Advancing Open, Responsible Research and Innovation: Recommendations

René von Schomberg, Stefan Böschen

HumTec Working Papers 2025/2

Imprint

Advancing Open, Responsible Research and Innovation: Recommendations

Authors

René von Schomberg	HumTec-Senior Research Fellow, RWTH Aachen University
Stefan Böschen	Professor for Technology and Society, RWTH Aachen University

Recommended citation
Von Schomberg, R. & Böschen, S. (2025). Advancing Open, Responsible Research and Innovation: Recommendations. RWTH Aachen University, HumTec Working Paper 25/2.

Keywords
RRI, anticipatory governance, responsive governance, policy recommendations

Published
December 2025

Contact
Dr. Dr. René von Schomberg; vonschomberg@inbox.eu
Prof. Dr. Stefan Böschen; stefan.boeschen@humtec.rwth-aachen.de

The REINFORCING Project has received funding by the European Union under grant agreement number: 101094435. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the REA. Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union

Herausgeber der HumTec Working Papers: HumTec-Board, Human Technology Centre (HumTec), RWTH Aachen, Theaterstr. 14, 52062 Aachen, Germany; sekretariat@humtec.rwth-aachen.de

ISSN: 3053-562X **DOI:** 10.82255/htwp.2025.2.151

Contents

Introduction

This working paper details recommendations for advancing Open, Responsible Research and Innovation (ORRI) through public policies and research and innovation initiatives. It draws on insights gained from the EU-funded REINFORCING project[1], which builds upon over a decade of experience in Responsible Research and Innovation and Open Science since their introduction under the previous EU Research and Innovation Programme, Horizon Europe (2014–2020). ORRI was initially established to steer research and innovation toward socially desirable outcomes while considering both positive and negative impacts, particularly regarding sustainable development objectives.

The practical implementation of ORRI became evident through mission-oriented research, the use of Living Labs, and specific EU-funded projects that provided some of the limited 'instruments' available to EU policymakers for giving a normative direction to research and innovation activities. While these ORRI-instruments employ a bottom-up approach, focusing on stakeholder and citizen participation, a more politically guided top-down model has emerged through initiatives such as the Green Deal, supported by legislative action, especially in climate policy.

Recently, there has been an observable dilution of ORRI principles in the European Commission's proposal for a new framework programme, as well as a reformulation of initial Green Deal ambitions in the work programme of the European Commission (2019-2024). Simultaneously, sociopolitical discourse increasingly emphasizes the importance of technological and digital sovereignty, necessitating top-down strategies and targeted instruments to provide a normative direction to research and innovation, an ambition it shares with open, responsible research and innovation. This working paper offers a concise overview of current policy gaps and provides **recommendations for strengthening ORRI using both bottom-up and top-down approaches**.

Our recommendations are structured around three key areas:

1. Public Governance of the Science, Technology, and Innovation Ecosystem based on ORRI principles,

2. The next European Framework Programme Horizon Europe (2028–2034),

3. Technological and Digital Sovereignty as sociopolitical objectives that can be addressed in conjunction with ORRI.

[1] https://www.reinforcing.eu/; 5-12-2025

1 Public Governance of the Science, Technology, and Innovation Ecosystem based on ORRI principles

The governance of science, technology and innovation requires a holistic approach to the whole ecosystem of public and private actors who are either active in or affected by this ecosystem. We can only achieve a trustworthy and reliable ecosystem if it is credible, responsive to all relevant stakeholders and has the capacity to provide a normative direction to research and innovation. Ecosystem governance needs to anticipate research and innovation targets as well as potential positive and negative impacts[2].

Credibility

The credibility of the ecosystem has traditionally been very much dependent on the self-regulatory capacity within the field of science and its institutions. Scientific integrity has been addressed by science-internal governing bodies such as Academies of Science and reinforced by public research funding bodies that require their beneficiaries to adhere to particular standards and codes of good conduct of science. However, fault lines are appearing in some areas of knowledge production. A very telling example of this is the changes in the infrastructure of scientific publishing. In the last decade, major academic publishers like Elsevier and Springer have shifted their primary business focus from publishing to data analytics services, which reinforces the emphasis on research outputs. However, important aspects of research, such as knowledge sharing, stakeholder engagement and collaboration, are not captured by these data analytic services. These research information systems allow scientists to identify relevant publications and data sources, but they also raise significant concerns:

1. *Steering research objectives*: Universities increasingly rely on the data-based productivity performance indicators provided by the previously mentioned systems, which can "steer" research agendas. Metrics-driven rankings compel researchers to publish in journals hosted by the same providers, thereby perpetuating a self-serving cycle. Consequently, scientific trends may be artificially "hyped" rather than emerging from genuine intellectual inquiry.

2. *Profiling researchers*: Publishers collect data on researchers' behaviour, such as search histories and preferred topics. Combining multiple data sources enables highly accurate personal profiling. This practice raises ethical concerns, including potential violations of data protection laws and grey areas surrounding privacy. Publishers often outsource data collection to third-party companies, which may sell the information for commercial purposes, sometimes without clear user consent. These practices enable also the commodification of knowledge as third parties may wish to purchase particular research outcomes.

3. *Erosion of the knowledge commons*: Publicly accessible knowledge is increasingly at risk. Budget constraints may force universities and public institutions to limit licensing agreements with publishers, leading researchers to favour specific platforms. These further concentrate control in the hands of a few dominant publishers, undermining the development of a "knowledge commons." Karen Maex, former rector of the University of Amsterdam, calls for a **European Digital University Act** to address these issues, complementing existing regulations like the

[2] The term "ecosystem" is used here to denote a network of interconnected entities, such as universities, governmental and non-governmental bodies, that collaborate to create, scale, and deliver new ideas, products, policies and services. Such an "ecosystem" is not simple a stable entity, to the contrary, it is evolving and getting continuously re-configured over time.

Digital Services Act[3]. Similarly, the German Research Foundation (DFG) warns that "scientific freedom" is at stake[4].

The current trajectory to steer science towards a quantitative-metrics-driven endeavor, in which the number of publications and citations trumps other qualities of research, undermines *scientific integrity* and the *credibility* of knowledge production. Simultaneously, closed competitive research environments erode the *reliability* of scientific findings and limit the *accessibility* of knowledge essential for the public good.

Together, these challenges threaten the ability of the science-policy ecosystem to identify *credible as well as reliable* knowledge for supporting any form of public policy objectives. Addressing these systemic issues requires urgent reforms to restore integrity, reproducibility, and openness related to modern scientific research.

The 2024 Barcelona Declaration on Open Research Information[5] which up to date has been signed by a couple of dozens of organizations that carry out, fund and evaluate research (including universities, research funding organisations etc.) is a commendable initiative. It addresses the proprietary character and closedness of research information infrastructures by endorsing the employment of open research information systems. However, a full implementation in the EU requires at least a concerted approach under the European Research Area. The European Commission intends to adopt the **European Research Area (ERA) Act** in 2026, as announced in the Competitiveness Compass for the EU[6], but the coordination among EU Member States, apart from general calls to support open science, falls fully short of addressing the topic to date.

Recommendation: Call upon the European Commission and Member States to promote the Barcelona Declaration under ERA and financial support for open research information infrastructures. Take legislative action concerning a digital university act or alternative action under the Digital Services Act to address the privacy of millions of researchers who use proprietary research information platforms of major publishing companies.

Responsive governance

The quality of the research and innovation ecosystem is determined by an appropriate mix of policies. One can distinguish two types of policies. The first type of policies incentivises innovators to increase their market competitiveness. This fosters productivity and efficiency. The second type of policies provides incentives to collaborate and share knowledge to drive innovations to socially desirable ends, notably societal-challenge derived objectives, by a coalition of committed stakeholders. Hence, we have currently policies in place to foster open science and collaboration with a view on tackling the societal challenges. Societal challenge-oriented research requires public investment, as this type of research addresses market deficits, notably for mid- to long-term sustainability objectives.

To address these challenges, science must foster social collaboration among all innovation actors. This involves encouraging mutual responsiveness among scientists, industry, societal interest groups, and public authorities, enabling coordinated research based on a shared understanding. Interdisciplinary and transdisciplinary research missions can emerge from such collaboration, producing knowledge that transcends disciplinary boundaries. Collaborative research and innovation make the alignment of public values with research and innovation possible.

---

[3] Karen Maex, Time Higher Education, 30 August 2021, internet: Karen Maex | Times Higher Education (THE); 5-12-2025

[4] datentracking-papier-en.pdf; 5-12-2025

[5] https://barcelona-declaration.org/; 5-12-2025

[6] EUR-Lex - 52025DC0030 - EN - EUR-Lex; 3-12-2025

Social collaboration can also occur at the institutional level, particularly at the interface between science and society. Here, societal and scientific actors share responsibility for steering science and innovation. For example, research councils and funding organisations are well-positioned to facilitate such joint steering processes. The European Union's Horizon Europe programme (2021–2027) exemplifies this approach, emphasising mission-oriented research that addresses societal challenges. Beneficiaries of such EU funding must co-design and co-create research agendas with stakeholders, including academia, industry, civil society, and public authorities. Such collaboration, underpinned by norms of openness and mutual responsiveness, fosters anticipatory governance and aligns scientific efforts with socially desirable outcomes.

Another example of co-creation of research agendas and innovation trajectories has been demonstrated by Living Labs which have provided spaces for organisational learning and experimentation, notably since the European Network of Living Labs (ENoLL) was founded in November 2006 under the Finnish Presidency of the Council of The European Union. Since 2006, the number of European benchmarked Living Labs has grown to 480+ (ENoLL, 2024). Living Labs have progressively taken up principles of Responsible Research and Innovation in their practice. According to ENoLL (2024)[7], Living Labs are defined as "user-centred, open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real-life communities and settings." Living Labs work as collaborative ecosystems built around the quadruple helix model of innovation:

- Citizens and civil society contribute with their lived experiences and needs;
- Academia brings research and scientific evidence,
- The private sector offers market perspectives and the capacity to scale;
- Public authorities ensure alignment with policy frameworks and societal priorities.

This definition of Living Labs embraces fundamental elements of open and responsible research and innovation, namely, to make stakeholders co-responsible and mutually responsive to each other by engaging them in an open co-creation process. This may involve co-enquiry by stakeholders, including citizens, through practices such as citizen science or collaboration with other stakeholder groups.

Recommendation: Provide a substantial budget for Societal Challenge-based, mission-oriented research in conjunction with financing instruments such as Living Labs (including citizen science) to foster socially desirable innovations. Research funders should require from their beneficiaries commitments to principles of open science as well as foster mutual responsiveness and collaboration among stakeholders of the science, technology, and innovation ecosystem. This also means that the named tension between top-down and bottom-up is explicitly processed, e.g. in the financing instruments' set-up, allowing co-decision of an extended peer community.

Anticipatory governance

The science, technology and innovation ecosystem must have a capacity to anticipate research and innovation outcomes with a view on socially desirable objectives and the outcomes' potential positive and negative impact. To provide that capacity, public policy must engage stakeholders in defining problems and developing alternative scenarios based on participatory foresight exercises. The goal of participatory foresight is to strengthen people's capacity to recognise and embrace uncertainty while collectively shaping a preferable vision of the future. In this way, dissent in science can become a productive force in policymaking rather than a barrier to decision-making, or worse, a source of paralysis. Multi-stakeholder foresight exercises, for instance, can align stakeholders with

[7] https://enoll.org/about-us/); 5-12-2025

shared social and public policy objectives (such as objectives derived from the European Green Deal). Foresight exercises are not instruments for public participatory scrutiny but activities to commit stakeholders to social objectives for which they have a shared responsibility. Public engagement in science-advice must be elevated to the level of meaningful participation in mid- to long-term research and innovation processes where responsibilities can be specified and therefore performed accordingly. Subsequently, stakeholders can translate common to individual responsibilities within the context of their organisations.

Recommendation: Provide budget for participatory foresight for mid- to long-term research and innovation trajectories derived from socially desirable objectives, such as the Green Deal. Doing so, this is an impactful means of aligning bottom-up and top-down political ambitions.

2 Watering down of Responsible Innovation under Horizon Europe (2028-2034)

Responsible Research and Innovation (RRI) was included in Horizon Europe (2020-2027) as an operational objective: promoting responsible research and innovation, taking into account the precautionary principle. Notably, recital 26 of the regulation for Horizon Europe states: 'With the aim of deepening the relationship between science and society and maximising benefits of their interactions, the Programme should actively and systematically engage and involve citizens and civil society organisations in co-designing and co-creating responsible research and innovation agendas and contents'.

The proposal of the European Commission for a new Framework Programme, despite aiming at doubling its budget, reflects a regress in thinking on how to address societal challenges with (responsible) research and innovation. In fact, RRI disappears as an operational objective with none of the proposed objectives coming even close to the notion of RRI. Under the chapter of 'collaborative research,' 'society' is addressed, amongst others, by the following phrase: 'Fostering a value-based and competitive Europe by advancing future ready skills, and driving inclusive innovation that empowers people, facilitates societal acceptance of technologies and supports sustainable growth that benefits all.'

The watering down of RRI is apparent:

1. Although RRI is certainly value-based, it is also value-driven in operational terms: there are, however, no provisions on how to implement this rationale under the Framework Programme (even though with an optimistic mindset one could read that the former rationale of 'co-creation and co-design' is still operational in the implementation of the missions).

2. RRI certainly entails 'inclusive innovation that empowers people' but here the ambition is disconnected from the normative orientation to improve our deliberative democracy, even though elements such as civic engagement will be encouraged by the programme; however, again without any implementation rationale.

3. RRI is not about promoting acceptance of technology as such but seeking normative acceptability of innovation processes and related outcomes by productively making stakeholders co-responsible both for the process as well as for the outcomes. What is thus being sidelined is the tedious learning process which involves that 'promoting' acceptance creates more often civic resistance rather than civic engagement to achieve socially desirable ends.

4. 'Supporting sustainable growth that benefits all' is more an ideology than it was ever a practice or could become a practice. RRI does not aim directly at economic growth, but the economic benefits are a result of socially desirable innovation processes, not just the result of any innovation that supports economic growth one way or another. RRI supports sustainable development rather than sustainable growth (whatever that means in the first place).

Recommendations:

- Reintroducing ORRI as an operational objective under the new EU framework Progamme for Research as well as reintroducing the rational of 'co-creation and co-design' with all relevant stakeholders, including citizens, under a future regulation of the new EU Framework Programme (2028-2034). In this regard, ORRI is mediating the tensions between top-down and bottom-up activities and is making these productive.

- Continuing with Societal-Challenge-based, mission-oriented research and the employment of Living Labs as means to steer innovation processes towards socially desirable ends. The missions must, however, be equipped with the capacity to practice ORRI. Experts and open research and innovation platforms that can provide this capacity should be mandatory for the implementation of the missions.

- The ethical dimensions of new technologies should not be reduced to issues of potential societal acceptance. Hence, deliberative fora for mediating and discussing relevant issues on the basis of the broader normative perspective of social desirability should be funded either within the context of individual research and innovation actions or as distinct exercises focusing on long-term, socially desirable objectives.

3 Technological and Digital Sovereignty as socio-political objectives that can be addressed in conjunction with ORRI

Finally, a third key area deserves attention: the infrastructural foundations for realizing ORRI-oriented research. Recently, technological sovereignty has emerged as a critical issue on the political agenda in both the USA and the EU. In the wake of the COVID-19 crisis, cybersecurity challenges and global competition, as well as multiple undesirable dependencies have become apparent. For instance, the EU lacks the capacity to produce essential medicines within its borders, making the Union more reliant on specific market operators than on nation-states. In light of cybersecurity risks, the complex issues of digital sovereignty and data sovereignty have become pressing policy matters. It is unsurprising that "technological sovereignty" remains undefined at the European level; currently, the notion exists as political aspiration only, resulting in a blend of partly inconsistent ideas aimed at achieving an ill-defined objective.

The **EU Chips Act**[8] exemplifies this situation. While there is recognition that semiconductors are a strategic asset for Europe and provide geopolitical leverage, the EU has not effectively integrated geopolitical objectives with economic security goals. Instead, the Act merely states the policy objective for the EU to supply 20% of global chip production capacity. This aim is to be achieved through traditional innovation strategies, such as fostering a climate conducive to start-ups and ensuring access to capital. Commentators have quickly pointed out that while these measures may strengthen the semiconductor sector, they do not lead to true technological sovereignty.

[8] Regulation - 2023/1781 - EN - EUR-Lex; 5-12-2025

The crux of the issue is that any move toward technological sovereignty necessitates a departure from an open economy and a relatively open innovation ecosystem. Technological sovereignty implies that a nation-state must have access to the technological capabilities required to produce products domestically, rather than relying on global markets. This inevitably suggests a level of 'closedness.'

This connects technological sovereignty with the concept of responsible innovation: responsible innovation aims to address market shortcomings by steering innovation towards socially desirable goals, such as those outlined in the European Green Deal. For some time, there was hope that strengthening the market for green technologies could help achieve the Green Deal's objectives. However, as markets consistently fall short of delivering an environmentally responsible economic transition, the question arises: *what mechanisms will promote innovation towards socially beneficial outcomes while ensuring some level of technological sovereignty?*

Technological sovereignty can be conceptualised in such a way that only minimal conditions are met, avoiding nationalistic implications. For instance, the concept can be understood as follows. It is the attempt to reduce unilateral dependencies or extend sovereignty to a network of reliable partners rather than centering on a single nation-state or region. Sovereignty might be limited to a few critical technological capacities. Yet this is a delicate balance: economic security issues are increasingly tied to various technological domains, from ICT and microelectronics to AI, while the pool of reliable partners may also shrink. The challenge will be to integrate a relatively self-contained system of technological development and engineering within an economic framework that remains as open as possible. An alternative would be to invest in international governance and collaboration, co-developing technological capacities with partners, and establishing mechanisms to ensure equitable access to resources and capacities.

The frameworks of technological and innovation sovereignty open a pathway to address existing gaps in the governance of technology and innovation. Both responsible innovation and technological sovereignty aim to embed socio-political objectives within the development of technology and innovation, affecting economic governance and providing directionality of technological capacities.

However, the two frameworks are also distinct. Let us consider responsible innovation first. The concept operates within a deliberative democratic framework, encouraging societal actors to be mutually responsive and collaborate toward addressing societal challenges. It relies on a process that balances stakeholder interests and promotes an inclusive dialogue on the societal impacts of technology. This approach incentivizes collaboration and shared responsibility among public, private, and civil sectors, aligning innovation with socially desirable outcomes.

In contrast, technological sovereignty suggests a more politically guided approach to technological development. It emphasizes the importance of reducing external dependencies and securing critical technological capacities through governance and policy intervention. This implies a more top-down direction for innovation, aiming to safeguard a degree of national or regional autonomy over essential technologies. The focus on sovereignty introduces a political dimension to innovation, where the state's role in shaping technology becomes more pronounced, potentially limiting market-led decision-making.

Taken together, these frameworks may signal a shift towards a more politically engaged governance model for technology, where innovation is not just a market-driven process but is actively shaped by socio-political priorities. We have to recognize both the collaborative potential of open, responsible research and innovation and the protective, sovereignty-oriented dimensions necessary for resilient technological systems. This convergence could support a comprehensive approach to

innovation governance, ensuring that technological progress aligns more closely with societal and democratic values. Innovation governance towards resilient technological systems is more likely to be successful if, apart from the mentioned convergence, a process to cope with the tensions of top-down and bottom-up regulatory actions is facilitated

Recommendation: Implement a comprehensive approach to innovation governance under research funding schemes including the new EU Framework Programme for Research and Innovation, ensuring that technological progress aligns more closely with societal, democratic values while aiming to increase technological and digital sovereignty. This may be achieved by integrating the co-creation and design rationale of ORRI with the social political objective of increasing technological and digital sovereignty.

Concluding outlook

Advancing Open, Responsible Research and Innovation (ORRI) in Europe requires combining top-down and bottom-up approaches. Bottom-up initiatives, such as Living Labs, participatory foresight, and mission-oriented research, create openness, collaboration, and shared responsibility among stakeholders. However, they need clear top-down support through policy direction, regulation, and strategic investment to reach systemic impact. European institutions and Member States must therefore align their governance frameworks to embed ORRI principles across all research and innovation programmes. This dual approach ensures that openness and mutual responsiveness go hand in hand with strategic autonomy and technological sovereignty. Only by integrating participatory, bottom-up innovation with coordinated, top-down policy direction can Europe build a trustworthy, resilient, and socially responsive science and innovation ecosystem. This is the more important as the mentioned governance objectives (Credibility, Responsiveness and Anticipation) might come along with trade-offs. Table 1 summarises the particular policy objectives in order to arrive at a credible, responsive and anticipatory governance of science, technology and innovation.

Table 1. Open Responsible Research and Innovation (ORRI) by credible, responsive and anticipatory governance of a Science, Technology, and Innovation Ecosystem

Governance Objective	*What (subject matter)*	*How (governance scheme)*	*Public Policy objectives*	*ORRI principle*
Credible	Scientific integrity	Self-regulatory mechanism in science	Science policy by science bodies (e.g. Academies of Science etc)	Independence of science and capacity of scientists to initiate original research
		Codes of Conduct		
Responsive	Science as a public knowledge commons	Open and collaborative science	Incentivise mutual openness and collaboration under Research and Innovation funding programmes	Openness and mutual responsiveness
	Responsive to public values	Science/tech. assessment Align research objectives with public values		
Anticipatory	Address market-deficits Define mid- to long-term socially desirable science and technology outcomes (SDGs for example)	Societal-Challenge-based, mission-oriented research Living Labs, Participatory Foresight	Institutional support Foresight and monitoring	Co-creation and co-design Inclusiveness: multistakeholder commitment to address mid- to long-term socially desirable objectives (such as SDGs)
		Citizen Science	Science education Multi-actor Science Communication	Scientific citizenship