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# Futures of Science for Policy in Europe

## Scenarios and Policy Implications

Research and Innovation

**Futures of Science for Policy in Europe: Scenarios and Policy Implications**
**Foresight on Demand Project**

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# Futures of Science for Policy in Europe: Scenarios and Policy Implications

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# *SUMMARY*

In this brief, we explore practices and processes by which information should be exchanged between knowledge actors and policy-makers with the intention to produce scientifically informed policies in Europe. We can see an increasing prominence of science in many public debates and the increasing willingness of governments to mobilize scientific and other advice mechanisms in the context of public debate.

The aim of science for policy is to produce actionable science, however, the level of control over those producing the knowledge and their responsibility for the consequences of the action is a matter of important societal dispute. Debates and interactions in the political and public space encompass interest-driven channels of communication, including scientific advice but also lay knowledge.

Therefore, science for policy needs to integrate knowledge from different sources and this requires building connections and relationships between actors from different scientific disciplines and across public administrations, affecting both the nature of science and the nature of policy-making. Science for policy may face adjustments in its modes of operation and its formats of interaction, which – at times – may well be at odds with the dominant empirical-analytical perception of science.

We make a deep dive into developments which are currently underway in the realm of research and innovation policy, and which can take us to different futures, including events largely unpredictable and decisions bound by constraints of diverse nature. We identify possible policy implications based on five scenarios of the future (in 2030), which highlight different types of science for policy ecosystems:

- Scenario A on *societal-challenge-driven and mission-oriented research and policy* provides the context for advice mechanisms to policy. Such a context can be amenable for scientific advice but it also entails risks for science.

- Scenario B on *participatory science and policy support 'under construction'* opens up the discussion on broadening the sources of evidence; why and how to include new types of actors beyond the 'usual suspects' (well-connected experts). This has implications for how to promote science and develop the policy support system.

- Scenario C on *data enthusiasm and AI overtaking scientific policy advice* illustrates the role of data, AI and international governance challenges and it alarms about over-reliance on multinational data providers, which may lead to a loss of transparency, autonomy and (normative) reflection in scientific advice. We should ask whether technology can be neutral, and whether scientific advice can be normative.

- Scenario D on *open science and policy support* points out that open science is not the same as open scientific advice whereby experts can speak frankly. Useful scientific advice has characteristics of a protected space where also unpopular (but well-founded) opinions can be voiced.

  Scenario E on *policy-based evidence-making in incumbent-driven industrial policy* increases weight on advice mechanisms and embedding data, evidence, and experimentation within government agencies, and government research and regulatory organisations.

The scenarios extrapolate different aspects of the relationships between government (or: government bodies) and the changing research and innovation ecosystem. The science for policy ecosystems depicted in each scenario can be in different phases of maturity (e.g. emergence, acceleration and consolidation) and they can take various forms and structures that constrain or facilitate the flow and use of knowledge. A key characteristic of knowledge (including in science and policy) is that it is always under construction. Institutionalized mature science for policy ecosystems may restrict the dynamism in knowledge and channel it in ways that serve the institution. Open and more ad hoc structures may favour a more open, diverse and dynamic science ecosystem. In different ecosystems science and democracy can also relate in many ways. If they are both pluralistic and open, they are likely to foster responsibility and accountability, for instance.

Science and policy interact in multiple and diverse ways at national and international levels, creating impressions and narratives around science for policy ecosystems in Europe. Looking into the future of the interactions provides insights into the challenges and opportunities faced by government, science and their interaction spaces, including intermediaries. Our scenarios emphasize the following noteworthy implications for the development of science for policy ecosystems in Europe.

### *Science for policy ecosystem and advice mechanisms*

The case for science for policy rests on its ability to contribute to the identification of problems and help policy-makers design more effective policies. Importantly, the EU has brought many advisory boards into policy-making over the years. Science for policy organisations, such as different intermediary organisations in the Member States, the JRC and the Scientific Advice Mechanism of the European Commission, and European Parliamentary Research Service (EPRS) in the European Parliament could form a strong EU science for policy ecosystem. For further co-creation and future-oriented deliberation, an overhaul of the governance system of scientific advice should address the mandates of different organisations and advisory bodies. They need to be evaluated regularly for their effectiveness, efficiency, and appropriateness.

New governance structures for policy advice should include wider stakeholder groups with research interests and ensure that participatory processes are meaningful. The roles and contributions of actors such as NGOs, associations, grassroots movements, concerned citizens, and ‘fugitives’ from the ancient régime, need to be assessed by research funders against case-specific criteria, covering aspects of quality of both product and process and including considerations of ethics.

Knowledge-based mechanisms should stay resilient in a world of “extreme populism” and “corporate capture”. Useful scientific advice has characteristics of a protected space, where both the mainstream voices and unpopular (but well-founded) opinions can be voiced. Issues with action can emerge when science for policy advice goes beyond the scope of vertical administrative structures and the established regulations and directives. Members States should consider how their scientific advice mechanisms relate to the established processes in the public administration and regulatory system, in particular those related to impact assessments, policy evaluations and structural reform processes.

### *Deliberation and alignment of public policies*

The divergence of scientific knowledge, scientific dissent, and uncertainty surrounding major societal challenges necessitate better deliberation mechanisms and coordination of policy mixes. This holds in particular for advice on societal-challenge-driven and mission-oriented public policy that draws on various policy impulses from R&I as well as sectoral policies.

Depending on the type of mission, new governance approaches could enable timely and regular interaction between knowledge production and decision–making in order to facilitate a better alignment research and innovation policy with of other public policies.

Co-creation of research output could also imply the co-creation of advice. In practice, the use of science advice is very much dependent on the leadership and culture of the different Commission directorates and government ministries in the Member States. Coordination of diverging agendas is impossible unless there is a willingness to collaborate and unless we understand what type of competence, knowledge, and cross-disciplinary skills are required from the different actors - cooperation, expertise, and resources between authorities operating in different contexts, and contents of legislation.

### *Value-based approach*

Science for policy should not alienate from nor hide value-based decisions and choices. It is a relevant part of the advisory mechanisms to also debate the values and their role in providing scientific evidence, and more in general, knowledge for policy. Questioning policy goals may not be "politically correct", but it is important that scientific advice raises uncomfortable truths. For instance, when engaging in debates on the EU's Open Strategic Autonomy, scientific advice, if managed appropriately,could strengthen balanced and inclusive approaches across levels of society and across relevant policies, which would include both better consideration of values and forward-looking contributions.

Appropriate management would involve interdisciplinary approaches that integrate the contribution of social sciences and humanities in the definition of societal challenges and in monitoring and anticipating socio-political trends without alienating citizens or undervaluing stakeholder participation and engagement.

This brief is the result of one of eight Deep Dive Foresight Studies in the project 'European R&I Foresight and Public Engagement for Horizon Europe' conducted by the Foresight on Demand' consortium for the European Commission. During the spring of 2023, an expert team identified factors of change and organised two scenario and one policy implications workshops, also engaging experts from academia, business and public administration around Europe. The process was also supported by discussions in the Horizon Europe Foresight Network. Further information and room for interactive discussion is provided on the project's website: www.futures4europe.eu

# 1. INTRODUCTION

Scientific analyses can help understand a policy problem, assess different policy options, assist in designing solutions that work and distinguish facts from fake news in public debate. The case for 'science for policy' rests on its ability to help policy-makers design effective policies in various policy domains and to support the democratic process[1]. The aim of science for policy is to produce actionable scientific knowledge, however, the level of control of those producing the knowledge of the action and their responsibility for the consequences of the action is a matter of important societal dispute. Debates and interactions in the political and public space deal with interest-driven channels of communication, including scientific advice, but also lay knowledge. Science for policy needs to integrate knowledge from different sources and this requires building connections and relationships between actors from different scientific disciplines and across public administrations, affecting both the nature of scientific research and the nature of politics.

Addressing the future of science for policy may be especially important considering potential changes in the societal context of science and in science itself:

- Provision of evidence and scientific knowledge change: AI is producing data for scientific research and evidence for policy-making faster than we ever had before.
- Scientific developments cannot be decoupled from normative and ethical debates in society.
- Scepticism is essential for the functioning of science[2]. However, societal scepticism over science is channelled by the echo chambers of social media, and the 'alternative truths' emanating from them.

Science for policy may face adjustments in its modes of operation and its formats of interaction, which - at times - may well be at odds with the dominant empirical-analytical perception of science.

In this policy brief, we explore futures of science for policy; practices and processes by which information should be exchanged between knowledge actors and policy-makers with the intention to design scientifically informed policy in Europe. We identify possible policy

[1] Evidence-informed policy-making refers to an approach to policy-making that aims at informing policy deliberations and decisions with the best available evidence. Evidence, in general, refers to “data, information, and knowledge from multiple sources, including quantitative data such as statistics and measurements, qualitative data such as opinions, stakeholder input, conclusions of evaluations, as well as scientific and expert advice” (European Commission: Better Regulation Toolbox, November 2021). In the context of the science for policy discussions, the focus is on evidence produced according to scientific methods (SWD(2022) 346 final).

[2] “Organized scepticism expresses the idea that the acceptance of all scientific work should be conditional on assessments of its scientific contribution, objectivity and rigor.” Merton RK. 1942. The Ethos of Science, J. Legal and Political Sociology. 1: 115 ‐ 126. Reprinted In: Merton RK, Sztomka P., editor., editors. Social structure and science, Chicago: University of Chicago Press, 1996.

implications based on five scenarios[3] of the future (in 2030), which highlight different types of the science for policy ecosystem serving various policy domains.

## 2. DEVELOPMENT OF ALTERNATIVE FUTURES - SCENARIO STRUCTURE

Scenarios[4] are not predictions of the likely future, but they depict qualitatively different possible futures. We develop **scenarios of the future in the year 2030** (written in the present tense, as if we were already in the future). We started by mapping the factors of change on future developments influencing science for policy (see Annex I), which helped demarcate the scenario work. Analysis of the factors leads us to identify key developments which are currently underway in the realm of research and innovation policies, and which can take us to different scenarios on possible science for policy ecosystems in 2030, in particular:

- Scenario A on societal-challenge-driven and mission-oriented research and policy support
- Scenario B on participatory science and policy support 'under construction'
- Scenario C on data enthusiasm and AI overtaking scientific policy advice
- Scenario D on open science and policy support
- Scenario E on policy-based evidence-making in incumbent-driven industrial policy

The science for policy ecosystems depicted in each scenario can be in different phases of maturity (e.g. emergence, acceleration and consolidation) and they can take various forms, structures that constrain or facilitate the flow and use of knowledge. A key characteristic of knowledge (including in science and policy) is that it is always under construction. Institutionalized mature science for policy ecosystems may restrict the dynamism in knowledge and channel it in ways that serve the institution. Open and more ad hoc structures may favour a more open, diverse and dynamic science ecosystem. In different ecosystems science and democracy can also relate in many ways. If they are both pluralistic and open, they are likely to foster responsibility and accountability, for instance.

To ensure that each scenario developed differs from one another two dichotomic dimensions were defined to provide a starting point for the scenario work and a structure that ensures that each scenario is truly different. Public governance emerged as a relevant issue as it influences a lot on how scientific advice is used. Stakeholder engagement in policy processes

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[3] We admit a huge oversimplification in the initial scenarios, due to future events being largely unpredictable and decisions bound by constraints of diverse nature. We also recognize that there are different terminologies in 'science for policy' and there are different views and underlying meanings. Also, the discussion was sprawling in the scenario workshops. However, the underlying focus was on the role of science in public administration and governance structures in policy-making.

[4] Exploring multipe scenarios helps expand one's own span of observation further towards the future and to possible threats and opportunities that otherwise might not be in the immediate focus of attention, or just neglected for being seemingly unlikely.

was considered important as this defines largely how the scientific community and other stakeholders can influence the problem framing and policy definition in general.

**The dimension of public governance**

(a) Directional, strong public governance: 'big' government, strong capacities and capabilities, planning and societal orchestration to direct society towards politically agreed value-based desired future

(b) Market-driven, weak public governance: 'small' government, weak capacities and capabilities, the government is limited to provide basic infrastructure, defence and law enforcement, and the framework conditions for competition; markets allocate resources and provide services

**The dimension of stakeholder engagement in problem framing**

(a) High stakeholder engagement in framing: Diverse and extensive set of stakeholders, including the general public, engage in framing the problems to be addressed by policy and the options available (as derived from science for policy)

(b) Low stakeholder engagement in framing: Few and narrow set of stakeholders are engaged in framing the problems to be addressed by policy (and science for policy)

The scenarios, highlighting different types of the future science for policy ecosystems, were positioned along the two extremes of each dimension. In the figure below, one can see the five scenarios positioned along the axes providing an analytical structure for the development of scenarios. While the dimensions were used to identify dominant features, also various options were considered in the scenarios in relation to their dominant features.

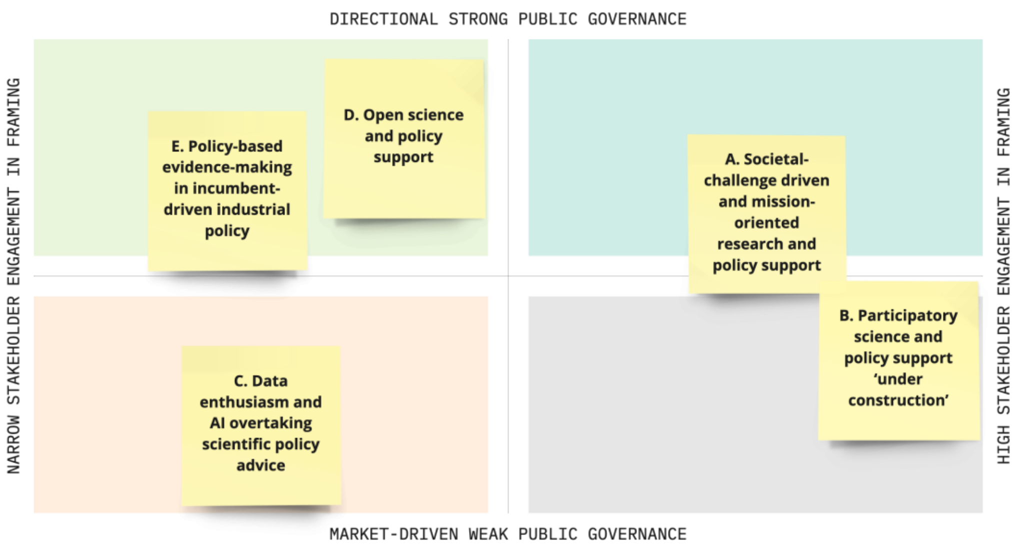


**Figure. Positioning of the scenarios along the key dimensions.**

# 3. FIVE 2030 SCENARIOS ON SCIENCE FOR POLICY

The following five scenarios are based on the initial work by the experts and subsequent inputs from the scenario workshops.

## 3.1. Scenario A on societal-challenge-driven and mission-oriented research and policy support

Scenario A addresses *societal-challenge-driven and mission-oriented research and policy* practices, which provide the context for advice mechanisms for policy. Such a context can be amenable for scientific advice but it also entails risks for science.

*Key dimensions*

- Moderately directional strong public governance
- Moderately high stakeholder engagement in framing

*In brief*

In 2030, stakeholders of the Quadruple Helix (e.g., Academia, Industry, Public Authorities, and Civil society actors) successfully co-create new research and innovation agendas across scientific disciplines and thus contextualise as well as align research and innovation efforts with socially desirable outcomes.

*Key Drivers*

This has become possible through the systematic promotion of societal-challenge-driven and mission-oriented research by research funders across the EU during the last decade and backed up by national Parliaments and the European Parliament, as it turned out to be the major new instrument that can be harnessed to drive innovations towards socially desirable ends. In such missions, stakeholders collaborate in research and innovation activities, including setting agendas, with a commitment to socially desirable outcomes. Key concepts are co-creation and co-design of research by all knowledge actors. The recent EU Framework Programme Horizon Europe demonstrated its success with its new feature of mission-oriented research and innovation (where the targets were essentially social, not simply techno-scientific) to foster innovation by co-design and co-creation towards overall objectives, democratically deliberated among stakeholders. The missions also included inputs from citizens and public and private R&I managers, thereby delivering earlier than expected on Green Deal objectives. The feedback mechanism with policy-makers offers new ways of deliberating pathways and options to drive research and innovation towards socially desirable ends, on the basis of knowledge and evidence that is co-produced. The organisational structures of missions have become embedded in the governance structures so as to provide policy advice beyond the research and innovation activities.

*Engagement of stakeholders/actors*

Societal-challenge and mission-driven research topped up Open Science by making science also more inclusive by the systematic incorporation of a broader range of knowledge actors beyond the academic context. It also facilitated globally organized mission-oriented research, having scientists sharing knowledge and data prior to publication with all relevant stakeholders and thereby marrying scientific excellence with societal relevance. The missions conducted were both at European scales and on national and regional scales, thereby allowing to effectively translate global issues such as climate change to specific regional and local needs.

The stakeholders operate on a basis of mutual responsiveness to each others' concerns, thereby creating consensus even if conflicts of interest may remain, for instance around intellectual property, which remains an issue for some industries. Public authorities have ensured an equal playing field among the stakeholders. Journalists are independent from the actors within missions but involved to critically reporting to a wider public how the missions evolve and pick up signals from both the scientific community and the societal stakeholders. They can investigate whether important scientific issues are considered or particular societal interests are not sidelined. The mission-oriented approach is not the only approach to science funding. Curiosity-driven research receives funding also with a view to the fact that long-term perspectives should not disappear from the research agenda.

*EU-level and international perspectives*

Europe's competitors fall short of equally implementing effective mechanisms for facilitating societal-challenge-driven mission-oriented research and innovation as they have promoted a purely market-driven approach and married it with key tech fostering industrial policies. This has led to international tensions as the EU leads by example in providing solutions for its citizens, including business innovations in relation to sustainable production and social innovations for sustainable consumption whereas Europe's competitors have taken the lead in some key-tech areas such as hydrogen-based tech but fail in their broad implementation and met with societal resistance to change. In several parts of the global south, people feel frustrated that the challenges have been defined from a too Europe-centric perspective. The trade with China and the US has come under public pressure as Europeans are disappointed by the information coming out from the missions, that quality standards for agricultural produce are not respected by Europe's trade partners with negative impacts on Europe's environment and public health. The key-tech approach, notably by the USA has led to further dominance of US companies on the global markets in particular areas such as AI, which, as an enabling technology, started to undermine the primacy of socially driven innovations.

*Policy and evidence base*

The systematic collaboration along the Quadruple Helix combined with a sensitivity for local and regional specifics enabled consensus among the main political actors on the interpretations of scientific evidence as well as on a forward-looking perspective of how policies might need to be readjusted in the future in light of changing scientific findings or societal demands. Societal-challenge-oriented and mission-driven research appeared to integrate a science policy advice dimension within the missions as such, among others backed by effective monitoring, foresight and evaluation methods and mechanisms. Moreover, the employment of value-sensitive technology assessment and value-based co-creation of the missions with all stakeholders including citizens will enable to give a direction to research and innovation as well as determine the characteristics of new technologies to some extent. This means that feedback to public policy is provided during the mission on an ongoing basis. The advice goes beyond research and innovation matters, as depending on the type of mission, other public policies such as regional policy and environmental policy need to be addressed. Vice versa, these other public policies will be better aligned with research and innovation policy. The feedback mechanism with public policy offers new ways of deliberating 'evidence' as transparent reporting by both policy-makers and the actors of the missions.

*Policy implications*

The possible future developments depicted in the scenario can spark further reflection on how such positive developments could be promoted and negative ones avoided, starting today. We list below possible implications mainly for further discussion in the realm of R&I policy.

Engagement of stakeholders/actors

- The scenario relates to the loss of interest in traditional research disciplines. The increasing public attention to societal mission-oriented research may have led to a situation that university students become less interested in the traditional scientific disciplines, even though they remain funded. There is also a lack of interest in unpopular areas such as nuclear engineering. Public authorities could consider further incentives to keep a critical level of availability of experts in unpopular areas.

- The scenario relates to the loss of social cohesion in Europe because of the national bias of beneficiaries of research funds. National Parliaments and the European Parliament may have increasing difficulties to reach a consensus on allocating mission-oriented research to the most socially desirable projects, since knowledge actors participating in the missions may tend to favour solutions relevant to their country of origin whereby North-west Europe is the biggest beneficiary of research funds. Part of Southern and Eastern Europe would feel left behind. Cohesion policies with targeted mission-oriented research funds for particular regions of Europe could become an option for public regional and research and innovation policy. This would also give a strong impulse for a more mission-oriented regional development policy approach.

European and international perspectives

- The scenario relates to Europe's focus on social-political aspects of the grand challenges, which may lead to trade frictions. Trade and competition policy is at odds with WTO requirements since European citizens define the quality of food products far beyond strict scientific standards of safety as emerged from mission-oriented research on issues related to sustainable production and consumption patterns. Trade conflicts are inevitable when imports of products for reasons of sustainability, social or ethical reasons are not accepted under WTO.

Policy and evidence base

- The scenario relates to the advice of formal, traditional scientific advisory bodies, which may well contradict the advice arising from mission-oriented research. Policy-makers cannot ignore the advice arising from the missions but at the same time must respond to formal scientific advice. Scientific advice under European regulations and directives could be obliged to take the outcomes of the missions into account. However, this can imply that the advice goes beyond the scope of individual regulations and directives. Hence an overhaul of the whole governance system of scientific advice is necessary, addressing the delimitations between the mandates of different advisory bodies.

Cross-cutting issue

- The scenario relates to Europe lagging in the development of key tech areas and being subject to the dominance of US operators in the EU market. The industrial policy could consider flanking policy measures, compensating for the fact that technology development is now predominantly outside of Europe, ranging from quantum computing, cloud services, space engineering etc. In addition, an effective tech-start-up programme could be launched.

## **3.2.** Scenario B on participatory science and policy support 'under construction'[5]

Scenraio B on *participatory science and policy support 'under construction'* opens up the discussion of broadening the sources of evidence; why and how to include new types of actors beyond the "usual suspects". This has implications for how to promote science and develop policy support.

*Key dimensions*

- Moderately market-driven weak public governance
- Extremely high stakeholder engagement in framing

*In brief*

By 2030 citizen science has gained visibility and momentum, having moved a long way from its early days when lay citizens were merely engaged in collecting huge amounts of data for researchers and did not have a say in any other phase of the process. Nowadays citizen scientists collaborate with professionally trained scientific researchers throughout the whole research process, often taking the initiative in selecting issues of inquiry and in some cases even methods of investigation. In the meantime, policy decisions are vehemently contested and potential advisers, scientific or not, debate and argue in open and public arenas, often using the weapons of personal attack, discredit, and blame to gain visibility and access to power. In such a conflictual situation, the scene is dominated by some authoritative influencers coming up with narratives capable of conquering and mobilizing huge crowds in protest. Thus, the mechanisms of advice-seeking and advice-giving are at a standstill, with science losing more and more of its former authority, subject to continuous revisions and adaptations, and permanently under construction. "Participatory science" describes the current state of affairs more precisely than "citizen science".

*Key drivers*

In Europe and the Western world, the crisis affecting the institutions of the modern state has not spared those of science. Disaffection for the mechanisms of representative democracy is paralleled by diffidence towards the increasing influence of a scientific-technological elite and

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[5] This scenario was insprised especially by the following sources: i) Eisenhower, D.D. (1961) Farewell address https://www.archives.gov/milestone-documents/president-dwight-d-eisenhowers-farewell-address; ii) Guston, D.H. (2012) *The Pumpkin or the Tiger? Michael Polanyi, Frederick Soddy, and Anticipating Emerging Technologies.* Minerva 50:363–379, DOI: 10.1007/s11024-012-9204-8; *iii)* Kaiser M. and Gluckman P. (2023). *Looking at the future of transdisciplinary research.* International Science Council discussion paper. DOI:10.24948/2023.05; iv) Rayner, S. (2012) *Uncomfortable knowledge: the social construction of ignorance in science and environmental policy discourses*. Economy and Society 41:1, 107-125, DOI: 10.1080/03085147.2011.637335

the military-industrial complex on the design and implementation of policy decisions and on research modes. In addition, cases of plagiarism, forgery, misconduct, and conflicts of interest are denounced with frequency and become of public domain, reported and amplified by mass and social media. Trust in the integrity of science has been progressively and rapidly eroding and confidence in its efficacy in the pursuit of common interests and societal well-being is questioned in many quarters.

Even within the traditional academic establishment, there are plenty of motives for dissatisfaction: inadequate research funds, insufficient salaries, unsustainable teaching loads, "metricization" of performance, unmanageable administrative burdens, and intolerable pressure to "publish or perish". Early-career researchers, in particular, resent job insecurity, precarity, exploitation, rigid hierarchies, discrimination, and lack of recognition, circumstances which have led to a worrying increase in mental health problems. Many have been driven out of academia, searching for refuge in alternative loci of employment.

*Engagement of stakeholders/actors*

An alert and knowledgeable citizenry, concerned about current trends, requests substantial changes demanding that research and policy are more attentive to their problems and needs. They get together on the basis of common concerns for events and phenomena which have disrupted or may disrupt their well-being and quality of life. Alerted by past experiences of dis- and misinformation, and concealment, they want to have a say throughout the processes of scientific research and risk assessment, beginning with the choice and the framing of the issues to be given priority. They also deploy technical skills (e.g. startups, DiY – Do it Yourself) and are able to collect huge resources via crowdfunding, donations, as well as access to funding mechanisms previously barred to non-professional researchers.

Within academia, the traditional model of rigid disciplinary borders has progressively lost ground and many of its supporters have defected from the educational system and moved to the private sector. Initiatives launched in the early 2020s, such as the Norwegian *Organisasjonen Ferske Forskere*[6] have gained momentum and multiplied internationally. Their political manifestos are similar in the claim that free and available knowledge is a prerequisite for democracy and in the renewed call for research and knowledge to be devoted to improve the lives of all mankind.

The new *modus operandi*, based on a revision and weakening of disciplinary boundaries inside academia, is open to everyday life problems, thus attracting new actors such as NGOs, associations, grassroot movements, concerned citizens and fugitives from the *ancient régime*, all contending with research interests. Even types of knowledge produced outside "scientific sanctuaries" are deemed relevant for tackling complex problems which cannot be framed in strictly disciplinary terms. These contributions go under different and partially overlapping labels such as: indigenous, anecdotal, traditional, lay knowledge and evidence-based practice, and produce results expressed in a variety of formats, usually quite diverse from those of standard academic research. Consequently, their assessment requires case specific criteria, covering aspects of the quality of both product and process and including considerations of ethics. Such changes are also visible with the coming of age of 2020's young researchers - academic leadership and CVs have undergone substantial changes. The multi- and inter-disciplinary research experiences have successfully multiplied, with the social sciences and humanities now considered equal partners to the natural sciences. In 2030, the linear approach, adopted until recently, has given way to the idea that research

[6] Organization for early career-researchers, https://ferskeforskere.org/home-en

needs to be holistic from the start and throughout all its following passages, including ethical, social, cultural and policy aspects.

*EU-level and international perspective*

Whilst the trends illustrated above are common to all EU countries, their speed and acceleration is not totally similar, complicating further the setting up of structures and mechanisms for policy advice. In some instances, participatory science has become part of a broader and diverse enterprise of knowledge (and evidence) production, with equal standing to academic science, from which it is no longer neatly separated; in others, its advance has been slowed down by system inertia and pressure from entrenched lobbies; still, in others, it has shown a tendency to become partisan and dogmatic.

In the US, there exists a profusion of citizen science experiences led by citizens and independent researchers, but academics are not keen to select problems and approaches that are not immediately rewarding in academic terms, also considering the high dependence of universities on private funding. Outside the Western world, notably in China, the traditional ways of producing and applying indigenous knowledge are still strong and highly appreciated but tend to be kept separate from those of "institutionalized science". If they have a role in policy advice, this is not visible and openly recognized. Everywhere, the rapid developments of AI have accelerated the obsolescence of products regarded as astonishing when they appeared in the early 2020s (ChatGPT for instance). Both threats and opportunities are contemplated or, perhaps better said, alternatives that some view as magnifying risk and uncertainty, others as enhancing safety and control. One such alternative is the possible replacement of both citizen science and "institutionalised science" by technoscience as a provider of evidence and source of legitimacy.

*Policy and evidence-base*

The present circumstances, which seemed highly unlikely just a few years ago, have required many changes and adaptations in policy decisions (including programmes of research funding) as well as in the mechanisms of policy advice. Evidence has acquired a much broader meaning than scientific data, as trans-disciplinarity and inclusion have become keywords in research on complex phenomena, resistant to a reductionist approach. Originally, most participatory science experiences were focused on local circumstances. However, in a short time span, its practitioners have built effective alliances by moving beyond the particular and providing insights for identifying and addressing global challenges. This occurred by including promoters of mission-oriented research and of open science, and also thanks to the opportunities offered by big data[7].

The main purpose of participatory science is to produce actionable knowledge, i.e. knowledge which is derived from transdisciplinary investigations and is useful for implementing strategies and provisions for the good of society. As always, understandings of "the good of society" appear quite diverse, if not incompatible, once one steps down from such a general claim to pragmatically defined objectives and adequate strategies to achieve them.

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[7] Note the recent developments, for instance, the CC-DEMOS (Competence Centre on Participatory and Deliberative Democracy) established in 2021 at the JRC Ispra, has been successful in developing participatory practices to support socially robust policies https://knowledge4policy.ec.europa.eu/participatory-democracy/about_en

This quandary is particularly challenging when it comes to policy advice, due to the increase of sources of knowledge considered legitimate and the expansion of the notion of evidence. The main, preliminary questions are: who are the competent advisers and who selects them? Once the “who” questions are solved somehow, the “how and when questions” come in: how are advisers selected? How do they provide their advice? With what frequency? Under which rules and circumstances? Etc. These predicaments are not new and importantly the EU and its Member States have brought many comitology and advisory boards into policy-making over years. Now that non-professional scientists are part of the scene, setting up advice mechanisms requires substantial adaptations. Further, these advice mechanisms need to be evaluated for their effectiveness, efficiency and appropriateness.

In the meantime, top-down decisions are vehemently contested and potential advisers, scientific and/or other, debate and argue in open arenas, often using the weapons of personal attack and blame to gain visibility and access to power. Who are the guardians of knowledge? And who guards the guardians? In such a conflictual situation, the (re-)emergence of a “scientific humanist” – a knowledgeable, wise imaginative person, with multiple competencies and no hubris – is unlikely. Thus, the mechanisms of advice-seeking and advice-giving are under construction, subject to continuous revisions and adaptations, whilst the scene is dominated by some authoritative influencers coming up with narratives capable of conquering and mobilizing huge crowds in protest.

*Policy implications*

The possible future developments depicted in the scenario can spark further reflection on how such positive developments could be promoted or negative ones avoided, starting today. We list below possible implications mainly for further discussion in the realm of R&I policy.

Engagement of stakeholders

- The scenario relates to a rapidly changing research environment, with new actors entering the scene, either welcomed or opposed by traditional ones. Appropriate revision of the procedures for research funding starting with the rules for writing and evaluating proposals could encourage positive collaboration and stifle e confrontation and conflict.

- The scenario relates to the demographic trends within universities, where a new generation of academics tends to show aspirations and follow trajectories which were not so popular with the previous generation. For example, many recognise the nexus between apparently separated problems (water supply, energy, food, energy production, ...) and are interested in producing actionable knowledge for sustainable development rather than in solving narrowly framed disciplinary problems.

The scenario relates to social science research, which may be better off not conceived as ancillary in the definition of societal challenges and be put in the condition of monitoring and anticipating socio-political trends by deploying a multiplicity of methods and techniques. The contribution of social sciences and humanities is fundamental to gaining depth and perspective in understanding where we are and how we got here, and providing insights on where we are heading.

EU-level and international perspective

- The scenario relates to inertia. In the face of continuous and rapid changes in R&I globally, appropriate adaptations and responses from science for policy organizations and technical regulatory agencies are needed.

- Whilst the trends illustrated in the scenario are common to all EU countries, their speed and acceleration vary, complicating further the setting up of structures and mechanisms for policy advice. With the rapid development of AI globally, both citizen science and institutionalised science may be replaced by technoscience as a provider of evidence.

Policy and evidence base

- The scenario relates to evidence in broad terms, i.e., as provided by different sources and produced with different methods. Rigorous and clear quality criteria could be established for assessing evidence. The term 'knowledge' seems more appropriate than 'evidence' for signalling interest in diversity and inclusion.

- The scenario relates to the issue of quality of knowledge. To have good quality knowledge for policy, it is necessary to have good quality policy for knowledge, whilst being aware that knowledge encompasses scientific as well as other types of knowledge (e.g. indigenous[8]).

- The evolution of citizen science needs to be recognised in political agendas and its trans-disciplinary approach is to be accommodated in advisory mechanisms. In that spirit, a recent report[9] by the JRC documents some innovative ideas such as that of "citizen sensing", referring to "a civic 'right to contribute to environmental information' when institutions struggle to fulfil their relative duties".

Cross-cutting issues

- The scenario relates to the trust in the workings of representative democracy, which has been eroding over the last decades. Inverting the trend would imply a gigantic collective effort, which is unlikely to materialize. However, it would be a huge mistake to ignore this "uncomfortable knowledge". Social science research and social innovation should explore mechanisms for making representative democracy more efficient and for devising new forms of deliberation.

The scenario relates to the social credibility of science. It is also worth considering that the "revolving doors" phenomenon may contribute to the crisis of trust also in the realm of R&I policy. The (hopefully close) end of the war in Ukraine will reshuffle the cards even in R&I and the current advisory mechanisms. Whilst it must be recognized that much innovation is often derived from military investments, decisions about the reallocation of resources, as well as the "conversion" of innovations to non-military goals should neither be delayed nor be conducted behind totally closed doors.

## 3.3. Scenario C on data enthusiasm and AI overtaking scientific policy advice

Scenario C on *data enthusiasm and AI overtaking scientific policy advice* identifies data, AI and international governance challenges and alarms about over-reliance on multinational data providers, which may lead to a loss of transparency, autonomy and (normative)

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8 NSF invests millions to unite Indigenous knowledge with Western science, https://www.nature.com/articles/d41586-023-02839-4

9 https://publications.jrc.ec.europa.eu/repository/handle/JRC123500

reflection in scientific advice. We should ask whether technology can be neutral and whether scientific advice can be normative.

*Key dimensions*

- Extremely market-driven weak public governance
- Moderately low stakeholder engagement in framing

*In brief*

In 2030, mainstream research across the EU includes a combination of data-driven and challenge-driven approaches, EU data platforms are in place and various digital solutions adopted by industries are successfully speeding up the deployment of cross-disciplinary discoveries. The disruptive nature of AI, though, has raised fundamental societal and ethical questions globally, still needs to be addressed. Policy choices are more and more based on 'predictions' from AI. The bias embedded in the algorithms influencing policy design has implications for societal fairness that could lead to a crisis of legitimacy of AI /or government.

*Key drivers*

The US had been ahead of Europe in data-driven economy and supercomputing, but the EU started to address the situation 10 years ago. The joint investment in EU cross-border cloud infrastructures and services to enable Common European Data Spaces as well as building the European quantum computers have proved crucial for the scientific community in Europe. Thanks to computational assets, important knowledge gaps have been addressed, understanding of complex phenomena has increased and cross-disciplinary approaches (data-driven & challenge-driven, hand in hand) have had a positive impact on EU research, e.g., on cancer, soil, oceans, climate change.

Contrary to traditional scientific outputs, data-driven solutions reach the market faster than purely challenge-driven scientific outputs. AI predicts – and thus favours – likely-to-happen outcomes, rather than radically novel ones. However, conflicts have risen in acceptance of data-driven dominance especially in social sciences.

The data-driven economy has become pervasive. In 2030, we can see that remote banking, personalised healthcare, web-based retail services and deliveries are everyday to EU consumers. E-government took huge steps in the 2020's (e.g. remote voting in elections, digital taxation). Despite the efforts of Common European Data Spaces, data-driven consumer services in the EU are still relying on the solutions provided by a handful of US companies.

*Engagement of stakeholders/actors*

New cross-disciplinary discoveries have been made by integrating data further in scientific disciplines. Several EU initiatives from the early 2020s' have provided concrete outcomes, e.g.

- Groundbreaking opportunities have arisen from advances in the fields of Earth Observation (EO), remote sensing, and machine learning including artificial intelligence (AI). Specifically for satellite capabilities, open and free access to data and tools, and advances in algorithms and data processing have offered opportunities for enhancing the use of EO in oceans and soil health monitoring.

- Much data are coming from the Copernicus space programme and Sentinel satellites or NASA's Landsat and MODIS platforms. As to the availability of geospatial and environmental data, the further contribution of open data has been provided by the Regulation on High-Value Datasets (see: the Open Data Directive).

- Computational cancer research has opened up a crucial understanding of cancer, and AI has expedited the solutions which can be used for prevention and early detection as well as diagnosis and treatment of cancer patients.

Data sharing in the EU industrial value chains proved to be very difficult in the beginning but today we can witness many applications, e.g.

- Industrial data platforms have been built around new strategic EU industries such as chips, hydrogen, and circular bio-based production.

- Computer-aided material design is extensively used in the EU industry to replace expensive, time-consuming testing and to shorten the development time of new products. AI has acted as an accelerator from lab to markets for practical applications.

- Digital twins, created on the basis of calculations, are controlling autonomous manufacturing and testing operations, in real-time.

Data produced by citizens in social media became a critical resource for commercial AI developments in the past. Thanks to public interventions, such as restricting the use of TikTok, and general awareness campaigns, EU citizens are today better aware of their rights and they have a voice to say, as stakeholders. This is different from the US where industry still has the power, and China where the political regime remains autocratic. Broad stakeholder groups from all parts of the society, as well as the public authorities, have been active in the debate and interventions on data-related privacy, human rights and security in the EU. AI experts, journalists, policy-makers, and the public have been increasingly discussing a broad spectrum of important and urgent risks[10] from AI. Yet mitigating the risk of human extinction caused by future AI has not become a global priority alongside other societal-scale risks such as pandemics and nuclear war.

*European and international perspective*

Public sector governance in the EU applies widely data-driven research outputs. In the 2020s the EU passed on its approach to trust in AI and proposed a legal framework for AI. Instead of reaching a harmonised global regulation on AI, the US and China implemented their own practices.

Huge investment streams from a handful of private sources on AI, data science and development of supercomputing and quantum computers have elevated data scientists but turned their science into an instrument of global power concentrations. The public governance of data-driven science itself and the responsibility-related questions of its potential consequences still remain open in the EU. The explosion of data and AI has also affected some practices in R&I funding agencies, including the European Framework Programme. In Horizon Europe, AI-assisted project proposals became mundane not only for

[10] https://www.safe.ai/statement-on-ai-risk#open-letter

the Commission but for the research funding agencies and public tenderers in the Member States as well. Lately, several experiments were carried out to rely on AI instead of expert evaluation when selecting projects to be funded. The results of these experiments received negative publicity, and in 2030, the funding agencies across the EU, including the Framework Programme, are approaching an existential crisis: why should taxpayers' money go to salaries for highly qualified experts in funding agencies and R&I administration, if the same job can be done using AI? The funding agencies are now trying to save their experts' jobs by introducing new evaluation practices based on deep learnings gained from ERC and EIC where the selection panels were interviewing the applicants person-to-person for assessment.

Many data-driven technologies are essentially dual-use technologies. This pushed for a fundamental change already in the previous multiannual financial frameworks (MFF) when Defence Research was introduced to the EC research portfolio for the first time. As an outcome of the debate on Open Strategic Autonomy in the 2020s, the relationship and technologies between military security, internal security, prosperity, and resilience are one of the focus areas in the new Framework Programme for R&I.

*Policy and evidence-base*

The debate on open science and open data vs. IPR and commercial interests vs. defence was fierce until recently. Today, however, the balanced approach is widely accepted ('as open as possible, as closed as necessary'). Academia in Europe has developed codes of conduct but is still struggling with ethical principles and consequences of free curiosity in science. During the Covid pandemics, it was widely understood that the EU prosperity depends on how well we succeed in maintaining our strategic autonomy in the global value chains and in the race of technology development. It became clear that decoupling geopolitics and science is not realistic.

In 2030, scientific controversies in science for policy advice are rarely accepted and decision-makers tend to care more about predictions. However, predictions either can become true or not. Especially in the social sciences it was known rather early. In 2030 we are facing an irrational struggle as data are perceived as facts and truth. This has started to paralyse both scientific research and politics. The new generation of scientists have lost an important part of their analytical skills and is therefore mainly relying on data. The bias embedded in the AI algorithms influencing policy design has implications for societal fairness. The combination of overconfidence and negative attitudes towards science has become dangerous, as it has led to the dissemination of false information and conspiracy theories, in both cases with great confidence.

*Policy implications from the scenario*

The possible future developments depicted in the scenario can spark further reflection on how such positive developments could be promoted, and negative ones avoided, starting today. We list below possible implications mainly for further discussion in the realm of R&I policy.

Engagement of stakeholders/actors

- Stakeholder groups from all parts of society, as well as the public authorities, are already active in the debate and interventions on data-related privacy, human rights and security in Europe. It is wise to continue the public debate so that EU citizens can stay tuned to the development of AI and understand the risks in AI.

EU-level and international perspectives

- Decoupling of geopolitics and science is not realistic. The debate on EU's Open Strategic Autonomy is pushing us to rethink our resilience, across policies and across levels of society.

- The EU has led by example in developing regulation on AI and has made efforts in pushing its competitors and trade partners to develop their regulations so that a harmonised global approach to AI amongst the technology leaders can be achieved, often against the interests of a few global power concentrations (huge investment streams from a handful of private sources in the US and government in China on AI, data science and the development of supercomputing and quantum computers).

- Synergy advantages should be sought when developing the European Single Market and the European Research Area. A strong scientific and technology infrastructure across the EU is needed for the EU strategic autonomy, and maintaining investments in EU cross-border cloud infrastructures and services is crucial to secure the trustworthy Common European Data Spaces and quantum computers.

Policy and evidence base

- Not many issues related to AI can be solved at the level of an individual Member State without good coordination at the EU level, and we need to be active in international fora. Public administrations at the MS level and EU level must have an attitude of collaboration: It is good to assess what type of competence and knowledge can be required from authorities operating in different contexts of policy and regulation. It is not self-evident that separate expert committees set up to solve difficult issues will succeed in proposing good policy measures. It is important to take care of the equal access of various interest groups to the preparation of policy measures, and new governance structures for policy advice should include wide stakeholder groups: New thought patterns can be systematically built by cross-disciplinary networks.

- Our thinking about the future has been fragmented and detached from decision-making processes. We live in a world where decision-making requires a broad understanding of complex and interconnected issues. In particular, the exponential technology development is challenging the values of its developers and users. For example, we must ask whether technology can be neutral, and whether scientific advice can be normative. There is a reason to include a strong consideration of human values in our joint foresight work so that we can face the right questions.

Cross-cutting and other issues

- It is important to pay attention to the analytical skills and ability for critical thinking of the new generation of scientists in the data-driven era.

- The funding agencies will need to develop new approaches and criteria for publicly funded programmes. But funding decisions should not be based on ´peer review' by AI. Equally important will be to develop peer review practices to better capture the relevant merits beyond the traditional excellence criteria.

- Members States should consider how their scientific advice mechanisms relate to the established processes in public administrations in general, and more specifically the processes in the regulatory system, in particular those related to impact assessments, policy evaluations and structural reform processes

## 3.4. Scenario D on open science and policy support

Scenario D on *open science and policy support* points out that open science is not the same as open scientific advice where experts can speak frankly. Useful scientific advice has characteristics of a protected space where also unpopular (but well-founded) opinions can be voiced.

*Key dimensions*

- Extremely directional strong public governance

- Moderate stakeholder engagement in framing

A societal call for open science convinced policy-makers and political actors to take action. The need to overcome the inefficiency of the scientific system and respond in timely manner to matters of broad public concern led to the rise of Open Science. This facilitated the establishment of an open, public research infrastructure with open science clouds that transcend national borders and scientific disciplines. Science became more responsive to matters of public concern, which refined relations with policy-makers gradually led to opening up the scientific advice mechanisms. However, this did not translate into a substantial change in the nature of a 'science for policy' as the conflicting basis of evidence and their interpretations persist surrounding the major societal challenges such as climate-change policy.

*Key drivers*

A call for open science outside of the scientific community came primarily as a response to crises such as COVID-19 and subsequent Public Health and Food scares, which convinced policy-makers and political actors to overcome the inefficiency of the scientific system to respond in timely manner to matters of broad public concern. The calls for a more open science within the scientific community were rooted also in several other negative trends. Publication processes slowed down. The existing peer review system was widely criticised as it was perceived to have a bias towards the status quo. Reproducing reliable research results became challenging. Hence, openness was called for to improve efficiency at the level of the scientific system rather than on the level of the 'productivity' of the individual scientists driven and backed up by a research assessment system based on quantitative metrics, such as bibliometrics and journal impact factors. In 2030, the institutionalisation of Open Science has lived up to the internal expectations of the scientific community. Unfortunately, the EU did not strike the right balance between the social benefits of the EU Open Science (OS) policy enhancing the accessibility and re-use of R&I results on the one hand, and on the other Intellectual Property Rights (IPR) strengthening the collaborative development of knowledge and technology while fostering industry's uptake of R&I results. This mistake was at the origin of the growing separation between the (open) public research system and the (proprietary) private R&D activities, which left knowledge transfer to one key mechanism: the mobility of researchers moving to industry. As a result of open science policies, publishing has become extremely expensive due to publishers just hiking up fees that authors need to pay for the paper to be open access as required by funding bodies. It led to inequities in the system and gave scientists based at institutes with substantial financial resources an advantage over other less financially equipped institutes.

*Engagement of stakeholders/actors*

The Open Science approach facilitated an open, public research infrastructure with open science clouds that transcend national borders and scientific disciplines. The interest to institutionalize open science was translated primarily through strong public governance exclusively by national and supranational science funders focusing on the rewards and incentives system of researchers. As a result, it did not lead to an engagement with Open Science by industrial actors, and the simplification of IPR clauses and mainstreaming of the use of data in Horizon Europe proved to be challenging.

*European and international perspective*

The EU took in the beginning the lead in open science. The fear that this would lead to the emigration of scientists to Asia and the USA did not materialize as Europe's major competitors made similar transitions to foster open science. However, geopolitics has excluded scientists from certain regions of the world as we see it now. Dependence on non-EU countries for key elements of the open science infrastructure (like data storage or processing facilities) has led to vulnerabilities.

*Policy and evidence-base*

Science became more responsive to matters of public concern, and gradually also opened up the scientific advice mechanisms. However, this did not translate into a substantial change in the nature of a 'science for policy' as the conflicting basis of evidence and their interpretations persist surrounding the major societal challenges such as climate-change policy.

Open Science improved the reproducibility of research by making data and methods publicly available. This increased the reliability and robustness of the evidence that informs policy but also generated information overload with lots of publications. This has created a challenge for science policy and other policies to make justified decisions under conditions of scientific dissent and uncertainty, which are now transparently communicated to the wider public.

The selection of expert advisers and deliberations of expert advisers are ever more transparent and available to be followed by anyone. The large number of varying stakeholder groups is getting involved leaving less 'space' for the representatives of scientific organizations. Responding to these concerns by multiplying advisory groups but with reduced budgets has also affected the quality of work. Furthermore, sometimes transparency hurts honest deliberations and frank advice from bureaucrats. Chief science advisers are relied on as government spokespersons, to some extent exploiting their scientific credibility to build up the legitimacy around the policies (even if not following scientific evidence). As a side effect, chief science advisers have become quite vocal sometimes even against their own government and leading to politicians and policy-makers in some cases reluctant to use them after those behaviours. At the same time lobbying groups have more opportunities to back up their positions with free available 'scientific advice'. Parliaments increasingly become a battle place for political actors basing themselves on scientific advice: it becomes a place for an irrational discourse on the 'facts'.

*Policy implications from the scenario*

The possible future developments depicted in the scenario can spark further reflection on how such positive developments could be promoted and negative ones avoided, starting today. We list below possible implications mainly for further discussion in the realm of R&I policy.

Engagement of stakeholders/actors

- The scenario relates to the research funders, which could consider adjusting their notion of 'research excellence' and procedures for peer review; at first by 'extending' excellence to openness to research outputs such as data and publications, by supporting publications in open access, and subsequently following it up promoting engagement with knowledge actors in society.

EU-level and international perspectives

- The scenario relates to open data portals raising cybersecurity issues. Foreign states may try to undermine the public use of those portals by cyberattacks. Also 'free rider' states benefit from their outcomes but don't equally feed the EU open data systems. The EU need to rethink its open cloud data platforms.

- The scenario relates to the search for a balanced approach between Open Science and IP policies in Europe. The crucial role of Intellectual Property in fostering knowledge co-creation for high socio-economic impact could be paid attention to and the concepts of Open Science and Open Innovation, based on IPR, could be promoted hand in hand.

Policy and evidence base

- The scenario relates to the need to open up scientific advisory mechanisms and making them more transparent. This may have, however, a downside as transparency may hurt honest deliberations and frank advice from experts. Hence, it may be worth considering also maintaining a trusted environment for advice where what is said is not quoted the next day in the media. The divergence of scientific information, scientific dissent and uncertainty surrounding major societal challenges may necessitate installing better deliberation mechanisms which bring policy-makers and dissenting scientists together. Science for policy organisations, such as different intermediary organisations in the Member States, the JRC and the Scientific Advice Mechnanism of the European Commission and EPRS in the European Parliament, could form a strong European science for policy ecosystem. They need to be evaluated regularly for their effectiveness, efficiency and appropriateness.

Cross-cutting and other issues

- The scenario relates to the opening up of science. If the IPR system remains untouched in parallel, this may lead to a situation, in which new emerging issues, e.g. on public health and security, require public subsidies for big foreign multinational firms as was the case with COVID-19. This opens the question if open science leads to banning of IPR from the publicly funded R&I process and limiting IPR to industrial applications.

## 3.5. Scenario E on policy-based evidence-making in incumbent-driven industrial policy

Scenario E on *policy-based evidence-making in incumbent-driven industrial policy* focuses on advice mechanisms and embedding data, evidence, and experimentation within government agencies, and government research and regulatory organisations.

*Key dimensions*

- Moderately directional strong public governance
- Moderately low stakeholder engagement in framing

*In brief*

By 2030, the idea of missions has lost its support and the EU has reversed to the more traditional top-down industrial policy approach in the middle of a legitimacy crisis for democratic institutions. Policy-makers have chosen a small number of priority areas based on their understanding of where the opportunities are, influenced by corporate interests and the scientific establishment. Some successful departments and agencies have invested in building strong in-house teams to collect, analyse and make available data on technology and industry trends to make more informed choices. Unfortunately, most departments did not follow this approach and were instructed by their political masters to look for quick political wins and/or satisfy their donors and supporters.

*Key drivers*

The missions paradigm encountered major resistance given its inability to deliver on the ambitious goals it had originally promised. The coordination of diverging agendas of different actors became impossible. The economic crisis resulting from Ukraine's war forced governments to undertake substantial budget cuts, reducing funding available to make visible progress on the missions, and changing citizens' priorities. Populism and distrust in organizations and institutions led to citizens (unfairly) seeing missions as fake promises designed to enrich the elites and technocrats rather than improve the lives of citizens. A new Make Europe Great Again movement, backed by some powerful incumbents, reshaped EU politics towards anti-democratic forces.

Most civil servants designing R&I policies are operating in an unfriendly environment, afraid of displeasing their political masters, and thus have become much more risk averse than in the past, with a strong fear of failure. There are, however, some proactive individuals who demonstrate that brave and enlightened public sector leadership to achieve real improvements for citizens is possible.

Public funding has been concentrated towards those with the strongest lobbies, going to a small number of well-connected industry sectors and established scientific fields. The scientific establishment operates in survival mode, not willing to challenge politicians' decisions but rather simply trying to protect funding levels for their own fields as much as possible.

As a result of all this, the performance of different scientific fields and industry sectors has diverged. The priority areas with strong incumbents have performed poorly. They have stagnated, as the large amounts of funding provided have been allocated not based on merit but rather on the basis of influence. Some of the priority areas without strong incumbents, which survived instead due to close alignment with citizens' preferences, have had some notable successes, developing technologies and sectors that have improved EU citizens' living standards. Finally, non-priority areas have been massively starved from funding and support, so the EU has mostly missed new emerging areas that were under the radar and that didn't have incumbents that advocated for them.

*Engagement of stakeholders/actors*

Open consultation processes that kicked off at the beginning of the previous decade to guide the new EU missions quickly became ticking-boxes exercises, with the responses received not being taken seriously by those designing policies. It didn't take much time until this became clearer to those responding to consultations, with many stopping to engage in further consultations and participatory processes. This decreased the quality, diversity, and richness of the input received, and reinforced the arguments for those advocating that consultations and other forms of public engagement were a pointless exercise, to the point that they were mostly dropped from the process.

In parallel, well-connected incumbents in the science establishment and the corporate sector prioritised other channels to influence funding allocation, through (1) direct engagement with senior decision-makers at the Commission and national governments, (2) participation and "capture" of the scientific committees and industrial strategy boards, (3) corporate funding for "independent" think tanks that focused on "policy-based evidence-making" rather than "evidence-based policy-making", and (4) direct or indirect ownership of the media.

*European and international perspective*

The EU's approach dominated by established interests has made it a less friendly destination for civic activists, researchers and start-ups. With some exceptions, the EU has become slower at identifying and supporting new emerging fields. This lack of agility has meant that the EU has missed the train on promising technologies and economic sectors, for instance on AI and space technologies. However, it has been able to maintain and reinforce its strength in some of the sectors and technologies. The bad news is that the global importance of these sectors is declining, and as a result global competitiveness and living standards across Europe have not been able to keep up with those of its main competitors.

*Policy and evidence-base*

Over this last decade, the role of evidence in the designation of priority areas and the design of funding strategies has been mixed, and very much dependent on the leadership and culture of the different Commission directorates and government ministries.

Two camps have appeared as a result of different leadership priorities and styles. Only a few departments and agencies have strong internal capabilities to create, collate, curate, and critically analyse evidence, while the most have weaker internal capabilities, and are much more open to be guided by their intuition, inspiring stories, and undue external influences (particularly in those areas with established incumbents that have sufficient funding and connections to put their case forward).

The few successful departments and agencies have invested in building strong in-house teams to collect, analyse and make available data on technology and industry trends to make more informed choices about which technologies and sectors to prioritise. They also have developed clear evaluation plans and learning agendas, embedding experimentation and small-scale risk-taking in their programmes to learn about how best to support different sectors, as each faces different challenges and operates in specific contexts. A small number of them have also opened up their data and analysis to the wider research community. By doing, so they have unlocked new opportunities for researchers to ask different questions or explore the same questions from different angles (using different methodologies and/or framing), as well as to improve the quality of the analysis and the robustness of the conclusions through peer review. This has led to a much richer and more granular understanding and fewer preventable mistakes.

Most departments and agencies did not follow this approach and therefore did not prioritise investments in evidence, data and scientific advice. Instead, the departmental leadership in most EC directorates and government ministries were instructed by their political masters to look for quick political wins and/or satisfy their donors and supporters. This created a talent drain across many departments (with demotivated civil servants) and substantially reduced the effectiveness of their attempts to advance research, innovation, and productivity in Europe.

*Policy implications from the scenario*

The possible future developments depicted in the scenario can spark further reflection on how such positive developments could be promoted and negative ones avoided, starting today. As a manner of example, we list below possible implications mainly for further discussion in the realm of R&I policy.

Engagement of stakeholders/actors

- This scenario showcases the risks of mismanaging expectations, overpromising and underdelivering, which is a recipe for backlash. This applies both to mission-driven policy in general but also to participatory processes used within those. Therefore, the answer may not necessarily be committing to increasing the use of participatory methods regardless of their impact, but rather ensuring that participatory processes are meaningful, impactful and effectively influence policy decisions, while being respectful of democratic norms.

- The scenario relates, at a higher level, to the twin (and related) risks of democratic backsliding and the incumbent’s capture of governments’ policy agenda, which may require exploring imaginative approaches to develop stakeholder engagement structures that are robust enough to serve as a counterbalance, particularly in the worst-case scenario, in a way that is respectful of citizens’ preferences expressed through democratic processes.

European and international perspectives

- The scenario connects to the idea that some of the most important research and innovation developments often happen on the fringes, emerging from a long tail of ideas that many thought had no potential. So, it is important to balance focus on strategic sectors and priorities, on the one hand, and bottom-up exploration of other ideas and opportunities with sufficient resources, on the other, as otherwise there is a risk of missing novel technology developments and falling behind other international competitors. The exploration of new territories and the scaling up new solutions in priority areas need to be well-balanced.

- The scenario relates to forward-looking capacities. More effective foresight practices, increased agility at responding to technological surprises, stronger international networks with new sources of knowledge, and better absorptive capacity to build on them, could all contribute to preventing Europe from falling further behind. Scientific research are international enterprises, even if national contexts also matter. Developing international consortia that build and collate knowledge can be a much more cost-effective approach to strengthening, refining, synthesising, and making accessible the knowledge base. These might also be more resistant to lobbying from national corporate players but thought needs to be given to how they are structured and governed to ensure they are driven by scientific considerations rather than becoming dominated by global corporate interests.

Policy and evidence base

- The scenario relates to policy-based evidence-making. Limiting such practices requires effective mechanisms to collate, curate and filter evidence, both within government agencies and beyond (including academia but also the media and the third sector), as well as increased transparency (educating society about it, as they are, directly or indirectly, the ultimate consumers and beneficiaries of evidence). This is a challenging task, as it requires recognising that evidence can be very diverse and often there is no single truth (even on very specific questions), but also ensuring that not all evidence should be weighted equally. More rigorous and credible evidence should be given priority.

- The scenario relates to the resilience of knowledge-based mechanisms that can survive in a world of “extreme populism” and “corporate capture”. Developing them is an important challenge, and part of the answer may come from embedding data, evidence, and experimentation within (and beyond) government agencies (rather than centralising those functions in small teams that can be easily closed down), and demonstrating their value to ensure wider buy-in.

# 4. POLICY IMPLICATIONS FOR SCIENCE FOR POLICY

It is important to understand the relationships between government and public administration in general, and the changing research and innovation system. Science and policy interact in multiple and diverse ways at national and international levels, creating impressions and narratives around science for policy ecosystems in Europe. Looking into the future provides insights into the challenges and opportunities faced by government, science, and their interaction spaces including intermediaries. In the following, we highlight possible implications for science for policy, based on cross-cutting findings from the different scenarios (see Annex II) and subsequent observations by participants in the dissemination workshops. Specifically for the EU, we have these three points to make:

## *Science for policy ecosystem and advice mechanisms*

The case for science for policy rests on its ability to contribute to the identification of problems and help policy-makers design more effective policies. Importantly, the EU has brought many advisory boards into policy-making over the years. Science for policy organisations, such as different intermediary organisations in the Member States, the JRC and the Scientific Advice Mechnanism of the European Commission, and European Parliamentary Research Service (EPRS) in the European Parliament could form a strong EU science for policy ecosystem. For further co-creation and future-oriented deliberation, an overhaul of the governance system of scientific advice should address the mandates of different organisations and advisory bodies. They need to be evaluated regularly for their effectiveness, efficiency, and appropriateness.

New governance structures for policy advice should include wider stakeholder groups with research interests and ensure that participatory processes are meaningful. The roles and contributions of actors such as NGOs, associations, grassroots movements, concerned citizens, and ‘fugitives’ from the ancient régime,  need to be assessed by research funders against case-specific criteria, covering aspects of quality of both product and process and including considerations of ethics.

Knowledge-based mechanisms should stay resilient in a world of “extreme populism” and “corporate capture”. Useful scientific advice has characteristics of a protected space, where both the mainstream voices and unpopular (but well-founded) opinions can be voiced. Issues with action can emerge when science for policy advice goes beyond the scope of vertical administrative structures and the established regulations and directives. Members States should consider how their scientific advice mechanisms relate to the established processes in the public administration and regulatory system, in particular those related to impact assessments, policy evaluations and structural reform processes.

## *Deliberation and alignment of public policies*

The divergence of scientific knowledge, scientific dissent, and uncertainty surrounding major societal challenges necessitate better deliberation mechanisms and coordination of policy mixes. This holds in particular for advice on societal-challenge-driven and mission-oriented public policy that draw on various policy impulses from R&I as well as sectoral policies. Depending on the type of mission, new governance approaches could enable timely and regular interaction between knowledge production and decision–making in order to facilitate a better alignment of research and innovation policy with other public policies .

Co-creation of research output could also imply co-creation of advice. In practice, the use of science advice is very much dependent on the leadership and culture of the different Commission directorates and government ministries in Member States. Coordination of diverging agendas is impossible unless there is a willingness to collaborate and unless we understand what type of competence, knowledge, and cross-disciplinary skills are required from the different actors.

### *Value-based approach*

Science for policy should not alienate from nor hide value-based decisions and choices. It is a relevant part of the advisory mechanisms to also debate the values and their role in providing scientific evidence, and more in general, knowledge for policy. Questioning policy goals may not be "politically correct", but it is important that scientific advice raises uncomfortable truths. For instance, when engaging in debates on the EU's Open Strategic Autonomy, scientific advice, if managed appropriately,could strengthen balanced and inclusive approaches across levels of society and across relevant policies, which would include both better consideration of values and forward-looking contributions.

Appropriate management would involve interdisciplinary approaches that integrate the contribution of social sciences and humanities in the definition of societal challenges and in monitoring and anticipating socio-political trends without alienating citizens or undervaluing stakeholder participation and engagement.

# *ANNEX I: FACTORS OF CHANGE*

While the main scenario dimensions and summaries provide the structure for the scenario work, the factors of change are for enriching the scenarios by providing further food for thought. In the workshops, participants related and adapted the factors to the dimensions of each scenario. They also proposed new factors and issues to be addressed. For the workshops, we prepared a very initial, non-exhaustive collection of factors of change:

**Societal and science-related drivers**

Impact of technologies on society and science (AI, quantum, metaverse, synthetic biology etc.)
Technologies and ethics
Polarisation (social, geopolitical etc.)
Trust in society, government, science
Authoritarianism vs (deliberative) democracy
Stability and security vs permacrisis
Climate change
New pandemics and epidemics
Demonstrations and other forms of civil activism
Increasing dis- and misinformation
The mobility of academic researchers to public administration
Science for society
Demographics of science
Scientists in industry and administration

**Engagement of stakeholders/actors**

Scientific community
Industry engagement in policy
Science-for-policy system: coordinated vs fragmented
Problem framing: stakeholder engagement
Problem solving: stakeholder engagement
Relationship between scientific support mechanism and the administration (capacity and willingness to take up advice)
Shifting towards multi-stakeholder governance models
Participatory mechanisms
Independence of future science advisers
Participation in science advice
Participatory processes
Coordination of science advice
New boundary organisations

**Policy and evidence-base**

The neutrality of science advice
Recognition of values and ethics in science advice
Political myopia vs future-oriented policy-making
Inclusion of societal challenges in evidence-based policy-making
Rise of ethical debates on scientific advances
Dealing with non-scientific sources of knowledge
The professionalisation of science advice
Transparent processes
Anticipatory processes
Funding for science for policy structures and activities
Velocity of advice

Recognition of uncertainty and complexity
Codes of practice (policy uptake and knowledge valorisation)
Evaluations of science advice systems
Research integrity & quality of evidence
Inter-, trans-, multidisciplinarity

**European and international perspective**
Resilience
European Open Strategic Autonomy
Cooperation between Member States (EU-level, variable geometry)
EU Institutions (regulation, policy coordination)
International organisations (human rights, trade agreements)

# *ANNEX II: CROSSCUTTING ANALYSIS*

**Engagement of stakeholders/actors**

*New forms of deliberation through meaningful and impactful participatory processes*

The broadening of stakeholder participation in science-for-policy processes, a common theme in the scenarios, is related to wider societal developments beyond R&I policies. The scenarios explore the consequences of (im)balanced participation of knowledge actors and other stakeholders in scientific research and policy framing. Notably, scenario E on industrial policy pinpoints that the answer may not be increased use of participatory methods regardless of their impact, but rather ensuring that participatory processes are meaningful and impactful to effectively influence policy decisions while being respectful of democratic norms. Mismanaging expectations, overpromising and underdelivering in policies, and participatory processes used within those, may lead to democratic backsliding. Further, scenarios E on industrial policy and C on data economy depict the risks of those in power limiting the engagement of stakeholders in research and policy preparatory processes. Scenario B on participatory science suggests that R&I could be utilised for exploring mechanisms and new forms of deliberation.

*Safeguarding critical thinking and acknowledging the broad spectrum of scientific disciplines*

Scenario A makes a point that the increasing attention to societal mission-oriented research may lead to the loss of interest in traditional research disciplines. Public authorities could consider further incentives to keep a critical level of availability of experts in traditional scientific disciplines and unpopular, though much-needed, areas.

Scenario C on data economy and science pinpoints that there is a reason to include a stronger consideration of values in our joint foresight work. Scenario B on participatory science suggests that the contribution of social sciences and humanities could be fundamental to gaining depth and perspective rather than just being conceived as ancillary in the definition of societal challenges and be put in the condition of monitoring and anticipating socio-political trends.

The issue of future skills is mentioned in connection with Scenario C, especially the need for the ability for critical thinking of the new generation of scientists in the data-driven era. Also, we live in a world where decision-making requires a broad understanding of complex and interconnected issues. Therefore critical (scientific) skills are needed from all actors (government, business, and academia) especially for data-driven and challenge-driven approaches to be developed, hand in hand.

*Balanced approaches in public R&I management*

Scenario D on open science pinpoints that the concepts of Open Science and Open Innovation could be promoted hand in hand. EU regulatory and policy frameworks could be used to help ensure that open scientific results are effectively used for societal purposes.

Scenario B on participatory science concludes that it is beneficial to have new actors entering the research system towards positive collaboration. However, they should be assessed against quality aspects, including ethical considerations. Scenario B on participatory science and C on data economy also point out the need of developing the current research funding procedures to capture the relevant merits beyond the traditional excellence criteria.

**European and international perspectives**

*Scientific advice mechanisms across the European Union*

Scenario E on industrial policy highlights that knowledge-based mechanisms in the EU should stay resilient in a world of “extreme populism” and “corporate capture”. Science for policy organisations, such as the JRC and the Scientific Advice Mechnanism of the European Commission, and intermediary organisations in the Member States, such as government research and regulatory organisations and agencies, could form a strong EU science for policy ecosystem, currently fragmented.

Scenario A on missions notes the possible difficulties of reaching a consensus and coordination on research at an EU level, especially if this favours North-West Europe and leaves further behind Southern and Eastern Europe. A dedicated dialogue between the various spaces of scientific advice across the EU could be of benefit to EU-level advice because it would allow drawing more systematically on the diversity of insights and perspectives developed in national or regional fora. This could be promoted for instance through cohesion policies.

*R&I is international, and so is science for policy*

The scenarios depict R&I in the international context and are connected to geopolitics, which seems relevant also for future R&I policies. Scenarios C on global AI governance and D on international research consortia depict opportunities in international cooperation, worth noting in R&I policy developments.

Also, the challenges for international cooperation are addressed. Scenario D on open science notes the risk of ‘free rider’ states using the knowledge with little own contribution and the importance of securing the open science platforms against cyber attacks of hostile foreign actors. Scenario A on missions also points to possible challenges associated with the mission-oriented approach that could lead to tensions with the free trade agenda, to be prepared for in R&I and trade policies. Scenario C with its focus on data points to the risk of over-reliance on multinational data providers, which may easily lead to a loss of transparency, autonomy, and (normative) reflection in scientific advice.

Scenarios D on open science and E on industrial policy point to the delicate balance between openness and the protection of intellectual property. This is a largely unresolved issue that might pose risks for effective (open) academia-business cooperation, at least in those sectors where IP plays a crucial role in the respective business models.

*Synergies and R&I policy actions for Open Strategic Autonomy*

Scenario C on data economy emphasises the importance of maintaining a strong EU science and technology infrastructure. Scenario A on missions relates to the issue of the EU lagging behind the US in key tech areas that require R&I policy actions, for instance, further efforts to support tech startups. More generally, the debate on the EU’s Open Strategic Autonomy is pushing scientific advice towards balanced and inclusive approaches across levels of society and across policies. Synergies should be sought when developing the European Research Area and the European Single Market. To ensure diverse perspectives in the policy advice there is a need to include a stronger consideration of values in joint foresight activities.

**Policy and evidence base**

*From evidence-base to knowledge-base*

Several scenarios addressed not only the collected evidence, i.e., the development of evidence and nature of evidence. Scenarios B on participatory science and E on industrial strategy prefer 'knowledge-base' to 'evidence-base', to include diverse sources. Scenarios C on data economy and E on industrial policy depict also forward-looking and forward-conscious aspects of policy support. With the EU policies increasingly confronted with challenges that could fully materialize in the longer term only, relying on forward-looking rather than just "evidence-based" knowledge becomes more and more important. In scenario A the missions are driven by long-term targets, scenario C on data economy reflects on the potential role of AI in developing forecasts and decisions. Also, Scenario D on open science and E on industrial policy broaden the scope to 'knowledge', which led the team to reflect on the need for foresight work where R&I is strategically prioritized in view of global competition and societal challenges - and open discussion of societal values in such decisions.

Furthermore, the scenarios note the difficulty of developing mechanisms of how knowledge for policy support is validated and prioritized, both the criteria and the process and inclusion of stakeholders, to provide advice actionable for policy.

*A broader knowledge base requires nurturing that base in the first place*

Maintaining a diversity of sources of (scientific) knowledge is an important pre-condition to be able to address potential risks arising in areas outside of the main political priorities, not least for purposes of scientific advice to policy. This may require also further attention to less popular disciplines (Scenario A on missions) and also considering the inclusion of the researchers outside of conventional research institutes (Scenario B on participatory science).

This has implications for research funding, which may need to be geared towards other than just the traditional academic and applied research communities (scenario B on participatory science, scenario A on missions). Maintaining a sound balance between principles of excellence, diversity, and prioritization, and the use of corresponding procedures and instruments of funding to carve out spaces for non-traditional actors in research (Scenario B on participatory science) is important from the perspective of science for policy, because without nurturing the necessary breadth of knowledge, it will not be possible to inform policy on a broad and diversified knowledge basis.

*Co-creation of scientific advice and structural reforms of national R&I systems*

The EU faces societal challenges which require timely and sometimes urgent (see Covid-19) response from the scientific system. Scenario A on societal challenge-driven and mission-oriented research is the only scenario in which timely advice can be generated under the condition that the mission embeds mechanisms for real-time monitoring, prospective analysis, and assessment. If this condition can be fulfilled, the option for real-time scientific advice on achieving socially desirable outcomes can be realised. This type of advice would meet greater societal acceptance as it would be mediated with societal actors in the missions. Co-creation of research will need to imply also co-creation of advice. Intermediary organisations, such as the JRC and the Scientific Advice Mechanism of the European Commisison, could be evaluated with regards to how they offer a platform for co-creation for scientific advice and ensuring also long-term forward-looking advice.

For the future-oriented dialogue, clarification of the current mandates of different science for policy organisations could be beneficial. New areas for action can emerge when the science for policy advice goes beyond the scope of vertical administrative structures and goes beyond the established regulations and directives. To be effective, R&I impact assessments, policy evaluations, and structural reform processes within the research and innovation systems in Members States should consider how their advice mechanisms relate to the established processes in public administration in general, and more specifically in the regulatory system.

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This policy brief explores important trends for the future of science for policy in Europe and the challenges and opportunities that they present for the development of science for policy ecosystems in the European Union. On the background of an increasing prominence of science in public debates and an increasing willingness of governments to mobilize scientific advice, the policy brief explores trends that shape the practices and processes of information exchange between knowledge actors and policy-makers with the intention to produce scientifically informed policies in Europe, and frame important challenges and opportunities for science for policy ecosystems in the EU.

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