Towards a Mission-Oriented Research and Innovation Policy in the European Union

An ESIR Memorandum

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Research and Innovation

Towards a Mission-Oriented Research and Innovation Policy in the European Union – An ESIR Memorandum: Executive Summary

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EUROPEAN COMMISSION

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2017 Directorate-General for Research and Innovation

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INTRODUCTION

The expert group on the Economic and Societal Impact of Research (ESIR)[1] is a group of independent experts set up by DG RTD of the European Commission in the fall of 2017. The members of the group are comprising Dominique Foray, Luke Georghiou, Georg Licht, Patrick Llerena, Mariana Mazzucato, Ester Martinez-Ros, Andrea Renda, Sylvia Schwaag-Serger, Luc Soete (chair), Marzenna Weresa and, external members, Richard Nelson and Jeffrey Sachs. As one of its first tasks the group was asked to reflect on the economic rationale for a new Mission-Oriented Research and Innovation Policy in line with the discussions starting on the development and design of a new Framework Programme. The ESIR Memorandum outlines both challenges and opportunities of reviving research and innovation policies with a mission-oriented lens.

RISE is the Research, Innovation and Science Expert high-level group[2] advising the European Commissioner for Research, Science and Innovation, Carlos Moedas. In autumn 2017, the Commissioner asked RISE to provide policy insights on mission-oriented research and innovation (R&I) policy at EU level. To ensure coherence between the work of the groups, a member of RISE, Luke Georghiou, participated in the work of ESIR on mission-oriented policy.

Research and innovation strategies are the pillars of Europe's 2030 strategy: achieving growth that is smart, inclusive and sustainable. Key to this process is providing a direction for change, while also enabling bottom up experimentation and exploration. Directions for innovation can be guided towards the grand challenges facing societies, whether decarbonising the economy, develop sustainable agriculture or tackling modern care problems. Missions are ways to frame the challenges into concrete problems that will require multiple actors to work together in new ways. Focussing on problems, rather than sectors can help rebalance economies that are over-reliant on few sectors and achieve transformational change by identifying and articulating **missions** that not just can galvanise but also transform production, distribution, and consumption patterns across various sectors in new directions. Addressing such challenges depends crucially on investments by both private and public actors, and much more.

In this document ESIR presents the current challenges being faced by the European area, and then discusses how a mission oriented R&I agenda can help to both tackle the economic problems as well as focus on societal challenges.

In the first section, we focus on **why** there is today a need for a mission-oriented R&I policy in Europe. It provides the ESIR group's analysis of the economic rationale for this new mission-oriented policy framework: its narrative.

In the second section, we describe **what** is meant by a mission-oriented R&I policy in Europe. We also try to clarify the different terms used. An essential distinction is the one between "challenges", "missions" and "instruments".

In the third section, we present our first reflections on **how** to implement a mission-oriented R&I policy. Implementing a mission-oriented R&I policy is a complex undertaking. We present here only some first ideas and concepts which could be used as background for an effective implementation of a mission-oriented R&I policy.

There are many more issues that need to be addressed and fall outside the scope of this first ESIR Memorandum: in particular the evaluation and monitoring methods which will take on an essential part within a mission-oriented policy framework. How e.g. to

[1] https://ec.europa.eu/info/research-and-innovation/strategy/expert-groups/esir_en
[2] https://ec.europa.eu/research/openvision/index.cfm?pg=expert-groups-rise

monitor and measure progress, evaluate and learn from mistakes, provide interactive feedback? Something we intend to address in more detail in our next report early spring 2018 focusing in more detail on the implementation of a mission-oriented R&I policy in Europe.

1 Why Europe needs today a mission-oriented policy approach towards R& I

1.1 On the need for a new Research and Innovation Policy[3]

Over the last decade, following the financial crisis, European economic growth has suffered from a lack of private investment and increasingly uneven levels of competitiveness across Member States (MS). In this context, the EC has continued to put forward its ambition to create economic growth not just in quantitative terms but also in qualitative terms: achieving growth that is smart, i.e. research- and innovation-based, inclusive and above all sustainable. The ambition to achieve a particular type of economic growth is an admission that the underlying rate of technical change bringing about productivity growth has not only a **rate but also a *direction***. Not all smart growth is inclusive, nor sustainable.

Acknowledging the direction of technical change requires, however, a quite fundamental re-thinking of the role of government and public policy in the economy. In particular, it requires a new justification of government intervention that goes beyond the usual one of the state as "repair shop": the fixing of market failures as in the case of R&D investment subsidies or tax advantages to fix private under-investment in R&D. Policy in this context will now also have to be about co-creating and co-shaping markets; about new, sometimes experimental ways to assess intervention so that dynamic system wide spill-overs are better captured; and about creating new criteria through which public policies can be justified, nurtured and evaluated.

In this context, research and innovation strategies can become the key pillars of Europe's 2030 strategy: achieving transformational change by identifying and articulating challenge-led ***missions*** that can galvanise innovation while transforming production, distribution and consumption patterns across various sectors. Addressing such challenges – whether decarbonising the economy, develop sustainable agriculture or tackling modern care problems – depends crucially on investments by both private and public actors, and much more. Providing a direction for such investments is what mission-oriented policy is about.

1.2 Addressing the low rate of return on R&I investment in Europe

The EU has been lagging in both innovation performance and R&D investments behind the US and Japan for decades. The soft, so-called Barcelona targets of 3% of GDP being spent on R&D within the framework of the ambitious Lisbon strategy of 2000 were never achieved[4]. Only some MS achieved the target, most saw the financial crisis putting severe pressure on maintaining public support for R&D as budgetary priority. Whereas leading innovation countries increased or at least maintained their level of public R&D, modest innovators and laggards appeared no longer to be able to afford their level of public R&D. Hence, the crisis and its aftermath increased the heterogeneity between MS' innovation capacity[5].

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[3] For a recent report which has very much inspired the present document see Mariana Mazzucato, *Mission-Oriented Innovation Policy: Challenges and Opportunities*, Working Paper IIPP WP 2017-01, September 2017.

[4] For an overview of the potential of the Open Method of Coordination within the Lisbon Strategy see amongst others Rodriguez, Maria Joao (2002) *The New Knowledge Economy in Europe – A strategy for international competitiveness and social cohesion*, Cheltenham: Edward Elgar.

[5] See e.g. Pellens et al. 2017, Public Investments in R&D in Reaction to Economic Crises – a longitudinal study for OECD countries, *ZEW Discussion Paper*.

Overall though, and as illustrated in Figure 1 below, the EU spends today in **relative and absolute** terms[6] more public funds on R&D than the US, Japan or China. While the impact of such public R&D spending on European productivity growth is something only to be established in coming years, public funding in Europe as a whole appears up to now not to have had the expected outcome in leveraging private R&D investments in Europe nor in reducing the gap in productivity growth between the EU and the US or Japan (see Figures 2 and 3)[7].

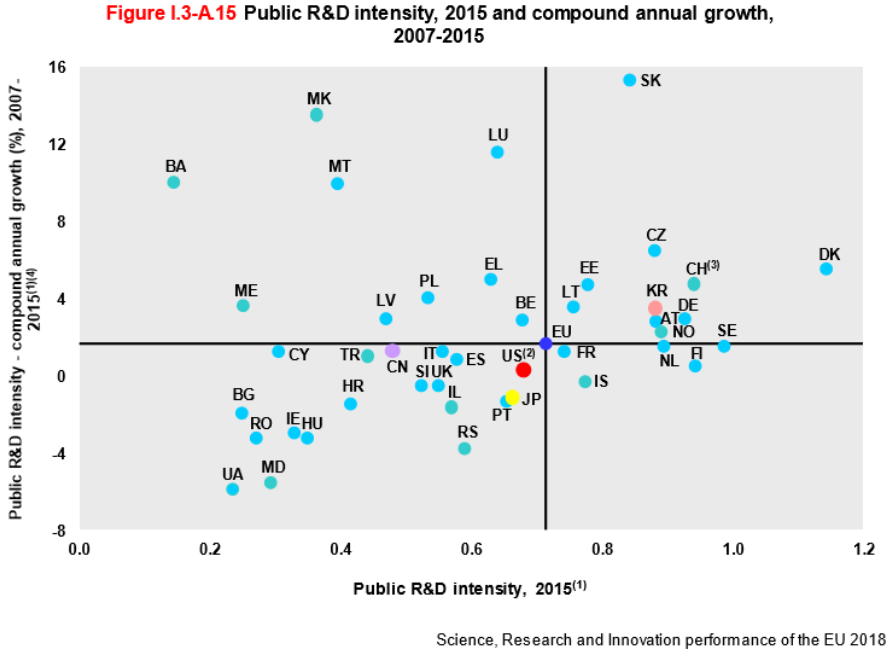

Figure 1, source: Science, Research and Innovation Performance of the EU 2018[8]

[6] In ***absolute terms*** this is the case if one uses standard purchasing power rates instead of nominal exchange rates. Thus, in 2015 the amount spent on R&D by the public sector was approximatively 103 BN euros for the EU as a whole and 193 BN euros by the private sector. For the US the figure was respectively 92 BN pps euros and 268 BN pps euros. For Japan 26 BN pps euros and 97 BN pps euros and for China 71 BN pps euros resp. 235 BN pps euros.

[7] Next to the amount of public and private money spent on R&D and on innovation, other expenses such as design and management have become increasingly important within the framework of evaluating public R&D programmes. For an overview of different types of innovation policy see Edler J., Fagerberg J. (2017), Innovation policy: what, why, and how? *Oxford Review of Economic Policy*, Volume 33, Number 1, pp. 2–23.

[8] https://ec.europa.eu/info/research-and-innovation/strategy/policy-support/science-research-and-innovation-performance-eu-srip-report_en

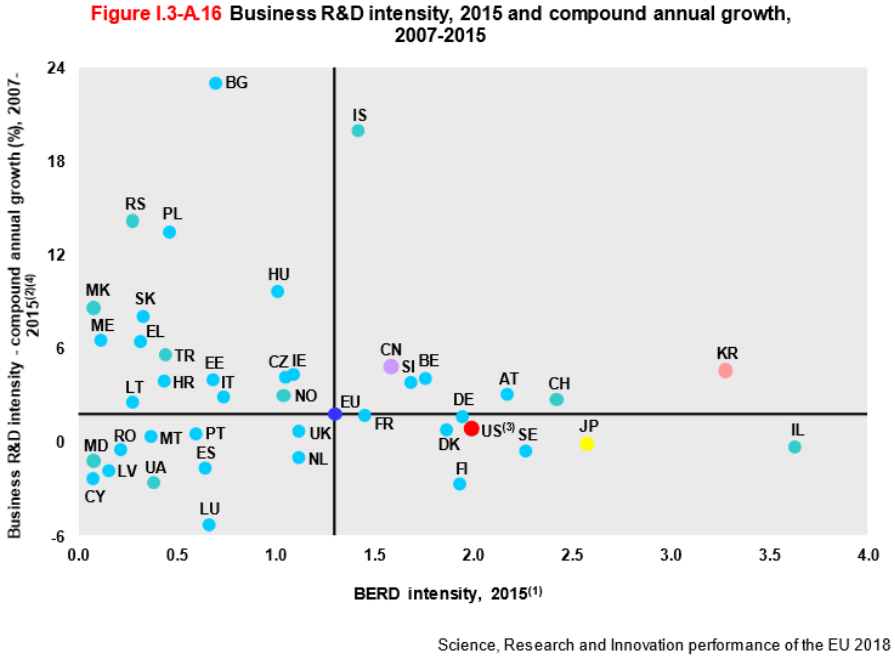

Figure 2, source: Science, Research and Innovation Performance of the EU 2018[9]

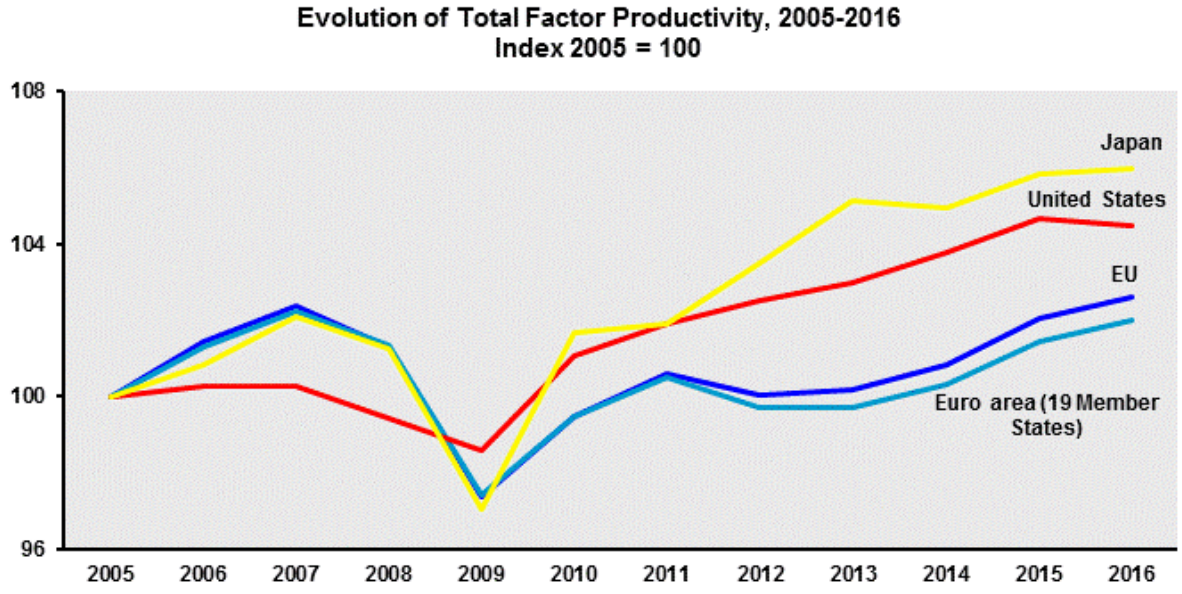

Figure 3, source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

9 https://ec.europa.eu/info/research-and-innovation/strategy/policy-support/science-research-and-innovation-performance-eu-srip-report_en

There are many possible reasons explaining the failure of Europe's R&D or innovation system to deliver its expected economic impact[10].

On the one hand, the fragmented nature of European public research, defined as an area of "shared" policy responsibility between individual MS and the EC, is likely to represent significant "costs of non-Europe" in the area of research[11]. On the other hand, differences in regulation or the lack of a European, as opposed to 28 different national procurement systems is likely to represent significant "costs of non-Europe" in innovation, increasing the costs of innovation and diffusion in Europe as opposed to truly single market countries such as the US, Japan or China.

In a certain way, the evidence presented in Figures 1-3 simply points to the fact that the rate of return to private R&I investment is significantly higher in the US, Japan or China than in Europe. From this perspective, continuing a European R&D policy, aimed at providing financial subsidies through the FPs to facilitate European collaboration between public and private R&D actors or other financial "risk sharing" support instruments, will at best only represent second-best solutions to the low level of private R&D investment in Europe. Such an approach seems to focus primarily on the various "market failures" linked to research and innovation investments. It appears broadly in line with most MS' approaches to research and innovation support policies with a growing number of European countries providing generic tax credit advantages to firms carrying out R&D. What has been described as the "repair shop" function of the state.[12] The leverage effect of such support policies both at EC and MS level appears to have been minimal in Europe as highlighted in Figures 1-3.

In other words: the need for a mission-oriented R&I policy is based on the urgent need to shift the attention away from R&D inputs[13] to the full impact of the many complex systemic interactions between basic and applied research, development, innovation, diffusion and the various accompanying spill-overs. In short, allowing for a more holistic approach to future R&D and innovation policy emphasizing the importance of supporting the whole innovation cycle starting from R&D investment and the creation of new ideas to their implementation, innovation and diffusion.

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[10] There is a substantial literature attempting to explain this so-called European paradox. See amongst others Dosi, G., P. Llerena and M. Sylos-Labini, "Science-Technology-Industry Links and the 'European Paradox'" in E. Lorentz and B.A. Lundvall, Eds. (2006), *How Europe's Economies Learn*, Oxford University Press, Oxford.

[11] See the recent document from the European Parliament, "Mapping the cost of non-Europe 2014-2019", estimating such costs at 3 BN a year

(see http://www.europarl.europa.eu/RegData/etudes/STUD/2017/603239/EPRS_STU(2017)603239_EN.pdf)

[12] See amongst other Cantner, U. (2017), *Innovation Roads Ahead*, JRC-OECD Concordi Conference, Sevilla.

[13] Along those lines, it is also important to refer to the increasing concern in the literature about the measurement of R&D, and in particular, the "industrial laboratory" biased nature of such activities. Early in the twenty-first century, a quiet revolution occurred. For the first time, the major developed economies began to invest more in intangible assets such as R&D alongside software, design, branding, than in tangible assets, like machinery, buildings, and computers. For all sorts of businesses, from high-tech firms, bio-tech companies to coffee shops and gyms, the ability to deploy assets that one can neither see nor touch appears increasingly the main source of long-term success. As Haskel and Westlake (2017) illustrate the emergence of this form of "capitalism without capital" represents one of the big changes of the last decade and raises some fundamental challenges, go well beyond measurement.

1.3 Unleashing private and public R&I investments

In this context of low investment, mission-oriented policies can help create new opportunities and landscapes that crowd in business investment, "tilting" R&D and innovation investments of private firms in particular directions. This new research and innovation framework highlights on the one hand the crucial policy distinction between subsidies and investments in the area of research and innovation and on the other hand, the particular role large, societal challenges could play in Europe co-creating new (local and global) markets. Contrary to previous FPs, the purpose of this new mission-oriented policy framework should now not be confined to use just public money to incentivise private firms to invest in R&I in general, but as we discuss in more detail in the next section to orient/direct those investments to specific missions, targets, objectives, set by policy in close interaction with both the public and private research community.

From an economic perspective, mission-oriented policies can increase the multiplier effect of public R&I investment, unleashing not only more private R&I investment and market-creating innovation[14] but also open up opportunities for new synergies with other European public financing instruments (e.g. the Structural Funds or EFSI). In setting out such a new mission-oriented policy framework, the core guiding principle should be on how to maximise the economic impact of the next FP 9. ESIR will not discuss individual MS' research policies, or the potential inefficiencies within each MS with respect to the organisation and set-up of public research institutions, but rather hope that these can be further aligned within the new mission-oriented policy framework.

Along those lines, ESIR also proposes that MS' generic tax-based research and innovation incentive schemes, operational in many European countries[15], be redesigned given their sometimes high sunk costs nature and potential "beggar-thy-neighbour" features. R&D tax incentive schemes have potentially substantial beggar-thy-neighbour effects when large, multinational firms look at how tax credits scheme differ between MS, when reorganising and/or optimizing their R&D investments within Europe. Patent box/Innovation box schemes are as general rule even more costly in terms of foregone taxes, and can result in large beggar-thy-neighbour effects. A more specific focus of such schemes[16] on e.g. SMEs would be more appropriate in addressing the high R&D costs for such firms and could hence broaden the involvement of such firms in the new proposed mission-oriented policy framework while at the same time influencing its design[17]. Alternative schemes in which, if successful, part of the tax credit granted for R&I activities is paid back, as in the case of Israel, might also be worth pursuing.

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[14] Draft findings from the JIIP study mapping mission-oriented policy approaches across Europe and globally, point to strong positive effects on private R&I investment as the MOPs trigger market creating innovation. Public R&D investments in the War on Cancer mission launched by president Nixon in 1971 or the EnergieWende mission launched by chancellor Merkel in 2010 have triggered substantial private R&I investment by firms positioning themselves in those new national and global markets.

[15] And subject of debate in MS, such as Germany which have resisted so far introducing such schemes.

[16] The empirical literature highlights the fact that a combination of tools e.g. tax incentives combined with direct grants might be a better solution to incentivize private R&D than use just only one of them such as R&D tax credits. See A.O Czarnitzki, D., & Lopes-Bento, C. (2012). Evaluation of public R&D policies: a cross-country comparison. *World Review of Science, Technology and Sustainable Development*, 9(2–4), 254–282. David, P. A., Bronwyn, H. M., & Toole, A. A. (2000). Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy*, 29, 497–529; and Arqué, P & Mohnen, P. (2015), Sunk costs, extensive R&D subsidies and permanent inducement effects, *The Journal of Industrial Economics*, Volume LXIII, 458-494, 2015.

[17]Recent research illustrates that R&D tax credits (for SMEs) are stimulating private R&D in SMEs (see e.g. Dechezleprêtre, A., E. Einiö, R. Martin, K-T Nguyen, J. Van Reenen, 2017, Do tax incentives for research increase firm innovation? An RD Design for R&D. See also the current German proposals on this topic.

2 What is a mission-oriented policy (MOP)?

2.1 An Outcomes-oriented policy – Set the target from the very start

The concept of mission-oriented research and innovation has been a fundamental pillar of public programmes in fields such as defence, agriculture and space exploration for decades as highlighted in the seminal publications of Richard Nelson[18] but remains rather ill defined. It does not have a formal definition in the OECD *Frascati Manual*. It was not even mentioned in Vanevar Bush's *Science the Endless Frontier*. The most classic reference is in a 1987 OECD paper by Henri Ergas in which he classified technology policy into a typology of mission-oriented versus diffusion-oriented and went on to contrast countries in the first group such as France, UK and the US which pursued 'big problem' issues in defence and health with a second group including Germany, Switzerland and Sweden who focused on making the best use of technology. Today it can be recognised that both approaches are needed simultaneously with missions creating markets and addressing societal issues while diffusion policies build capacity and improve productivity of firms.

Mission-orientation has been less visible in European Framework Programmes despite regular calls for a more programmatic approach. For example in 2006 the Aho Group[19] called for large scale strategic actions in key sectors to provide an environment in which supply-side measures for research investment can be combined with the process of creating a demand and a market. In 2007, the ERA Rationales Group proposed structuring programmes around Grand or Societal Challenges.[20] In 2009, the Knowledge-Based Economy expert group[21] proposed a specific stage-based process to design R&I policies for such grand, societal challenges. Horizon 2020 moved in this direction with the introduction of Societal Challenges and Innovation Partnerships but these have not achieved the level of coordination or the sense of purpose needed to have a transformative impact on Europe's economic and social goals. In the current debate the Lamy group has taken a lead in proposing a mission-oriented, impact-focused approach to address global challenges. The central role of market creation in mission-orientation, as opposed to addressing market failures, has been highlighted by Mariana Mazzucato[22].

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[18] See in particular Nelson, R. (1977), *The Moon and the Ghetto*, Fels Lectures on Public Policy Analysis, January 17, 1977 and Nelson, R. (2011), The Moon and the Ghetto Revisited, *Science and Public Policy*, Volume 38, Issue 9, pages 681–690, https://doi.org/10.1093/scipol/38.9.681

[19] http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf

[20] https://ec.europa.eu/research/era/pdf/eg7-era-rationales-final-report_en.pdf and see also Georghiou L, Europe's Research System Must Change, *Nature* 452, 935–936 (24 April 2008) https://www.nature.com/articles/452935a

[21] See EC Expert Group Report on *The Role of Community Research Policy in the Knowledge-Based Economy*. October 31st, 2009.

[22] See amongst others Mazzucato, M (2013) The Entrepreneurial State: Debunking the Public Vs. Private Myth in Risk and Innovation. London: Anthem Press; Mazzucato, M. (2014), Think Piece: "A Mission Oriented Approach to Building the Entrepreneurial State", paper commissioned by Innovate UK-Technology Strategy Board November 2014T14/165 https://www.gov.uk/government/news/long-term-growth-innovations-role-in-economic-success

Mazzucato M. (2016a) "From Market Fixing to Market-Creating: A new framework for innovation policy", Special Issue of Industry and Innovation: "Innovation Policy – can it make a difference?", 23 (2); Mazzucato, M. And Penna, C. C. R. (eds.) (2015a) Mission-Oriented Finance for Innovation: New Ideas for Investment-Led Growth. London: Policy Network/Rowman & Littlefield); Mazzucato, M. and Semieniuk, G. (2017) "Public financing of innovation: new questions", Oxford Review of Economic Policy, Volume 33 (1): 24–48. https://academic.oup.com/oxrep/article/33/1/24/2972707/Public-financing-of-innovation-new-questions

A key advantage of missions is that they can create opportunities for multiple sectors to work together, and if the right instruments are used, for bottom up experimentation to be key to the process of discovery.

Although, as highlighted above, there is no standard international terminology it seems useful to define **challenges** as the broader social problem aim or benefit that is being sought (e.g. fighting climate change), while **missions** represent the more narrowly defined package of activities that will deliver a verifiable result on a planned timescale that represents clear progress against the challenge. A "mission", etymologically, recalls the idea of a mandate to **achieve a specific result**. This, one could argue, can be expressed in terms of quantitative targets (-20% of CO2 emissions by time x addressing the challenge of climate change); one-off achievements ("man on the moon" as in the current popular concept of a "moonshot"); or a specific direction, unaccompanied by measurable targets ("cleaner water"). When policies are mission-oriented, they can adopt any of these types of missions. Orienting policy towards a specific mission requires two additional elements.

The first essential element is **accountability**. Whatever the mission, the institution that has been "mandated" (Latin: mittĕre) to achieve it should be held accountable for the choices made, the process followed, and the results achieved. This is why very often specific missions have been achieved by creating or empowering specific institutions to pursue them. Achieving accountability is a result of governance arrangements, and the attribution of sufficient resources and competencies to the agency or institution that is tasked with mission accomplishment.

A second additional, related element is **measurability**. Keeping track of whether the mission is being achieved, especially if targets have been set, allows a more precise and accurate attribution of responsibility, which arguably aligns the interests of the agent (i.e. the agency) with those of the principal (i.e. the government, and ultimately citizens). While it is not only true that "what gets measured gets done", it is true that reporting on steps made and results obtained towards the achievement of a given target might in certain circumstances motivate agencies to become more effective in pursuing that target.

Against this background, measurement through indicators should normally occur through output and outcome indicators, especially in R&I policy. Input and process indicators typically constrain the institution in charge of pursuing the mission, and are often non-technologically neutral. One of the key problems in the Europe 2020 agenda was the use of an input indicator (R&D expenditure over GDP) as a measure of success. Mission-oriented policies and spending programmes should take the form of outcome-based policies focusing accountability to the outcome achieved, rather than look only at the way in which it was pursued and by whom it was carried out.

Most of the FP7 and H2020 projects addressing societal challenges[23] have often been primarily fed by "supply-push" research policy concerns with the research community playing a central role, often becoming even a stakeholder in the way to address those "big challenges", relying in its financial sustainability increasingly on EU-funded research

[23] A stronger focus on societal challenges objective has been addressed by: FP7-Cooperation (Health, Food-Agriculture, ICT, Nano-Materials, Energy, Environment, Transport, Social Sciences & Humanities, Space, Security), CIP-EIP, CIP-ICT and CIP-IEE. Climate change and renewable energy are key priorities in the EC Horizon 2020 research programme. ESIR will examine if and how each of the objectives have actually been addressed. Often, the missing element in these sub-programmes was quantitative metrics (reference points) allowing to examine ex post the degree of their implementation. That is why a mission-oriented policy framework will have to include clear metrics allowing to assess whether the "mission has been completed". On the other hand, parametrization of innovation, which is an intangible concept will have to be proposed with caution as it is not clear how and when society wants more patents or more commercialization efforts.

projects. Implementation in terms of innovation was often disappointing. Typically, users and more broadly the demand side were insufficiently involved in the design and development of innovative ways to address those societal, global challenges. Policies putting diffusion of new technologies and innovation as core priorities were typically set aside as these fell outside the traditional "market failure" vision on R&D policy[24].

A mission-oriented policy framework, which we will call from now on MOP, covers the full cycle. It starts from ways to select missions, the design of specific policy instruments, the measurement of progress towards their target, its timing and fully integrated evaluation and learning process.

2.2 Framing the missions - Missions of the 21st Century as Europe's response to global societal challenges

With more scientists and engineers involved in research than in any other part of the world, the EU owes it to itself – and the rest of the world[25] – to remain a central player in addressing the big, societal challenges of our times. These have been well defined in the 17 so-called Sustainable Development Goals (SDGs) which form a clear, at global level democratically chosen set of global societal objectives. The importance and role of the SDGs have been highlighted in the recent Work Programme of the Commission for 2018[26].

Indeed, a defining feature of many of the challenges European society is confronted with, is that those challenges are **global** in reach. The very existence of the UN "Sustainable Development Goals" (SDGs), which should in our terminology be rather defined as complex, "**wicked challenges**", is a clear manifestation of the global nature of most societal challenges. As a result, greater international cooperation, both in finding and implementing solutions including the supply and demand side, will be an absolute must

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[24] For a discussion of the limits of the market and systems 'fixing' approach, see in particular Mazzucato M. (2016) "*From Market Fixing to Market-Creating: A new framework for innovation policy*", op.cit.

[25] Notwithstanding the insights which can be obtained from the recent implementation of mission-oriented research and innovation grants in other countries such as Japan. The results of the study on mission-oriented R&D grants in Japan showed e.g. that mission-oriented grants promote diversity of science more than curiosity-driven grants keeping however in mind the importance of complementarity between these two types of grants (See Shimada J., Naotoshi T., Suzuki J., (2017), Promoting diversity in science in Japan through mission-oriented research grants, *Scientometrics*, Vol. 110, pp. 1415–1435).

[26] In November 2016, the European Commission adopted a series of communications that outlined the future agenda for 2030, centred on SDGs . Despite the fact that sustainable development is considered as a fundamental and overarching objective of the EU, enshrined in Article 3 TEU, and despite the existence of a EU strategy since 2001 and a set of Sustainable Development Indicators since 2005, the salience of this strategy at the highest political level had never been particularly strong until the UN 2030 agenda was launched: in particular, the strategy was heavily criticized for lacking ownership and governance (Gregersen et al. 2016). Interestingly, the Commission presented the new agenda as a joint commitment with Member States and "many different actors", aimed at fostering a "stronger, more sustainable, inclusive and prosperous Europe". While the language closely mirrors the narrative of Europe 2020 (smart, sustainable and inclusive growth), emphasis on policy coherence both internally and in the external action agenda appears to be stronger. And importantly, the new agenda carries recognition of the important role that better regulation could play in fostering policy coherence for the long term. The Communication on "Next steps for a sustainable European future" clarifies that use of the Commission's better regulation tools is a "way to ensure further mainstreaming of sustainable development in European policies", since "all Commission impact assessments must evaluate environmental, social and economic impacts so that sustainability is duly considered and factored in". The Commission then adds that also ex post evaluations must also analyse all three dimensions "in a strong integrated approach". In the Commission's view, the current Better Regulation Guidelines (which include also guidance on stakeholder consultation) provide a strong basis for this mainstreaming exercise.

within any MOP framework[27]. Furthermore, translating global challenges into missions focusing on societal challenges is especially useful to avoid a too narrow industrial and innovation policy feeding a specific sector or industry. Missions contributing to societal challenges require transformation rather than handouts. Doing so, the particular interactions of cross-sectorial innovation and trans-disciplinary basic and applied science are essential.

Furthermore, given that the European project began as a project of peace and solidarity, mission setting could well represent a strategic way to revive the spirit of Europe in one of its most delicate phases (rising populism across Europe, democracy and the rule of law, BREXIT). In so doing it could be driven by '**European values**' that are today not shared so widely by the Trump administration, neither by countries, including some MS struggling with the democratic process. These values include, next to openness, also values such as equality, solidarity, public education and health care, security and social welfare. These are all values strongly embedded within the SDGs: one more reason for ESIR to view the SDGs as a powerful point of departure for rethinking Europe's efforts, instruments and approaches to promote research and innovation.

Therefore, the overall SDG-framing of a mission-oriented approach must be situated within an EU policy agenda built on European values. The EU can drive a policy "frontier" which is at the same time more actionable and more ambitious than the overall SDGs. Such ambitious societal missions have to take place the level of the EU, mobilising the full set of supply- and demand-side policies at EU and national level. This means that the final identifications of EU-level missions should be made in line with the future Europe 2030 agenda. This could include a proactive role, assessing the new horizons and possibilities that R&I policy opens up for the future of Europe in 2030 (see Figure 4 below[28]).

Obviously not all SDGs can be addressed through R&I policy, nor can they be achieved through just EU policy. However, the EU can become the anchor point for global programming of international, European, national MS and regional/local R&I policies.

[27] The RISE expert group's report stressed the Open to the World perspective in Europe's future research and innovation policy and recommended that global challenges be the driver for strengthening international cooperation, including science diplomacy with countries and regions outside the EU (see also: Schwaag Serger, S. and S. Remoe (2012), International Cooperation in Science, Technology and Innovation: Strategies for a Changing World Report of the Expert Group established to support the further development of an EU international STI cooperation strategy, EC.EU Expert Group 2012). As argued in the RISE report, in light of current trends towards growing protectionism and techno-nationalism in several countries, including MS, the EU should take a clear stand for openness: not just openness in science and innovation but also openness to the world, assuming a leading role in promoting global cooperation in tackling selected grand challenges.

[28] MFF stands for Multi-annual Financial Framework.

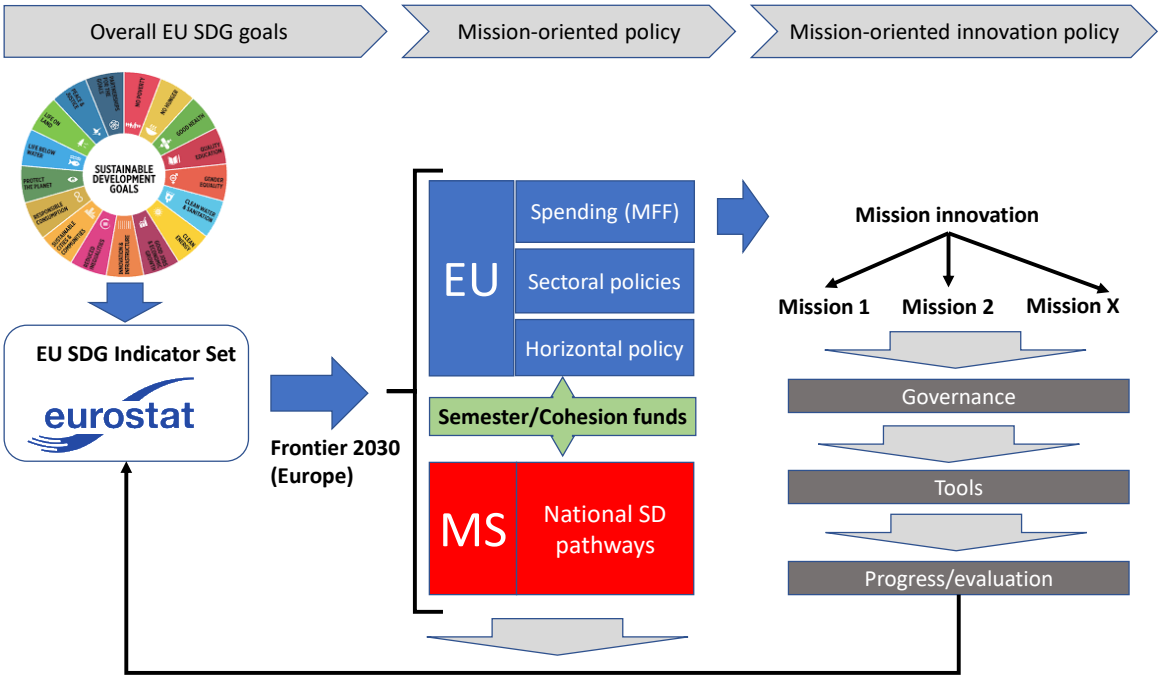

Figure 4, source: Andrea Renda

2.3 A taxonomy of challenges

The idea of a challenge has become firmly rooted as a means to guide innovation and other policies. It has the dual advantage of forming a *coordination envelope* to align a series of measures and instruments, which may have diverse governance, and the provision of a *channel of communication* with stakeholders including the wider public. It is possible to categorise challenges by whether they are economically, socially or scientifically driven but in reality most combine elements of all three.

Conceptually the missions addressing the challenges fall into two main categories:

> **Type A)** Addressing a challenge which is potentially solvable and can therefore relatively easily be reduced to discrete or verifiable goals; this includes the archetype of the moon landings (to be clear, under the definitions used here the aim to put a human on the moon was a challenge and the Apollo Programme was a mission); and more recently the development of the Ebola vaccine. The fundamental nature of the mission is to accelerate change in a set direction; and
>
> **Type B)** Addressing a challenge where solutions are unknown and the problems are 'wicked' and escape simple definition – wider societal problems such as sustainability or migration come into this category. The fundamental nature of these missions is to transform an entire economic or socio-technical system.

Framing the role of EU in the global SDG setting, four challenges appear today particularly relevant for mission-oriented policies at EU level:

- Decarbonisation, and combating climate change;
- Developing digital technologies, including AI and cyber-security for better public services;
- A healthy life at all ages (e.g. life style changes and prevention, affordable care, and controlling deadly diseases such as dementia or cancer;
- Sustainable cities, embracing circular economy and future mobility.

2.4 Identifying missions - finding the right level of granularity

What should now be the scope of missions in relation to those broad societal challenges? Should there be primarily "accelerator missions" simply speeding up progress in a particular field or rather "transformer missions" leading to systemic change? Or should there be both sorts of missions and, if so, what would be the correct mixture of such accelerator and transformer missions? At what level of granularity should one design individual missions?

Clearly, an essential step in moving from the previous set of global, complex, macro-level challenges to workable missions is the need to establish a level of granularity which remains clearly traceable to the high level goal (and hence remains meaningful at a political and societal level) but also allows resources to be directed and coordinated towards a set of measurable goals.

This implies a sequence of identification and articulation during which policy tools that extend participation, such as foresight, play a key role. This approach was explored extensively during the design phases of the Joint Programming Initiative and summarised in the Voluntary Guidelines on Framework Conditions for Joint Programming, which also proposed a cyclical approach[29]. A caution is that challenges may be captured by fashion in terms of which issues rise to the top of the agenda and hence a rigorous process of evaluation is needed to ensure continuing relevance and commitment. An example of an issue that rose to the top of the agenda and then subsided was the perceived threat from Avian Flu (which may of course return). Somewhat paradoxically, the eventual missions derived from challenges need an element of flexibility that allows them to evolve in the light of changing opportunities and demands.

"Missions" can create the frame for addressing these challenges as concrete problems to solve across sectors involving different actors and the full spectrum of research, innovation and diffusion[30]. Sectors are too narrow – challenges are too broad: missions are the intersection whereby challenges help direct finance towards solving problems that cause inter-sectoral investments. Even the 'old' type of missions, such as "Going to the moon", required basic research, applied research, public actors, and private actors coming from very different sectors[31]. Furthermore, the spillovers that occurred from the mission were supported by specific commercialisation and diffusion processes.

Missions are most easily defined when they are couched in terms of a scientific or technological target which is inherently quantitative – for example an efficiency level for photovoltaic conversion or the storage capacity to weight ratio of a battery. With Type B missions the option exists to find partial solutions which represent real progress towards the challenge but which only address elements of it that are reducible to missions. This is commonly referred to as establishing the correct granularity. An example in the cancer domain is a mission based on prevention and early diagnosis or particular cancers which could be a combination of research on biomarkers and a roll-out campaign to encourage at risk groups to take tests in the workplace or other non-hospital locations. Access to

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[29] http://ec.europa.eu/research/era/docs/en/voluntary_guidelines.pdf (p.24)

[30] For a discussion on the ways in which missions can be formed to spur innovation across multiple sectors and types of organizations, see Mazzucato, M. (2017), *Mission Oriented Policies: Challenges and Opportunities* , UCL IIPP Working Paper 2017-1.

[31] For a discussion about US missions in energy, agriculture and health, see Foray, D., D. Mowery, and R. R. Nelson. 2012. "Public R&D and social challenges: What lessons from mission R&D programs?" *Research Policy* 41 (10): 1697–1902 and for the connection to defense priorities, see Mowery, D. C. (2010). "Military R&D and innovation." In *Handbook of the economics of innovation* (Vol. 2), ed. B. H. Hall and N. Rosenberg, 1219–1256. Amsterdam: Elsevier.

affordable treatments and higher survival rates also require changes of the entire public health care system.

However, as noted above socio-economic challenges are by their nature more complex (or messy) and may involve parallel progress on a number of fronts including, but going far beyond, technology to include infrastructural and behavioural change. Similarly, while we focus here on the possibilities for a European wide mission oriented policy for FP9, it will be just as imperative to foster learning between MS on how to create "national" mission-oriented policies and open up further European FP to outside involvement and participation.

In practical terms, this analysis takes us to the other two elements of challenges, market creation and the integration of supply and demand. There are few if any Type B challenges which can be resolved by RTD measures alone. Some examples of dependencies are shown in Table 1 below using cases from the current working list of ideas for missions.

Historically lead markets such as wind power in Denmark and fax machines in Japan have derived from a combination of favourable innovation conditions (e.g. technological competence and business competition), heightened need (e.g. nuclear opt-out or difficulty of transmitting Japanese characters creating scale in demand) and a supportive regulatory environment (initial premium pricing or early telecoms regulatory reform). Many of the options presented offer similar opportunities for Europe but will only be realised if the full power of a single market for innovation is brought to bear. Public procurement may provide an additional accelerant in many cases.

2.5 Identifying missions - selecting missions

As mentioned before, ESIR does not see its role as selecting particular missions. However, some general comments can be made on the method of selecting missions.

There is a clear need to involve civil society at an early stage in the selection of missions to ensure legitimacy and long-term resilience in the goal setting. Some MS, such as the Netherlands have had experiences with broad societal, civil engagement in identifying core areas of science and research that would be prioritized in addressing societal challenges. Such involvement is also essential in order to prevent the risk of capture by both the scientific and business community of particular "missions". Ultimately, every lobby group in Europe attracted by possible funding will be claiming to have a mission.

The selection of missions will involve close interactions between the EC and MS. There are many opportunities for knowledge sharing from national and local experiences. There is in the initial stages a clear need for some sort of 'mapping' and learn from those experiences[32].

The initial number of missions should be relatively small: 5 to 10. To gain widespread support a portfolio will be needed covering key socio-economic domains. Those chosen are likely to be missions where innovation policy is also a substantial part of the solution but complementary measures as listed in Table 1 in areas such as regulation, procurement, training and public investment will also be needed.

There are of course also existing (and planned) activities which have strong mission-oriented elements. To become "missions" within a MOP framework they will need though greater clarity and focus. Criteria should relate to real societal challenges faced by a number of EU Member States or by a large proportion of EU citizens. One may think of:

[32] See in particular the JIIP project which will deliver its initial results of such a mapping exercise early next year; see also the EC Workshop 7th December, 2017 Studies in support of mission-oriented R&I policy.

PRIMA – the focus on nutrition, water and migration highlights important challenges but an example of a mission in this area would be provision of clean water through desalination at the same price as existing sources. This would have particular resonance in the South of Europe and would underpin Science Diplomacy in the Mediterranean region.

Cancer is a societal challenge but it is important to define within a mission based on increasing long-term survival with a clear rationale for the target of three out of four patients and the need to ensure that the approach is inclusive across all Member States.

More generally, use could be made of the so-called '**MATURE**' framework[33] for selecting and choosing missions. Missions should be **M**easurable as mentioned above in section 2.1 an intrinsic characteristic of any mission, **A**chievable as in the etymological meaning of the word mission, **T**ransformative including complementary changes as illustrated in Table 1, **U**nderstandable to citizens in Europe, **R**&I relevant but not solely and **E**ngaging in terms of mobilising enthusiasm among policy actors, civil servants, stakeholders and citizens.

At a more practical level, one should start from:

- first of all respecting the *framing* mentioned above in section 2.2;
- second develop a common EU *Intelligence and Foresight* based on a common network of EC, EP STOA, and MS which would include technology road-mapping, establishing global megatrends, strategic policy as well as business market intelligence, and social media trend scanning;
- third create a website where stakeholders, citizens organisations and research performing organisations (public and private) can send in *concrete proposals* of missions respecting the guidelines and criteria of a mission; and interact with Commission services to ensure the proposals are real candidates for missions according to the set criteria; and
- fourth generate high-level policy debates both in the European Parliament and Council, involving also the Committee of the Regions in the selection of the proposed missions.

[33] The use of this MATURE acronym is of course rather open for discussion. In so far as one is talking about innovation policy, one should address immature fields and new activities with agglomeration economies or coordination failures.

Table 1 Dependencies on Complementary Measures

Challenge	Mission	Complementary Measure
Zero Waste Households	Fully recyclable packaging technologies that increase shelf life & minimize use of plastics	Regulation to ensure take-up by producers. Economic or behavioural incentives for consumers to increase recycling. Public/private investment in recycling infrastructure
Cyber-safe Navigation	Innovative cybersecurity technologies based in Europe	Substantial training initiative to benefit from technologies. Parallel work in psychology and culture of security. Systemic approach to eliminate points of failure outside scope of technologies.
Water-stress free regions	New membrane technologies	Complementary infrastructure notably renewable energy. Procurement initiatives to accelerate take-up beyond the normal slow replacement rate for infrastructure. Conservation measures to reduce demand.

3 How to implement a European MOP: some first reflections

3.1 Lessons from the past

The old-fashioned mission-oriented policy of the 1950s to 1980s was characterized by a high degree of centralization. Goals were centrally determined. Their high costs encouraged a narrowing in the range of options explored and their technical complexity restricted participation in program execution to a few highly sophisticated agents. This in turn had two consequences: such MOPs placed a heavy burden on administrative capabilities - design and implementation involved a high degree of administrative discretion; and the monitoring of performance relied primarily on administrative processes rather than on controls normally exerted by product and factor markets. These missions were at the same time high risk ventures. In effect, a few large bets were being placed on a small number of races. This inevitably created the danger both that the wrong bets would be chosen and that the large outlays devoted to these programs were crowding out more valuable alternative uses. For ESIR this is the sort of design we precisely do **not** want.

The mission-oriented policy of the 21st Century implies to some extent the exact opposite: the freedom to experiment, decentralization, mass flourishing, local decision processes, etc. It is here that the distinction in policy design between **goals** and **programs** will be particularly useful in learning from the past and designing a framework with a proper balance between top-down directionality and bottom-up creativity and entrepreneurial discovery.

3.2 How will a MOP differ compared to a FP such as H2020

While the implementation of the mission-oriented policy is most effective as a core element across each of the current 3-pillar structure of H2020, the focus on missions should be the bread and butter of the Challenges pillar. Precisely because of the risks involved, the next FP will keep the current variety of R&I policy instruments with a new mission-oriented policy as a federating and structuring force, playing a significant but not overarching role.

The discussion about missions above is also an input into what kind of vertical policies one will have to aim for. Rather than have vertical policies aimed at sectors, missions should allow vertical policies to be aimed at problems that cause cross-sectoral investment and innovation, requiring both basic research and applied research. Therefore, missions should not be a threat to the ERC policies, which should remain about blue-sky science. Indeed, for clarity the ERC should remain "science for science" and might ultimately become the instrument of a Common Research Policy at European level, even at global level. ERC 'proof of concept' papers could however be make powerful, or even paradigm-shifting, contributions to missions, design in an iterative manner. Moreover, missions should be heterogeneous, with some related to problems that require breakthroughs in basic research (e.g. a "cure for Alzheimer"), and others more focused on innovation and market creation (e.g. "cyber-safe navigation"). Missions may also be heterogeneous in terms of geographical footprint and participation (e.g. an environmental mission on the Arctic, a migration- or water-focused mission for the Mediterranean): that being the case, the governance and even the location of mission-oriented organisations should also reflect, to the extent possible, the different mix of geographical and industrial interests. Finally, missions may also be chosen to reflect a suitable balance between natural science and social sciences (humanities); alternatively, each mission should be designed to incorporate both components.

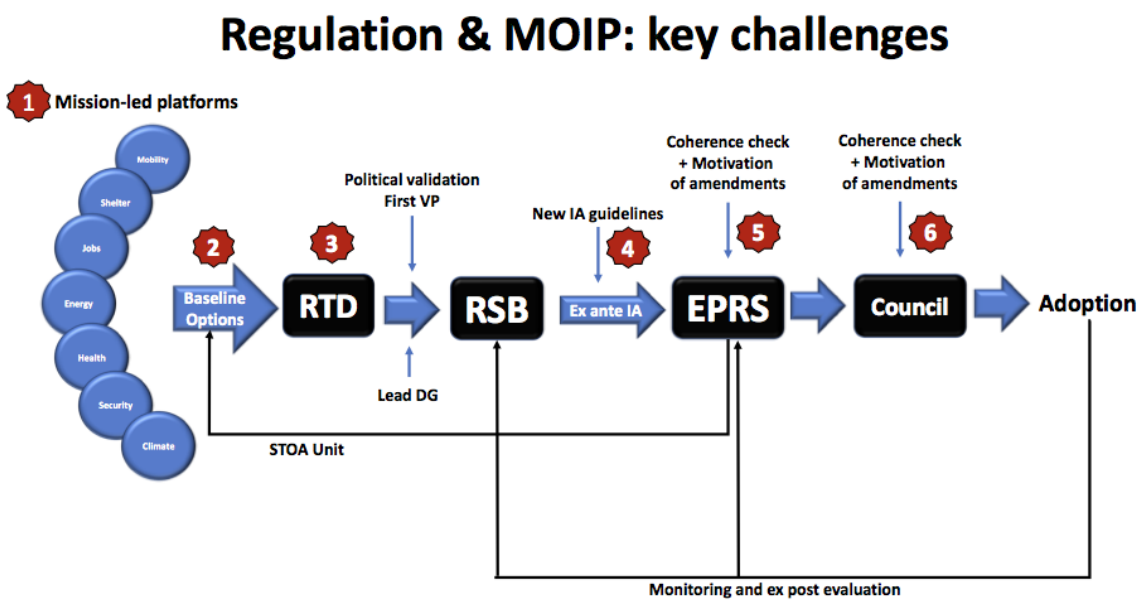

Figure 5, source: Andrea Renda

However, horizontal policies going well beyond the "Challenges" pillar of H2020 and DG RTD will be needed to make sure that the new MOP framework impacts and leverages investments in other areas such as regional development, education, skills, training, etc. – all key to productivity enhancement. The rather artificial separation between the three areas of "science for science", "science for industry" and "science for society" is from this perspective a confusing structure for understanding innovation, particularly within a MOP framework. Within a MOP framework, innovation should be considered as a non-linear process, requiring interactions throughout the entire chain, and ensuring a more dynamic dialog between the various points in the chain—including the *demand* side (via both procurement policies as well as bold policies affecting the nature of consumption), so that challenges and missions benefit from that dialog. Furthermore, the downstream investments – not the blue-sky ones – should be explicitly mission oriented.

In short, a Mission-Oriented R&I approach will require close interaction between the three areas/pillars of research: in some cases tackling in particular the insecurity and high risks involved in carrying out new frontier driven research; in other cases providing long term stability and security so as to allow incumbents to accelerate their investments in new breakthrough technologies; and in other cases opening-up disruptive innovation enabling new market creation opportunities. At the same time, the often disciplinary approach characteristic of many of the H2020 projects in each of the three pillars is likely to become much more directly challenged within a Mission-oriented approach. Furthermore, if one wants real "additionality" of EC funding, i.e. creating new research and innovation networks that would not have been formed without EC funding, getting people to work together on specific problems will require that those networks form in more specific ways causing real inter-disciplinarity.

3.3 Long-term stable EU goals with flexible missions

Many economists on research and innovation have highlighted the importance of a long-term, ambitious but predictable framework for the private sector combined with steady and balanced public research budgets: research is an experimental, cumulative and interactive process. It is very costly to adjust the level of effort over time. These large adjustment costs make multi-year funding horizons crucial.

While long-termism is hence essential, at the same time, missions require also clear processes which in the medium-term can inform when a mission might undergo change.

It may be that going down a route for a mission reveals the mission to either be a bad idea, or to cause unexpected consequences. The tap can then be turned off – a pivot made, or a total turn.

In other words, missions require adaptability, flexibility but also dynamic metrics and evaluation. They will be very hard to measure through cost-benefit analysis both ex-ante (to justify an intervention) and ex-post. While missions will inevitably be set from above, they must aim to foster as much bottom up experimentation as possible – i.e. nurture creativity and even serendipity, not stifle it[34]. Thus, missions should not be confused with 'dirigiste' top down static linear vertical policies.

As we discussed already above in section 2.2, it will be essential to develop a framework which distinguishes clearly between the challenges, the goals of the mission and the policy instruments and programs[35] developed addressing those. While as we highlighted a mission can be translated into a goal adding possibly accelerators, programs should be considered as the relevant units to incentivize and support self-discovery in the directions indicated by the goal or reflected in the mission. Such a framework allows one also to manage the hyper-complexity of the policy process by analysing a MOP as a modular structure when the scope of the policy is not only with DG RTD, not only with the Commission but with the EU as a whole entailing a much larger number of programs and organisations.

3.4 What instruments for an effective MOP?

What instruments, what mechanisms can one suggest and recommend for an effective MOP? There is a broad range of options on both the supply (human capital, fundamental research, R&D, technologies, innovative solutions) and the demand sides (innovation-friendly regulation, public and private procurement of innovation, prices, Living Labs and social innovation for advanced consumers and early adapters). The purpose of any instrument is to contribute to achieving the mission. Each mission would need a specific mix of instruments (or relative weight of the portfolio). There should be instruments that fund the development of new ideas; or that fund R&I infrastructures and alliances relevant for the mission; or fund innovation and incentives for change in organisations, including public sector innovation or empowering of key actors; or fund the scale up of demonstrators to Living Labs in Madrid, Berlin and Sofia, allowing firms to elaborate flexible innovative solutions. This way, one would turn Europe's cultural diversity and advanced consumers into a competitive advantage for the private sector.[36]

Finally, instruments to fund the scaling-up of tested innovative solutions to the Single Market with regulation and standards allowing this swiftly to occur would also be needed. This requires forward-looking regulation in line with the roadmaps and milestones set for the path towards innovative solutions. We will be elaborating in a forthcoming implementation note on some of those paths.

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[34] See the emphasis in the work of Dani Rodrik on the need for processes of self-discovery Rodrik, D. 2004. "Industrial policy for the twenty-first century." *John F. Kennedy School of Government Working Paper Series* rwp04–047.

[35] As suggested by Paul Romer in his seminal growth policy paper Romer, P. (2002), *Should the Government subsidize supply or demand in the market for scientists and engineers?*, NBER WP 7723.

[36] This can also be a competitive advantage at national level. Recently, Finland has elaborated a more flexible regulatory and innovation policy in view of becoming a global hub for the testing and experimentation of new innovative solutions.

Figure 6 below illustrates how within the framework of a new FP9, these interactions might be structured along different Technology Readiness Levels (TRL).

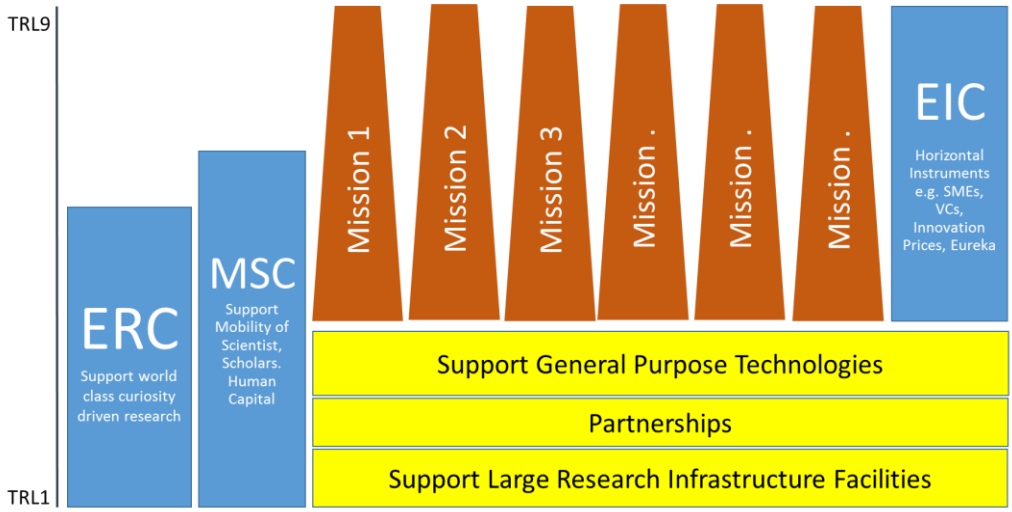

Figure 6, source: Georg Licht

3.5 Mission-oriented organisations

Missions need mission-oriented organisations. It is obviously not just about money being thrown at a problem. The implementation of a MOP framework, capable to drive funding into specific directions and at an appropriate scale, needs organisations/institutions with specific features and characteristics. The relevant institutions have to:

- transform their landscapes and to create new markets rather than to fix failures within existing markets and landscapes[37];
- be in charge of a successful co-design of the mission implementation process;
- be in charge of the achievements of the mission and accountable of the investments made;
- be highly adaptable to the feedbacks from the self-discovery processes by the partners and operators, flexible in the usages of the instruments;
- be able to co-design specific instruments if necessary;
- be endowed with a relevant degree of freedom, be able to manage in a dynamical way the portfolio of projects and programmes in order to re-orient the search and the funding according the emerging opportunities;
- be able to cope with, and adjust to, existing operators in research and innovation landscape.

These organisational changes require dedicated funding combined with institutional reforms building on public sector innovation and a balance between change incentives for staff and institutional perennity.

[37] See discussions about mission oriented organisations in reference above Mazzucato, M. (2017) IIPP-WP 2017-1

Mission-oriented organisations are essential for the governance and implementation of missions. There is a need for agencies or new "programme managers" with specific competences and with some strategic capabilities. In fact, the MOP framework is a move from an *ex ante* programming to a strategic evaluation process of the projects, acquiring a coherent portfolio of projects, with – once the missions are set – a strong bottom-up emergence of projects – experimental, even local, but potentially to be scaled-up – and supported in order to compensate for the costs of 'non-Europe' [38].

Mission-oriented organisations must welcome the explorative processes underlying adaptive and dynamic organisations. This is indeed the reason why organisations as DARPA are known for hiring scientists[39] on secondment so that a limited period of tenure is not confused with a lifetime career. Not only will missions require public, private, third sector and different industrial sectors to collaborate, within the public there are likely to be different types of actors: public R&D agencies, sectoral agencies, public banks. The fact that countries differ greatly in their ability to form such organisations with success (e.g. the KfW public bank in Germany has been much more successful at stimulating investment and innovation in the private sector, than the CDP--its counterpart in Italy), is precisely the reason why more attention should be applied to the organisational dimension, as well as to the details of specific instruments.

3.6 Innovation-driven policymaking

MOP can lead to significant advantages also for the application of the innovation principle, and of innovation deals.

The innovation principle has been so far applied in ex ante impact assessment more as an afterthought than as a guiding principle of policymaking. The policy problems are identified with no specific reference to innovation (rather, to the ten priorities), and only when policy alternatives have been identified the innovation principle applies. MOP requires a Copernican revolution in this respect: mission-oriented organisations can host the debate on policy changes that are needed in the existing stock of regulations, as well as the prospects for new policy interventions that would facilitate the accomplishment of the mission. Mission-oriented organisations would ideally develop baseline scenarios, as well as alternative scenarios in which various combinations of technologies and business models contribute to achieving the mission: these could become part and parcel of the future impact assessments that will have to accompany needed policy changes. DG RTD could play an instrumental role in translating the activity of mission-oriented agencies into actionable policy insights, to be represented in the Impact Assessment Steering Groups and with the Regulatory Scrutiny Board.

Likewise, if mission-oriented organisations embed a discussion of existing policy obstacles and prospective policy reforms, then they would also be able to apply for innovation deals in a more convincing and concrete way. Ideally, these organisations should be led by portfolio managers that have sufficient capacity and status that they can "pick up the phone" and call policymakers at EU and MS level. This would make the innovation deals a much more effective instrument for the accomplishment of the missions.

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[38] The successful project could 'win' additional fundings in order to scale up to the European level or to the international market compensating for costs of 'non-Europe' (multiplicity of regulations, standards, etc.). In case of success, the burden of the non-Europe would then fall on the shoulders of the Commission, hopefully an endogenous incentive to remove them.

[39] And more widely than just scientists. Mission-oriented organisations need also motivated human resources. For that it will be necessary to invest in continuous training and improving conditions to get people more involved and linked with the mission. Managment of diversity, the characteristics of teams, negotiation capacity, communication skills or/and positive leadership are also crucial to succeed.

3.7 Non-prescriptive programmes

By its very nature, a discovery process is about success, failures and surprises – that is to say the generation of much unpredictable information that should be used by the government to continue, discontinue, adapt the various programs and to identify issues that warrant further investigations. The social value of a discovery process is thus conditional to answering such questions like: what kind of policy design can maximize informational spillovers (about success, failures and surprise), provide high quality monitoring mechanisms and introduce a high degree of flexibility (to discontinue what has failed, increase support to potentially successful routes, etc.)? Self-discovery is related to an experimentalist culture of governance. Self-discovery and experimentalist policy culture do represent the most reasonable responses to the issue of co-designing a mission policy with stakeholders.

In short: the notion of self-discovery and how it is integrated into the policy process will be absolutely crucial to transform the old-fashioned policy concept of "mission-oriented" into a modern mission-oriented framework.

An additional challenge for policy coordination for a mission-oriented approach in Europe relates to the fact that the missions might substantially differ in importance and priority directions between Member States. One will need a realistic, pragmatic and open approach, which recognizes the different development levels of MS, allowing variable forms of cooperation, developing the EU's economic strengths while promoting unity in the Union. MS need different channels to express their necessities using Agencies, national DG, Framework programs, academics, companies, etc.

The closer a mission is oriented towards application ("the market") the more likely this will be the case. In addition, near-market research, in line with the complex modularity structure sketched out above, will also attract the interest of ministries beyond national research ministries (e.g. missions like "overcoming Alzheimer" will attract the interest of ministries responsible for health, social welfare policies and R&I policies). Hence, policy coordination between national ministries and between the European Commission and national research ministries becomes important to different degree depending to the stage of research (basic vs. applied vs. development vs. innovation).

The German Energiewende "mission" invoked by the first "red-green coalition" government in Germany comprised various packages of measures to change the conventional nuclear and fossil fuel energy system towards a renewable energy production system including a full set of policy instruments like green taxes, subsidies and regulatory instruments and comprise electricity, housing, heating and mobility sectors. The foundation of the German Energy Agency (DENA) provided a forum for policy discussion and coordination bringing together various ministries, industries and stakeholders, stimulating innovations in the production, use and storage of energy including new business models[40].

During the MOP definition phase coordination between EU commission and MS can follow the established pattern of program definition. However, during the implementation phase a higher degree of flexibility will be needed as a more complex set of stakeholders (national ministries) need to be and wants to be involved. One possible mechanism to ease coordination could be a larger use of co-funding between MS and EU commission during the implementation phase (e.g. for near market projects) at the project or the instrument level. In this way, missions might be more easily adjusted to specific needs of a Member State.

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[40] See this document (in German) https://www.dena.de/de/integrierte-energiewende/ with a discussion in English here http://www.sdgsgermany.de/en/speaker/karsten-sach

Consistent involvement of the Member States is necessary to define the strategic orientation of FP9 and its concrete design; furthermore, all programme modules should be evaluated regularly and conclusions should be drawn for future programs. There should be different levels and ways of coordination between the EC and MS depending on e.g. the closeness to the market of missions. As a rule the closer to the market the larger should be the say of MS and (of course a financial co-investment of MS).

At this abstract level, ESIR aims at designing a policy process which includes both a top down and a bottom up components (a mix of government strategic choices and processes of self-discovery of methods, strategies and technologies) – that is to say an intermediate process aimed at enhancing entrepreneurial initiatives and innovation within a framework (goals) structured by the government.

We will elaborate further on the design of such processes in a forthcoming MOP implementation note which builds on the expertise of individual ESIR members backed up by evidence from in-depth case studies and a global mapping of mission-oriented policies in Europe and globally.[41] Here we like to conclude with some more conceptual reflections open for discussion and debate.

3.8 Addressing the complexity of EU-wide missions

The notion of MOP creates to some extent an "**oxymoron**": an ostensible self-contradiction revealing an underlying paradox. In this case the fact that missions as "goals" can be understood as being relatively stable, with often rather well-established objectives that are neither too risky nor too radical for which there is a broad base of intellectual support. Such goals with possibly sub-goals should, to be effective, remain relatively constant over time. They also, as we argued in the previous section, imply clear metrics measuring progress. In this sense the proposed MOP represents a clear, transparent policy structure that allows policy makers to coordinate resource allocation and concentrate efforts and initiatives in a particular direction.

On the other hand, the concept of R&I within the notion of MOP implies to some extent the exact opposite: the freedom to experiment, decentralization, mass flourishing, local decision processes, etc. It is here that the distinction in policy design between **goals** and **programs** will be particularly useful in overcoming this implicit contradiction in adopting a MOP framework embracing the Commission and interested EU Member States.

3.9 Developing a modular approach to governance and learning

The design of a MOP framework is inevitably marked by an inherent tension between the need for governments (at all levels) to make at some point strategic decisions about goals and priorities and the need to maximize bottom up information and initiatives from those who are innovating in the public and the private sectors.

A way to overcome this tension is to abandon the specific meaning of "well-defined" of the PA framework and limit the ex-ante information conditions to the principle that what is known ex ante is limited to a broadly defined social goal and to let then actors to discover the best routes and technologies to achieve it.

By contrast to "goals", a **program** is a specific policy proposal that seeks to move the economy towards a specific goal. Programs can be less conservative and more experimental than the underlying goals. A variety of programs could be tried including ones where there is uncertainty about whether they will succeed. They can be modified or stopped.

[41] This evidence will be derived from ongoing studies performed by the JIIP consortia.

This trial and error, more experimental framework will help to implement a MOP framework defined now in terms of a **modular structure**.

A MOP which is likely to address one or the other so-called grand challenges should involve many dimensions, which means not only the development of new science and technologies but also demand side policies (procurement, adoption), programs supporting societal development (education, consumers' behaviours) as well as any kind of necessary change/adaptation in regulation and regulatory frameworks (norms, standards, taxes, labour market, competition policy, trade policy, etc.).

Given this multi-dimensional logic of a MOP, it is obvious that the scope of such a policy should not be limited to DG RTD's "field of operation", otherwise the old bias towards technology push will be difficult to avoid. A mission-oriented policy implies a shift to an innovation-driven policy making at the level of the European Commission's "field of operation". This is necessary to capture synergies between funding programmes and the articulation between innovative solutions and the larger regulatory framework[42]. However, this shift to a superior and more ambitious level – the EU as a whole – might also be desirable because of the fact that it will allow one to integrate as much as possible Member States' involvement as well as that of citizens and communities – the horizontal dimension – and regions -- the vertical dimension. However, shifting to this higher level of operation: the EU as a whole, will also generate an enormous complexity of programs and significant coordination problems which will have to be solved.

As ESIR we propose to use modularity as a tool to manage such complexity[43].

Let us define all EU, national and regional programs as well as programs focusing on supply, demand, regulation or societal issues as "modules". Modularity can be compared to conducting multiple experiments in parallel. A module (here a program) is a quasi-autonomous subsystem, which contributes to a more complicated process/goal (mission) by being combined with other subsystems (programs) through certain connective rules. Each subsystem (program) in this modular structure can be designed independently, providing the connective rules are followed. Our hypothesis is that the trade-off between this freedom of programs to experiment and the need for systemic coherence and integration can be solved by using modularity thinking.

A modularity approach makes it possible to separate what each program needs to communicate to clarify the connective rules (the visible information) from the invisible

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[42] There are a number of interesting challenges in broadening this multi-dimensional logic of MOP. One may think of the relationship between MOP and current State Aid rules in Europe, within the context of DG Comp being regularly criticized in focusing in its "mission" solely on the single market creation rather than e.g. on strengthening Europe's knowledge economy through R&D investment enabling innovation (see a.o. the ENIRI report: https://ec.europa.eu/programmes/horizon2020/en/news/state-aid-support-schemes-rdi-eus-international-competitors-fields-science-research-and, subsequently supported by the Lamy and Callas HLEG reports and also reflected in the recent (November 2017) tender call of DG Comp, stating: "... despite the significant simplifications introduced in 2014, *there appears to be a perception in some quarters that State Aid rules can have a negative impact on R&D activities, for example that they are difficult to comply with, create additional costs and cause delays. Evidence of this perception can be found in the ENIRI Report and the Report of the HLEG monitoring simplification for beneficiaries of ESI funds, while the report of the Lamy High Level group states in general terms that '[t]he current State Aid rules are perceived as insufficiently innovation-friendly'*). In principle though there exists now an instrument which would facilitate missions and MOP, namely acquiring the status of Important Project of Common European Interest (IPCEI, see http://europa.eu/rapid/press-release_IP-14-673_en.htm). Currently there is an IPCEI in the field of nano-electronics being created but with substantial administrative delays.

[43] The modular approach is mainly used in the field of innovation management and technology development. We use it as an analogy to develop our concept of mission oriented policy involving complex coordination of programs.

information (that others do not need to know). Modularity provides thus a mechanism in which only a fraction of processed information is shared among all coordinators and policy makers.

Modularity helps also to solve the trade-off between using different types of programs at different levels to boost experiments and realize local opportunities and maintaining coherence and cohesion in the whole policy system.

3.10 On implementing modularity governance

Bringing down these conceptual insights to practical implementation, we propose the following.

The central issue to be addressed is whether a particular generic form of modularity could be the most suitable one to create a good balance between freedom to experiments within all programs at all levels and co-ordination of the whole policy process which can be deployed at various levels of complexity: DG RTD, the European Commission, and the EU. The theory of modularity analyses relative efficiency of various forms: hierarchical decomposition (with the grand architect – here the Commission – pre-setting all rules), information assimilation (with the architect in the lead but adaptable) and evolutionary connection (without a single architect).

When the operational scope of the mission is predominantly in the realm of R&I (for instance science or restricted technological "accelerators" missions), then the first form of modularity governance might work: call it "hierarchical decomposition". It describes a system whose key features are pre-designed by a single 'architect' (DG RTD within the context of the FP). This architect is specialised in processing exclusively the visible information and determines the connective rules prior to the design of the modules (programs).

When the operational scope of the mission policy shifts to the Commission as a whole (for instance of a more pervasive "accelerator" or a broader "transformer mission"), with a higher impact if carried at the EC level***, then the second form of modularity governance will be preferable: what we call "information assimilation"***. It is a system in which the architect (DG RTD) leads but does not create inflexible system features. Connective rules continue to be fine-tuned even after the programs in the respective modules have started. Information about changing conditions is exchanged between the architect and the modules as well as between the modules.

When the operational scope of the mission policy shifts to the EU as a whole with essential synergies with SF, EFSI, CAP, regulation, MS, regions (for instance "transformer" missions of a higher level of granularity), then the third form of modularity governance should be chosen: what we call "evolutionary connection". It involves multiple architects and multiple agents engaged in the design of programs, with a continuous assimilation of new information. Activities are carried out in parallel and duplicated. Through information exchanges between the programs and the architects, a few connective rules may emerge in an evolutionary way.

In the case of a complex and ambitious mission, think e.g. of the case of obesity, the link between research in a number of very different areas from nutrition, life sciences to behavioural sciences to the impact on the governance of regulation in the health sector, innovation in the agro-food industry, education in primary schools, back to more fundamental science, there will be a need for deployment both "horizontally" (DG RTD + other DGs) ***and*** "vertically" (EU, MS and regions). The evolutionary connection principle is likely to be here the only way to manage such complexity.

The heuristic of modularity provides in our view a very rich framework to think of complex coordination problems such as the one is facing here – a policy process involving many programs to achieve one mission or goal. It is also obvious that the more complex a system is (such as a mission policy which operates at the EU level and thus involves a

great multiplicity of programs) the more efficient the "evolutionary connection" logic will be, since it can adapt connective rules to complex and evolving conditions rather than fully pre-defining them[44].

[44] See Aoki and Takizawa (2002), Modularity : its relevance to industrial architecture and for a non-technical introduction to the literature about modularity, D.Foray (2004), *Innovation in the knowledge economy*, chapter 2, Paris: OECD; as well as Baldwin and Clark (1997), "Managing in the age of modularity", *Harvard Business Review*, September

4 Conclusions: From Why and What to How – from Theory to Practice

This first ESIR Memorandum provides an overview of some of the main issue involved in setting up a MOP framework in Europe. There are clearly many more issues not addressed here: in particular concrete options on *how* to implement a mission-oriented approach in line with the economic rationale. This would imply new evaluation and monitoring methods, essential parts within any MOP framework. How e.g. to monitor and measure progress, evaluate and learn from mistakes, provide interactive feedback?

There are also many other operational aspects dealing with the last section on "how" to implement a MOP framework which need to be further elaborated upon, such as concrete options for portfolio design and governance.

As ESIR expert group we refrain on purpose from proposing in this Memorandum particular missions. We do not see this as our role as economic policy experts in the field of research and innovation. Rather we use here and there ideas for missions as they have been suggested and proposed by various groups, as cases to illustrate particular points.

Finally, we consider this ESIR Memorandum in the first instance as a "living document": an invitation to others to enrich the document with comments, references and examples, as the debate in Europe takes form in the coming weeks and months and gets the attention of interested parties.

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The expert group on the Economic and Societal Impact of Research (ESIR) is a group of independent experts set up by DG RTD of the European Commission in the autumn of 2017. As one of its first tasks the group was asked to reflect on the economic rationale for a new mission-oriented research and innovation policy.

The ESIR Memorandum contains the first reflections of the group of experts, all leading economic policy analysts in the area of R&I in Europe who have published extensively over the years on the nature, purpose and implementation challenges in the design and implementation of a mission-oriented R&I policy framework.

Studies and reports