be comparable in order to allow the cross-country comparability, they have all been extracted from the Eurostat datasets. For each of the indicators, the data for the latest year available and the average annual growth rate over the last ten years were used.

#### 3.1.2. Step 2: Desk research

The aforementioned indicators are complemented with selected information on national R&I policies and the latest related trends. A particular attention is paid to R&I strategies, main funding instruments and their possible challenge or mission orientation.

The analysis of the collected policy information focuses on both **internal** and **external** (mostly European) **drivers** of a potential transition towards a mission-orientation:

- **Internal factors** consist of the **national R&I strategies** (vision and main objectives, as well as level of mission orientation), the **main R&I funding**

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**instruments** (procedure for the allocation of public R&I funding, selection criteria and whether these instruments consider mission-oriented initiatives);

- **External factors** relate here to any decision at the European level for a move of R&I policy towards missions. The responsiveness of national R&I systems will be influenced by the degree of alignment of national R&I policy with the European one (e.g. transposition of the societal challenges identified in Horizon 2020 into national R&I strategies) and initiatives promoting and/or encouraging the participation of national R&I performers in European R&I programmes or initiatives.

### 3.1.3. Step 3: Country fiches

On the basis of this collection of statistical indicators on national R&I funding and policy information, individual country fiches are elaborated. These consist in short descriptions of the national R&I systems aimed at highlighting their main characteristics, and at assessing whether they present some assumed basic conditions for a move towards a mission-oriented R&I policy approach\(^3\). The country fiches give a glimpse of the broad national R&I policies, but a better understanding of the success of mission-oriented R&I initiatives requires additionally specific project-level policy mixes. Illustrations thereof are given through case studies.

### 3.2. Cross-country analysis

#### 3.2.1. National R&D expenditures, reliance on EU funds, and challenge orientation of government R&D budget: Current situation

The EU Member States are plotted on two charts built by using the three aforementioned indicators. Figure 11 focuses on potential internal factors for a move of national R&I policies towards missions, i.e. the share of GDP dedicated to R&D and the share of government R&D budget earmarked to societal challenges. External factors are represented in Figure 12 positioning the Member States in accordance with the share of their R&D expenditures financed by the European Union and the challenge orientation of their government R&D budget.

By observing the two charts, it seems that the challenge orientation of national government R&D budgets is **not correlated exclusively neither with the level of national R&D expenditures relative to GDP nor with the financial contribution from the European Union** to these expenditures.

The EU Member States with a share of government R&D budget earmarked to societal challenges superior to the EU median include, on the one hand, large economies and/or countries with well-established and autonomous (funding-wise) R&I systems, like Denmark, France, Germany, Italy and the United Kingdom. On the other hand, the Czech Republic, Greece, Latvia, Poland, Portugal, Slovenia and Spain share with the former countries a non-negligible challenge orientation of their government R&D budgets, but their relative national R&D expenditures rely, to a higher extent, on EU funds. It may be assumed that those countries will be particularly responsive to a move of EU R&I policy towards missions. Interestingly, the challenge orientation of the Hungarian and Luxembourgish government R&D budgets is associated with lower level of national R&D expenditures and lower contribution from EU funds. In these countries, the relatively little funding available might be concentrated into few specific challenged-oriented programmes.

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\(^3\) The collected policy information and statistical indicators do not aim at giving an exhaustive assessment of the degree of mission or challenge orientation of EU Member States. It focuses mainly on some funding characteristics and ignores other components of importance in such orientation, including governance and interactions with other (non-R&I-related) policy fields.
The Member States with a lower share of challenge-oriented government R&D budget in comparison with the EU median value include countries with diverse profiles too. Austria,
Belgium, Finland and the Netherlands have already high national R&D expenditures which barely rely on EU funding. They are therefore likely to be less responsive to a change in EU R&I policy. Policy decisions at a national level might be instead the main driver for an increased allocation of the government R&D budget to societal challenges and missions. Conversely, Bulgaria, Cyprus, Lithuania, Malta and Slovakia, while having currently low challenge-oriented R&D budget too, may be driven by an EU-level decision to move R&I policy towards missions, considering the high reliance of their national R&D expenditures on EU funds. Very few countries (Ireland and especially Croatia) do not present favourable basic conditions for such a transition of R&I policy: a share of challenge-oriented government R&D budget, relative R&D expenditures and contribution from EU funds inferior to the EU median. A move towards mission-oriented R&I policy may nevertheless be driven by other factors.

In addition to the wide diversity in the assumed basic conditions, at the national level, for mission orientation, it may be noticed a division between the newest 13 Member States and the older ones. They do not differ much in respect to their challenge orientation, but more regarding the level of national R&D expenditures relative to their GDP (lower in EU13 except in Estonia, the Czech Republic and Slovenia) and the reliance of these expenditures on EU funds (higher in EU13 except in Croatia and Hungary). These differences in the assumed basic conditions for mission orientation of R&I policy should be taken into account, as a move of EU R&D policy in this direction should be an opportunity to reduce the gap between both groups of Member States. Otherwise, the European added value of such decision would be discussable.

3.2.2. National R&D expenditures, reliance on EU funds, and challenge orientation of government R&D budget: Change over the past ten years

Over approximately the past ten years (until 2016, last year for which Eurostat made data available), trends in R&I funding could be observed across the European Union that may be in favour of a move of R&I policy towards mission orientation. Indeed, the relative volume of national R&D expenditures, the share of these expenditures financed by the EU, and the government R&D budget earmarked to societal challenges have increased annually for most of the Member States.

On average, the EU Member States have increased their GERD to GDP ratio by 3.1% annually over the last decade. The contribution made by the European Union to national R&D expenditures has increased at an annual average growth rate of 5.6% since mid-2000s. If we consider only the new Eastern members which joined the European Union after 2004, this ratio more than doubled and increased by 12.2% on a yearly basis. Regarding the share of government R&D budget that is earmarked to societal challenges, the Eurostat data report an annual increase of 5.5% on average over the last decade.

No well-grounded inference on correlations between these trends can be made. However, they may help draw country profiles.

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4 Only Latvia experienced a decrease by more than 1%, while the average annual growth rate was two-digit in Slovakia (10.9% possibly boosted by EU funds) and Bulgaria (11.6%)

5 Only Greece (-5.5%) and Estonia (-3.4%) have been benefitting from less EU financial support. In seven of the Central and Eastern European countries that joined the European Union the most recently, the share of EU-funded national R&D experienced increased by more than 10%: the Czech Republic (32.7%), Slovakia (29.1%), Croatia (25.5%), Romania (23.7%), Malta (14.5%), Lithuania (13.3%) and Poland (11.2%).

6 The annual average growth rate is superior to 10% in Malta (41.0%), Poland (19.3%), Romania (15.3%), Slovakia (14.0%) and Slovenia (12.6%). Conversely, Bulgaria and Croatia became less challenge oriented respectively by 14.9% and 13.6% annually and on average.
EU contribution to programmes targeting societal challenges unlikely to infer on national trends

Finland and France show a slight decrease in the share of their government R&D budget that they earmark to societal challenges. In parallel, the EU contribution to their R&D expenditures continues growing at a decent pace. An even stronger downturn in challenge-orientation is observed in Bulgaria, Croatia, Cyprus, Hungary, Italy and Lithuania. In these countries, national R&D expenditures did not reflect the trends towards the challenge orientation of EU R&I funding. This may be explained by the fact that these countries have different priorities when it comes to R&D, and that the EU contribution to national R&I expenditures had other focus than societal challenges like R&I infrastructures and capabilities.

EU contribution to programmes targeting societal challenges likely to influence the trends in the new Member States

Several new Member States (the Czech Republic, Lithuania, Malta, Poland, Romania and Slovakia) report a double-digit increase in EU contribution to their R&D national expenditures. This might have contributed to their similarly significant increase in budget allocation for grand challenges. It can be suggested that the accession to the EU contributed to shaping the R&I systems of these new Member States and orienting them towards challenges.

Member States moving autonomously towards mission-orientation

For other countries, which already had a well-established R&I system in the early 2000s, such as Austria, Denmark and Sweden, the move towards challenge-orientation seemed to have happened autonomously, most probably for internal policy reasons. The increase in the EU contribution to their national R&D expenditures is below the EU median, while the pace of increase in the government R&D budget earmarked to societal challenges is well above those of many other EU-15 Member States.

3.2.2.1 Challenge and mission orientation of national R&I strategies

In line with the observed trends towards more R&I funding earmarked to societal challenges, it can be observed that most EU Member States (20 out of 28) have already implemented R&I strategies with some degrees of challenge orientation (see Table 1).

Table 1 Countries with R&I strategies including challenge/mission-oriented approaches

<table>
<thead>
<tr>
<th>Country</th>
<th>Strategy Name (Year of implementation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Becoming an Innovation Leader (2011)</td>
</tr>
<tr>
<td>Belgium</td>
<td>Vision 2050 (2016) – Flanders</td>
</tr>
<tr>
<td></td>
<td>Marshall Plan 4.0 (2015) – Wallonia</td>
</tr>
<tr>
<td>Denmark</td>
<td>Denmark: A Nation of Solutions (2012)</td>
</tr>
<tr>
<td>Finland</td>
<td>Vision and Road Map of the Research and Innovation Council (2017)</td>
</tr>
<tr>
<td>France</td>
<td>National Research Strategy (2015)</td>
</tr>
<tr>
<td>Germany</td>
<td>High-Tech Strategy (2006)</td>
</tr>
<tr>
<td>Greece</td>
<td>National Smart Specialization Strategy for Research &amp; Innovation 2014-2020</td>
</tr>
<tr>
<td>Hungary</td>
<td>National Research and Development and Innovation Strategy 2013-2020</td>
</tr>
<tr>
<td>Italy</td>
<td>National Research Programme 2015-2020</td>
</tr>
</tbody>
</table>
Lithuania | Innovation Development Programme 2014-2020
Luxembourg | Third Industrial Revolution (2016)
The Netherlands | National Research Agenda (2015)
Poland | Plan for Responsible Development (2016)
| Strategy for Responsible Development (2016)
Portugal | National R&I Strategy for Smart Specialisation 2014-2020
Romania | National Plan for Research, Development and Innovation 2015-2020
Slovenia | Research and Innovation Strategy of Slovenia 2011-2020
Spain | Spanish Strategy of Science, Technology and Innovation 2013-2020
Sweden | National Innovation Strategy (2012-2020)
The United Kingdom | Industrial Strategy (2017)

Some other countries have adopted a slightly different approach and listed, in their strategic documents, ‘priority research areas.’ These areas could be selected either due to their strategic importance for the national economy and competitiveness or because they relate to pressing societal and/or technological challenges. Italy’s National Research Programme 2015-2020, for instance, focuses on six areas of national interest: aerospace and defence, health, nutrition and life quality, sustainable manufacturing and environment, cultural heritage and creativity industry, digital agenda and smart communities, as well as infrastructures and smart mobility.

Finally, few countries have R&I strategies with clear goals and targets and could be therefore considered as mission oriented to some extents. The Luxembourg Third Industrial Revolution, under the broad objective to transform the national economy and accelerate its transition towards a more sustainable model, sets, for instance, the target of a fully electric fleet car by 2050.

Almost all countries with a share of government R&D budget earmarked to societal challenge superior to the EU median have implemented R&I strategies with mission- or challenge-oriented components, except the Czech Republic and Latvia. In both countries, instruments prioritising national R&I funding are nevertheless in force. The Czech Government clearly set six priority research areas for the period 2012-2030: knowledge economy, energy, natural resources, social sciences, health, and, security. The Latvian Government similarly identified research priorities in a 2013 Regulation on “Priority Directions of scientific research for 2014-2017” and a 2014 Order on the "State of Research Programmes": climate and energy, innovative and advanced materials, health, sustainable use of local resources, sustainable development, and the national history, languages, culture and values.

Some countries have implemented R&I strategies with some degrees of challenge or mission orientation, but the share of their government R&D budget earmarked to societal challenges is relatively low if compared with the EU median. These are: Austria, Belgium, Finland, Ireland, Lithuania, the Netherlands, and Sweden. The lack of appropriate enforcing mechanisms may partly explain such discrepancy between R&I strategies and effective challenge/mission orientation. For instance, the Austrian strategy for research, technology and innovation called “Become an Innovation Leader” puts emphasis on some grand challenges (including climate change). However, the high share of public funding allocated through block grants to public universities or bottom-up competitive funding (e.g. by the Austrian Science Fund and the Austrian Research Promotion Agency’s Basic Programmes) may hamper the challenge orientation of the national government R&D budget.
Conversely, other countries with mission- or challenge-oriented R&I strategies in place have adapted accordingly their existing R&I policy instruments or implemented new ones ensuring the effectiveness of such orientation. For instance, in Slovenia, research in higher education institutes is exclusively funded through competitive calls (more likely to foster challenge/mission orientation).

The R&I strategies of a few EU Member States do not include any mission or challenge orientation. In most of the newest 13 Member States, the R&I system is still young (e.g. Cyprus and Malta) or relatively weak in comparison to other EU countries (e.g. Bulgaria and Croatia), and R&I strategies are mainly aimed at strengthening national R&I capabilities. For instance, the Cypriot ‘National Policy Statement for the Enhancement of the Entrepreneurial Ecosystem’ aims to improve framework conditions for innovation. In Bulgaria, the ‘Better Science for Better Bulgaria strategy’ aims to increase funding for R&I activities and improve interactions between the R&I stakeholders. In those countries, R&I policy instruments (including funding mechanisms) have consequently low or no challenge or mission orientation, but aim at promoting R&I activities in general, attracting new talents, encouraging corporate investments in R&I and entrepreneurship, closing the gap between research and innovation (e.g. through seed funds), increasing participation in international R&D programmes and projects, and so on.

It must nevertheless be noticed that the countries that have not implemented R&I strategy with challenge or mission components so far do not ignore the achievement of societal challenges. They seem to consider it somehow as a spill-over: improved R&I capabilities are expected to ease the development of innovative solutions to such challenges.

3.3. The path to the FP9: official position of Member States on mission-oriented R&I

By considering the position papers on the future of the Framework Programme released by the national Governments since the midterm evaluation of Horizon 2020, few conclusions can be drawn on the expectations of the Member States on FP9.

First of all, 12 countries discuss mission orientation as a main feature of the next FP, and all of these do it positivity. Some (e.g. Hungary) make a mention only and prefer to refer to the challenge-orientation of the EU R&I programming. Other Member States (e.g., Germany and Italy) explain extensively their conception of mission-orientation, revealing that the policymakers already engaged in a fruitful conversation with national and European R&I stakeholders in R&I.

All the Member States that took official opinion on FP9 consider that the current three-pillar structure of Horizon 2020 with the third pillar oriented towards societal challenges should be maintained. Socioeconomic challenges are still a major concern and should draw further the attention of the European Union. Silos-breaking is an additional important issue to be addressed, as several Member States urges to invest in interdisciplinarity and intersectoral cooperation in order to respond more quickly to emerging societal issues (e.g. Croatia and Germany).

By keeping social sciences and humanities (SSH) as a separate topic, several countries expect them to be given a bigger role in the next FP: Hungary, for instance, asks to better integrate them throughout the FP and keep a dedicated programme part. In general,

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7 Not all 28 Member States outlines a clear position on the future FP: Luxembourg, Malta, Cyprus and Greece did not release any official document, while few Eastern European countries, such as Bulgaria, Latvia, Lithuania, Latvia and Romania, expressed their positions in a common paper together with the Visegrad Group members (the Czech Republic, Hungary, Poland and Slovakia).
mission must be cross-sectorial and should also guarantee sufficient collaboration between science, industry and society.

The Member States should also try to shape the Framework Programme so that it responds to pan-European issues, or challenges, common to all European countries and all European citizens. The Czech Republic, for instance, gives particularly importance to the Pan-European added value factor.

**Stronger focus on citizens**

Citizens’ engagement is a key element for several countries. According to the German government, citizens will better identify the added value of a common European approach in achieving pan-European "missions", only if members of the civil society are adequately involved in defining the "missions" and in ensuring that these missions address real and concrete societal needs.

In order to ensure citizens involvement, a stronger attention to an engaging narrative and to an improved communication is recommended. For example, Denmark suggests tangible missions underpinning the overall political objectives and able to enhance visibility and create a more strongly engaging narrative of FP9.

To ensure uniformity in communication of the actions of the European Union with those of other organisations, the global challenges outlined in the 17 United Nations Sustainable Development Goals and their related targets are considered a useful streamlining reference. This is the case of the position papers of the British, Italian, Irish or Swedish governments.

**The favourite themes for mission-oriented initiatives**

Few Member States propose a list of fields in which they would appreciate a renovated mission-oriented approach. Several of them call for a stronger focus on key societal challenges to cope with inequalities and lack of cohesion among European regions (Germany, as well as several EU-13 Member States). Denmark wishes the new missions to focus on green growth, better health and public healthcare, digitalisation and other new technologies, while Slovakia adds to this list broader challenges, such as natural resources and energy, climate change and environment, demography and even globalization. International issues find also a privileged place in the list of potential areas where to develop a mission-oriented narrative for EU R&I policies: Italy, for instance, urges to consider missions related to migration and integration, as well as disaster risk reduction.

Finally, the role of SMEs should also be reconsidered and become central in the new FP9: the Finnish position paper refers to “transformative missions capable of supporting breakthrough innovations and innovators creating new markets”, for which the newly established European Innovation Council (EIC) can have a leading position in supporting entrepreneurship and innovative market solutions.

**3.4. Conclusive remarks**

It may be asserted that if the EU institutions would implement a shift of the European and national R&I policies towards mission-orientation, most EU Member States would need to be accompanied/guided - to some extent - in such a process. The role of the EU institutions must therefore be adapted to the specific features of national R&I systems.

- In all Member States that consider moving their R&I policy towards mission, R&I strategies should be revised to give this direction. Amendment to R&I funding system should be accordingly considered. Otherwise, the mission orientation of strategy will remain a policy discourse. Similarly, mission-oriented
R&I policy instruments uncoordinated due to a lack of an overall strategy (and directionality) are expected to have reduced impacts on systems that need to be transformed.

- The **countries whose national R&I expenditures significantly rely on EU funding** (including structural funds) may be particularly responsive to a move of EU R&I policy towards missions (at least on the short term). Their transition would be nevertheless more effective in the long run, once their R&I capabilities are strengthened and their reliance on external funding is lower.

Mission-oriented R&I could be considered as an opportunity for those countries with a less mature R&I (funding) system to **accelerate the development of their R&I capabilities**. Missions and the accompanied concentration of funding may contribute to (re)shaping their R&I systems while giving them a mission orientation. The likely improved visibility of R&I in those countries may additionally help them tackle the **brain drain issue**. Furthermore, the Member States with less mature R&I systems can be assumed to be less impeded by R&I institutions and long-standing practices than those with a longer history of R&I policy, and therefore to be able to **move their R&I policy towards missions more easily**. In consequence, a mission orientation of EU R&I policy accompanied with measures for improving R&I capabilities, where needed, could, to some extents, reduce the discrepancies between national R&I systems and performance across the European Union.
4. EXPLORING CASES OF PAST MISSION-ORIENTED R&I INITIATIVES

Mission-oriented R&I initiatives that could be considered a compendium of existing examples were investigated with a view to draw policy lessons for the European Commission (in the context of the preparations of FP9). The objective of this task is to analyse at least ten paradigmatic examples of mission-oriented R&I initiatives. The following describes first briefly the activities conducted and then focused on the overall findings.

4.1. Case study methodology

4.1.1. Step 1: Case selection

The case studies are looking at major, past or on-going mission-oriented R&I initiatives with long trajectory and significant economic, societal or environmental impact already achieved. When appropriate, the case studies are targeted to comparison of different initiatives either a historic case with more current one, or initiatives that have similar objectives but are initiated in different geographical areas in order to pin-point the differences and similarities of the initiatives.

The case studies finally selected consist of: the US War on Cancer, Energiewende (Germany), the Chinese Solar energy initiative and the US Sunshot, Brain initiatives in the European Union and United States, DeltaPlan (the Netherlands), the Man on the Moon (Apollo Project), the e-Estonia initiative, the electric vehicle initiatives in China and Norway, and Concorde and Airbus.

4.1.2. Step 2: Designing the case study approach

The evaluation for each case relies on a dedicatedly designed logic chart. The aim is to describe, analyse, and relate the context, activities and measures, inputs and resources, and outputs, outcomes and impacts to the respective case (see Figure 13).

Figure 13. Case Study Approach
4.1.3. Step 3: Data collection

The information about these dimensions stemmed from documents describing the context and motivation for the mission-oriented R&I activity (policy analysis, strategies, white papers etc.), the set-up, governance, modus operandi and resource (programme documents, administrative regulations and orders etc.) and the perceived and measured effects (outcomes, outputs and impacts; to be derived both from evaluation reports) as well as from related expert opinions gathered through interviews. The data sources included information publicly available e.g. government/funding agency/initiative’s webpage, existing academic and other types of policy studies, and other material describing and analysing the policies (e.g. news, magazine articles). In addition, with the primary data collection, interviews were used to complement the desk research information for some of the cases.

4.1.4. Step 4: Case study reporting

The case study reporting followed the structure presented below.

- Summary of the case study (Chapter 1);
- Context and objectives of the initiative (Chapter 2 including a description and analysis of the contextual factors and objectives of the initiative);
- Resources and management (Chapter 3 including a description and analysis of the governance and coordination of the initiative, financing model, and key actors involved in the initiative);
- Policy instruments and wider policy-mix used for implementing the initiative (Chapter 4 including a description of the R&I policy instruments used for implementing of the initiative, and the connection with other policies);
- Realised or expected outputs, outcomes and impacts (Chapter 5); and
- Conclusions and lessons learned (Chapter 6).

4.2. Summary of the cases

Airbus (private, a part of a comparative case study with Concorde)

Airbus is a consortium established in 1964 of European aerospace manufacturers, set up by the French, English and German governments and was founded to compete with the American aircraft manufacturers. Its origins trace back to the late 1960s, when the France, Germany and the United Kingdom decided to foster collaboration between their respective aircraft manufacturers for the development and manufacturing of planes for short- to medium-range and high-capacity airlines. In comparison to Concorde, Airbus has a much stronger market orientation and a strategy much more attentive to the needs of airline companies (beyond Europe) which may be potential purchasers. Nowadays, Airbus is a private company involving British, French, German and Spanish partners. The first aircraft available under the Airbus brand was the A300, in 1972. Since then, the increase in orders has been exponential. In time the Group has become on the world’s top two commercial aircraft manufacturers, competing directly with the American Boeing Company. This case study explores both initiatives, their overall context, implementation and main impacts from the perspective of mission-oriented research and innovation policy.

Apollo Program (United States)

Apollo was a programme in the 1960s designed to land an American on the Moon and return safely to Earth. The Apollo Program was successfully accomplished on July 1969 when Apollo 11 Mission set foot on the surface of the Moon. Neil A. Armstrong and Edwin
E. Aldrin-landed on the lunar surface while Michael Collins orbited overhead in the Apollo command module.

Brain Initiative (United States)

On April 2, 2013, President Obama launched the BRAIN Initiative as part of a broader White House Neuroscience Initiative to “accelerate the development and application of new technologies that will enable researchers to produce dynamic pictures of the brain that show how individual brain cells and complex neural circuits interact at the speed of thought.” The challenge is to map the circuits of the brain, measure the fluctuating patterns of electrical and chemical activity flowing within those circuits, and understand how their interplay creates our unique cognitive and behavioural capabilities.

Concorde (private, a part of a comparative case study with Airbus)

The Concorde was the first supersonic transport passenger-carrying commercial airplane, built jointly by aircraft manufacturers in France and the United Kingdom. The collaboration was launched by the signature of a bilateral agreement in 1962 to share costs and risks in producing an SST, with the first prototype produced 10 years later and the first routes inaugurated in 1976. The manufactured aircrafts were procured by the respective state-owned airline companies, British Airways and Air France. Their Concorde fleets flew to destinations all over the world, mostly on transoceanic routes. Due to financial unviability, which hampered its uptake by other airline companies, and the fatal crash of 2000, Concorde operations were finally ceased in 2003.

Delta Plan / Delta Programme (the Netherlands)

The Delta plan originally dates from late 1930s. After the North Sea flood of 1953, the initial plan has been revised and the new Delta plan was developed to protect the Netherlands from flooding by developing a series of construction projects to shorten the Dutch coastline with in total 700 kilometres. To be able to accomplish the mission research and technological development were needed to develop and build tailor made construction works and to take into account safety on the one hand and nature, tourism and the economy on the other hand. The project is still ongoing, because the fight against flooding is a permanent challenge. Furthermore, the mission has since 2008 been broadened. Besides the protection from flooding by the sea, the current Delta Program (initiated under the Second Delta plan) aims to make the Netherlands resilient to climate change and ensure a sufficient supply of fresh water in 2050.

e-Estonia

Estonia has been named ‘the most advanced digital society in the world’ as a result of their long-term policy e-Estonia. The initiative grew out of the partnership between a forward-thinking government, a proactive ICT sector, and a switched-on, tech-savvy population, and have built an efficient, secure and transparent ecosystem. Different types of e-services have become routine for citizens of Estonia: i-voting, e-taxes, e-police, e-health care, e-notary, e-ban king, e-census, e-school and much more. The success of the initiative relies on a clever infrastructure that has made it possible to build a safe e-services ecosystem. Essential solutions that enable the e-society to function smoothly were all built by local Estonian companies. Estonia has shared its e-governance journey with 60 governments globally, and exported its solutions to over 130 countries around the world.

Electric vehicle initiative (Norway)

The ongoing Electric Vehicles initiative in Norway can be seen as a way to address different challenges that the country and the world has: conversion to green energy and greenhouse gas emissions. However, the initiative started out with being a help for the national electric vehicle-producers, Think and Buddy in the beginning of the 1990’s. The first objectives were to create an industry of electric vehicles in Norway. This was done through the first
tax incentives. Later, the Norwegian parliament have decided that by 2025, all new cars that are sold shall be zero (electric or hydrogen) or low (plug-in hybrids) emission.

**Energiewende (Germany)**

The Energiewende is a national long-term strategy for the development of a low-carbon energy system based on renewable energy and energy efficiency. The national initiative is an integrated policy that addresses all sectors of the economy and is framed by two key policy documents, namely the Renewable Energy Act (EEA) in 2000 and the Energiekonzept (Energy Concept) strategy in 2010. Energiewende is driven by four objectives: fighting climate change (through a reduction of CO₂ emissions), phasing-out nuclear power, improving energy security (through a reduction of fossil-fuel imports) and guaranteeing industrial competitiveness and growth (through industrial policies targeting technological, industrial, and employment development). The goal of the initiative is to phase out Germany’s nuclear power plants by the end of 2022, and the transition of the energy system to become strongly reliant on renewable energy resources by the year 2050. The Energiewende’s success depends on the technological innovations realised through research and development activities. In its Sixth Energy Research Programme, the German Federal Government outlined the principles and focus of its funding policy. It envisages concentrating funding to an even greater extent on those technologies that could contribute to the objectives of Energiewende.

**Human Brain Project (European Union)**

The Human Brain Project represents a new partnering model for long-term European cooperative research in the European Research Area, demonstrating the potential for common research efforts. The Human Brain Project (HBP) strives to accelerate the fields of neuroscience, computing and brain-related medicine. This acceleration will be achieved by a strategic alignment of scientific research programmes in fundamental neuroscience, advanced simulation and multi-scale modelling with the construction of an enabling research infrastructure.

**New energy vehicles (China)**

With the aim of addressing energy security problems (dependence on imported oil), urban air pollution concerns emerging from rapid growth of vehicle population as well as challenges of economic upgrading, China has invested heavily on the development of new energy vehicles (NEVs) since early 2000s. The Chinese NEVs policy aims at a large-scale systemic transition in transport. The current target of the Chinese government is to have 5 million NEVs on the roads by 2020 and that by 2025 at least one in every five cars sold in China will be a new energy model.

**Solar Energy in Chinese Five-Year Plans (China, a part of comparative case study with US SunShot)**

The Chinese five-year plans highlight solar energy as one of seven strategic emerging industries subject to specific government support, preferential treatment and public planning and control of the industry. The guiding principles of the policy was to implement and apply scientific findings in industrial applications, to seize the global opportunities created by the transition of the energy systems and strengthening the Chinese photovoltaic (PV) industry competitiveness. The plan also aimed at reducing the costs of PV power generation and quality improvements of the PV products and production technologies.

**SunShot Initiative (United States, a part of a comparative case study with Solar Energy in Chinese Five-Year Plans)**

The SunShot Initiative was launched in 2011 by the US Department of Energy’s Solar Energy Technologies Office (SETO). The overall mission of the SunShot is to support solar energy adoption by making it affordable. The initiative plans to do this by supporting efforts by private companies, universities, and national laboratories attempting to lower the cost
of solar electricity. More specifically, the goal set in 2011 was to reduce the costs of solar technologies by 75% before 2020. Due to the technological progress made and overall favourable market conditions of solar systems, the targets have already been achieved, and updated to reduce the costs of solar energy by additional 50% between 2020-2030.

**War on Cancer (United States)**

War on Cancer started in 1971 with the signing of the National Cancer Act by President Nixon. This Act is generally viewed as the beginning of the War on Cancer, understood as the national effort to find a cure for cancer by increasing research to improve the understanding of cancer biology and the development of more effective cancer treatments. The objectives and milestones were achieved through the National Cancer Program Strategy, a combination of selected laboratory, field and clinical research courses of actions. The National Program Goal was to develop the means to reduce the incidence, morbidity and mortality of cancer in humans.

**4.3. Cross-case analysis**

**4.3.1. Summary of the case studies**

The initiatives selected for the analysis cover a balanced selection of case studies, in terms of:

- Geographical coverage (seven European, four US and two Asian initiatives)
- Thematic area (five transport-, three energy-, three health-, one digitalisation- and one security and resilience-related initiatives)
- Type of initiatives (five policy approaches, six public initiatives/programmes and two private initiatives)

In addition, the case study selection involved historic already finalised initiatives (three) and on-going initiatives (ten).

**Table 2 Summary of the case studies**

<table>
<thead>
<tr>
<th>Title</th>
<th>Country</th>
<th>Thematic area</th>
<th>Type</th>
<th>Level</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus</td>
<td>France, Germany, Spain and the United Kingdom</td>
<td>Transport</td>
<td>Initiative (private)</td>
<td>International</td>
<td>1967-</td>
</tr>
<tr>
<td>Apollo Project Brain Initiative</td>
<td>US</td>
<td>Aerospace</td>
<td>Programme Initiative</td>
<td>National</td>
<td>1961-1972</td>
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<tr>
<td>Concorde</td>
<td>France, United Kingdom</td>
<td>Transport</td>
<td>Initiative (private)</td>
<td>International</td>
<td>1962-2003</td>
</tr>
<tr>
<td>Delta Plan / Delta Programme</td>
<td>Netherlands</td>
<td>Security and resilience, climate change</td>
<td>Programme</td>
<td>National</td>
<td>1937-2050</td>
</tr>
<tr>
<td>Electric vehicle initiative</td>
<td>Norway</td>
<td>Transport</td>
<td>Policy approach</td>
<td>National</td>
<td>1989-2025</td>
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<tr>
<td>Energiewende</td>
<td>Germany</td>
<td>Energy, climate change</td>
<td>Policy approach</td>
<td>National</td>
<td>2010-</td>
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<tr>
<td>Human Brain Project</td>
<td>EU</td>
<td>Health</td>
<td>Initiative European</td>
<td>2013-2023</td>
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<tr>
<td>New Energy Vehicles (NEVs)</td>
<td>China</td>
<td>Transport</td>
<td>Policy approach</td>
<td>National</td>
<td>2001-2020/2025</td>
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<tr>
<td>SunShot Initiative</td>
<td>US</td>
<td>Energy</td>
<td>Initiative National</td>
<td>2011-2030</td>
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</table>
The case studies assessed the basic characteristics of mission-orientation of the initiatives and overall the initiatives show that:

- All the cases show **important level of directionality** and the initiatives are contributing towards solving societal challenges and/or industry transformation;
- Majority of the initiatives have **high degree of intentionality** in terms of specific and well-articulated goals and clearly set timeline and milestones;
- Almost all the initiatives mobilise **important public and private investments**;
- Most of the initiatives are focused in a balanced manner on new **knowledge creation** (basic research, TRLs 1-4) and **knowledge application** (applied research, TRLs 5-9), although small variation of the technological advancement level can be seen between the initiatives;
- Similarly, almost all the initiatives engage **demand-side policies** and involve **multi-disciplinarity**, at least to certain extent.
- Nine initiatives out of thirteen show **multi-level and/or horizontal governance** of policies and finance.
- All the initiatives have **reflexivity** mechanisms in place and show flexible policy design and timely monitoring activities, at least to certain extent.
- **Openness** in terms of being connected to international agendas and networks and involvement of citizens vary more between the initiatives.

**Table 3 Mission-oriented features of the selected case studies**

<table>
<thead>
<tr>
<th></th>
<th>Apollo Project</th>
<th>Airbus</th>
<th>Brain Initiative</th>
<th>Concorda</th>
<th>Delta Plan / Delta Program</th>
<th>e-Estonia</th>
<th>Energiewende</th>
<th>Human Brain Project</th>
<th>New Energy Vehicles</th>
<th>Norwegian EV Initiative</th>
<th>Solar energy in CN FYPs</th>
<th>SunShot Initiative</th>
<th>War on Cancer</th>
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4.3.2. Context and objectives of the initiatives

The initiatives analysed in the case studies are all arising from a clear necessity, and are strongly rooted in the background contextual factors. The initiatives are created to meet a need or an urgency, either focusing on:

- Solving or mitigating societal challenges; or
- Achieving, maintaining or reinforcing global technological and/or industrial leadership; or
- Various degrees of combinations of societal and economical motivations.

Basically, all the public policy mission-oriented initiatives are driven by societal challenges. Health, climate change, energy security, environmental concerns, and safety and security are the most prevailing societal drivers of the mission-oriented initiatives analysed. The societal challenges are however very different by nature and scale, varying from localised threats (e.g. flooding in the case of the Delta case, local air pollution in the cases of the Chinese initiatives, modernisation of the country in case of e-Estonia) to measures aimed at solving challenges that are important in a global scale (e.g. cancer or climate change).

The economical drivers include cost savings, achievement of secure supply of energy, economic growth, job creation and incentives to maintain, achieve and enhance technological and industrial forerunner position in global scale. This leadership position is expected to lead to important economic returns by leveraging the domestic technological and industrial capacities in global markets. Obviously, the privately-led initiatives (Airbus and Concorde) are typical examples of initiatives that are pushed forwards mainly by achieving market leadership and financial benefits. These initiatives had however also wider political drivers as well, such as maintaining and enhancing aerospace industry in Europe. However, the economical drivers are not exclusively limited to private initiatives. For example, the initiatives such as the US SunShot, Energiewende, e-Estonia or the Chinese Solar Energy or New Energy Vehicles have the goal to gain global forerunner position in the respective technologies. Although all the above-mentioned initiatives have clear societal targets driving the initiatives forward, gaining industrial competitiveness is also important.

The process of defining missions varies also significantly between the initiatives. Some initiatives have been shaped from initially niche grassroots movements (Energiewende), others are formalised after an open stakeholder consultation process (Human Brain Project in Europe), in which scientists, industrial stakeholders, and specialists from a broad range of disciplines were consulted. Other initiatives were result of high-level centralised governmental decisions such as US Apollo, US War on Cancer, e-Estonia, the electric vehicle initiatives of Norway and China or the solar energy policies of US and China.

Table 4 Objectives of the case studies

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Objective(s)</th>
<th>Timeline</th>
</tr>
</thead>
</table>
| Airbus        | • To create and develop a European consortium of European aircraft manufacturers able to compete with their American counterparts/competitors (e.g. Boeing, Lockheed and McDonnell Douglas);  
                • To create a European consortium capable of producing bigger airplanes suitable for long and medium distances (as up to the 1960s most European counties produced aircraft too small for the needs of market of that time). | 1967-         |
| Apollo Project| • To land an American on the Moon and return safely to Earth.                                                                                                                                               | 1961-1972    |
Brain Initiative • To deepen understanding of the inner workings of the human mind and to improve how we treat, prevent, and cure disorders of the brain. 2013-2025

Concorde • To develop the first supersonic aircraft for (civil) transport;
• To strengthen and further develop technological industrial sectors linked to the aircraft industry, face to the concurrent American and Russian industries. 1962-2003

Delta Plan / Delta Program • Protect the Netherlands from flooding by the sea;
• Make the Netherlands resilient to climate change and the sea-level rise;
• Ensure a sufficient supply of fresh water. 1937-2050

e-Estonia • An ICT infrastructure that supports economic growth, the development of the state and the welfare of the population.
• Larger number of jobs with higher added value, improved international competitiveness and higher quality of life.
• Smarter governance.
• Enhanced awareness of Estonia as an e-state all over the world. 1997-

Energiewende • To phase out Germany's nuclear power plants by the end of 2022, transform the energy system to become strongly reliant on renewable energy resources (min. 60% of the final energy consumption, min. 80% of the gross electricity consumption) and enhanced energy efficiency, and to reduce GHG emissions by 80-95% by the year 2050. 2010-

Human Brain Project • The HBP is a 10-year European Flagship project, aiming at a comprehensive understanding of the human brain. The HBP aims to combine all existing knowledge and data about the human brain for building a realistic computer model of the brain by 2023. Such model will help researchers understand how the human brain works and the diseases affecting it. 2013-2023

New Energy Vehicles (NEVs) • To have 5 million New Energy Vehicles (i.e. cars that are either partially or fully electric) on the roads by 2020 and that by 2025 at least one in every five cars sold in China is a new energy model. 2001-2020/2025

Norwegian EV initiative • The first objectives were to create an industry of electric vehicles in Norway. This was done through the first tax incentives. Later, the Norwegian parliament have decided that by 2025, all new cars that are sold shall be zero (electric or hydrogen) or low (plug-in hybrids) emission. 1989-2025

Solar energy in CN FYPs • To reduce the price of solar power and to increase the manufacturing of PV systems. Other objectives are to increase R&D for key technologies, developing new, advanced technology and manufacturing processes for PV, promoting favourable policies for the domestic market, and improving PV standards, product quality inspection and certification systems. The 13th five-year plan (2016-2020) continues providing support to Chinese solar energy sector. 2011-2020

SunShot Initiative • To lower the costs of solar energy to make it cost-competitive with other forms of energy generation by 2020. In September 2017, it was announced that the utility-scale solar energy cost target had been met three years ahead of schedule. The initiative will continue to work to lower the cost of solar energy and has established a goal to halve the cost of solar energy by 2030. 2011-2030

War on Cancer • Eradicate cancer as a major cause of death by increased research to improve the understanding of cancer biology and the development of mode effective cancer treatments such targeted drug therapies. 1971-2016

The objectives of the initiatives show high directionality to solve a societal and/or industrial challenge, and most of the initiatives are also characterised by high level of intensionality, i.e. clear target setting and timeline, typically characterised by over ten years’ time-horizon and specific shorter-term milestones. The scope of the objective-setting of the initiatives analysed can be broadly divided into two groups:

- **Accelerators** – focused on accelerating the technological development and/or deployment. Initiatives such as the Airbus, Apollo, Concorde, US Brain Initiative, EU Human Brain Project, or War on Cancer are all primarily focused on achieving highly ambitious research and/or technological goals faster, more efficient and coordinated manner. These initiatives can have both societal and economic targets.

- **Transformers** – focused on transformative change. Compared to accelerators, the transformer-type of initiatives are targeted towards technological development and deployment of a new technological trajectory i.e. contributing towards a change between existing, prevailing trajectory and a new, emerging technological trajectory. These types of initiatives are often involving a systemic change i.e.
accelerating the technological development alone is not enough but more profound change how technologies are accepted by society and applied by consumers are needed. Clear examples of this type of mission include German Energiewende, E-Estonia, DeltaPlan of the Netherlands, US SunShot, Chinese Solar Energy policies, or the clean transport initiatives of China and Norway. These initiatives have typically societal targets but can also aim at economic goals.

Both types of initiatives can have a broad or narrow scope. For instance, Airbus, Apollo and Concorde have a specific, predefined target, whereas the US and EU Brain initiatives and US War on Cancer have wider scope and the research and technological development can take various paths. Similarly, the transformative missions can vary between very broad initiatives like Energiewende, which aims to transform the entire energy system of Germany, to narrower scope initiatives such as the clean transport initiatives of Norway and China that are focused on electrification of road transport. What clearly differentiates the transformative missions from the accelerator-type of missions is the wider scope of policy-mix applied and the larger role of demand-side measures and citizens. It should however be noted that the division of the initiatives to the above-mentioned categories is not entirely exclusive. Accelerator-type of missions can also significantly contribute towards a transformative change. For example, Concorde or Apollo have characteristics of transformative change within aerospace sector. Similarly, although US SunShot is contributing towards a systemic change from fossil fuel-based energy system towards renewable energy source-based energy production, it is primarily aimed at accelerating the PV technology development.

4.3.3. Resource and management

The initiatives analysed all have an important scale in terms of budget and resources dedicated. The budget of the initiatives varies between one billion and hundreds of billion euros, and is largely defined by the scope and timeframe of the initiatives.

Table 5 Governance and budget of the case studies

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Main governing body</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbus</td>
<td>Airbus Board of Directors</td>
<td>USD 40 billion</td>
</tr>
<tr>
<td>Apollo Project</td>
<td>National Aeronautics and Space Administration NASA</td>
<td>USD 25.4 billion (USD 163 billion inflation adjusted to 2008)</td>
</tr>
<tr>
<td>Brain Initiative</td>
<td>National Health Institute BRAIN Multi-Council Working Group</td>
<td>USD 2.86 billion</td>
</tr>
<tr>
<td>Concorde</td>
<td>Standing Committee of Officials and Committee of directors of Concorde.</td>
<td>GBR 1.134 billion</td>
</tr>
<tr>
<td>e-Estonia</td>
<td>Ministry of Economic Affairs and Communication</td>
<td>The e-Estonia policy has been running for more than 20 years. However, there is not any official estimation of the overall budget used for it. EUR 5.7 billion (annual budget)</td>
</tr>
<tr>
<td>Energiewende</td>
<td>The Federal Ministry for Economic Affairs and Energy</td>
<td>EUR 5.7 billion (annual budget)</td>
</tr>
<tr>
<td>Human Brain Project</td>
<td>European Commission</td>
<td>EUR 1 billion</td>
</tr>
<tr>
<td>New Energy Vehicles (NEVs)</td>
<td>The central of government of China, and in particular the Ministry of Science and Technology (MOST), the National Development and Reform Commission (NDRC) the Ministry of Industry and Information Technology (MIIT) and the Ministry of Finance (MOF). Estimates: EUR 51 billion (2015-2020, subsidies) EUR 3.2 billion (Charging stations), EUR 2 billion (R&amp;D)</td>
<td></td>
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<tr>
<td>Norwegian EV initiative</td>
<td>The Norwegian Parliament and the Norwegian Electric Vehicle Association</td>
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</tbody>
</table>
Solar energy in CN FYPs | Chinese Ministry of Science and Technology is the main responsible of the solar R&D in the country. The five-year plans are coordinated by the central government and National Development and Reform Commission of China. | Estimate: USD 150 billion (2016-2020)

SunShot Initiative | The Solar Energy Technology Office (SETO) at the US Department of Energy (DOE). | USD 1.3 billion

War on Cancer | National Cancer Institute | USD 117.8 billion

The main governing body of the initiatives is typically national government (i.e. ministries or governmental institutions). It can also integrate public and private stakeholders, involving for example universities and industry (US Brain Initiative), or stakeholders from several countries (EU Human Brain Project, Airbus and Concorde). Typically, the executive coordination of the initiatives is supported by high-level political steering involving various administrative levels (e.g. Federal and Länder joint steering of Energiewende Joint Committee of Chinese NEV, or Steering Committee of Delta Plan), or more scientific advisory boards (e.g. US Brain Multi-Council Working Group, Blue Ribbon Panel on War on Cancer) that ensure the compliance of the activities with initiative's long-term vision. One of the most recognised models is Apollo’s, that combined centralised planning and a hierarchical organisation with decentralised and flexible technology development processes. This management model can be considered as one of the key success factors of Apollo Project. Furthermore, some governance structures ensure a clear separation among scientific steering, strategic and financial decision making and the daily implementation (e.g. EU Human Brain Project).

All the initiatives (including the private ones) are financially strongly supported by public sector funding, having a varying degree of private investments. In general, the higher the technology readiness levels, the higher the private sector's presence is. The initiatives solely focused on advancing basic research or initial technological development are characterised by larger share of public funding (e.g. War on Cancer, US or EU Brain Initiatives). In the initiatives that are aimed at deployment of technologies with expected market results, the public funding is also used to incentivise the entry of private funding, aiming at significant leverage effect. For example, in the cases of the Chinese solar energy initiative and the German Energiewende, the state-owned investment banks have played a significant role in inducing private investments by offering low-cost loans in different stages of the supply chain including investments in manufacturing plants (e.g. PV cell and module manufacturing), production technologies (renewable energy installations in different scales), as well as investments made by the energy consumers (e.g. house-hold energy-efficiency). Other initiatives such as the Norwegian and Chinese electric vehicle policies rely on e.g. investment subsidies and tax measures to boost the private investments.

It is important to note that the long-term direction setting and stable public funding, are considered as key factors creating favourable conditions for private investments. Many of the initiatives analysed are characterised by important scale of public support guaranteed during a relatively long timeframe, which is considered to mitigate the risk and uncertainty perceived by the private sector investors. Overall, the long funding cycles are considered to improve the flexibility needed to respond to changing circumstances and opportunities.

Typically, missions are tightly controlled with rigorous and transparent monitoring systems, that assess the progress frequently and take the necessary measures to maintain the focus of the initiative. In some cases, there are specific tools and programmes to collect and publish data that can assist the decision-making process (e.g. SEER Program for Cancer data in US, NREL monitoring the photovoltaic levelized cost of electricity, or Annual Monitoring Report of Energiewende). In some cases, such as Concorde and Airbus initiative, the monitoring system can even be considered as decisive factor determining the success (or failure) of the initiatives.
Regarding to **citizen engagement**, while it is true that all the missions involve communication actions and most of them include participative dynamics with different stakeholders, only very few initiatives (basically Norwegian EV and Energiewende are the only cases) have actively and successfully engaged citizens in the choice of the priorities, or in the design, implementation or evaluation process. Despite this, citizen’s involvement importance is much more widely recognised, especially when the initiative implies a high economical effort for the country. As President Kennedy said: “I believe we should go to the Moon. But I think every citizen of this country as well as the members of Congress should consider the matter carefully in making their judgement, to which we have given attention over many weeks and months, because it is a heavy burden...”. At the end, mission-oriented R&I policies in general and especially those aimed at achieving a systemic transformation necessitate broad support and participation from the whole society.

4.3.4. **Policy instruments and wider policy-mix used for implementing the initiative**

The policy-measures that are applied to implement the targets of the initiatives can be characterised by two types of policy-mixes largely defined by the scope of the initiatives:

- **Mainly focused on research and innovation (R&I) support** (e.g. research and technology development grants, testing and piloting, knowledge transfer and dissemination measures). Initiatives characterised by focusing solely on R&I support include: US Brain Initiative, US War on Cancer, US SunShot, and EU Human Brain Project. Also, Apollo Program and the private initiatives Airbus and Concorde can be considered to be mainly driven by R&I policy although they involve also a wider set of policies (e.g. industrial policies and public procurement).

- **Involving policy-mix including measures to support supply** (R&I, industrial policies) and **demand** (e.g. public procurement, tax incentives, investment subsidies, regulation). Initiatives such as Energiewende, e-Estonia, Chinese Solar Energy and New Energy Vehicles, or Norwegian Electric Vehicle are examples of initiatives involving a wide set of policies.

The **research and innovation policy measures** mentioned in the case studies include R&D grants for research institutes or groupings of research institutes, public research laboratories and universities (e.g. War on Cancer, US SunShot, EU Human Brain Project and US Brain Initiative), research project funding involving research sector and industry (e.g. Chinese NEV, US SunShot, Chinese Solar Energy R&D) and development projects involving industry actors only (e.g. Concorde and Airbus and Chinese Solar Energy R&D support). Also, other activities such as research infrastructure support, researcher curricula development, education, training and platforms for knowledge transfer and dissemination are frequently mentioned.

The **demand-side policy measures** include laws and regulation (used at least in Energiewende, e-Estonia, and Chinese NEV cases), public procurement (e.g. Apollo, Concorde, and Chinese NEV), support to manufacturing industry (e.g. Chinese Solar Energy and Airbus), tax incentives (Energiewende, Norwegian EV, and Chinese NEV), investment subsidies (Energiewende, Chinese Solar Energy, and Chinese NEV), feed-in-tariffs (Chinese PV, Energiewende), renewable energy auction schemes (Chinese PV, Energiewende) and trade policy measures (Chinese NEV, Chinese Solar Energy and indirectly US SunShot).

All the missions require the active **involvement of a high number of disciplines and technologies**. Most of them, no matter the area, highlight the importance of ICT technologies (big data, algorithms, communications, bioinformatics, smart grids) and, in many cases, interactions with social sciences are increasingly important (psychology, psychiatry, sociology, behavioural economics and so on). The energy-related initiatives all mention the energy storage and battery technologies as among the current barriers or future success factors of the missions. More and more frequently, missions open ethical and societal questions about data privacy and transparency and ethics, among others. Because of that, multi-agent platforms are often created to support the missions (e.g. the EU Human Brain Project, and Energiewende).
Many of the initiatives are strongly linked to international initiatives, and they can be directly linked to the United Nations Sustainable Development Goals and agreements (e.g. Paris Agreement on global response to the threat of climate change).

There is some consensus as to the idea that knowledge and expertise does not necessarily reside in a single country or area, and that there are not enough cross-cutting mechanisms to support international or multidisciplinary teams or global initiatives. In this line, to support the missions, support activities to enhance complementarities and synergies at different levels are a big help (e.g. FLAG-ERA Project in EU Human Brain Flagship). Also training programmes (EU Human Brain Project Curriculum, National Cancer Institute Awards) to exploit the convergence among different disciplines, networks and consortia to find convergences and synergies (Cancer Target Discovery and Development Network, BRAIN Initiative Public Private Partnership Program, Cell Census Consortium), tools to foster technology transfer to the market (SBIR Program and STTR Program in the United States) and tools to share data (US Neurodata Without Borders) are implemented.

Many of the initiatives aim to enhance the cooperation and openness with similar or complementary projects (i.e. between US Brain Initiative and EU Human Brain Project, US Brain Initiative and US Cancer War on Cancer/Cancer Moonshot), and also improve the engagement with other governance levels. In this line, the cross-country initiatives such as Concorde and Airbus can serve as examples how European R&I efforts can be aligned across the national borders.

4.3.5. Realised or expected outputs, outcomes and impacts

The analysed cases of mission-oriented R&I initiatives are in different phases of development: some are purely historic cases (e.g. Apollo Project, Concorde and War on Cancer), for which the results have been analysed and documented, other cases, despite sometimes having very long trajectories, are still on-going and often the results and especially the impacts of the initiatives are still unclear. Overall it can be said that mission-oriented initiatives can be highly efficient tools to achieve technological objectives more rapidly and to induce a change in prevailing system by boosting the development and deployment of new emerging technologies.

- In terms of short-term outputs, the initiatives analysed have contributed to inducing significant private investments and new research projects. They are strongly associated to creation of new knowledge in terms of publications, and new technologies, tools and instruments. They have also been attributed to number of patents, national standards, and new management models. The initiatives have also resulted to many new policy instruments, laws and regulations, and creation of new research centres and laboratories. In addition, many new platforms and linkages between national and international actors are commonly mentioned outputs.

- In terms of achievement of the goals set and outcomes of the initiatives, there are number of initiatives that have successfully achieved their targets or made significant progress towards the set targets. The initiatives should not however be only assessed in terms of whether the targets were achieved or not. Although some of the initiatives have not reached their targets in the given timeframe, in some respects they can be considered as success stories. For example, Concorde made significant advances in supersonic transport, although the initiative did never achieve the goal of commercial aircraft. War on Cancer did not erase the cancer but made significant advances in the ways cancer can be prevented, detected and treated. Energiewende will most likely miss its emission targets but have made significant progress in renewable energy deployment and phase-out of nuclear energy. Norwegian EV initiative failed to create domestic electric vehicle industry in the country, but Norway is currently leading the way of EV deployment in the global scale. On the opposite side, also the seemingly successful initiatives can be considered less merited, depending on the point of view. The SunShot Initiative achieved its goals ahead of schedule but failed to maintain competitive PV
manufacturing industry in the country. The Apollo Program did not only land a man on the Moon and returned him safely back to the Earth, but also contributed towards technological breakthroughs in many sectors and industries. However, this was done with support of unlimited public budget. All in all, the success (or failure) of a mission-oriented initiative is not a dichotomy but a sum of many aspects.

- In terms of impacts, many of the initiatives analysed show impressive track records in terms of creation of economic growth and new jobs generated because of the initiatives. Many of the initiatives can also be directly associated to creation and support of entirely new industrial sectors. The initiatives show important societal impacts as well (e.g. reduction of cancer deaths, air pollution and greenhouse gas emission reductions, increased safety and fresh water supply, advancing digitalisation of public administration and society). In addition, some of the initiatives are associated to contributions towards significant behavioural changes such as in the cases of e-Estonia or Energiewende.

4.3.6. Conclusions and lessons learned

The case studies analysed present a compendium of very different types of mission-oriented R&I initiatives. They are all strongly rooted in temporal, geographical, political, and thematic contexts and consequently the target setting, implementation and success of the initiatives is influenced and motivated by many different factors. Each of the initiative have their strengths and weaknesses, and drawing generalised conclusions may not do justice to the uniqueness of the initiatives and their sometime very specific success factors. The following aims to however to highlight key overall messages:

- The initiatives are strongly rooted in their context and their formation is characterised by a clear necessity or urgency to solve societal and/or technological challenges. The initiatives are often based on a strong innovative ecosystem that provide suitable framework for missions to flourish. In many cases, the success of the mission is due to long historical trajectories and prior creation of R&I capacities. Although an accelerator type of mission is aimed at achieving scientific and technological progress faster, it may actually be based on decades of prior research. For example, the US War on Cancer relied on a sophisticated scientific and technological research system, with a high level of coordination between the actors. This allowed to leverage most of the synergies and complementarities, and to accelerate the delivery of the results and benefits.

- Basically, all the initiatives show strong top-down leadership and important direction setting by public policies. Majority of the initiatives have also very-well specified targets and pre-defined timeframe to achieve them. Typically, the initiatives show persistent and long-term dedication of public policies, which in turn is a key factor in engaging the citizens and private sector investments. The direction setting is not however a question of ‘picking winners’ but ‘picking willing’, a process of prioritising the societal challenges and creating favourable conditions for the best solutions to merge, co-evolve and compete. Good example of the direction setting is the German Energiewende, which did not prioritise any renewable technology over another. Similarly, the Chinese New Energy Vehicle or Norwegian Zero Emission Vehicle initiatives have set the direction to transform the transport system, and plug-in electric vehicles have become cornerstone of the solution. Progress of the initiatives especially aimed at transformative or systemic change like the examples above, but also those initiatives targeting towards solving societal problems by accelerating technological development (e.g. health missions) unavoidably takes a lot of time. The public sector needs to show persistency with the mission direction but at the same the policy should be reflexive and flexible enough to reassess and re-steer the initiative based on the progress made and changing dynamics of technological and market developments.

- Many initiatives show that, apart from strong directionality and centralised top-down leadership, also stakeholder and citizen engagement and joint ownership
of the missions are equally important. Here transparent and good communication plays an integral role to create a shared vision and common responsibility of the mission. However, the co-ownership of the missions should not endanger the centralised direction and target setting. Too high-level aspirations for consensus can lead to compromised decision-making and mitigate the ambitiousness of the initiatives. Thus, a balanced “mix of top-down direction-setting and bottom-up buy-in” (Energiewende) should be considered.

- Also, an adequate legal and regulatory framework is essential (e.g. National Cancer Act for War on Cancer, specific Delta Law in the Netherlands or nuclear phase-out law in Germany are good examples), but also new management models (e.g. Apollo Project, the steering of Energiewende involving Federal and Länder levels, formation of Delta Commission or the management models of cross-border initiatives Concorde, Airbus and EU Human Brain project). Importance of cross-silos coordination at the level of government and experimenting new ways of policy-making involving many stakeholders in different phases of the policy-making process can be considered as important characteristics of mission-oriented initiatives. Missions require to set up specific governance structures with full-time professionals and to keep close contacts with all stakeholders. A balanced system of separation of powers between steering, strategic and financial decision-making and the day-to-day management is a must to establish from the outset.

- Similarly, many of the initiatives show novel ways of financing the initiatives involving public-private partnerships in different forms. The initiatives are typically funded by large scale public budgets (R&D or thematic priorities such as energy, transport or environment), or they can be supported by separated public funds (e.g. Energiewende’s Energy and Climate Fund or Delta Plans Delta Fund). Some of the initiatives (e.g. Energiewende and Chinese PV policy) also show important role of state-owned investments banks supporting local administration, industry and private household investments. Other initiatives are directly formed as joint initiatives of public and private sectors (e.g. Airbus, Concorde and US Brain Initiative). In other cases (e.g. Chinese and Norwegian clean vehicle initiatives, Energiewende, Chinese solar energy policies, important investment subsidies and tax incentives are provided to catalyse the private sector investments. The private sector investments are crucially important to ensure the continuity of the initiatives, and to mitigate the dependency of the initiatives relying too much on governmental support. E.g. changes in political power resulting to drastic policy changes, or phase-out of public subsidies, are examples of situations in which private sector engagement is decisive. Hence, ensuring a balanced participation between the public and private actors is of high importance in such missions.

- Many of the initiatives analysed deal with global societal challenges and require integral and holistic policy approach, often beyond the scope of R&I policy alone. Especially those missions aimed at transformative change imply a large-scale systemic change characterised by not only the need of accelerating the technological development but also engaging the public and private demand to become drivers of the change. The success of these policies is largely dependent on the match between the new technological solutions and the needs, acceptance and support of the society. Thus, the initiatives aimed at transformative change necessitate a comprehensive policy-mix involving supply- and demand-side policy measures. In principle, the supply-side policies are oriented to support technological development and industrial capacities needed to facilitate the systemic change, whereas the demand-side policies are targeted to create or re-target demand, and to facilitate the societal acceptance and the change in consumer habits.

- Based on the initiatives analysed, it can be said that the orchestrating a policy-mix aimed at providing holistic support for both supply- and demand-sides is not an easy task. None of the transformative mission-oriented initiatives have
been fully successful in their aims of mastering in a balanced and timely manner the supply and demand. E.g. German solar energy manufacturing industry was not able to meet the rapid growth of installations (boosted by generous feed-in-tariffs of Energiewende) in a cost-competitive manner, and basically gave important impetus to growth of Chinese photovoltaics manufacturing industry. Similarly, the Norwegian EV policy failed in creation of domestic electric vehicle manufacturing industry. At the same time, the policy has been very successful in creating demand for electric vehicles, currently fully met by imported vehicles (e.g. Tesla). The US SunShot is a successful mission in technological terms, but much less successful in terms of supporting photovoltaic manufacturing industry in the United States, and a major part of the solar energy installations in the United States are covered by solar systems imported from Asia. In the Chinese NEV case, it appeared that the government’s original assessment of the domestic car manufacturers’ competences was too optimistic leading to unrealistic target setting and slow progress. Hence a realistic assessment of the technological and industrial capacities in the country or region with respect to the core technologies and global competitiveness of the manufacturing industry needed for the mission, can be considered as critical success factors.

- Equally important decisive factor of the transformative missions is the proper analysis of demand and willingness or readiness of citizens to become integral contributors of the transformation. Here, Energiewende can be considered a success. Apart from the fact that the citizens can be considered as the initiators of the grass roots movement of the energy transition, the citizens are also co-owners and co-payers of the transition. On the contrary, initiatives such as Chinese NEV have been less successful in encouraging consumers to buy NEVs. The Concorde initiative can be considered a technologically relatively successful initiative, however it failed to become a commercial success because airline passengers were not prepared to pay the costs of the super-sonic transport. Thus, a clear understanding of the market and readiness of the citizens to contribute towards the targets of missions, can also be decisive success factors for (transformative) missions.

- Mission-oriented R&I initiatives can comprise several, and in some cases, even contradictory objectives. A good example of complex relation of objective setting is German Energiewende. Despite achieving important growth of renewable energies, the simultaneous phase out of nuclear energy and growing energy demand, has led to unchanged levels (same level as 1990) of energy generation from gas, coal and lignite, and to slower decrease in greenhouse gas emission levels. In the Chinese NEVs case, the wide range of objectives (economic and technological development, CO₂ emission and pollution reduction, energy security) have led to complex interdependencies and may even lead to opposite (negative) impacts on some of the target categories (i.e. increase in pollution and CO₂ emissions). Such complexities in terms of targets and potential unwanted outcomes are important to consider when planning and launching large-scale transformative missions.

All-in all, mission-oriented R&I initiatives can be powerful tools to accelerate technological development and contribute towards a systemic change and many of the initiatives analysed show remarkable success in terms of achieving the targets but also in terms of wider societal and economic impacts. A confluence of a clear societal need or urgency, long-term but reflexive direction setting and commitment of public policy-making, adequate public funding combined with private investments, scientific and technological capabilities, and ‘buy-in’ of stakeholders, with all sharing a common vision, are good ingredients for a successful mission. “Somehow or other, when we came together, we were greater than the sum of our parts. We became capable of doing what in most cases, would be considered impossible. We were better than we ever expected to be. We were more successful than we were expected to be. And really, with the exception of a bad accident on the launch pad, we brought every crewman home” (Apollo Project).
5. FROM THE CURRENT EU R&I POLICY TO A MISSION-ORIENTED EU R&I POLICY

5.1. Introduction

This chapter compares the currently existing R&I policy set-up (the ‘baseline’ situation) with a full-fledged mission-oriented policy set-up, and analyses what it would take to change the current policy approach into a mission-oriented policy approach, highlighting in particular the R&I dimension. Starting from and based on two major examples of how current EU R&I and related policies are formulated and implemented, this chapter focuses on three central questions:

1) How does current EU policy for these two example cases look like? What are the main features of current R&I and broader policy context for these two examples (the ‘baseline’) and what policy outcomes have been generated so far?

2) To what extent do the two examples of current R&I and related policies show features of a mission-oriented approach? To what extent do they reflect accelerator and/or transformer missions?

3) What changes would be needed to transform the current policy set-up and turn it into a true mission-oriented policy set-up, taking these two examples as starting point? To what extent can this approach be replicated to other R&I policy themes? How scalable is the mission-oriented approach, both in the two thematic domains and in other ones?

In close co-ordination with the Commission services, the following examples of current R&I policy were selected for further analysis:

- The Active and Assistant Living Programme (AAL), in close conjunction with the EIP on Active and Healthy Ageing (AHA) and the JPI More Years Better Lives (MYBL).

- The Strategic Energy Technology (SET) Plan, in close conjunction with the 2020 Energy Union 20/20/20 targets: a 20% reduction in CO2 emissions compared to 1990 levels, 20% of energy, on the basis of consumption, coming from renewables and a 20% increase in energy efficiency.

Comparing the current EU R&I approach with a mission-oriented R&I approach, set in their broader policy context

In analysing and comparing the current EU R&I approach with a hypothetical mission-oriented R&I approach, a number of topics is reviewed, including:

- The origin, ambition, objectives, timeline, scale, scope, policy mix and financing arrangements of the current and mission-oriented R&I approach

- Its formation, main drivers, stakeholders and citizen involvement

- Its technical and political feasibility, covering technical and financial risks, success factors, political and societal impacts

- Policy mix: policy instruments and their interaction/complementarity

- Governance: organization, management and coordination, public-private involvement

- Scalability: scope to scale up and extend solutions in view of the mission at hand
Dealing with uncertainty and the scope for revision/adaptation during mission implementation in view of changed context/circumstances: how does the mission cope with uncertainty? What provisions are there to re-steer (elements of) the mission in view of contextual changes (e.g. arising competing solutions; technological and market changes)

- Monitoring and evaluation

- Communication and dissemination

- Coherence: linkages to other governance levels; linkages to broader EU targets (H2020, other policy strategies, programmes, etc.)

- The extent to which the current R&I policy set-up shows features of a mission-oriented approach

- Changes needed to transform the current R&I policy set-up into a true mission-oriented policy set-up, taking account of the above main headers (see previous bullets).

The comparison as described in the next sections takes stock of available documentation, analyses and insights relating to the two selected R&I policy examples, the AAL Programme and the SET-Plan. In addition, use is made of the insights and conclusions of other case studies of mission-oriented R&I policy.

5.2. Brief Summary of the cases

This section shortly discusses how current EU policy looks like in the two cases at hand. What are the main features and elements of current R&I policy (the ‘baseline’) and how do these translate into empirical terms?

5.2.1. The Active and Assisted Living Joint Programme

The Ambient Assisted Living Joint Programme (AAL1, running from 2008 until 2013) and its follow-up the Active Assisted Living Joint Programme (AAL2, running from 2013 until 2020) aim to “create better conditions of life for the older adults and to strengthen the international industrial opportunities for EU industry in the area of information and communication technology (ICT)”. The AAL Programme funds cross-national projects that involve small and medium enterprises (SMEs), research bodies and end-user organisations (representing older adults). In the table the main characteristics of the AAL Programme are summarised.

<table>
<thead>
<tr>
<th>Table 6 Active and Assisted Living Programme (AAL)</th>
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<tbody>
<tr>
<td><strong>Aspects</strong></td>
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<tr>
<td>Origin</td>
</tr>
</tbody>
</table>
| Objective(s) | - Improve quality of life of older people via ICT-based solutions to active and healthy ageing  
- Strengthen Europe’s digital sector |
| Timeline | 2013-2020 |
| Budget | EUR 700 million (2014-2020) |
| Policy mix | Comprehensive mix, including financial support (via calls for proposals), non-financial support to commercialisation (AAL2Business), efforts for promoting standards and interoperability of developed solutions and components and a prize (AAL Smart Ageing Prize). |
| Scalability | The relatively limited size of the projects and the different nature of the healthcare systems of AAL Partner Countries make that the chances for scalability of AAL solutions are limited by design. This inhibits reaching |
sufficient critical mass needed to achieve radical new solutions. Furthermore, the set-up of the AAL Programme and its limited EU Member State participation make scaling a challenge.

Dealing with uncertainty and scope for intermediate revision/adaptation
Calls can be adapted to fit changing needs; the overall programme is revised only after a number of 7 years (two changes so far). There is little opportunity to re-steer or by-steer ongoing projects

Main governing body
AAL Association

Monitoring and evaluation
Monitoring of the portfolio of projects funded (annual reports of the funded projects and final reports of the funded projects). Progress and impact of the programme itself has been reviewed by independent experts several times (midterm reviews, final evaluation, etc.)

Coherence
Programme can be linked to EU initiatives JPI MYBL, EIP AHA, EIT Health, FP7 and H2020 as well as to national and regional initiatives

Main outcomes, outputs and impacts
- Outputs:
  - Almost 200 projects funded over 2008-2016 involved more than 1,500 partners (with a public funding commitment or around EUR 300 million)
- Outcomes:
  - Improvement of collaboration between firms and end-users.
  - Improvement of collaboration between firms and research organisations.
  - Accelerated commercialisation of profit-making ICT-based solutions (and components thereof).
- Impacts:
  - The AAL Programme is considered at least ‘somewhat effective’ in achieving its socio-economic objectives.

5.2.2. The Strategic Energy Technology (SET) Plan

The SET-Plan (Strategic Energy Technology Plan) is the R&I roadmap for development of technology and solutions to enable an affordable and secure green transformation of the EU economy, to combat climate change and to achieve the 20/20/20 climate targets. The objective of the SET-Plan is, through a wide stakeholder consultation, to define detailed roadmaps for 13 R&I themes between EU Member States, research and industry. The SET-Plan steering group is the governing body that is responsible for the plan, and is closely tied to EERA (European organisation of energy research organisations) and the 9 Energy related industry platforms (ETIP's). In the table the main characteristics of the AAL Programme are summarised.

Table 7 Strategic Energy Technology (SET) Plan

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Strategic Energy Technology (SET) Plan</th>
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<tbody>
<tr>
<td>Origin</td>
<td>The EU climate and energy package aims to ensure the European Union meets its ambitious climate and energy targets for 2020. The targets were set by EU leaders in March 2007, when they committed Europe to become a highly energy-efficient, low carbon economy, and were enacted through the climate and energy package in 2009.</td>
</tr>
<tr>
<td>Objective(s)</td>
<td>Enable an affordable and green transformation of the economy, by developing technologies and systems, reducing costs of renewable energy sources and increasing energy efficiency</td>
</tr>
<tr>
<td>Timeline</td>
<td>2010-2020 and 2020-2030</td>
</tr>
<tr>
<td>Budget</td>
<td>No budget</td>
</tr>
<tr>
<td>Policy mix</td>
<td>The SET-Plan consists of 13 roadmaps designed for each of the Strategic actions in the SET-Plan, for the implementation relying on instruments and programmes of the Member States and the EU</td>
</tr>
<tr>
<td>Scalability</td>
<td>As the SET-Plan is only a plan, and as such neither a funding mechanism nor an instrument, the R&amp;I investment scalability is not determined within the SET-Plan. Yet the scalability of development of carbon-neutral energy systems and the scalability for cost-effective technological solutions to the carbon-neutral production, transmission and grid systems, balancing and control of power, heat, cooling, increased efficiency itself is scalable at global level.</td>
</tr>
</tbody>
</table>
Dealing with uncertainty and scope for intermediate revision/adaptation

As the SET-Plan in essence is based on 10-year roadmaps for the themes, the revisions have been minor to the overall plan, while there are constant revisions to the themes within the plan. Yet the new SET-Plan and the roadmaps herein are a fundamental revision, a collective, strategic approach.

As the SET-Plan includes R&I within competing carbon-neutral technologies, that reduces the risk of lock-in and does, at least conceptually, allow for adaptation of R&I advances. One may ask why R&I in CCS is still a part of the strategic plan, as this technology is severely lagging behind in development and cost reduction. Therefore, one may argue that the decision which themes and technologies are to be part of the overall plan is not nested in or based on a cost-effectiveness or assessment analysis.

Main governing body Monitoring and evaluation Coherence Main outcomes, outputs and impacts

| SET-Plan Steering group | Progress monitoring within the 13 themes, via the roadmaps and reported annually in the State of the Energy Union. | Programme can be linked to the 2020 Energy Strategy, ETIP’s, FP7 and H2020 as well as to national and regional initiatives | • Outputs: The SET-Plan provide clear roadmaps for R&I on 13 R&I themes • Outcomes: The SET-Plan, act as a forum for coordination among member states, research and industry for defining key strategic R&I missions, enabling the green transformation • Impacts: The SET-Plan and the strategic actions in the SET-Plan is widely reflected within EU R&I funding programs like Horizon 2020, and Member State R&I programmes |

5.3. Changes needed for shifting to a mission-oriented approach

This section describes to what extent the two cases show features of a mission-oriented approach. The AAL Programme and the SET-Plan will be analysed against the general criteria to which a mission-oriented R&I approach should adhere.

5.3.1. How to turn the AAL Programme into a mission-oriented programme?

The following overview discusses the main features of the AAL Programme, based on a number of criteria with key importance to a mission-oriented set-up. The next sections highlight the main barriers and necessary steps towards achieving a mission-oriented approach.

Table 8 Mission-oriented features of the AAL Programme

| Directionality (links to societal challenges, industry transformation): | The AAL Programme aims to accelerate systemic transformation in the healthy ageing domain to tackle societal challenges and increase business opportunities for the ICT industry. Its objectives are linked to FP7’s health research programme, Europe 2020 Strategy, and H2020 Societal Challenge 1, as well as the overarching target of the AHA to increase the average healthy lifespan of EU citizens by 2 years by the year 2020 and MYBL’s aim to enhance coordination and collaboration between European and national research programmes related to demographic change. Further directionality and selection of projects could ensure a more effective acceleration in the development of new solutions. Currently lack of and decentralisation of ownership directly affects the directionality and intentionality of the AAL Programme. Partner States, primarily driven by their own national interest, have not empowered the central Management Unit to achieve a common strategic vision oriented towards the common goods. Such a shared vision is still missing. Only a few Partner States have integrated the AAL Programme in their ageing and health policies. |

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9 Interview with the Director of the AAL programme on 6th November 2017.
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<tr>
<th><strong>Intentionality (specific, well-articulated goals):</strong></th>
<th>The objective of the AAL Programme is clearly stated in its dedicated strategy and its calls for proposals, however, it does not target any defined (quantified) goals.</th>
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<tr>
<td><strong>Clearly set timeline and milestones:</strong></td>
<td>The AAL Programme does not have a clear timeline in terms of milestones or roadmap.</td>
</tr>
<tr>
<td><strong>Scale / scalability:</strong></td>
<td>The AAL Programme is project-based, with an average total budget of about 3 million EUR per project, covering a wide variety of topics within the AAL domain. The relatively limited size of the projects and the different nature of the healthcare systems of AAL Partner Countries make that the chances for scalability of AAL solutions are limited by design which inhibits reaching sufficient critical mass needed to achieve radical new solutions. The dispersion of public investments across numerous projects (191 between 2008 and 2016) may hamper the ability of the AAL Programme itself to accelerate the development of (radically) new solutions to active and healthy ageing. And even if new solutions are developed, the divergence in health systems between Member States further limits the scalability of developed solutions from one country to another one. The size of the AAL Programme as a whole of 700 million EUR for the period 2013-2020 serving 19 Partner countries is relatively modest, i.e. less than 100 million EUR a year spread among 19 countries.</td>
</tr>
<tr>
<td><strong>Mobilises public and private investments:</strong></td>
<td>The AAL projects are co-financed by public organisations (both the European Commission and national agencies) and private partners.</td>
</tr>
<tr>
<td><strong>Policy mix:</strong></td>
<td>The AAL Programme offers an extensive policy mix ranging from financial support, non-financial support to commercialization activities.</td>
</tr>
<tr>
<td><strong>Focused on new knowledge creation (basic research, TRLs 1-4):</strong></td>
<td>Knowledge creation is not explicitly targeted, but not excluded either.</td>
</tr>
<tr>
<td><strong>Focused on knowledge application (applied research, TRLs 5-9):</strong></td>
<td>AAL projects aim to the development of new solutions that could be introduced onto the market within two years after the end of the project. As highlighted in the AAL Final Evaluation, financial support to the development of new solutions is not enough to achieve systemic transformation. The AAL Programme has also to ensure the uptake of solutions. To prevent that new solutions are shelved, the AAL2 Programme has implemented the AAL2Business instrument, providing non-financial support to ease and accelerate the commercialisation of developed solutions; consortium building; elaboration of business models; organisation of workshops with end-users and other stakeholders; training for better interactions with investors; matchmaking and networking events. Indirectly, uptake has been supported by promoting AAL standards and interoperability.</td>
</tr>
<tr>
<td><strong>Demand articulation (involves instruments for inducing demand):</strong></td>
<td>Strong emphasis is put on the involvement of end-users so that new solutions are genuinely tailored to their needs, but there is no specific instrument for inducing demand. However, its policy mix consists of supply-side instruments only. Despite the requirement to involve end-users in the co-design of new solutions, uptake is not encouraged by support to induce or increase demand. The AAL Programme helps the commercialisation of solutions, but not their wider adoption and diffusion.</td>
</tr>
<tr>
<td><strong>Multi-disciplinary (inter-disciplinary and/or trans-disciplinary):</strong></td>
<td>The AAL Programme enhances a multi-disciplinary approach contributing to the development and commercialisation of ICT-based solutions.</td>
</tr>
<tr>
<td><strong>Joint coordination (multi-level and/or horizontal governance of policies/finance):</strong></td>
<td>The AAL Programme involves the European Commission, countries and regions. However, its consistency with national and regional initiatives remains currently the sole responsibility of its Partner States and varies widely. The AAL2 strategy for the 2014-2020 period identifies synergies between the AAL Programme and other EU policy initiatives in the same field, but further efforts are required to operationalise these. EU policy initiatives on health and ageing should be brought in line, in mutual hierarchy and with clear objectives.</td>
</tr>
</tbody>
</table>
Reflexivity (flexible policy design, timely monitoring): The AAL Programme is regularly monitored and has undergone several evaluation exercises since its inception. Following the recommendations of the AAL1 final evaluation AAL2 has been brought in line with AHA to further facilitate the deployment of developed solutions at the European level. The focus of AAL2 is still on ‘ageing well’, but with more specific attention for industry support, especially aiming at SMEs, and innovative products. Furthermore, the AAL2 2014-2020 strategy defines success indicators for that purpose, but they are mostly input-oriented. Its future design based on sound monitoring and evaluation should allow for adaptation of the AAL Programme and AAL projects during their lifetime based on independent evaluation outcomes.

Openness (connected to international agendas and networks): The AAL Programme should be brought more in line with other high-level EU policy initiatives on health and ageing and should be transparent and well-communicable to EU citizens.

Involvement of citizens: The involvement of end-users in AAL projects as co-designers is required. Despite the broad definition of ‘end-users’, they currently do not encompass all citizens in the target group.

The current societal challenge-based AAL Programme could contribute to a broadly formulated EU transformer mission that targets systemic transformation on healthy ageing by providing ICT-based solutions for older people, enabling them to prolong their working life, stay socially active and age well at home.

Within the context of divergent national policies, frameworks and systems in healthcare, standards and quality of living, perceptions and expectations between Member States, and with healthcare and ageing policy remaining in the remit of national policy formation and implementation, the current lack of real ownership of and for the AAL Programme and its lack of integration in national health and ageing strategies all make that systemic transformation is difficult to replicate between Member States. The first and most important requirement for a mission-oriented set-up is a better alignment and integration of various EU initiatives on health and ageing, combined with a comprehensive EU strategy for the use of ICT to address the ageing challenge. In this aligned set-up, the AAL Programme could serve a broader integrated healthy ageing mission. Conditional to such alignment and integration are shared levels of awareness, a similar sense of urgency and ditto commitment to healthy ageing of AAL Partner countries. A further requirement, in view of the fact that healthy ageing is an EU-wide challenge, is that active participation in AAL Programme design and programming should be broader than the current half of the current Member States, taking account of the needs and absorptive capacity of most and preferably all Member States.

Thirdly, within the scope of the broader transformer mission the AAL Programme needs to be structured with quantified objectives, milestones, a clear timeline and a roadmap. In view of the supporting competence of the EU, a focus on a smaller but dedicated number of themes could help to define a clearer, more targeted and hence more effective AAL Programme. Furthermore, the concentration of means and attention on a limited number of themes on which progress can be made with sufficient potential for radical innovation could warrant the scalability of AAL solutions by their design.

Fourthly, by aligning and integrating the AAL Programme within a broad transformer mission, it could be ensured that the AAL Programme not only helps the commercialisation of solutions, but also their wider adoption and diffusion in each of the Member States. For this a specific way of working in AAL funded projects towards solutions consisting of components that can be combined flexibly over time and standardised interfaces between systems and components to ensure that combinations can be made in a seamless manner [considering that the (ICT-based) solutions developed with the support of the AAL Programme must adapt to different national health systems and to growing and changing needs of end-users].
5.3.2. How to turn the SET-Plan into a mission-oriented programme?

The main drawback from a policy point of view is that the SET-Plan is ‘just’ a plan, without an own dedicated funding programme, and with its funding relying on numerous instruments and programmes of the Member States and the EU. Among these projects under an endless web of instruments and programmes, redundancy is inevitable, and continuous learning for progress are not well incorporated. For the SET-Plan and its 13 R&I themes to take a true mission-oriented approach, dedicated funding with the funding objective related to the core purpose of the R&I mission would be key. The following overview discusses the main features of the current SET-Plan in more detail.

Table 9 Mission-oriented features of the SET-Plan

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directionality (links to societal challenges, industry transformation):</strong></td>
<td>The SET-Plan is linked to the energy and climate change goals within the Horizon 2020 Societal Pillar. The SET-Plan acts as a strategic R&amp;I tool within the Energy Union and the mission set out in 20/20/20 and the 2030 targets under the Paris Agreement.</td>
</tr>
<tr>
<td><strong>Intentionality (specific, well-articulated goals):</strong></td>
<td>The SET-Plan in itself has had and continues to have very clear goals, that can be broken down in 13 topics, to be interpreted as independent and narrowly defined accelerator ‘sub-missions’ for development within specific technologies or settings. For each of these sub-missions, using a thorough stakeholder involvement process, detailed R&amp;I roadmaps are made, with clear targets and a ‘best estimate’ of the needed R&amp;I funding to achieve the targets.</td>
</tr>
<tr>
<td><strong>Clearly set timeline and milestones:</strong></td>
<td>Both the first SET-Plan from 2009 and the consecutive SET-Plan currently being made, have a clear timeline, the first from 2010 to 2020 and the oncoming one for 2020 to 2030. In both there are developed detailed roadmaps with clear technological milestones and the timelines for these specific elements in the ‘sub-mission’ roadmap.</td>
</tr>
<tr>
<td><strong>Scale / scalability:</strong></td>
<td>The scale of the SET-Plan is considerable measured in absolute and relative investment terms, even though the plan consists of 13 independent technology-based topics (‘sub-missions’). Less clear is how these ‘sub-missions’ translate to scalable solutions that can be applied throughout the EU.</td>
</tr>
<tr>
<td><strong>Mobilising public and private investment:</strong></td>
<td>in 2016 23 billion EUR was invested in R&amp;I in the SET-Plan priorities, of which 77 % came from industry, 18 % came from national research budgets and 5 % came from the EU. Investments in renewable energy and the energy transformation in Europe are considerable. As an example, nearly 241 billion EUR has been invested in infrastructure under the ESFI instrument alone.</td>
</tr>
<tr>
<td><strong>Focused on new knowledge creation (basic research, TRLs 1-4):</strong></td>
<td>Some parts of the activities in the SET actions are related to basic research, while most are mainly related to demonstration and systemic innovation. Yet in all topics knowledge creation TRLs 1-4 and knowledge application TRLs 5-9 applies. The SET-Plan is a multi-technology basket plan.</td>
</tr>
<tr>
<td><strong>Focused on knowledge application (applied research, TRLs 5-9):</strong></td>
<td>see above</td>
</tr>
<tr>
<td><strong>Demand articulation (any instruments for inducing demand?):</strong></td>
<td>The measures within the SET-Plan do not involve instruments for demand, only measures for R&amp;I. Yet demand measures related to the 20/20/20 targets and the Energy Union are in place, together with regulation such as the ETS scheme, and also affect the technological development within the SET-Plan technologies.</td>
</tr>
<tr>
<td><strong>Multi-disciplinary (inter-disciplinary and/or trans-disciplinary):</strong></td>
<td>The SET-Plan, i.e. the 13 sub-missions within it, is multi-disciplinary as a whole, yet for several of the given</td>
</tr>
</tbody>
</table>
actions points like Concentrated Solar Power (CSP) or Carbon Capture and storage/utilization (CCS/U) it is not.

| Joint coordination (multi-level and/or horizontal governance of policies/finance): |
| The SET-Plan is from 2017 onwards organized along 13 themes, to be seen as 13 R&I sub-missions. In each of these sub-missions, there is a strong coordination between Member States dedicated to that specific sub-mission, through the allocation of national R&D funds and stakeholders from industry and EERA. The SET-Plan both acts as an R&I roadmap for each of these 13 sub-missions, but also as a co-ordination mechanism between the EU, the Member states and stakeholders. |

| Reflexivity (flexible policy design, timely monitoring): |
| The SET-Plan and the progress within the 13 themes or sub-missions is closely monitored, via the roadmaps among the key stakeholders. Since the 2030 targets for the Energy Union have been adopted by the Member States and the EU in 2015, there have been conducted a larger broadly stakeholder-based consultancy aiming at defining an updated SET-Plan and new roadmaps. In this "new" SET-Plan set-up, e-mobility has become a vital component, where R&I and investments in especially batteries have become a major target. |

| Openness (connected to international agendas and networks): |
| The original 20/20/20 targets and the new targets for 2030 are clearly connected to international agreements on climate change and, likewise, to the #SDG goals related to climate change. The SET-Plan and the policy is thus directly connected to signed agreements on international R&I missions. |

| Involvement of citizens: |
| The activities do only to some extent involve citizens and mainly so within 2 of the 13 themes. In Smart consumer centric energy systems and Smart cities and communication citizens and consumers play an active role. The remaining 11 themes with R&I actions are highly R&I- and domain driven. Citizen involvement in the R&I process itself makes little or no sense. The lack of citizen involvement in the SET-Plan steering group and in defining the 13 themes is obvious, as it is defined from the needs of large utilities and the suppliers to these utilities. The themes of the SET-Plan would be different if citizens were to be involved, as dispersed ownership, localised system and self-containing approaches would be part of the plan as they offer viable and cost-effective solutions. |

The SET-Plan in its current set-up is not an accelerator mission or mission-oriented programme. Rather it is a plan with a governance body, but without a formal funding mechanism and without having formal governance therefore of the actual R&I projects it is planning.

The critical part of the SET-Plan is funded by various instruments under Horizon2020, outside the body that determines its strategic path. To align both, a proposal may be to directly allot an R&I funding mechanism for SET-Plan activities, to be governed and decided by the SET-Plan steering group. As it is, the purpose of Horizon 2020 or any of the instruments therein, is not to fund R&I with the specific and singular purpose to solve a mission. Horizon 2020 and the instruments herein have other purposes, like science excellence, creating competitiveness, helping SME’s, to which also the evaluation mechanism of these instruments is geared. Where there not necessarily is a direct conflict in this, one cannot state that there is not.

Important to a mission-oriented R&I accelerator programme is that there is widespread learning and knowledge sharing among the R&I activities, and that these are constantly applied to steer and guide the mission but also to enhance results and impacts. When looking at the current Horizon 2020 set-up, such a procedure is by no means clear today. Billions are invested through various instruments and the investments are measured against overall targets, but cross-facilitation and measures of learning within and among
instruments programmes on a day-to-day basis, do not seem to be in place. R&I initiatives today are funded as a patchwork, as a puzzle with bits and pieces from different funding mechanisms, that all do a bit of change and colouring to each piece.

Allowing funding to be directly coupled to the R&I mission, based on roadmaps, would open the door to a much more agile and flexible approach, which would also allow for a more stringent evaluation of added value and progress related to the R&I mission targets.

**Turning the SET-Plan into a mission**

First and foremost, a mission-oriented approach would require a lasting commitment from the EU and Member States to a dedicated transformer mission to which R&I accelerator missions – in line with the 13 sub-missions of the current SET-Plan - is a vital part.

Including citizens and civil society as a true stakeholder in the development of the plan and the definition of R&I themes, would lead to another plan and most likely a broader acceptance of the plan. Looking at the German Energiewende, the citizens are seemingly more pro prioritisation of the green transformation, than industry and policy makers, and are more willing to pay for the transformation. Therefore, involving citizens will most likely act in favour of defining and prioritising societal missions that require transformation and includes initial costs to spur this transformation.

Secondly, a mission-oriented approach would have to clearly define the purpose of R&I within the wider mission, preferably with one unified goal, being to solve the mission, and to establish measuring procedures only related to this.

Thirdly, a mission-oriented approach would require ensuring that R&I missions escape the complexity in instruments and governing bodies, and being evaluated against the purpose and objectives of Horizon 2020 which are too broad on the one hand and too little specific on the other. Rather a dedicated SET-Plan specific monitoring and evaluation framework is preferred.

Fourthly, a mission-oriented approach would require giving R&I missions one single body of governance to perform the mission, and letting the R&I governance body be a part of a single body responsible for the broader transformer mission to which the R&I mission are a part.

**5.4. Main conclusions and lessons for Mission-Oriented policy design and implementation**

The comparison of the analyses of the AAL Programme and the SET-Plan against the general criteria to which a mission-oriented R&I approach should adhere is presented in the table above. The comparison reveals that the SET-Plan already includes many of the MO R&I characteristics, from directionality, intentionality and clearly set timeline, to multidisciplinary, joint-coordination and European added-value, whereas the AAL Programme appears to contain less mission-oriented characteristics.

**Table 10 Comparative degree of mission orientation of the AAL Programme and the SET-Plan**

<table>
<thead>
<tr>
<th></th>
<th>Active and Assisted Living Programme</th>
<th>Strategic Technology (SET) Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directionality</td>
<td>✓</td>
<td>√√</td>
</tr>
<tr>
<td>Intentionality</td>
<td>✓</td>
<td>√√</td>
</tr>
<tr>
<td>Clearly set timeline</td>
<td>X</td>
<td>√√</td>
</tr>
<tr>
<td>Public and private investments</td>
<td>√√</td>
<td>√√</td>
</tr>
</tbody>
</table>
The two cases highlight the importance of an integral and coherent vision when designing and implementing mission-oriented policy. Both the SET-Plan and AAL Programme have a strong technology and R&I focus, with their overall objective relating to other, overarching and ‘higher’ policy objectives in the energy and the healthy ageing domain, respectively. In other words, both the SET-Plan and the AAL Programme do not operate in isolation, but are linked to other EU initiatives, and deliver value – solutions - in view of ‘higher’ policy objectives defined under these initiatives.

A coherent and integral vision and clear linkages between related EU policy initiatives are essential - a condition sine qua non - for a targeted mission-oriented policy. Both the SET-Plan and the AAL Programme can be turned into accelerator R&I missions and embedded in wider missions, formulated to attain systemic transformation in the energy respectively the healthy ageing domain.

Shared levels of awareness, sense of urgency and commitment

The chances for a successful mission-oriented approach are higher when participating Member States and/or potential stakeholders across the EU have shared levels of awareness on the challenge ahead and share a sense of urgency to act and really commit themselves to the mission.

EU and Member State competences

Both cases show the complexity and the challenges of an EU-driven mission-oriented approach in policy domains like health and ageing where the EU has only a supporting competence\textsuperscript{10} and in policy domains where the EU has - shared competence such as energy but also research and technological development. The AAL case is in this sense different from the SET-Plan in which the EU has a shared competence with the Member States, and where its ‘right to play’ is hence clearer and more obvious since expected. In policy domains where the EU has exclusive competence such as the internal market or the common

\textsuperscript{10} See Title I, Part I of the Consolidated Treaty on the Functioning of the European Union.
fisheries policy, mission-oriented policy – if and where desirable - could be relatively easily established from a policy mix and governance perspective.

Where the EU has only a supporting competence, the requirement of a shared level of awareness, a jointly felt sense of urgency and joint commitment is far stronger than in policy domains where the EU has shared or exclusive competence.

**Clear and quantified goals, milestones and a dedicated budget**

To turn the SET-Plan and the AAL Programme into mission-oriented programmes would require setting clear and quantified goals and milestones, and preferably a roadmap. The SET-Plan case forms evidence that a dedicated budget managed by a dedicated governance body would ease the attainment of objectives and could accelerate a mission-oriented programme.

**Uncertainty and the scope for revision/ adaptation**

Whereas the mission itself should be firm and clear in terms of direction and intention, the mission should be flexible enough to re-steer where needed, in view of contextual changes (e.g. arising competing solutions; technological and market changes) and unforeseen developments.

**Scale and scalability**

Concentration of budgetary means, e.g. in larger projects, and concentration on a limited number of themes on which progress can be made with sufficient potential for (radical) innovation can both be useful in achieving mission objectives. Different institutional and/or regulatory contexts can inhibit scalability, as the AAL Programme case aptly shows.

**Evaluation and a more agile and flexible approach**

Allowing funding to be directly coupled to the R&I mission, based on roadmaps, would allow a much more agile and flexible approach, which would also open up possibilities for a more stringent evaluation of added value and progress related to the R&I mission targets. A more targeted mission-based monitoring and evaluation system, ensuring that R&I missions escape being evaluated against the purpose and objectives of the Framework Programme, is to be favoured against the current monitoring and evaluation framework. Such an approach would also allow, based on evaluation results, limited adaptations in programme design and implementation where deemed necessary.
6. POLICY OPTIONS FOR A MOVE TOWARDS MISSION-ORIENTATION

In this chapter, five policy options are defined and compared based on the findings collected through the Study. The Policy Option 1 (hereafter PO1) is a scenario in which no significant change will be introduced to the current EU R&I policy, implying that the approach of the Work Programme 2014-2017 of Horizon 2020 will be the one also followed by FP9. Following PO1, FP9 will consequently not be mission oriented. The Policy Option 2 (hereafter PO2) could not be considered as a proper mission-oriented approach either, as it would consist in focusing further on some thematic areas (the so-called 'focus areas'), but without the aim of finding concrete solutions to well-identified problems.

The policy options 3, 4 and 5 are different approaches of mission orientation. Policy Option 3 (PO3) aims to the achievement of missions that require the transformation of systems. Targeted problems are often wicked and of societal nature. On the reverse, Policy Option 4 (PO4) consists of a move towards accelerator missions, that is, missions that could be achieved thanks to the development of (often breakthrough) technologies and/or research activities in a faster, more efficient and coordinated manner. In these cases, policymakers need to orient R&I activities in a certain direction, but no transformation of any system is sought nor necessary (but it may happen as an unintended outcome). Finally, Policy Option 5 (PO5) is a hybrid model mixing the transformer and accelerator types of missions. Its consists mostly of initiatives whose overall objective is solve to well-identified societal problems, but whose solutions require the development of new solutions and therefore solving technological challenges.

Data and other pieces of evidence were collected via scoping interviews, an online survey, expert and stakeholder interviews, and a dedicated workshop.

Scoping interviews were held with European Commission’s officials (e.g. DG RTD, DG CNECT, DG REGIO) and national organisations with a view to get their insights on mission orientation and the ninth Framework Programme. They were asked their views on the challenges that should be addressed by mission-oriented approach, the nature of the missions, and the expected benefits and risks of the transition of the EU research and innovation policy in that direction. The scoping interviews were followed by subsequent correspondence and meetings with the European Commission, where further inputs to the scope of the work for the definition of the Policy Objectives were received.

A total of thirteen case studies, considered as paradigmatic examples of MO R&I initiatives from which policy lessons for the European Commission (in the context of the preparations of FP9) could be drawn, have been conducted with a view to investigate their overall context, the way they have been implemented and managed, and their impacts that could have been measured so far. The selected cases consist of past or ongoing mission-oriented R&I initiatives with long trajectory and significant economic, societal or environmental impact already achieved.

An online survey was launched on 6th December 2017 targeting predominantly H2020 participants. The goal of the questionnaire was to achieve a qualitative and partly quantitative assessment of stakeholders’ views and experience on the policy objectives, the policy options and the impacts. On 19 December 2017, a total of 7,148 responses had been received. The analysis focused on completed and fully exploitable answers which amounted to 1,863.

Table 11. Number of respondents grouped by type

<table>
<thead>
<tr>
<th>Type of stakeholders</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Organisations</td>
<td>458</td>
</tr>
<tr>
<td>Category</td>
<td>Count</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Higher or Secondary Education Establishments</td>
<td>491</td>
</tr>
<tr>
<td>Private for-profit entities (excluding Higher or Secondary Education</td>
<td>618</td>
</tr>
<tr>
<td>Establishments)</td>
<td></td>
</tr>
<tr>
<td>Public bodies (excluding Research Organisations and Secondary or Higher</td>
<td>162</td>
</tr>
<tr>
<td>Education Establishments)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>134</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,863</strong></td>
</tr>
</tbody>
</table>

In addition to the survey, a total of 40 experts and stakeholders were contacted for interviews by the Consortium. They were asked about their views on the key characteristics of a possible mission-oriented approach in FP9, its objectives, the way it could be implemented, and their potential impacts. Interviewees were representatives of all stakeholders deemed relevant across the European Union (see Appendix A):

- Policy-makers: EU institutions (e.g. the European Commission and the European Committee of Regions), national ministries and public agencies in charge of research and innovation policies, and local authorities (including regions and cities);
- Research, Technology and Education actors: Research and Technology Organisations (RTOs); Higher Education Institutes (HEIs); Research networks and technology platforms;
- Industry (including business associations);
- Civil organisations active in fields related to research and innovation and/or societal challenges; and
- Research and Innovation experts (including specialised private foundations and consultancies).

Finally, a workshop was organised, in collaboration with the European Commission, DG RTD, on 20th February 2018 with almost 20 participants (Appendix B) from all over the European Union representing:

- Policy-makers: international organisations, national ministries and specialised agencies;
- Research, Technology and Education actors: RTOs, HEIs, managers of R&I initiatives;
- Industry;
- Civil organisations active in fields related to research and innovation and/or societal challenges; and,
- Individual research and innovation experts.

In the first part of the day, small groups were asked to give their perspectives on the directionality of mission-oriented R&I initiatives, their governance, the implied horizontal, vertical and multi-level coordination, and the engagement of citizens. In the afternoon sessions, participants, again divided in small groups, were asked to reflect on the different policy options.
6.1. **PO1 – PO2: Baseline scenario**

The current status of the EU funding schemes for R&I initiatives is particularly complex for a number of reasons related to national specificities and obstacles due to the management at European level. All innovation ecosystems are characterised by numerous interdependencies among several categories of stakeholders. To create a strong knowledge-based system in the field of research and innovation is notoriously a challenging endeavour. The conception and design of new policies can be done in a limited time, while their implementation may take longer periods, characterised by deadlocks and obstacles.

6.1.1. **The current structure of the Framework Programme should not be radically changed, as it is deemed as satisfying by several categories of stakeholders.**

The interim evaluation of Horizon 2020, while identifying few areas in which there is room of improvement, also underlines how some critical issues have instead improved. For instance, more SMEs are joining in comparison with the past and the collaboration among different types of stakeholders is increasing.

The current structure and functioning of the Framework Programme offers the opportunity to the stakeholders to participate jointly and successfully to common pan-European projects. The current arrangement given by the division in pillars and topics, implemented by instruments with well-established processes and goals, should therefore be maintained. Several partners from scientific sectors and industries coming from different countries dispose of a system to successfully liaise and establish sustainable and effective collaborations. Horizon 2020 offers instruments to create cross-sectorial synergies on a variety of issues, which allow policy-makers to address national and regional societal challenges.

By keeping the current structure and by reediting the instruments and objectives, the future Framework Programme will continue offering stakeholders the opportunity to contribute in addressing societal challenges. The FP9 should improve the existing mechanisms and further support the development of efficient R&I ecosystems.

6.1.2. **The current structure of the Framework Programme encourages collaboration and competition between European R&I actors but has a rather low impact on fostering innovation.**

Despite the positive elements, both policymakers and practitioners of the R&I sectors tend to agree that Horizon 2020 does not contribute to developing innovation and fostering growth as expected.

Practitioners in the field of R&I may spend too much time and efforts in understanding H2020 themes and the functioning of its instruments, instead of actually contributing to research and the development of innovative solutions.

Moreover, the current structure does not allow citizens or civil society organisations to take part to important decision-making processes regarding the future of European economy and society.

Another hampering factor to innovation is the weakness of the learning mechanisms in the current situation: a lack that should certainly be addressed in FP9.

6.1.3. **The FP9 should have a simplified structure, focus on demand-driven innovation and more flexible instruments**

To increase results in terms of research and scientific outputs, as well as to increase innovation schemes to truly foster growth and address societal challenges, the number of instruments should be dramatically reduced and the governing and granting bodies unified.
The scope of the calls should also be better defined and specify the societal goals they aim to tackle.

Rules determining funding sources and partnerships should instead become more flexible.

Moreover, to truly spur innovation and uptake technology, the EU institutions should aim to support societal change capable of creating new markets for innovative products, which may be the direct result of the EU investments.

The 2020 targets agreed by the European Union in terms of energy sources represents an example of how demand-driven innovation is the key to success for future common challenge-oriented initiatives.

6.2. **PO3: Transformer missions**

Transformer missions (‘transformers’) refer to large R&I endeavours that address European societal challenges, such as climate change, with the aim of achieving a transformative change in how different societal sectors and organisations function and how citizens live. Transformers require not only research and innovation achievements, but they also necessitate changes in regulation and user behaviour, and even creation of new markets. This often entails a systemic change in how technologies are accepted and applied by society in large.

Transformers require coordinated R&I activities across several sectors and thematic policies (i.e. energy, transport etc), as well as citizen engagement and social innovation. Coordination between sectoral policy and regulatory actors is vital, and strong multi-level governance and coordination model is called for (EU, national, regional and urban levels). Examples of transformer of mission include German Energiewende, DeltaPlan of the Netherlands, US SunShot, and Chinese Solar Energy policies.

6.2.1. **Condition 1: Policy-mix**

Transformer missions aim at solving large-scale societal challenges and boost systemic changes, which calls for a cross-sectoral policy-mix that goes beyond the R&I policy. Since transformer missions should be legitimated by citizens and respond to their social needs and demand, it is reasonable that the policy-mix should include demand-side measures like fiscal incentives and public procurement. The non-technological barriers (e.g. regulation, standards, user/societal acceptance) can play a crucial role for the success of transformative missions, and therefore collaboration between different policy domains is important in order to create sufficient coordination and trust between the R&I policy and other policy domains.

While the benefits of cross-sectoral alignment of regulatory and policy actions are quite evident for transformer missions, it should be noted that not all sectors are mature for cross-sectoral collaboration, and, in some cases, it may increase transaction costs significantly. Therefore, inventing new cross-sectoral policy instruments should be avoided and focus should be in the better alignment and simplification of existing policy instruments where possible.

6.2.2. **Condition 2: Bottom-up practices**

Bottom-up practices refer to the involvement of citizens in the definition, design and implementation of transformative missions. Thorough understanding of market demand and readiness of citizens to become integral contributors of transformer missions are crucial success factors for achieving necessary large-scale societal changes. By citizen engagement, not only the legitimacy of using public funding for transformer missions is secured, but it can also produce such inputs, perspectives and visions that are necessary for the realization of missions with societal impact.
The challenge of citizen engagement is the question of who should represent the citizens, (e.g. coalitions vs. individuals, educated vs. non-educated) and what role they should have in the decision-making and selection of topics (ownership vs. consultative). It should be also noted that transaction costs of transformative missions could increase with citizen engagement without proper coordination and management practices in place.

6.2.3. **Condition 3: Visibility and communication**

Visibility of transformer missions is closely connected to the issue of citizen engagement addressed above. Engaging citizens in the definition of transformer missions may result in more visibility and media attention to the mission topics. If citizens are expected to play a role in transformer missions, communication efforts are required along with education and training activities.

Overall, transformer missions have potential to be seen as powerful tools to transform research results into societal benefits. Concrete examples of how European R&I can help us to tackle the challenges like climate change may result in positive visibility of EU as a whole and help the citizens to see the added value of EU-coordinated R&I activities.

6.2.4. **Condition 4: Vertical collaboration and synergies**

The complexity of vertical governance (cities, regions, the Member States, EU) is evident in case transformer missions, as there are challenges specific to the certain Member States and regions besides common European challenges. The common governance model implies that EU sets the general direction and framework whereas the Member States have free hands to adjust their own priorities within the given framework. With this respect, transformer missions with a clear target setting may help Member States to elaborate their own targets and priorities with the aim of better alignment with EU policies.

In order to get regions and cities involved, it could be considered whether the large-scale transformer missions could be complemented by smaller satellite initiatives taking place at regional level. Especially, supporting innovation in SMEs could benefit from regional considerations (including smart specialisation strategies).

6.3. **PO4: Accelerator missions**

Accelerator missions concentrate and direct resources towards (highly) ambitious and clearly defined goals, whose accomplishment relies on accelerated scientific and technological advancements. However, even though technological breakthroughs are here the primary (but not exclusive) focus, societal and economic effects also need to be considered: initiatives such as the Apollo Program, the Concorde and the US War on Cancer show how also scientific and technological goals may produce clear spill-over effects into several industrial branches and society as a whole.

From a policy perspective, accelerators could be promoted for the following reasons:

- Strengthen research capabilities and develop research activities in a specific field for an accelerated knowledge creation (e.g. War on Cancer);
- Achieving/Sustaining competitiveness in certain technology areas/sectors/branches and hence contributing to knowledge-based, sustainable economic growth (e.g. Concorde, Airbus);
- Achieving/Sustaining (technological) independency in sensitive areas such as energy production, ICT services and security, core industries or environmental related areas;
- Providing new products and/or services to the markets;
• Providing functional solutions for societal or environmental problems with specific urgency (e.g. Delta Plan for flood catastrophes, War on Cancer, German Energiewende);

• Contributing to alignment and cooperation in the European Union by promoting 'lighthouse Projects' with high visibility on EU-level that serve as common point for orientation of public and private entities.

Compared to applying ‘transformative’ types of missions, emphasis on ‘accelerators’ would have the following attributes, based on the analysis of the respective case studies:

• A somewhat higher number of more defined missions that are linked to technological breakthroughs;

• Less emphasis on social innovation and coordination with other policy spheres and regulations;

• Great emphasis on cross-sector and cross-disciplinary dimensions in order to truly achieve innovative solutions;

• Focus on the provision of market-ready new products and/or services (i.e. innovations) and on their economic potentials.

For the practical implementation of the ‘accelerator’ type of missions, some key principles could be identified arising from the several empirical foundations of this study. These are grouped around two main elements, the design and monitoring structure as well as the responsibility for formulation and implementation.

6.3.1. Technological/accelerator missions have a wide variety of impacts to be considered, and truly contribute to developing breakthrough solutions

Accelerators are meant to direct R&I efforts towards the achievement of scientific and technological development targets and innovation that are deemed as urgently needed. Hence, a potential move of EU R&I policy towards accelerator-type missions is considered as an appropriate option to encourage R&I activities. At the same time, potential economic, societal and geopolitical impacts need to be considered in the ex-ante assessment, though with less strict monitoring or evaluation criteria since they are not primary targets with more uncertain effects.

Moreover, as accelerator missions focus on limited sets of technological solutions, they are suitable for allowing higher risk taking and for applying experimental approaches. Consequently, accelerators have the potential to truly contribute to technological breakthroughs by being more open for failures.

6.3.2. Structure and design

From the analysis of both mission-oriented cases, stakeholders interviews and workshop participants, some core basic design features of ‘accelerators’ have been identified:

• Targets are to be clearly formulated and measurable;

• Risk-taking and encouraging experimental solutions should be promoted;

• The timeframe for achieving results can be set rather short between five to ten years;

• Progress needs to be constantly monitored;

• Cross-sectoral and interdisciplinary approaches should be followed; and,
• Make use of already successful models, such as the public-private partnerships.

6.3.3. New mechanisms to monitor and evaluate the specific impact of technological/accelerator missions should be conceived

The monitoring system, in accordance with the aforementioned features of the accelerator missions, has to meet the requirements of limited administrative burden and to be flexible and adjustable. For this reason, targets should be clearly broken down in milestones, by potentially also incorporating milestone-based funding.

The societal or economic impacts of these initiatives should not be measured by only considering the investments, but also by confronting them against the technological objectives and the potentiality the new solutions to be commercialised.

The European Commission should be in charge of designing new types of monitoring mechanisms and of initiating and supervising evaluation processes.

6.3.4. Design of technological/accelerator missions

A stable and flexible conversation between the European Commission, the Member States and the industrial stakeholders should be guaranteed. Furthermore, a pronounced emphasis of the European Commission on certain technologies may cause scepticism in Member States if it conflicts with national interests and values (e.g. genetic engineering; nuclear power).

Design and implementation of missions requires both horizontal and vertical coordination. The former is considered to be more suitable for the implementation of the missions, while the latter for the design of them.

As industry is the most knowledgeable about the technological challenges that need to be addressed, it has to take a leading position in the definition of the ‘accelerator’ type missions. Industry lead should happen in collaboration between large companies and SMEs and with appropriate mechanisms to avoid dominance of any of the participants in the discussion.

The role of public organisations and citizen mainly consist of reflecting on the societal impacts of missions and guaranteeing their social compatibility.

6.3.5. Implementation of technological/accelerator missions

Horizontal coordination in the implementation of the missions can be successfully ensured by setting up management bodies or entities. For the accelerator type of missions, platform solutions (e.g. Joint Technology Initiatives; Art. 187), if they have proved success, could serve as a role model. The advantages of this approach are:

• Realising high commitment of involved public and private stakeholders by formalized structures;

• Share financial burdens and benefits;

• Ensure cross-sector and cross-disciplinary approaches in implementing missions.

6.4. PO5: Mix or hybrid scenario

Mission-oriented R&I policy can be a powerful tool to accelerate technological development and contribute towards a systemic change. It is about selecting, setting a direction, clearly defined targets and timeframe for R&I policy with final aim to improve the welfare of society. The missions should be focused to provide solutions to societal challenges, which can be very different by nature and scale, varying from more localised threats (e.g. flooding
in the case of the Delta Plan, local air pollution in the cases of the Chinese initiatives, modernisation of the country in case of e-Estonia), to measures aimed at solving complex challenges that are important on a global scale (e.g. health or climate change).

6.4.1. **Condition 1: A combination of accelerators and transformers is needed for successful mission-oriented policy**

These above-mentioned challenges can be met by both accelerator or transformer type of missions. The accelerator missions are targeted to accelerate scientific, technological or industrial change in a set direction, whereas the objective of a transformer mission is to transform an entire economic or socio-technical system in a set direction. Both type of missions can be equally relevant for achieving societal or economic implications, which can be much wider than the original target of a mission. Independently of the type of a mission, societal acceptance, citizen engagement and wide market uptake of the technologies are necessary conditions for successful R&I activities. Technological solutions remain merely artefacts until the moment society have the opportunity and willingness to use them.

Despite the fundamental nature of the two types of missions is different, they can also be considered as highly interrelated, cyclical or cascaded activities: Accelerator-type of missions can significantly contribute towards, or even lead to a transformative change, and transformative missions can be backed-up by a number of technology focused missions forming a portfolio of accelerators driving the transition forward. Mission-oriented R&I initiatives are typically characterised by long-term direction-setting of public policies, and over the course of a mission, the fundamental characteristics of the activities can evolve from initial focus of advancing scientific and technology development, towards needs to a more profound change how the developed technologies are accepted by society and applied by consumers, or vice versa, a transformative mission can at certain point necessitate hastened technological development to achieve the systemic change. For example, the low-carbon transition is necessitating fast development and dramatic cost reductions of energy storage technologies to advance towards real systemic change.

It is considered that both types of missions are needed, and a combination of transformers and accelerators would be most effective approach also to engage all the stakeholders to common targets. The European mission-oriented R&I policy should involve a mix of technological and societal objectives, the ir relative importance being dependent on the nature and characteristics of the challenge, and the most appropriate approach would be to combine a broad overarching societal challenge (transformer) and technology-oriented missions (accelerators) in all those domains where technological advances or breakthroughs are essential for solving societal challenges, and achieving wider economic and well-ware implications.

6.4.2. **Condition 2: The governance of the missions needs to be flexible and reflexive**

The governance of the missions must be flexible, in order to adapt to changing conditions (e.g. maturity of technology, or wider changes in operating environment) and to be able to liaise with right stakeholders at right moment, and reflexive, in order to allow timely changes in both the technology applied and the policy instruments employed.

The governance structure for a mission-oriented initiative should be transparent and simple, and built in temporal manner for the duration of the mission. Strategic coordination (potentially involving a quadrable helix) and operative management (core group in a form of an agency or a platform implementing the mission) should be separated to ensure a well-functioning management structure, and it should be supported by a transparent monitoring system. The governance structure should however fit the purpose and the composition should vary depending on the goal of each mission. The governance of the mission would imply an important change of mind-set, moving away from monitoring the inputs and activities towards results and outcomes. The role of the governance should be seen as an enabler of change or a mediator facilitating that the supply- and demand-side actors have optimal conditions to work together, and to unleash the potential for important societal and economic implications.
Timing and targets of the missions should be aligned with the challenges - societal challenges, which by definition suppose a broader target-setting in a fairly distant future should be cascaded into more precise and shorter-term objectives involving technological sub-missions (accelerators). The target of the mission should be considered as a continuous process including a number of milestones, guided by a roadmap, and characterised by continuous monitoring and feedback-loops in order to assess the progress and if needed redirect the mission. The lower level objectives should remain technology neutral and should be expressed in open and abstract approaches to leave room for bottom-up solution definition and allow breakthrough technologies to emerge. The instruments implementing the missions should clearly define the expectation in terms of outcome, but leave the way getting there open, and also more flexibility and reflexivity would be foreseen in terms project type, size and duration.

6.4.3. Condition 3: The governance of missions necessitates balanced bottom-up and top-down elements

Furthermore, the governance of missions should balance between bottom-up and top-down elements. On the one hand, it should guarantee the involvement and ultimately buy-in of citizens, and granting some degree of autonomy to the stakeholders for the implementation of the mission, and, on the other hand, it should ensure top-down direction-setting and clear mission ownership.

Defining, programming and implementing a mission are three different phases, and involve varying degree of bottom-up and top-down elements. The mission definition departures from the needs of the society and the markets (economic and social challenges and megatrends), and involves all levels of political and R&I stakeholders in the discussion process. At the same time, the definition however requires strategic prioritisation, selection and direction setting from top-down, that eventually should be democratically legitimised. The programming of missions should be done in strategic and operational levels, the former involving wider stakeholder community (quadruple helix, also citizens), whereas the latter, structures resembling a core agency or platform take a leading role. The implementation of the missions involves the R&I stakeholders in a broad manner allowing the solutions to merge bottom-up. The role of citizens as drivers of the societal change should not be neglected at any stage, especially in those missions that necessitate transformative change. Although a wide consensus of the pivotal role of citizens in missions exists, much less agreement is found on how it should be done. Some consider that existing structures such as NGOs or similar organisations would best represent citizens, whereas others consider that novel approaches involving “citizen conventions” would be needed and much more direct involvement of citizens is desirable. All in all, a combination of top-down direction setting, wide mission ownership and bottom-up solution definition and deployment are characteristics that make mission-oriented R&I policy truly effective.

6.5. Conclusions: Comparison of the policy options and Steps towards mission orientation

6.5.1. Overcoming the current state of the FP

The current EU Framework Programme for Research and Innovation (Horizon 2020) has shortcomings that will need to be addressed in FP9. Interviewed R&I stakeholders consider, for instance, that it focuses too much on operational aspects of projects and not sufficiently on what they aim to achieve and on the societal impacts of funded R&I activities (despite a dedicated pillar). The introduction of mission orientation in FP9 could be a solution in this respect. In comparison with the current situation (i.e. the non-mission-oriented H2020), any type of mission-oriented R&I approach is foreseen to have higher impacts. Most of the surveyed representatives of industry even deem that initiatives aimed at addressing specific technological challenges (the so-called ‘accelerator’ missions) will have a high or medium impact, while less than 10% of public organisations reported to believe that the current non-mission-oriented approach has a high impact (see Figure 14).
6.5.2. Societal and technological needs to be met

However, as several R&I stakeholders reported in interviews and the dedicated workshop, the impacts of mission-oriented R&I initiatives should not be considered exclusively in economic terms. Mission orientation is a means to give R&I a direction, that is, a means to orient R&I preferably towards societal challenges. A mission-oriented FP9 would therefore contribute to transforming R&I results into actual benefits for the society. For that purpose, it is of utmost importance to set clear directions that a wide array of stakeholders, including citizens, will endorse. A clear focus on societal challenges is indeed the main factor enabling the implementation of mission-oriented R&I initiatives for almost 20% of the survey respondents (other enablers were similarly ranked by lower shares of respondents). It may relate to the reduction of air pollution (e.g. the Clean Air London initiative), the improvement of cancer treatment (e.g. the US War on Cancer and CancerMoonshot initiatives), or the scarcity of water resources (e.g. the Singaporean NEWater programme).

Figure 14 Foreseen impacts of policy options

In some instances, the targeted missions aim to solve particularly urgent problems, such as the protection of the Dutch coasts against the rise of the sea level (e.g. Delta Plan). However, less than 10% of the surveyed R&I stakeholders consider that the lack of a sense of urgency impedes the implementation of mission-oriented R&I initiatives. What seems to be the most important is that policymakers express clear commitment to achieving a mission (e.g. the Special Law for Venice 171/73 declaring the safeguard of Venice and its lagoon against acqua alta a “priority national interest”). R&I stakeholders need to consider this mission legitimate and to understand it along the same lines, such that they can contribute to it fully and consistently.

6.5.3. Citizen engagement with missions

The best way to ensure that stakeholders endorse the set directions is by involving them in the definition of missions. However, many concerns were expressed in the workshop and interviews in relation to citizen engagement. There is a broad consensus that they should have a role in the implementation of mission-orientation R&I initiatives, but many R&I stakeholders are reluctant to involve them in the decision-making process and are willing instead to limit their role to buy-in or co-creation of new solutions (confusing here citizens with end-users). However, citizen involvement could alternatively be seen as a
highly effective means to orient R&I towards societal challenges and to ensure that societal impacts are considered in any (technological) choice. Representatives of civil organisations have additionally highlighted that past experiences demonstrated increased visibility and media coverage for the missions discussed by the citizens. Key success factors are the random selection of participants (to avoid the participations of civil organisations defending their own agenda), training of participating citizens, dialogue with all stakeholders (including researchers and industry) and the commitment of policymakers to taking into account the outcomes of the citizens discussion in the final decision. Civil organisations suggest creating ad hoc Citizens Conventions which will be commissioned the definition of missions in specific thematic areas, while representatives of regional authorities propose to elaborate on the Smart Specialisation platforms.

6.5.4. Concentration of resources

As stated by a participant in the workshop, “having one mission is not having another mission in another way”. In other words, setting a direction is making a choice and prioritising between goals and targets. This choice is to be enforced first by concentrating budget and resources in the given direction(s). Almost three quarters of the surveyed R&I stakeholders consider that the concentration of higher share of FP budget in few missions will improve the efficiency of mission-oriented R&I initiatives. Similarly, when asked about barriers to their implementation, an insufficient budget was ranked first, second and third by the largest shares of respondents, highlighting the importance of having sufficient resources dedicated to the missions.

6.5.5. Breaking the silo-structure and improving collaboration

Directionality also means breaking silos and fostering cross-sector and cross-disciplinary collaboration. Stakeholders as well as industrial sectors have their own interests and needs, justifying the division of the current Framework Programme in silos. However, it constitutes, at the same time, one of the main hampering factors for the achievement of missions. As the division in pillars of Horizon2020 would probably be maintained, the future FP9 should further develop the societal challenges pillar and establish effective new mechanisms to involve different types of actors, such as researchers and scientists, funding agencies or end-user representatives, while articulating the mission-oriented approach in the other two pillars.

The impacts of mission orientation, indeed, are significantly higher when the governing body is capable of engaging a new constellation of actors (ideally) in all phases of the mission cycle: namely, decision on which mission to undertake, its design and implementation. Cross-sectorial approach may mean to imply the industry – through industrial federations or company networks – in the development of transformative missions, or to involve citizens and civil society organisations in the development of more accelerator-type missions. Cross-disciplinary, instead, means to focus on engaging new relevant actors across a wide range of fields: for instance, modern societies cannot cope with climate change by developing new indicators and setting milestones for the energy sector only, but should instead have a broader picture and act on transport or food management (e.g. Third Industrial Revolution in Luxembourg).

In the effort to break down the silos in a constructive and effective manner, the EU institutions may additionally consider improving (vertical) coordination across the multiple levels of policy-making. By definition, all mission-oriented initiatives aspire to have a broad impact on a societal challenge which affects several communities and/or many ranks/strata of these. Therefore, even if the mission is launched at EU level, the involvement of the local authorities becomes crucial. Improved coordination among similar types of stakeholders is likewise essential, as no societal challenge necessitating a technological solution can be tackled without the association of different types of industries concurring along the same chain to the elaboration of the needed solution.
6.5.6. Role of the stakeholders in the improved governance structure

Despite the importance of bottom-up approach in the definition and implementation of mission-oriented R&I initiatives, the overall governance of such initiatives should also show some top-down components. The enforcement of the set direction(s) and the related vertical, horizontal and multi-level policy coordination require the appointment of a (high-level) owner to orchestrate the mission-oriented R&I initiatives. If a mission orientation is introduced in FP9, the European Commission is considered very well positioned to have such a role. It could, for instance, act as a broker and mediator facilitating the interactions between the different actors and stakeholders across the policy domains and levels of governance. Its role does not limit to overseeing the choice, implementation and monitoring of policy instruments. In the context of European mission-oriented R&I initiatives, the European Commission may be in charge of ensuring that all involved Member States share the understanding of the missions and commit to them. If these conditions are not fulfilled, directionality will be weak or even doomed to failure. For instance, the lack of a clear ownership hampers the transition of the European Active and Assisted Living (AAL) Programme into a proper mission-oriented R&I initiative. Its governing body is not sufficient to overcome the various levels of national commitment to the ‘mission’ and the shared competencies between the European Union and the Member States.

Figure 15 Role of stakeholders in the adoption of (transformer- or accelerator-type) mission-oriented R&I initiatives

Source: Survey data JIIP.

6.5.7. SWOT analysis

There is no one single mission-oriented R&I approach but a variety of different combinations, which present different degrees of both transformative and accelerative components, which may aim at having consequences on varied sets of fields and which also generally engage in their governance actors coming for a broad variety of industrial and societal domains. In this highly articulated and heterogeneous picture, common ingredients which may determine whether the accomplishment or the failure of a mission. These elements are here below presented according to a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats). Because PO5 is a mix of transformers (PO3) and accelerators (PO4) missions, the SWOT focuses only on PO3 and PO4.
### Table 12 SWOT

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<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
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<tr>
<td>PO3: Transformer</td>
<td>PO4: Accelerator</td>
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<tr>
<td>PO3: Transformer</td>
<td>PO4: Accelerator</td>
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**Societal change is an appealing concept for several members of the society, which may be translated into widespread support among citizens.**

**Can count on potential significant engagement of citizens (if strong leadership and adequate coordination structures are applied).**

**Specific role of major industries and/or industrial clusters to undergo the development of new technological solutions.**

**More suitable than other kinds of missions to produce breakthrough innovations, as they are more open to failure.**

**Sense of urgency created by authorities and other stakeholders which is not the result of a societal need and which can easily be questioned until undermining the sustainability of the mission.**

**Due to the extensive length over which this kind of mission develops (decade(s)), the conditions which its design was based on may change and the implementation may need improvements and adjustments.**

**If no market dimension is present, the mission is unlikely to occur, since its main objective is the development of a new product or service meeting a market.**

<table>
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<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
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<tr>
<td>PO3: Transformer</td>
<td>PO4: Accelerator</td>
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<tr>
<td>PO3: Transformer</td>
<td>PO4: Accelerator</td>
</tr>
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**Emerging of strong political leadership capable of setting a mission-driven political agenda which may receive legitimacy through democratic elections.**

**In case of global challenges, the international consensus possible through well-established forums where multilateral discussion and agreements can be taken.**

**Emerging of strong industrial leadership capable of proposing new solutions which may receive legitimacy through the positive response of end-users and consumers.**

**Niche or small markets which have not been satisfied by the current commercial solutions.**

**Demand-side particularly articulated, which may respond positively to the launch of a technology-focused mission.**

**Political change which can undermine the legitimacy of the mission (e.g. in case of elections, due to conflicts, etc.).**

**International conflicts and rivalries between nations can weaken the created consensus to tackle global challenges.**

**Governance change which can undermine the legitimacy of the mission (e.g. change in the management of the industry leader, new political balance, etc.).**

**Unforeseen technological outcomes which can hamper the achievement of the mission.**
7. IMPACT ASSESSMENT AND MEASUREMENT OF MISSION-ORIENTATED R&D INITIATIVES

Over the past decades, various methods have been developed to assess the socio-economic impact of publicly funded research in differing degrees of refinement (Bach & Wolff, 2017; Drooge & Spaapen, 2017; Fahrenkrog, Polt, Rojo, Tübke, & Zinöcker, 2002; Feller, 2017; Gaunand, Colinet, Joly, & Matt, 2017; Joly & Matt, 2017; Jones, Manville, & Chataway, 2017; Ruegg & Feller, 2003; Seus & Bührer, 2017). Because evaluation approaches co-evolve with the types of policies employed (Gassler, Polt, & Rammer, 2008), they have been trying to capture an ever-widening range of impacts as the concept of innovation and related policies has broadened considerably over time (Gassler et al., 2008). Both in Europe as well as in the United States, evaluations have increasingly tried to cover not only scientific outputs, but also their broader impacts on society or their potential to produce broader societal effects (Bornmann, 2013).

In the 2015 Lund Declaration, an agenda for the European Research and Innovation Area is put forward to better address global challenges and in doing so, aligning national and European strategies, instruments, resources and actors; supporting frontier research, interdisciplinary collaboration, mobility of world-class scientists and research infrastructures; developing global partnerships with top scientists and innovators; and reinforcing open innovation and the role of end-users. With the advent of ‘new’ mission-oriented R&I initiatives that are not solely guided by technological, but pre-dominantly by societal targets, the requirements for their evaluation have equally changed. The new characteristics of this type of policy approach raise a number of fundamental challenges for (ex-ante) impact assessment and subsequent (ex-post) impact evaluation.

Only a few of the investigated mission-oriented R&I initiatives (e.g. Energiewende) made significant attempts to cope with these evaluative challenges. It might be fair to say that, where we encountered some form of impact assessment, it was mostly confined to quite traditional approaches. Mostly, these were attempts to quantitatively assess economic impacts. While this is valuable (and difficult) in its own right, the evaluation challenges for mission-oriented R&I initiatives are stretching far beyond that. While some examples could be used as a starting point in this direction, none would be up to the task right now. Hence, the development of appropriate processes and metrics for the impact assessment of mission-oriented R&I initiatives has to be developed alongside the development of the approaches, taking into account the specificities of the different types of mission-oriented approach. Here, it can only be attempted to outline a proposal for a systematic approach and some guiding principles for conducting ex-ante impact assessment and ex-post evaluations of new mission-oriented programmes.

7.1. Challenges and requirements for the assessment and evaluation of mission-oriented R&I initiatives

The ‘new’ mission-oriented R&I initiative which have emerged in the past couple of years present the following characteristics which define the requirements for their assessment:

- Most recent mission-oriented R&I initiatives – corresponding to the nature of societal challenges – are addressing issues that are broader in nature and scope

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12 For an overview of historical shifts in RTI policy, see Gassler, Polt and Rammer (2008).
13 See for an earlier description Soete and Arundel (1993) and for a more recent one Foray, Mowery and Nelson (2012) which shape the requirements of their assessments. It has to be added, though, that mission-oriented policies can have different characteristics in terms of goals, instruments, stakeholders and effects. Hence, the characteristics given do not apply to the same extent and at the same time to all types of mission-oriented programmes.
than earlier technology-centred variants of mission-oriented R&I initiatives. They involve a multitude of actors and stakeholder and deal with much longer time-horizons. This has considerable bearing on the role and weight of public and private actors, but also of other stakeholders. Contrary to old mission-oriented R&I initiatives, their most recent variants would ascribe a much larger role to private sector actors.

- It has also become a frequently used design feature of mission-oriented R&I initiatives that they span from basic research all the way through diffusion and implementation, hence the whole innovation (policy) cycle. This is because the ambition of mission-oriented R&I initiatives is not just to foster innovation, but to trigger processes of socio-technical change that require the diffusion of the innovations in question, as well as wider systemic changes to happen.

- This in turn requires the coherent use of a substantial number of the instruments available in the toolbox of R&I policy and beyond, ranging from programmes stimulating (oriented) basic research to the development of business models which would foster a rapid up-take of the respective technology. Especially demand-side instruments come into play here, as well as sectoral or thematic policies in key areas such as energy, health, agriculture, or environment. The choice of the appropriate ‘policy mix’ might again differ between the areas (e.g. aging societies, food-safety, climate change etc.)

- In the same vein, the goals and objectives of mission-oriented R&I initiatives have become multi-facetted. In contrast to single-issue programmes like the often-cited role model of the earlier types of mission-oriented R&I initiatives (e.g. the Manhattan and the Apollo programmes) even programmes confined to one topic or area (e.g. the US energy programmes) are expected to serve multiple goals, ranging from the mission in the narrow sense to commercial effects at the level of the individual participating firm to effects on other policy areas like national security and the like.

In short, nowadays mission-oriented R&I initiatives can be interpreted as ‘systemic policies in a nutshell’ with most of the characteristics and obstacles systemic policies face in general. This is not only true for the ‘transformer type’ of mission-oriented R&I initiatives, but might equally apply to ‘accelerator types’, if they are large and radical enough to have the potential for disruptive change of innovation systems (e.g. some mobility technologies).

While typical commercial, micro-level effects can be analysed with the help of well-established assessment and evaluation methods (Fahrenkrog et al., 2002; Policy Research in Engineering, Science & Technology, 2002; Ruegg & Feller, 2003), this systemic policy approach poses considerable challenges for the assessment of impacts with regard to higher-order mission goals. First of all, the impact of mission-oriented R&I initiatives has to pass through different stages before it can actually exert an influence on new mission goals. The immediate impact of a mission-oriented R&I programme occurs at the level of the participating firms or research organisations, where new research results are produced and – at least in some cases – innovations are introduced to the market. However, it is only after widespread uptake and diffusion of an innovation in the target system that an impact of a mission-oriented R&I programme on higher-order mission goals can be observed. In several cases of mission-oriented R&I initiatives, far-reaching transformative changes in the target system are needed to realize mission goals; changes that can at best be triggered and facilitated by research and innovation.

14 We conceptualized four different stages (see Figure 16).
Secondly, for mission goals to be realized, changes are also needed at different levels of the target systems. Borrowing from the multi-level perspective on socio-technical transitions, change processes in technological niches and for individual firms (micro-level) can be distinguished from shifts in the socio-technical regimes (meso-level), and possibly even at the level of socio-technical landscape (macro-level). The dominant socio-technical regime, however, raises important constraints for a potential transition of the target system and for the potential mission-oriented impacts to be induced by R&I policy programmes.

Most "new missions" as the guiding aims of funding programmes tend to be defined at the level of such meso-level socio-technical regimes. Realizing these missions requires the widespread uptake and diffusion of innovations, if not a transformation of the production and consumption practices.

7.2. Methodological implications for ex-ante impact assessment and ex-post evaluation: Towards a process model

7.2.1. Levels and pathways of impact: a framework

Against the background of the above characteristics and requirements of mission-oriented R&I initiatives, the subsequent section aims to outline a novel methodological framework for the evaluation and assessment of mission-oriented R&I initiatives. Established R&I programme evaluation methodologies focus mainly on the impact of funding programmes at the level of niches, with a view to the increase in innovation performance and research outputs but tend to restrict the impact analysis at regime level to economic matters such as competitiveness and employment, or an outlook on technological or at best techno-economic potentials of the supported R&I activities. Some programme evaluations with a dedicated diffusion-orientation have focused on the uptake of new technologies in industry, as well as organisational implications they have raised. Others have attempted to demonstrate impacts on employment. However, these approaches capture only some aspects of what is understood nowadays by societal missions.

We therefore propose a conceptual framework to underpin the study of impacts which builds on two main dimensions:

- First, the ‘impact processes’: Impact pathways range from thematically oriented, sometimes even basic, research to innovation, diffusion and system transformations, with the latter two stages being particularly relevant to the goals of the ‘new missions’. At the earlier stages, R&I funding directly affects the realization of research and innovation activities in firms and research organizations, i.e. at micro-level. Here, impacts can be measured rather directly (though not always comprehensively). At the later stages, at which mission targets are usually defined, effects only materialize to the extent that the innovations can be taken up (diffusion) and transformative processes are induced.

- Second, the ‘impact level’: Contributing to the achievement of mission goals implies changes to be realized at different levels, i.e. changes at micro-level of individual behaviour, as well as at meso-level of structures and institutions, which in turn are embedded in change processes at macro-level. In some cases, the transformative processes may also affect this wider macro-level.

This simple framework implies that rather than looking at innovation systems in the traditional sense, we need to study impacts on mission goals within a framework of “systems of innovation, production and consumption” (Weber & Rohracher, 2012) as the

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15 Here we have adopted the three levels or domains of analysis that have been suggested by the transitions literature (Geels, 2002).

16 As an example, see the Austrian evaluations of the FlexCim programmes (Geyer et al., 2001).
frame of reference. While maintaining a systems language, this perspective draws much broader boundaries for system analysis, impact assessment and evaluation than the traditional innovation systems perspective. It also looks at the interdependencies between innovation activities on the one hand and production-consumption practices on the other hand. One could argue that this approach integrates two hitherto separate streams of system analysis, namely innovation systems analysis and the analysis of production-consumption systems (e.g. Tukker, Charter, Vezzoli, Stø, & Munch Andersen, 2007).

What needs to be explored for purposes of impact assessment and evaluation against the background of this broadened view on innovation, production and consumption are impact pathways that are non-linear and often involve feedback and rebound mechanisms between the levels and/or phases.

**Figure 16 Conceptual framework of impact processes and impact levels**

<table>
<thead>
<tr>
<th>Impact level</th>
<th>Micro-level</th>
<th>Meso-level</th>
<th>Macro-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Oriented) Basic Research</td>
<td>Impacts on R&amp;I goals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A good example of the different levels of IA can be obtained from the evaluation setting employed in one of the European Joint Programming Initiatives (JPIs):**

**Figure 17 Example links between Objectives and Impacts based on FACCE-JPI**

Source: Example based on FACCE-JPI amended from ERA-LEARN 2 Del. 4.3
7.2.2. Methodological implications – ex ante

The framework depicted above allows explaining what kinds of impacts should be taken into account in impact assessment, as well as in evaluations, if mission-orientation is taken seriously as a policy target. Adopting it has several methodological implications:

First, we would see a shift in emphasis towards ex-ante (or concurrent) assessments. Policy frameworks with potentially long gestation periods and substantial impacts on societies and economies need to undergo a careful ex-ante analysis of their potential impacts (including unintended ones). For such ex-ante impact assessment, we suggest a forward-looking, scenario-based approach, exploring scenarios at three different levels in order to cope with different types of future contingencies:

- **Context scenarios** to cope with broader contingencies and constraints at the level of a socio-technical landscape. They thus provide different frames and assumptions for bundles of potential impact pathways.

- **System scenarios** are based on a thorough exploration of possible impact pathways that inter-connect micro- and meso-level developments. The systems under study must have a sufficiently broad scope, similar to systems of innovation, production and consumption, if impacts on mission goals are to be studied. As missions are expressed not just in terms of innovation, but in terms of actual changes in living, working and producing in society, a broader systemic frame must be chosen, which covers both R&I and sectoral/thematic production-consumption aspects.

The knowledge on which the elaboration of such system scenarios draws is a mix of theoretical insights into the structure and dynamics of systems, exploration of current observable trends and developments at micro and meso levels, but also of unexpected developments and wildcards, which require a great deal of creativity to be imagined. This knowledge delivers a structured, but at the same time open understanding of how a system might evolve in the future. Different degrees of openness and relaxation of assumptions about the continuity of current trends are possible; it is just a matter of making such choices explicit. In the same vein, the process by which this knowledge is created and fed back into the policy process must be open and flexible: in case of new options, technological opportunities or changing societal demands, re-considerations of mission targets must be possible to avoid lock-in.

- **Policy and funding scenarios**: Different packages or even roadmaps of R&I and sectoral policies need to be assessed and compared in terms of their expected impacts on mission goals against the background of different context scenarios and system scenarios. The impacts of these packages of instruments need to be studied with regard to different target system scenarios. This is necessary because the target system scenarios depend also on other factors of influence than the policy instruments under study. Other actors may exert an influence as well. Not the least, system scenarios need to be compatible with the way the wider context evolves, which is expressed in terms of context scenarios.

An impact assessment of a particular funding programme would thus not be conducted in isolation, but the programme would be seen and assessed as part of a package or portfolio of policy instruments, aiming to shape the target system in the direction of the envisaged mission goals. This is essential because the impact of a specific programme is inter-related with that of other policies and initiatives. In fact, recent mission-oriented R&I initiatives tend to bundle different specific instruments, as recognition of the need to apply policy mixes if mission goals are to be approached. A serious impact assessment would thus need to anticipate possible impact pathways, taking into account the interactions between different policy instruments. Such systemic, multi-instrument intervention logic is essential in order to give justice to the complexity of the transformative processes needed to reach mission goals.
Figure 18 gives an overview of how the process of an ex-ante impact assessment of a mission-oriented R&I initiative could look like. The three levels of scenarios correspond to the three vertical streams, addressing the context of the system of innovation, production and consumption (SIPC) under study, the SIPC itself, and the policy and funding instruments that are currently applied or might be in the future. Ultimately, the process of exploring future impacts in a scenarios framework (Steps 1 to 4) should feed into what could be called a social cost-benefit analysis of policy and funding system scenarios with regard to their suitability to reach mission goals for different consistent context-SIPC scenarios (Step 5).

**Figure 18 A process model for ex-ante impact assessment of policy instruments on mission goals**

- **Current context of SIPC**
- **Current SIPC**
- **Current policy and funding system**
- **Context scenarios**
- **Emerging requirements & assumptions**
- **SIPC scenarios and visions**
- **Consistency analysis**
- **Policy and funding system scenarios**
- **Social CBA of policy & funding system scenarios**
- **Adjustment of policy & funding system scenarios**
- **Realisation of preferred policy & funding system scenario**


It is also important to notice that such an approach is needed also as tool for concurrent policy assessment and adaptation: in long-term policy frames needed for the
implementation of mission-oriented R&I initiatives, there is a frequent necessity to re-visit the original targets, re-adjust the goals and instruments, sometimes even the portfolio of technologies. An example in case is e.g. the German Energiewende, which, during the course of the programme was confronted with significant changes in relative process of energy sources, new technological breakthroughs but also technological bottleneck which asked for an adaptation of the programme over time.

However, we should be fully aware of the limits to modelling in quantitative or even monetary terms the kinds of impacts expected. Social costs and benefits need to be understood in qualitative as well as to the extent possible - quantitative terms. A process of sense-making is thus required that builds conceptually on the notion of social cost-benefit analysis. Depending on complexity of impact pathways, only upper and lower bounds of impacts of mission-oriented R&I initiatives on mission goals can be assessed, while more modest and specific programme goals may be accessible to more precise assessments.

Given the complexity, uncertainty and ambiguity of the future (Renn, Klinke, & van Asselt, 2011), it is important to foresee an iterative process of learning (Step 6). The so-called Collingridge dilemma implies that we continuously acquire new knowledge about new social, economic and scientific-technological developments, as well as about the impacts of these developments on mission goals, and - as a consequence – about the impacts of policy instruments (Collingridge, 1980). A continuous re-adjustment of policies and instruments is thus of crucial importance for a long-term strategy of new mission-oriented governance.

7.2.3. Methodological implications for ex-post Impact Assessment

In general, the ex-ante assessment of policy interventions defines also the framework for a subsequent ex-post evaluation. However, when dealing with mission-oriented policy, the evaluative focus naturally has to shift from ex-post to (i) ex-ante impact assessment (especially on ex-ante social cost-benefit assessment) and on (ii) the process of joint vision and policy forming (which is formative by nature) for a number of reasons:

- Ex-post evaluation of the contribution of the involved R&I policies to the achievement of the mission goal is facing even greater obstacles as evaluation of individual funding programmes because the multitude of instruments and actors involved exacerbate the well-known attribution problems between inputs/actions and outputs/systemic changes.

- In the same vein, the time span between the initiation of change through the various measures of the respective ‘policy-mix’ and the effects (especially the ones on the ‘system/regime’ level) can be very long and beyond the scope of current monitoring and evaluation techniques.

Still, in our view, ex-post evaluation of mission-oriented policies has the potential to ‘trace back’ (most likely in a case study manner) specific impulses that were in the end strong enough to change the system (e.g. by being able to identify for the effects of the results from basic research to the achievement from mission-oriented research). In doing so, ex-post assessment would be a source for general ‘policy learning’, e.g. about the respective roles of basic research, social and institutional change and other dimensions that can drive systems change. It would be of limited value as a tool for investment decisions, though.

7.3. Conclusions and future perspectives

7.3.1. Mission-oriented assessment and evaluation in practice

A first screening of current practices in assessing and evaluating mission-oriented R&I programmes has shown that very few such exercises actually have been conducted so far. However, first steps have been made in countries with explicitly mission-oriented
programmes, in particular Austria, Denmark, Finland, Germany, Sweden and the United Kingdom.

In Austria, for instance, the high level of aspiration of R&I funding programmes in terms of contributing to mission goals has led to the formulation of demanding requirements for their assessment and subsequent evaluation. Other countries like Denmark have started to explore the requirements for future assessments and evaluation in line with their strategy (DCSR, 2013; DMSIHE, 2012).

However, there is currently no systematic overview of ‘good practices’ of assessing and evaluating mission-oriented RD&I programmes available yet. As new approaches are being tested, these should be carefully monitored. There is definitively a need to broaden the information base on such assessments and evaluations.

In view of the methodological challenges associated to assessing and evaluating mission-oriented programmes, there is also a need for exploring new directions of policy research. New approaches to impact assessment need to be developed and tested, including new types of system modelling that allow capturing the complexity of impact pathways and scenarios in systems of innovation, production and consumption. At the same time, the inherent limits to impact assessment need to be recognized and accepted. Evaluations as well as impact assessments should also build on a broader range of dimensions of analysis, in line with the range of mission-oriented goals. Economic impacts are just dimension to consider, next to social, environmental and other dimensions. Finally, in view of the long-term impacts to be considered, iterative processes of learning and adjustment need to be put in place, drawing on the insights from impact assessments and evaluations.

7.3.2. A possible way forward – A "PESCA" approach for new mission-oriented programs

This chapter calls for a new approach in impact assessment when dealing with new mission-oriented policies. The stressed far larger complexity of these types of policies raise the stakes for impact assessment considerably, but we think that they can be tackled. For this purpose, a framework which puts much focus on the following elements should be considered:

- Ex ante impact assessment, based on scenario approaches and potential impact pathways, with a strong component of ‘Social Cost-Benefit-Analysis’;

- The establishment of sound relations between instruments and mission-goals upfront;

- An iterative-formative assessment process, which allows for the adjustment of objectives and instruments over longer periods of time to take account of

  - new technological possibilities;
  - better understanding of technological and economic potentials and limitations;
  - changing perceptions and needs of society;

- Ex-post evaluation in this frame would serve rather as a tool for historical ‘critical path analysis’ to identify the key drivers which were responsible for the success/failure of a specific policy than as one by which to rank investment priorities

A frame of reference which is broadened beyond R&I, in order to cover also domain-specific policies (e.g. in transport, energy, health, etc.), will be essential if the scope of new missions is seriously interpreted as a transformative process. This approach to be labelled the “PESCA (Prospective & Adaptive Societal Challenges Assessment) Approach”, though demanding, would be a step forward in evidence-based mission-oriented policy making. It is a very much needed one, as current experiences with mission-oriented polices show (like
the ‘Energiewende’ or Climate Change oriented policies amply demonstrate) and should be a high priority of the near future.
8. CONCLUSIONS

8.1. Towards mission orientation in EU R&I policy

8.1.1. Coping with the wide diversity of mission-oriented R&I initiatives

Mission-oriented R&I initiatives, be they private or public, typically are ambitious, exploratory and ground-breaking in nature, often cross-disciplinary, targeting a concrete problem, with a large impact and a well-defined timeframe. More specifically, they have a clearly defined (societal or technological) goal with preferably qualified and/or quantified targets and progress monitored along predefined milestones. Mission-oriented R&I initiatives tend also to be sizeable (in relation to GDP or overall R&I investments by a country), cross-disciplinary and cross-sectoral by nature, consequently involving several types of stakeholders. They utilise a mix of policy instruments going beyond the realm of R&I policies and require horizontal policies cutting across governance levels. Finally, their results, which rely on different solutions, should be applicable to different industrial sectors and social contexts.

Among all these features, directionality and intentionality differentiate mission-oriented R&I from other types of policies, such as systemic or challenge-oriented policies. Orientation towards missions the next EU Framework Programme for Research and Innovation (FP9) therefore requires willingness and commitment to achieving concrete and commonly agreed objectives within a specific timeframe, and thereby to contribute to solving identified problems. However, the diversity of mission-orientated R&I initiatives is a striking feature. They are multi-faceted, embracing a wide variety of initiatives e.g. for strengthening cancer research capacities in the United States (CancerMoonshot), protecting the Dutch coats from floods due to the rising sea level (DeltaPlan), or accelerating the diffusion of electric vehicles in Norway. All of these examples have distinctly different scope, approaches, instruments, governance structures and management.

Mission-oriented R&I initiatives may be grouped on missions that are narrowly or broadly defined. Some initiatives aim at accelerating the development of new solutions to well-defined problems involving mostly technical (not meaning less complex) challenges (e.g. like sending a Man on the Moon). Others target highly complex societal challenges (e.g. climate change or energy) implying multi-faceted problems and therefore requiring transformation of systems. Both types should be considered are ideal-types positioned at each end of a scale on which mission-oriented R&I initiatives can be positioned.

Hence, if the European Commission intends to adopt a mission-oriented approach in FP9, it will need to deal with the fact that there is a plurality of mission-oriented R&I initiatives rather than a singular mission approach or definition and that there are scales of mission-oriented R&I initiatives. From this perspective, there is much evidence that EU scale R&I missions would be best serves in a hybrid model (including or combining accelerator and transformer elements), that is flexible in addressing different types of challenges and different levels of complexity, while at the same coordinating and concentrating the effort and resources towards the commonly agreed objectives.

8.1.2. Policy evaluation needs to evolve to meet to challenges of mission orientation

Monitoring and evaluation of mission-oriented R&I initiatives are elements of key importance, as they have to ensure continued directionality and the aligning of all initiatives within a mission to contribute to the objectives. The purpose of continuous evaluation and monitoring is to enable governance bodies to formulate timely responses to changes in societal priorities, and technological and economic developments. Many of the envisaged missions will have a long-time span in a dynamic world. If missions are carefully defined and linked to for instance the Sustainable Development Goals the risk that the mission itself becomes fully obsolete is limited, but certain technological solutions may be overtaken by competing solutions, or prove to be to complex or expensive, or, as seen in
the case of the Norwegian EV mission, some policy objectives evolve differently from what was expected, necessitating a change (i.e. a shift from an industrial to a climate change policy). Thus, the mechanisms need to be in place to identify and check, steer initiatives, and if needed to amend (e.g. change in the mobilized policy instruments) or in the worst case even cease them.

Orientation towards missions therefore implies **revising the way initiatives are monitored and evaluated**. Due to the intrinsic directionality, traditional R&I output indicators, such as the number of publications or patent counts, cannot be considered enough. R&I is not the objective in itself, but a means to achieve broader objectives. A new evaluation approach would strongly take into account in how far R&I initiatives contribute to the mission objectives and targets. Accurate (progress and intermediate) measurement can be problematic, especially for large scale transformer missions. The achievement of objectives in the accelerator type of missions can in many cases be obvious (for instance, the landing of Neil A. Armstrong on the Moon on 21st July 1969 and his safe return on Earth marked the success of the Apollo Program), the evaluation of the long term and very board transformative missions is often more complex.

If the ambition is to have visible socio-economic impacts, **the evaluation and monitoring of mission-oriented R&I initiatives should also consider their (unforeseen and unintended) impacts in addition to the achievement of and progress towards the specified targets**. For instance, the success of Airbus should not be measured only by referring to its market share in comparison to its competitors (especially Boeing), but also in relation to the number of jobs it creates across Europe, the wider economic impacts, how it contributes to other policy goals (climate change for instance), or spill over effects of knowledge creation and diffusion. Such a wider approach would allow having a more comprehensive view on the initiatives. For instance, the Norwegian Electric Vehicles initiative is a success if only the increase in electric vehicles on the national road or CO2 reduction is considered. Most of the new electric cars, if not all of them, however are manufactured by foreign companies (such as Tesla). If the initiative intended to support local manufacturing industry, the mission has to be seen as a failure.

Finally, it must be noted that missions (and especially the more complex ones) cannot be achieved by a single initiative but by multiples ones. they therefore need to be evaluated and monitored in a holistic manner, and not individually. The evaluation should not merely emphasise principles of effectiveness and efficiency, but especially their (internal) consistency and coherence. Although this is current practice in for instance the Better Regulation Guidelines, the requirements in the context of mission initiatives are considerably more stringent. If the European Commission decides to shift its EU R&I policy (partly) towards missions, it should therefore **implement ‘portfolio’ evaluation mechanisms** to address the challenges.

**8.1.3. Mission-oriented R&I policy and European cohesion**

As demonstrated in many studies and in many assessments, there are significant differences between R&I systems, characteristics and performance between the EU Member States. In the discussion around the next Framework Programme (FP9), concerns of the Eastern Member States have been raised on a number of occasions at the policy discussion level, and several stakeholders point at the European cohesion issue as one of the main points to be addressed for the successful of the future European funding strategy for R&I.

The way the EU institutions can tackle the cohesion challenge can critically affect the achievement of any mission implemented at the EU level. It is therefore crucial to conceive the mission orientation in a way that takes into account the progress of countries with less mature R&I (funding) systems and facilitates their further development. To accelerate the development of their R&I capacities can be even considered a mission itself, which – if successful – would set the basis for a major and more effective participation of organisations and industries which previously have not fully been part of the EU common strategy.
In a way clearly-defined missions can be an incentive for all stakeholders to invest and concentrate efforts, and thereby creating increasing strengths.

Along the same lines, a mission orientation mission in FP9 could also, for instance, help tackle brain drain, which is certainly one of the major concerns of the EU13 countries as the brain drain significantly reduces capacity and hampers progress towards fully participating as more advanced Member States. The less advanced Member States in terms of R&I systems, can take mission-oriented R&I and the resulting concentration of resources and funding as an opportunity to (re)shape and strengthen (at a higher pace) their R&I systems, while improving their visibility and attractiveness, especially by providing young talent with incentives (as career development, international cooperation with top institutes around Europe and specialisation) to stay. Furthermore, the countries with less mature R&I systems can be assumed to be less impeded by R&I institutions and long-standing practices than those with a longer history of R&I policy, and therefore to be able to move their R&I policy towards missions more easily.

Member States with established R&I systems can focus on implementation of the strategies and deliver the results needed across Europe, by forming so-called ‘coalitions of the willing’. Countries with less extensive experience in collaborating internationally but committed to contributing to large-scale schemes solving grand-challenges may join and benefit in return from their joint participation and ‘leap frog’.

8.1.4. Mission-oriented R&I policy and downstream synergies

Mission-oriented R&I initiatives (especially those targeting global societal challenges) often need to include smaller projects implemented at local level with narrower objectives for achieving mission objectives. In implementing a mission-orientated approach in FP9, the European Union should build upon the instruments and platforms that are already in place in order to ensure that local and regional actors contribute effectively and consistently to the achievement of the missions.

One of the well-established instruments which has been deployed with overall (be it varying) success for the pursuit of societal challenges objectives is the Smart Specialisation Strategy (RIS3). Smart Specialisation platforms play a major role in orienting, encouraging and coordinating R&I at the regional level, also in less-developed EU regions and Member States. As public funding is only one of the sources of funding for the mission initiatives, it is essential to mobilise private actors at the regional level while creating synergies with other relevant stakeholders and guaranteeing some degree of citizens involvement. The RIS3 already developed the instruments establishing interactions among private firms, government bodies, researchers and citizens on which a mission-oriented R&I approach in FP9 should build. The dedicated platforms, by improving dialogues between the different actors at the regional level, can support the co-definition as well as the implementation of missions. In addition, the common agreed goals will provide an incentive for local and regional players to identify and deploy solutions developed at different levels (EU and national) within a mission, thereby enforcing a downstream effect and better utilisation and take up of results of for instance the European programmes, which is currently still a weak element.

8.1.5. Transition towards mission-oriented R&I initiatives

If the European Commission decides to introduce mission orientation into the next Framework Programme for Research and Innovation (FP9), the process should not be revolutionary but rather an evolutionary, to facilitate a smooth transition from the current R&I policy approach to the new orientation. The third pillar of Horizon 2020 has already enforced an orientation towards broadly defined ‘societal challenges’, and its work programme 2018-2020 went one step further by introducing focus areas. Missions build upon the challenges and both concepts are not disconnected to the extent that mission-oriented initiatives aim to solve specific problems related to broader challenges.
Although the introduction of missions is not be entirely disruptive, it will still have a degree of disruption, create some uncertainties and raise concerns from the R&I stakeholders who have gained experience with the current R&I policy approach and have adapted their practices. A mission-oriented FP9 will require new adaptations and learning.

To address this issue and reduce the effects of the inevitable disruption in current practice, the European Commission may want to consider adopting a multi-phase approach. The mission-oriented approach could be restricted to few themes in which largely commonly agreed challenges exist (‘low hanging fruits’ from that perspective, e.g. energy or climate change) in a first period, thus giving time to R&I stakeholders and policymakers to adapt to and learn from the new (application of) instruments, mechanisms and processes and governance structures. At the end of this period, the mission orientation approach will be evaluated and possibly amended, prior to its expansion to other themes.

The diagram below provides an overview of a possible approach to the processes in Mission Oriented R&I in FP9.

**Figure 19. Mission Oriented Policies in FP: the process**
8.2. Implementing mission-oriented R&I initiatives

8.2.1. Preconditions for mission-oriented R&I

Mission-oriented R&I initiatives are especially diverse because different missions have different implications and because the implementation of these initiatives is highly influenced by existing institutions (comprising of the legal framework and cultural background), instruments and policies already in place.

- The evidence shows that missions do not emerge in a vacuum but in national, regional, sectoral and technological systems with their respective specificities. The EU Member States have built, for instance, different national R&I strategies and funding mechanisms influencing the readiness to implement mission-oriented R&I initiatives. The introduction of mission orientation in R&I agenda until now mostly occurred in countries with a well-established R&I system, and with a propensity and tradition to earmark a (relatively) significant share of their public R&D budget to societal challenges. It is therefore no surprise that most of the analysed mission-oriented R&I initiatives originated – and in most of the cases developed entirely – in what the EU Innovation Barometer qualifies as ‘innovator drivers’, such as Germany, the Netherlands and the United Kingdom. Countries whose R&I systems are of minor scale and which do not traditionally focus on societal challenges, have more difficulties in mobilising and coordinating sufficient resources to deal with societal challenges. Their priority is to build or strengthen their R&I capacities for which the solution of societal challenges is often limited to being a potential positive externality.

- The success of mission-oriented R&I initiatives also depends on long historical trajectories, including past R&I projects that have contributed to the creation of knowledge and to the development of specific capacities. In the United States, the War on Cancer has laid the foundations for the CancerMoonshot, by supporting and building a strong base, over decades, for cancer research. In consequence, if the European Commission intends to give its R&I policy a mission orientation, it should not neglect basic research because of an unnecessarily strong focus on applied research and innovation. If the three-pillar structure of Horizon 2020 is maintained, mission orientation should therefore not be confined to the third pillar (societal challenges) but cut across and be articulated in the other two, i.e. scientific excellence and the future European Innovation Council.

8.2.2. Coordination and governance

(1) The appropriate governance structures

The type of governance and of coordination mechanisms adopted are crucial elements which determine the success or failure of mission-oriented R&I initiatives. Lack of clear and empowered governance structures (and consequently the ownership) to implement and steer mission-oriented R&I initiatives has been regarded as one of the main barriers to the mission success.

Our research demonstrates that there is no single suitable governance structure, in the same way that there is no single societal challenge to tackle or a single mission to accomplish. The most appropriate governance structure depends on the nature and scope of the missions, the stakeholders to be involved, and the geographical, sectoral and technological systems (including the cultural background and the policy practices) in which missions emerge.

Governing structures for missions at EU level should be different from those employed by the EU institutions in the past. They should, on the one side, include a new constellation of actors, including who were previously excluded from the management of R&I policy initiatives, while, on the other side, they should consider new roles for the traditional
**actors** who can contribute to the policy objectives in a different and complementary way. For instance, citizens should be given a say as end-users of the solutions resulting from (technological) accelerator-type mission and as members of the society subject to transformative change; while the public bodies in charge of R&I funding schemes may become brokers and play a role in defining and managing concerted actions or act as a catalyst.

Evidence shows that a successful governance should improve multi-level commitment: on the one side, by searching for cooperation with and openness to similar or complementary projects, and, on the other side, by ensuring coherence with the policy strategies and programmes which the mission depends on, at local, national and regional levels (by leveraging relevant vertical coordination).

Once again, however, these assumptions must be contextualised for each mission: more specifically, **accelerator and transformer missions each have optimal governance structures with very different characteristics and features.** Due to the widespread opinion that transformer missions should be based on the buy in, commitment and contribution of the society at large in order to be successful, the structures designing and implementing them should represent that broad variety of stakeholders, in particular the industry and the citizens, in different roles. In the case of most accelerator type missions, the role of the research and industrial sectors should be more prominent than in other contexts.

Irrespective of the diversity of mission-oriented R&I initiatives and their governance, national and European public authorities often have to play an extensive role. Most missions, due to their cross-border if not pan-European scope, may consider including the European institutions – and in particularly the European Commission – in their governance in order to **coordinate stakeholders coming from different European (and sometimes non-EU) countries.** Along these lines, the cross-country initiatives such as Concorde and Airbus can serve as examples of how European R&I efforts can be aligned across the national borders. Endeavours addressing technological improvements should also involve industries, besides universities and research centres. Finally, setting up agencies in each sector or policy domain (e.g. health, environment, transport, etc.) for the management and implementation of the mission orientation is an appealing proposition that the European Commission may want to consider.

In addition to the beforementioned characteristics, a well-structured governance should **always be supported by high-level political guidance involving various policy-making levels and/or scientific advisory boards.** The commitment of the political and administrative authorities is crucial, especially due to the fact that the missions may be implemented over extensive periods (of ten years or more). Besides keeping close contacts with all relevant stakeholders, the governance shall count on the expertise and the experience of full-time professionals, who, according to the need of the implementation, can be organised in technical, scientific and/or societal advisory boards. Finally, it must be underlined that sufficient power as well as recognised expertise must be concentrated in the governing body in order to make it effective.

**Definition, design and implementation are three different stages in the development of mission-oriented R&I initiatives. It is crucial to identify who – and at which stage – is to take part to them. There is no evidence of clear preference of R&I stakeholders for involving specific actors or a propensity for a bottom-up or a top-down approach.** Most of the actors consulted and the research conducted on present and past mission-oriented initiatives suggest maintaining a balanced governance between the two paradigmatic approaches. However, as previously demonstrated, transformer and accelerator missions may require involving different sets of stakeholders, which determine different governance structures and therefore differing approaches.
For transformer missions, a bottom-up approach seems to be particularly relevant, with the participation of a variety of actors such as industry, researchers, and citizens. The involvement of the latter category of stakeholders is justified by the fact that they are the best placed to identify the most pressing societal needs and to define the socioeconomic indicators against which the results of these missions would be evaluated. However, other categories of actors, such as industry, researchers and local public authorities, should also be engaged in the definition of (transformative) missions and in the implementation of the relative initiatives in order to ensure that the perspective of citizens is not short-sighted and that is does not neglect technological feasibility.

When the missions aim to solve global challenges, is worth considering top-down approach to define the priorities. Although the identification is largely a bottom up exercise, the actual decision which mission to select and develop with the support of a structured set of initiatives should be taken top-down by the EU institutions in close cooperation with the Member States, key stakeholders (educational and/or industrial) and the citizens.

Most of the implementation procedures, such as building up a roadmap, setting milestones, deciding concrete actions, etc., should ideally bank on bottom-up mechanisms, be it that they are to be guided, orchestrated in a more top down fashion.

To ensure a cross-policy approach, the European Commission should set the missions based on wide open consultations and transparent and inclusive preparation processes. In the same way, the following implementation phase should adopt a bottom-up mechanism, involving all national levels of political and R&D stakeholders.

The choice of modalities to implement a mission should instead be the responsibility of public and private stakeholders through a bottom-up approach. This implies a non-prescriptive approach (very different from current practice) so that stakeholders themselves should provide best solutions (that can be competing) to address a specific objective, and also chose the best way (instrument) to implement.

Accelerator-type missions rely less on a bottom-up approach, but the processes of their definition and implementation cannot reasonably exclude industry, citizens and public authorities. Missions are ambitious by nature, but they should also be realistic. In consequence, representatives of industry, research and other experts must reflect on what can be achieved, how and by when. Despite the fact that the primary objective of accelerators is not to address and solve societal challenges as such, but instead respond to urgent industrial, economic and geopolitical concerns, citizens should also be engaged to reflect on the societal impacts of these issues, of the missions targeting them, and of their anticipated solutions.

Past mission-oriented R&I initiatives, whose main focus was on solving (complex) societal challenges, such as the Apollo Program and the Concorde project, benefitted from social acceptance and support mainly due to intensive dedicated communication efforts from the governments. Similarly, the MOSE project, whose public image has been suffering from scandals related to its management, has designed educational programmes for local schools aimed at explaining its mission and the technologies that it uses to address it.

Communication to citizens is an effective means to encourage their (longer term) buy-in of the missions, but citizen engagement could and should be more ambitious, involving them at earlier stages including in the definition of the missions.

(3) Horizontal (cross-policy and cross-sector) coordination: What is the role of R&I policy and of other policy domains? How do they interact?

Horizontal coordination (across sectors and disciplines), aiming to engage, connect and commit stakeholders in the governance of mission-oriented R&I initiatives, is considered to be particularly relevant for the implementation of the missions. It implies breaking down silos and replacing them with bodies responsible for ensuring cross-disciplinary and cross-sector approach, even though their origin and existence is
justified by procedural elements. In fact, silos are to be considered a hampering factor for mission-oriented R&I initiatives, even for those focusing on technological problems and aimed at accelerating the development of new solutions. A move of EU R&I policy towards mission orientation should be complemented with a renewed attention to cross-sector and cross-disciplinary cooperation and coordination at the heart of the policy.

In this respect, with the aim of creating cross-sectorial and cross-disciplinary missions, horizontal coordination can be successfully ensured by new bodies, such as advisory boards created to support the policy maker in the missions’ implementation.

(4) Vertical (cross-level) governance: What is the role of countries and subnational authorities? How do they interact?

Vertical coordination refers to coordination across the different levels of policymaking. It is essential to the definition of missions and partly to the design of the related initiatives. A key issue is the matter of unique and shared competences. In those cases where the EU has a unique competence, it can and should decide which missions to pursue, through a top-down approach but still involving all relevant national, regional and even local authorities. In the case of shared competences between the EU and Member States, the decision should be based on a joint process.

Many societal challenges are by nature cross-border and even global (e.g. climate change and energy). R&I initiatives aimed at tackling them should include smaller initiatives with narrower scope and usually implemented at a more local level. However, it is of utmost importance that these initiatives do not function in an isolated manner. They must be considered as a whole in order to be able to contribute to the mission objectives, hence carefully coordinated and steered in the chosen direction. In setting a new strategy for FP9 with a mission orientation, the European Commission should, in consequence, put emphasis on facilitating and encouraging downstream synergies by rationalising, coordinating and synchronizing the national and EU-level activities that contribute to solving the same missions. Vertical coordination would identify and justify what is best doing nationally and what instead should be done at EU level.

A good example of coordination between national and European level is the Smart Specialisation Strategy which has already been successfully implemented with the direct involvement of cities and regional authorities under the guidance of the European Commission competent bodies. Building upon this existing infrastructure in function of the missions should be considered.

Regarding funding instruments, broad scale missions would also require top-down vertical coordination of the European Commission to align with European Structural and Investment Funds (ESIF).

The diagram below gives an overview of the hybrid models and implementation features.
8.2.3. *Instruments for mission-oriented R&I*

Any quest for a ‘one-size-fits-all’ policy mix that would apply to any mission-oriented R&I initiative is doomed to fail. The choice of policy instruments must first and foremost depend on the nature of the missions and the context and the (national, regional, sectoral and technological) systems in which they will be implemented. Directionality has nevertheless major implications: the necessity of policy mixes expanding R&I policy, and a balance between free choice of policy instruments and top-down coordination.

Because mission-oriented R&I policies are policy initiatives aimed at giving direction to R&I in order to achieve wider goals, the realm of policy instruments to utilise must go beyond R&I policy instruments. It must include relevant sectoral policy measures, like energy policy for missions related to energy but also for instance climate change or mobility, and consider, especially in the case of the transformer-type of missions, demand-side policy measures. Like mission-oriented R&I policy, domain policies do not necessarily focus on the creation of new knowledge, products and services with a view to increase economic competitiveness per se. They utilise demand-side policy instruments to accelerate the diffusion of innovations and the creation of markets to achieve objectives specific to their sector (e.g. the creation of a market for solar PV panels and the reduction of greenhouse gas emissions).
Two types of demand articulation can be envisaged. One type aims at identifying existing needs and communicating them to innovators, in order for supply to better match demand and the new solutions will be more likely to be adopted and will have an accelerated uptake and deployment. Such demand articulation may rely on the involvement of a wide array of stakeholders, including especially end-users, in the co-definition and co-design of mission-oriented R&I initiatives, which is nevertheless often challenging and faces several hurdles. Furthermore, existing demand is sometimes short-term and has a tendency to overlook long-term and complex societal challenges. They might therefore not support mission orientation. In consequence, demand articulation focusing on matching (better) supply and demand should not be confused with other mechanisms to involve citizens and other stakeholders more effective in the definition of missions.

Another type of demand articulation consists of changing consumption habits and orienting demand in selected directions. Several mission-oriented R&I initiatives (e.g. Concorde or the Chinese New Electric Vehicles initiative) mobilise public procurement with the idea of making the public sector a first and lead user, i.e. a user whose demand will be imitated by a larger population. The Norwegian Electric Vehicles initiative used fiscal incentives and undertook demonstration programmes to accelerate the diffusion of these vehicles. For being effective, this type of demand articulation needs to be considered legitimate (citizens must endorse the selected orientation e.g. by being involving in its definition), any (especially regulatory) barriers must be removed, and measures for (e.g. financially) supporting and promoting demand that goes in the selected direction should be in place and coordinated.

Considering the wide diversity of mission-oriented R&I initiatives and the necessary flexibility of their implementation process, it could be argued that instruments should not be prescribed, and that their choice should be made freely by the R&I stakeholders who decide themselves the best way (i.e. which technology and which instrument) to achieve the missions. However, considering the high number of instruments available, their complex interactions and the risk of opportunistic behaviours, a dedicated body should oversee the selection and implementation of instruments and control whether they are appropriately coordinated and oriented towards the given mission and whether they adapt to any change in this respect.

If the FP9 is intended to have a mission orientation, the European Commission may consider playing this role. The use of an inappropriate instrument may otherwise hamper or slow down the achievement of the mission targets. In the German Energiewende initiative, the decisions to phase out nuclear energy and to cease feed-in tariffs for photovoltaic electricity, despite they had their own rationales, impeded the attainment of the goals in terms of reduction in greenhouse gas emissions.

8.2.4. Citizen engagement

Despite the large consensus on citizen engagement in mission-oriented R&I initiatives among the diverse categories of R&I stakeholders, there is no clear picture about their actual role. Industry, higher education institutes and research and technology organisations are concerned that citizens will drift their research and innovation agenda away from their priorities and towards ‘fashionable’ missions that they cannot achieve because they do not have the required capacities. In their perspective, the purpose of citizen engagement is the buy-in and societal acceptance of the selected missions. However, such approach ignores illustrative mission-oriented R&I initiatives, like Germany’s Energiewende, where missions were first defined by grassroots citizen movements and then implemented and steered by public authorities in a more top-down manner.

The main purpose of citizen engagement is to reflect on societal challenges. In the case of accelerator-type of missions, they can give a perspective on the foreseen societal impacts of different technological options and ensure that these missions are not exclusively technologically oriented. Their role is not limited to test, as potential end-users,
the feasibility of technologies and help the selection of those for which markets could be the most easily created.

The importance of citizen involvement is higher in transformative mission-oriented R&I initiatives, as it shall aim at contributing to defining their direction. Public consultation is nevertheless not the most appropriate approach. Citizens must be trained and informed about the decisions they need to make. During their training, they are exposed to the discourses of different categories of stakeholders, which must furthermore explain their position. **It is of utmost importance that citizens are comfortable to make decisions for which they will feel accountable.** This approach has been already experimented and proved the ability of citizens to grasp complex issues and to make well-thought and innovative proposals to solve them (see the box below).

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**Box 1. Past Experience of Citizen Involvement in Mission-Oriented R&I Initiatives**

**Human Genome Mapping**

The consensus conference on the application of knowledge gained from mapping the human genome (1989) was one of the first uses of this innovative democratic tool developed by the Danish Board of Technology. The citizens panel demonstrated an ability to grapple with a **highly complex and sensitive issues** such as the human genome including DNA analysis, prenatal diagnosis and genetic manipulation and to integrate these issues with wider social issues. Since the conference, the tool has been employed in several other countries spreading throughout and beyond Europe and has been used on very different topics and variety of societal problems.


**Climate Change and Citizens**

The citizens conference on “Climate Change and Citizens” held in 2002 in France showcases the potential of a **structured participatory process** engaging citizens in addressing urgent societal challenge. Citizens were **randomly selected** to increase the diversity of views and underwent an intensive and pluralist **training** to provide them with the necessary information to grapple with the topics, after which they **interviewed experts** in order to confront different ideas. The citizens presented 36 **recommendations**, both general (i.e. on investment into R&I for renewable energy technologies) and concrete (i.e. on carbon sinks). The Conference Report concluded that the process was an effective way to generate a responsible and rational response to the crucial choices presented to us by climate change and a means for the citizens to exercise their citizenship. The recommendations are still valid years later.


**World Wide Views on Global Warming:**

World Wide Views on Global Warming was an international citizens involvement project based on methods developed by the Danish Board of Technology and the principles of the citizens conference. Scientific experts, political decision makers and a diverse range of stakeholders

Contributed to dialogues held around the world that involved **38 countries 4000 citizens**. The citizens grappled with complex issues and dilemmas related to
climate change. Their recommendations included more research into new and advanced CO₂-low technologies.

Thanks to a clear process and real responsibility given to the selected citizens, the conventions result in original decisions that took into account the general interest, for example recommendations on global technology transfer for CO₂-low technologies.


Note: These examples were selected and provided by Global Health Advocates and Sciences Citoyennes.

Civil organisations are promoting citizen involvement based on the model of Citizen Conventions, whose basic principles are the random selection of participants, their training, open dialogue of experts, and the binding nature of the conclusions. Citizens may also be involved by leveraging on existing infrastructures and platforms at the local levels, like the regional Smart Specialisation platforms. If citizen engagement is to be promoted at the European level, the European Commission may consider relying on past transnational experiences such as the World Wide Views on Global Warming which involved more than 4,000 citizens from a total of 38 countries and led to recommendations for easing the transfer of low-carbon technologies. At the European level, the European Commission may need to orchestrate a similar process and then ensure that the decisions taken by citizens are taken into considering in the decision-making process which will thereby gain further legitimacy and support.
9. APPENDIXES

Appendix A. List of interviewed organisations

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Type of stakeholder</th>
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</thead>
<tbody>
<tr>
<td>Austrian Chamber of Commerce</td>
<td>Austria</td>
<td>Industry</td>
</tr>
<tr>
<td>Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT)</td>
<td>Austria</td>
<td>Policymaker</td>
</tr>
<tr>
<td>Austrian Institute of Technology (AIT)</td>
<td>Austria</td>
<td>RTO</td>
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<td>Austrian Research Promotion Agency (FFG)</td>
<td>Austria</td>
<td>Public agency</td>
</tr>
<tr>
<td>Basque Business Development Agency (SPRI)</td>
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<td>Public agency</td>
</tr>
<tr>
<td>Business Finland</td>
<td>Finland</td>
<td>Public agency</td>
</tr>
<tr>
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<td>Spain</td>
<td>Public agency</td>
</tr>
<tr>
<td>City of Copenhagen &amp; Region of the Greater Copenhagen</td>
<td>Denmark</td>
<td>Local authority</td>
</tr>
<tr>
<td>City of Vantaa</td>
<td>Finland</td>
<td>Local authority</td>
</tr>
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<td>Public agency</td>
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<td>Spain</td>
<td>R&amp;I expert</td>
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<td>Denmark</td>
<td>Public agency</td>
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<td>Danish Board of Technology</td>
<td>Denmark</td>
<td>R&amp;I expert</td>
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<td>The Netherlands</td>
<td>Public initiative</td>
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<td>Eindhoven University of Technology</td>
<td>The Netherlands</td>
<td>HEI</td>
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<td>Austria</td>
<td>Public agency</td>
</tr>
<tr>
<td>European Commission, DG Climate</td>
<td>European Union</td>
<td>Policymaker</td>
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<td>European Commission, DG CNECT</td>
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<td>Policymaker</td>
</tr>
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<td>European Committee of Regions</td>
<td>European Union</td>
<td>Policymaker</td>
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<td>European Construction Technology Platform</td>
<td>European Union</td>
<td>Technology platform</td>
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<td>European Energy Research Alliance</td>
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<td>Research network</td>
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<td>Industry</td>
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<td>Global Health Advocates</td>
<td>European Union</td>
<td>Civil organisations</td>
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<td>Infineon Technologies Austria AG</td>
<td>Austria</td>
<td>Industry</td>
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<td>Latvian Ministry of Economics</td>
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<td>Policymaker</td>
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<td>Sciences Citoyennes</td>
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Appendix B. List of organisations represented at the workshop

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<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Type of stakeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active and Assisted Living (AAL) Programme</td>
<td>European Union</td>
<td>R&amp;I initiative</td>
</tr>
<tr>
<td>CDTI</td>
<td>Spain</td>
<td>Public agency</td>
</tr>
<tr>
<td>Deutsche Stiftung Weltbevoelkerung (DSW)</td>
<td>Germany</td>
<td>Civil organisation</td>
</tr>
<tr>
<td>DigiTrust</td>
<td>European Union</td>
<td>Industry</td>
</tr>
<tr>
<td>European Association of Research &amp; Technology Organisations (EARTO)</td>
<td>European Union</td>
<td>RTO</td>
</tr>
<tr>
<td>European Factories of the Future Research Association (EFFRA)</td>
<td>European Union</td>
<td>Industry</td>
</tr>
<tr>
<td>Global Health Advocates</td>
<td>European Union</td>
<td>Civil organisation</td>
</tr>
<tr>
<td>IFRIS</td>
<td>France</td>
<td>HEI-RTO</td>
</tr>
<tr>
<td>IMEC</td>
<td>Belgium</td>
<td>RTO</td>
</tr>
<tr>
<td>INRA</td>
<td>France</td>
<td>RTO</td>
</tr>
<tr>
<td>Ministry of Education and Research</td>
<td>Estonia</td>
<td>Policymaker</td>
</tr>
<tr>
<td>OECD</td>
<td>Global</td>
<td>Policymaker</td>
</tr>
<tr>
<td>Platform I4.0 Austria</td>
<td>Austria</td>
<td>Industry</td>
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<tr>
<td>The European Chemic Industry Council (CEFIC)</td>
<td>European Union</td>
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<tr>
<td>Vinnova</td>
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Appendix C. References


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In view of the preparation of the future research and innovation Framework Programme of the European Union (FP9), the study collects evidence to assess the potential impacts of alternative mission-oriented R&I approaches. A desk research and the analysis of mission-oriented R&I initiatives improve the understanding of their potential impacts and help determine the potential influence of a move towards mission orientation in the EU28 countries. The Study identifies three potential scenarios: a transition to accelerator or transforming missions only, or to the compound of these two (hybrid model). Opinions and data from a varied audience of stakeholders were collected through interviews, a survey and a workshop. The main findings are that the introduction of a mission-oriented approach is widely supported, and that the hybrid model is deemed the most appropriate. The design and implementation of this approach will need to consider carefully the engagement of a wide array of stakeholders including citizens, the coordination across policy domains, policy departments and governance levels, and evaluation and monitoring mechanisms among others.

Studies and reports