



Align Act Accelerate

Research, Technology and Innovation
to boost European Competitiveness

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Align, Act, Accelerate

***Research, Technology and Innovation to boost
European competitiveness***

Commission Expert Group on the Interim Evaluation of Horizon Europe

Table of contents

RECOMMENDATIONS.....	5
PREFACE.....	10
FRAMING AND CONTEXT.....	13
BACKGROUND AND EVIDENCE FOR EACH RECOMMENDATION	22
Recommendation 1	23
Recommendation 2	33
Recommendation 3.....	41
Recommendation 4	46
Recommendation 5.....	49
Recommendation 6.....	61
Recommendation 7	69
Recommendation 8.....	76
Recommendation 9.....	86
Recommendation 10.....	95
Recommendation 11	102
Recommendation 12.....	111
REFERENCES	113
ANNEX 1: LIST OF POSITION PAPERS BY STAKEHOLDERS.....	122
ANNEX 2: TERMS OF REFERENCE OF THE EXPERT GROUP	126

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Foreword

Strong public and private investments in research and innovation are essential for Europe's future. As Mario Draghi pointed out in his report on *The Future of European Competitiveness*, they are key drivers of productivity and wellbeing. But Europe faces the risk of falling behind. To keep pace with technological advancements, address global challenges and secure the EU's scientific leadership in a turbulent geopolitical context, we must reverse this trend. This is why President Ursula von der Leyen, in her *Political Guidelines for the next European Commission 2024-2029*, calls for research and innovation to be placed at the heart of our economy.

For over 40 years, the European Framework Programmes for Research and Innovation have strengthened Europe through scientific cooperation, pooling efforts to address shared priorities and funding world-class researchers and innovators. This has led to major scientific discoveries, breakthroughs in key technologies and economic value. Every euro invested in the programme returns at least five euros in benefits to society. Yet, given the magnitude of the challenges ahead, we must continually step up our efforts. To do so effectively, we need to learn from past experiences and improve based on robust analysis and evaluation of our actions.

This is why Commission's Directorate-General for Research and Innovation commissioned an independent high-level expert group to provide concrete recommendations for the future of the Framework Programme. Their work, grounded in a broad consultation of stakeholders and extensive evidence, focuses on the programme's effectiveness, efficiency, relevance, coherence and European added value. This report is the result of a year-long effort by the experts and contains a set of recommendations aimed at enhancing the remaining years of the current programme, Horizon Europe, as well as feeding into the reflection on future European investments in research and innovation.

I extend my sincere thanks to the members of the expert group for their timely and insightful report. Their recommendations offer valuable perspectives for more impactful, streamlined and targeted European research and innovation funding, harnessing Europe's full potential and diverse talent pool. I am confident this report will inspire meaningful debate among all who envision a stronger and more attractive Europe where bold, excellent ideas can thrive and deliver value for all thanks to large-scale support both at European and national levels.

Iliana Ivanova,

European Commissioner for Innovation, Research, Culture, Education and Youth

RECOMMENDATIONS

1. **Create momentum through a whole-of-government approach**, aligning a **transformative research and innovation policy** with the **EU strategic agenda** and recent **high-level policy recommendations**:

- a. **Boost “Europe’s competitiveness - and its position in the race to a clean and digital economy” by “starting a new age of invention and ingenuity. This requires putting research and innovation, science and technology, at the centre of our economy” (Europe’s Choice¹);**
- b. **Advance European market integration and promote the “fifth freedom”, which should encompass the free movement of research, innovation, knowledge and education (Letta²). This requires strengthening Europe’s attractiveness for talent and RDI investments;**
- c. **Implement a strong European Research, Development and Innovation (RD&I) framework to drive European added-value and help establish a robust “Research and Innovation Union” (Draghi³). This requires strengthening the Framework Programme across the entire research, technology and innovation spectrum.**

2. **Make Europe globally competitive, secure, sustainable and resilient** by delivering more excellent research, impactful innovation and technology scale-ups through a **stronger framework programme**. The programme should be a **game-changer for Europe’s declining competitiveness**, by stimulating public and private investment in research, development and innovation (RD&I), including technological development, throughout Europe on regional and national levels.

3. **Deliver European added value** through a **portfolio of four interrelated and interdependent “spheres” of action**: i) **competitive excellence**; ii) **industrial competitiveness**; iii) **societal challenges** and iv) a **strong research and innovation ecosystem**:

- a. **Provide increased, better focused and ring-fenced funding across the full spectrum of RD&I. This requires an increase in the budget for the next Framework Programme to 220 billion Euro.**
- b. **Fund all applications reviewed as excellent across the framework programme through a combination of EU Framework Programme, Structural, and Member State funds (e.g., through Seals of Excellence).**
- c. **Guarantee that the framework programme allows Europe to take the lead in international/global RD&I collaboration and governance.**

¹ European Commission (2024). Political Guidelines for the next European Commission 2024-2029. https://commission.europa.eu/document/download/e6cd4328-673c-4e7a-8683-f63ffb2cf648_en?filename=Political%20Guidelines%202024-2029_EN.pdf

² Letta, E. (2024). Much more than a market. <https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>

³ Draghi, M. (2024). The future of European competitiveness, https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en

4. Respond to the rapidly changing science and innovation landscape and the need to stimulate disruptive research and innovation in Europe: **Establish an experimental unit** to test new programmes and instruments with **fast time to funding** (e.g., innovation prizes, ARPA type programmes, AI tools, innovative methods for identifying and reviewing proposals).
5. Strengthen **competitive excellence** by:
 - a. *Reinforcing the **criteria of excellence** in RD&I throughout the programme and its various actions.*
 - b. *Preserving the **nature** and **expanding the success and budgets** of the **European Research Council, European Innovation Council and MSCA programme**.*
 - c. *Attracting and retaining talent through an **enhanced MSCA programme**, including a **new instrument to foster careers of young researchers** (“Choose Europe”).*
 - d. ***Streamlining and boosting the European Innovation Council Fund** by attracting substantial private investment (e.g., from EIB, Member State financial institutions, pension funds).*
 - e. ***Introducing disruptive innovation programmes into the EIC, together with the capacity to attract more private co-investment of disruptive ideas and firms.***
6. **Stimulate industrial RD&I investment** in Europe by **creating an Industrial Competitiveness and Technology Council** to effectively engage eminent practitioners and experts who will ensure the framework programme’s attractiveness and relevance to industry by:
 - a. *identifying and **monitoring technologies** and value chains critical for European strategic autonomy & long-term competitiveness.*
 - b. *supporting pan-European **collaborative research** that has a clear European added value and cannot be achieved by a single country, including for the implementation of the current thematic clusters (energy, climate, transport, food, safe and secure societies) and related partnerships with industrial relevance*
 - c. *strengthening appropriate and **user-friendly instruments**: this implies revisiting **partnerships**, as well as **creating and governing a more open, less prescriptive programme** to attract new partners for collaborative research.*
 - d. *linking to relevant European policies, regulations and framework conditions.*
7. Address **societal challenges** more effectively by **creating a Societal Challenges Council** with the purpose of:
 - a. *Effectively engaging eminent practitioners and other experts in identifying priorities that align with the European Strategic Agenda (a **free & democratic Europe**, a **strong & secure Europe**, a **prosperous & competitive Europe**), as well as societal challenges that are currently not sufficiently addressed (e.g., **climate change, biodiversity loss, planetary boundaries, mental health**).*
 - b. *Linking up with **philanthropy and civil society**.*
 - c. *Identifying and funding the RD&I components of relevant current or future **missions** while **elevating their governance**, policy and regulatory elements out of the Framework Programme.*

8. Foster an attractive and inclusive RD&I ecosystem in the EU by:

- a. *Implementing a strategy to secure long-term investment in world class **research and technology infrastructures** that serve the needs of researchers, industry and the public sectors, including in the digital area.*
- b. *Strengthening **university alliances** to promote learning and institutional cooperation and development across borders.*
- c. *Requiring **Member States (MS)** to make **ambitious national plans and investments in RD&I** through the **European Semester process**, including use of **structural funds**. This high-level co-ordination of MS and European RD&I plans should lead to **increased co funding** (e.g., of research and technology infrastructures), **increased efficiencies** (e.g., greater MS funding of Seals of Excellence) and **increased European added value**.*
- d. *Providing incentives for Member States with lower success rates to **capitalize on excellence** through a combination of increased national RD&I expenditure, including use of **structural funds** and **focusing on FP initiatives that work** (e.g., Teaming) or for which there is an **evidence-based rationale** (e.g., EIC pre accelerator programme, MSCA).*

9. Drive radical simplification, user orientation and efficiency through:

- a. ***Eliminating non-core, redundant and underperforming programmes** (e.g., EIE and EIT).*
- b. ***Adopting a portfolio approach to agile project funding** that accepts responsible risk in return for **reduced administrative burden and transaction costs**. This requires a radical reform of the application system to “**trust first/evaluate later**” and become more applicant-friendly, Commission-efficient, and impact-oriented and to ensure a reduced time to fund. **Priority should be given towards simplification for beneficiaries**.*
- c. ***Having less prescriptive calls** across the framework programme as an efficient and predictable instrument to capture opportunities in the uncertain and fast-moving scientific, technology and business environment. Additionally, this decreases administrative and transaction costs, contributes to simplification and facilitates engaging industry, innovators and philanthropy.*

10. Unleash the power of demand by developing an innovation procurement programme to stimulate faster scaling-up by industry.

11. Adopt a nuanced, granular and purpose-driven approach to international cooperation to successfully navigate a more complicated and changing geopolitical environment:

- a. *Recognise that countries can be **partners, competitors** or **systemic rivals** and that the same country could be all of these in different domains of RD&I (e.g., climate change, electric vehicles or high technology semiconductor chips). This requires a **utilitarian approach**, asking “Who are our partners for which RD&I domain/question?”.*
- b. *Develop a purposeful (asking “Why?”) approach to collaboration with possible rationales being working with countries with strong research systems, with like-minded countries or with developing countries, the pursuit of joint interests and mutual benefits, inclusion and justice or **accessing an international talent pool** – some of whom we may wish to attract to Europe.*

12. Embrace the fact that dual use occurs naturally given the ubiquitous nature of modern technology (e.g., AI, material science, the internet, drones) and the broad needs of a modern military (e.g., health, fitness). Instead, administer programmes as “military RD&I” and “everything else” (i.e., civilian, dual use) and **optimise the innovation dividend** arising from the need for increased national security and defence expenditure by **exploiting dual use both ways**.

PREFACE

Safeguarding and strengthening the **unique added value of European Research, Development and Innovation (RD&I)** is the main purpose of this report. With the **framework programme for research and innovation (FP)**, the **EU has an established, proven and internationally envied instrument** for supporting science, technological development and innovation. It is both a hallmark and a bedrock of the European project and of Europe's future, bringing together researchers, institutions, innovators, enterprises and society across sectoral, disciplinary and national borders in a joint quest to do good science, tackle the biggest challenges our societies face and create prosperity. The **Treaty on the Functioning of the European Union** clearly spells out the purpose of **EU research and innovation policy** and frames our analysis.

But this report also takes into account the significant and daunting **uncertainties and unique challenges** of our time: climate change, war, changing demographics, increasing inequality, pandemics, the erosion of democracy and basic rights, increasing global strategic competition and a constellation of emerging technologies and their interplay with ethics/security/competitiveness, changes in the labour market, fake news and science denial, to name just a few. **Current generations must tackle these interacting challenges** to build a better world for future generations. **Science, technology and innovation are the critical currency in addressing these challenges.**

For this to happen, we propose a number of **transformative actions** for the **remaining three years of FP9 - Horizon Europe (2025-2027)** and to adequately prepare the **next European Research and Innovation Framework Programme, FP 10 (2028-2034)**. The title of our report captures the need for Europe to:

- **align** its efforts to strengthen research, technological development and innovation with its strategic goals but also to ensure that regulatory, economic, financial and other policies are aligned to allow research, technology and innovation to realize its full potential (Recommendations 1, 11 and 12)
- **act** boldly and effectively to ramp up Europe's scientific, technological and innovative strength (Recommendations 2, 4-8)
- **accelerate** the creation, utilization and commercialization of research and knowledge, the scaling of innovative solutions, the development and uptake of technology and the green transition. This also requires an acceleration in the ability to respond to challenges and seize opportunities that might arise in a rapidly changing environment (Recommendations 1 and 3-10).

Our recommendations seek to boost **Europe's competitiveness**, defined as **the ability to provide state-of-the-art products, services and technology-based solutions which contribute positively to overall sustainability (economic, environmental and social) for which there is a market demand or that create new markets.**

The report is based on in-depth discussions and meetings over the period January-September 2024 of the expert group assembled by the European Commission in 2023. These were supported by a large amount of data and background documents provided by DG RTD, including the EC's post assessment of Horizon 2020 (i.e., FP 8) and the interim evaluation of Horizon Europe (FP 9). In addition, all members of the expert group involved external key stakeholders in the work to benefit from their insights and feedback. Overall, we received more than one hundred position papers (see Annex 1) and conducted many meetings and conversations with stakeholders.

We advocate that Europe pursue a “**transformative agenda**” to address four critical core themes, listed in Box 1, which we term “**spheres**” of action, because of their structural interdependencies and interrelations. The “transformative agenda” should be launched in the short term, through specific actions in the last three years of Horizon Europe, 2025-2027, and embedded in the next EU framework Programme, 2028-2034, as outlined in this report.

Box 1: Four “Spheres” of action for a *transformative agenda* for the EU RD&I Framework Programme

1. Promote and strengthen ***competitive excellence in science and innovation***.
2. Foster ***industrial competitiveness*** through strategic research and innovation initiatives.
3. Promote societal transformations through research and innovation, by addressing ***societal challenges***.
4. Strengthen the ***European RD&I ecosystem***.

The report is organized in three main and independent parts: **Recommendations; Framing and context;** and **Background and evidence for each recommendation.** For those of you who do not have the time or interest to delve into the background and evidence for each of our recommendations, we strongly encourage you to at least read the framing and context section, in addition to the recommendations.

We sincerely thank all individuals and organisations that contributed position papers and engaged in discussions with us. These greatly assisted the expert group in its detailed evidence gathering, assessments and deliberations. We also thank the staff of DG RTD who provided us with many reports and data and who responded to specific data requests from our members. All the group members participated in extensive discussions, evidence reviews and external consultations and contributed to shaping this final unanimously supported report.

FRAMING AND CONTEXT

WHY? – a changing and challenged world

Europeans take great pride in their achievements of the past decades in terms of freedom, prosperity, human dignity and rights, culture, excellence in medical and social care, technological progress and quality of life. Much of this overall progress in our society results from the passion, curiosity, and inspiration of its inhabitants, young and old. Indeed, progress in science, technology and innovation provides the bedrock for the security, prosperity and opportunities Europe offers its citizens.

Going forward, more than ever, research and innovation will be absolutely essential for protecting Europe, for preserving what Europeans hold dear, and to guaranteeing a better future for coming generations (i.e. being a “good ancestor”⁴). In a more conflict-ridden, unstable and rapidly changing world, it is investment in research and innovation that will ensure Europe’s (and its Member States’) future security, strength and freedom and thus Europe’s ability to successfully navigate in turbulent times.

While other countries and regions are significantly ramping up their research and innovation capabilities, **Europe is currently falling behind** in terms of both investments in and impact from research and innovation. This points to a relevant difference compared to when the last expert group delivered its recommendations: at that time the group confidently declared that “Europe is a global scientific powerhouse”. Since then, **Europe’s global importance in research, innovation and technology development has declined** (see Box 2). Thus, precisely at the time when it matters more than ever – for economic development, for combating and mitigating climate change, for defending Europe’s freedom and security – **the EU is falling behind in science, technology and innovation.**

⁴ Krznaric, R. (2020), The Good Ancestor.

Box 2: The increasing global competition: a wake-up call for Europe⁵

- As measured by the top 1% most cited scientific publications worldwide, the **EU ranks third, behind China and the USA**, with its share of the total **declining from 20.7% in 2000 to 17.8% in 2020**. The European Union ranked second globally for the total number of scientific publications, behind China and ahead of the USA, and accounted for 18.1% of the global total in 2022, amounting to approximately 650 000 publications. Over the past two decades, the **EU's contribution to global scientific publications has dropped** from 25.5% in 2000 to 18.1% in 2022;⁶
- From 2005 until 2015, the EU was leading the world in terms of **scientific AI publications** (37%), followed by China (34%) and the US (29%). However, **by 2021 China had surpassed both the EU (30%) and the US (28%)**, accounting for 42% of publications⁷. Looking at the breakdown per sector, the EU ranks second in all of the four main sectors (i.e. health, environment, transport and agriculture), while the US leads in health and China in the other three. As China steadily enhances the quality of its publications (measured as top 10% most-cited scientific publications), the **EU has descended to the third position globally**, closely trailing the United States.
- The EU's share in total **patent applications has been declining in recent decades**. Accounting for around 30% of the world's patent applications in 2000, the EU's share declined to 17.3% in 2021. Between 2014 and 2020, the EU led in global high-value patent filings related to renewables (29%) and energy efficiency (24%), but lost ground in smart systems (17%), ranking fourth after the US, China and Japan;
- **EU's technology base is more diversified than that of other major economies**, but the EU is disproportionately **more specialized in less complex technologies** than its counterparts: i) The **EU shows a higher specialization in food chemistry, climate and environmental technologies**; while ii) The US and China are leading in areas related to digital technologies such as semiconductors, computer technologies, optics, digital communications and audio-visual technologies, which are the expected to be key drivers of growth in the near future⁸;
- **Europe has kept civilian and military research and innovation systems apart**. In contrast, the US has successfully linked disruptive science, innovation and technology development to US defence policy, allowing it to meet national security needs and simultaneously benefiting US economic growth and competitiveness through commercial applications. Similarly, China has pursued civil-military fusion for many years.
- The Framework Programme's emphasis on **short-term objectives and short-term collaborative innovation projects** (typically, for 2 to 4 years) appears to be suboptimal, or at least insufficient, in bolstering of Europe's international competitiveness.

When the previous expert group (i.e., the “Lamy group”) presented its recommendations on the future EU framework programmes for research and innovation seven years ago, it identified several European challenges such as a weakness in capitalizing on the knowledge it produces (innovation deficit), the fact that it trailed key trading partners in terms of R&D investments, and large differences between EU Member States when it

⁵ See, for example, OECD (2024). “Declaration on Transformative Science, Technology and Innovation Policies for a Sustainable and Inclusive Future”. https://www.oecd.org/en/publications/2024/04/oecd-agenda-for-transformative-science-technology-and-innovation-policies_5ced463a.html

⁶ European Commission (2024), Science, research and innovation performance of the EU (SRIP), <https://op.europa.eu/en/publication-detail/-/publication/c683268c-3cdc-11ef-ab8f-01aa75ed71a1/language-en>

⁷ European Commission (2023), AI in Science, <https://op.europa.eu/en/publication-detail/-/publication/094c045c-9e21-11ee-b164-01aa75ed71a1/language-en>

⁸ European Commission (2024), SRIP.

comes to RD&I performance. The report highlighted the pivotal role of RD&I in generating growth and tackling pressing societal challenges such as building a digitally smart, low carbon, energy efficient, circular economy that brings good quality of life and builds a fair society⁹.

Today, not only do these challenges persist, but **additional challenges have emerged**. Thus, in several ways, the world has changed dramatically since the last expert group presented its recommendations. In addition to the Covid pandemic and Brexit, the following developments are reshaping the context of EU research, development and innovation policy:

- **The rise of disruptive and generative technologies:** The launch of ChatGPT in November 2022 constitutes a tangible manifestation or culmination of the development of information technology which has been in the making for more than half a century. In addition to artificial intelligence, other technologies (such as quantum technologies and communications, synthetic biology and cellular technologies for protein enrichment of food products, among others) are now reaching a point where their broad transformative potential – for business, science, humanity and the planet – is becoming more widely understood unleashing hopes and fears of utopias and dystopias¹⁰.
- **The worsening climate crisis:** Rather than slowing down, climate change has accelerated¹¹ and its effects are increasingly felt across the globe. As the fastest warming continent, extreme weather events are affecting millions of people in Europe¹². Significantly more needs to be done to both combat and mitigate and adapt to climate change, and more needs to be done significantly faster than so far.
- **The return of geopolitics and system (or ‘great power’) competition:** nearly four decades after the end of the Cold War, a new systemic rivalry is emerging with particularly China (and countries such as Russia, North Korea and Iran which are associated with China’s interests; Box 3) and the United States competing for power, ideology, resources and the mastery of core technologies.
- **The return of war:** The Russian invasion of Ukraine on February 24, 2022 is the largest attack on a European country since World War II. It also seems to be part of a general trend: The Israel-Hamas war is the largest military conflict in the region in 50 years. Civil war in Sudan is killing tens of thousands of people and displacing millions. Overall, 2023 saw the largest number of armed conflicts since 1946.¹³

In line with the above topics, the main themes of the *OECD Science, Technology and Innovation Outlook 2023* (a biennial report which identifies major trends in science,

⁹ European Commission (2017), “Lamy Report”, <https://op.europa.eu/en/publication-detail/-/publication/ffbe0115-6cfc-11e7-b2f2-01aa75ed71a1/language-en/format-PDF/source-77975731>

¹⁰ See e.g., Suleyman and Bashkar (2023). “The Coming Wave: Technology, Power, and the Twenty-first Century’s Greatest Dilemma”, Vintage Publishing.

¹¹ World Meteorological Organization. (2023). “The Global Climate 2011 2020” <https://library.wmo.int/records/item/68585-the-global-climate-2011-2020>

¹² World Meteorological Organization. (2024). “European State of the Climate 2023”, <https://wmo.int/publication-series/european-state-of-climate-2023>

¹³ Uppsala University (2024), “UCDP: Record number of armed conflicts in the world”, <https://www.uu.se/en/press/press-releases/2024/2024-06-03-ucdp-record-number-of-armed-conflicts-in-the-world-~-:text=Never%20before%20have%20there%20been.collection%27s%20starting%20point%20in%201946.>

technology and innovation policy) were **global crises, disruption, strategic competition and sustainability transitions**. These themes thus form an important backdrop against which countries and the EU will need to formulate their research and innovation policies for the foreseeable future. At the same time, navigating the challenges but also the opportunities arising from the above-described context will depend critically on research and innovation.¹⁴

Box 3: The rise of Chinese Science and Technology¹⁵

- China is notably absent in the “Lamy Report “of 2017 (mentioned only 4 times and in connection with other countries i.e. not as a relevant actor on its own), while in the latest OECD Science, Technology and Innovation Outlook 2023, it receives 258 mentions. In 2019, the European Commission declared China a systemic rival, marking a significant shift in its previously largely positive view of the interaction with and influence of the country.
- The geopolitical frictions between China and the US can partially be explained by **two factors**: Firstly, the **rise of disruptive technologies** mentioned above and their growing importance for power (military, economic, political), and secondly, a rather **dramatic shift in the global distribution of scientific resources** from democracies to authoritarian regimes¹⁶ and from the West to the East. Regarding the latter factor, **China is the dominant force in both phenomena**¹⁷. While China’s scientific rise has added tremendous resources to the global research enterprise of science, it is also challenging established systems, institutions and norms, due to its sheer size and the government’s ambitions, but also its view of the relationship between science and the state.¹⁸

In addition to the above mentioned factors that are framing research and innovation policy, a further cross-cutting dimension is **speed** – the speed of technological change and its adoption, the speed at which the international order is transforming (e.g., the rise of great power competition, the shaping of new coalitions and alliances in the wake of the Russian invasion of Ukraine, the weakening of democracy and polarization of society)¹⁹, and the speed at which we need to act to combat and mitigate climate change. The pace at which

¹⁴ ESIR, an expert group to the EU, points to ways in which research and innovation can ensure that countries and regions can navigate and even thrive in an age of “poly-crisis” – interacting and mutually reinforcing crises. See ESIR. (2024). <https://op.europa.eu/en/publication-detail/-/publication/1ea38aaf-b67f-11ee-b164-01aa75ed71a1>

¹⁵ See, for example, Economist. (2024). “If there is one thing the Chinese Communist Party and America’s security hawks agree on it’s that innovation is the secret to geopolitical, Economic and military security”, <https://www.economist.com/leaders/2024/06/13/how-worrying-is-the-rapid-rise-of-chinese-science>

¹⁶ Economist. (2022). <https://www.economist.com/finance-and-economics/2022/03/19/globalisation-and-autocracy-are-locked-together-for-how-much-longer>

¹⁷ See <https://www.rathenau.nl/en/science-figures/process/collaboration/china-scientific-superpower-making>, <https://www.economist.com/science-and-technology/2024/06/12/china-has-become-a-scientific-superpower> and <https://issues.org/what-do-chinas-scientific-ambitions-mean-for-science-and-the-world/>, OECD STI Outlook 2023.

¹⁸ See, for example, Marginson and Yang (2022) and Schwaag Serger et al. (2021). See also Qian (2024) for an analysis of China’s research funding system and the effects of AI.

¹⁹ Many have been a long time in the making, but their full effects are only now becoming tangible.

change is happening and at which we need to act collides with the “embedded inertia in science systems”²⁰, but also challenges the decision-making processes and structures of mature democracies.

Finally, in the past decade, we have seen the **dramatically rising importance of a handful of primarily US companies in conducting basic research** at their own cost and with their own personnel. Thus, “...due to significant growth in R&D funded by businesses, the share of total U.S. R&D funded by the federal government decreased from 30% in 2011 to 19% in 2021. The business sector now funds 36% of basic research, close to the 40% share of basic research funded by the federal government”²¹. It is against this backdrop that we formulate our recommendations for the EU’s research and innovation programmes.

Given a more hostile international environment and growing competition over core technologies, **Europe must step up its investments in its future strength**, and it must do so both at national and at EU levels, and both in the private and public domains. **Funding, facilitating and fostering research, technological development and innovation** has perhaps never been as important **for the future of Europe** (but also for the future of democracy, the planet, and a rules-based world order) as it is today. Only with strong science, technology and innovation, Europe can demonstrate that **democracy, the welfare state, personal freedoms (including academic freedom) go hand in hand with economic development, competitiveness, sustainability and secure and thriving citizens**. Without it, Europe risks becoming irrelevant, insecure and, frankly, being irresponsible.

AI provides a useful illustration: In the last two years, the wave of generative AI has swept across the world, transforming uses in virtually every field, forcing companies to undergo profound transformation to maintain their competitiveness, mainly to the benefit of giant American firms, and raising questions about the preservation of European culture and values. **Research and technological development enable Europe to produce the new architectures, the next paradigms, that will enable it to lead the next wave.**

In the midst of war, climate change, the recent pandemic and political, economic and social disruption, we should not forget that **crises are powerful drivers of innovation**²². Thus, the current challenges we face – individuals, countries, regions and the planet – also provide impetus and a conducive environment and **opportunity for entrepreneurship, cooperation, mobilization, breakthrough and disruptive science and innovation**. They also provide an opportunity for ‘**setting things right**’, e.g., combining economic development with environmental and social sustainability, and they empower companies, citizens and communities to act.

With the framework programme for research and innovation, **the EU has a unique, established and proven instrument for supporting science, technological development and innovation**. The Treaty on the Functioning of the European Union clearly spells out the purpose of EU research and innovation policy: ‘The Union shall have the objective of strengthening its scientific and technological basesand shall encourage

²⁰ OECD (2023). OECD Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption. <https://doi.org/10.1787/25186167>

²¹ National Science Foundation (NSF) (2024), "The State of U.S. Science and Engineering 2024", <https://ncses.nsf.gov/pubs/nsb20243/key-takeaways>

²² Taalbi, J. (2017). What drives innovation? Evidence from Economic history. *Research Policy*, 46(8), 1437-1453. *What drives innovation? Evidence from Economic history.* <https://doi.org/10.1016/j.respol.2017.06.007>

undertakings, including small and medium-sized undertakings, research centres and universities in their research and technological development activities of high quality.²³ There is **ample evidence that Europe has greatly benefited from the EU framework programmes for RD&I**, and that these programmes have achieved results that would not be possible at national level, thus clearly showing their added value and complementary nature to national programmes and initiatives (Box 4).

Box 4: The added value of European RD&I: a brief summary²⁴

- Macro-economic modelling has estimated that the long-term effect of **Horizon 2020 resulted in an average annual increase in EU GDP of EUR 15.9 billion**, totalling EUR 429 billion over the period 2014-2040 (representing an impressive multiplier, given its total budget of about EUR 80 billion).
- Micro-econometric analysis highlighted how Horizon 2020 grants, on average, **increased winning firms' employment levels by 20%, and their turnover and total assets by 30%**, compared to comparable non-funded firms²⁵.
- In the first three years of Horizon Europe 7,474 SMEs were participating in the programme, 34% of all participants. **More than half of Horizon Europe SMEs are new to EU RD&I programmes**. Success rates of SME applications have strongly improved (up to 19.9% from 12% in Horizon 2020).
- Since their inception – 40 years ago – EU framework programmes for RD&I, by pulling together intellectual and financial resources at European level, have been instrumental in **expanding the frontiers of science, generating new knowledge and developing large-scale solutions to emerging challenges**, such as diseases and pandemics, climate change and biodiversity loss, digital transition (including state-of-the art supercomputers, next generation chips and smart phones), energy security, smart mobility, space and security.

We identify **four dimensions** where the EU framework programme for research and innovation has a unique added value compared to national and regional programmes, i.e. where it can do things the latter can't do, or it can add significant value to their efforts. These are **competitive excellence, industrial leadership/competitiveness, societal challenges**, and the **RD&I ecosystem**. For each of these dimensions we provide recommendations for strengthening future EU programmes for research and innovation and thus their ability to contribute to Europe's future competitiveness, security and sustainability (Box 5).

²³ Article 179, Treaty on the Functioning of the European Union.

²⁴ European Commission (2024), Ex-post evaluation of Horizon 2020. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2024%3A29%3AFIN&%3Bqid=1706525982183>

²⁵ European Commission (2024), Research and innovation for a competitive green and fair Europe. <https://op.europa.eu/en/publication-detail/-/publication/e830b15b-e4db-11ee-8b2b-01aa75ed71a1/language-en>

**Box 5: The unique role of European RD&I Framework programmes:
*where they have done better than national research funding***

1. Multi-country collaboration. Most national programmes can do bilateral collaborations easily and trilateral ones occasionally, but rarely more than that. The European Horizon programme is arguably the best in the world for multi-country collaboration.
2. Competition and reputation for excellence at European (not just national) level. This is due to Europe-wide competition.
3. Projects of scale, beyond the means of a single country (especially smaller countries).
4. Large and expensive multi-user research and technology infrastructures including pilot lines, demonstrators etc.
5. Implement quickly EU policy and priorities, by creating synergies between EU industrial, regional, energy, environment, defence and RD&I policies.
6. Catalyse Member States to participate/co-fund.
7. Inspire Member States, e.g., by experimentation with new programmes and by best practices.

HOW? – Align-Act-Accelerate

Based on the context described above, evaluations of the current and past framework programmes, and cumulative experiences and benchmarking of research and innovation policy instruments, we identify modalities, approaches and principles for how the framework programme can effectively support and promote research and innovation in the EU in the future. Our recommendations are anchored in the following guiding principles:

- **Double down on what works:** the framework programme as an instrument is well proven to be an effective programme for strengthening research, innovation and competitiveness:
 - by funding and promoting pan-European pre-competitive collaborative research;
 - by using European public-private partnerships (international, interdisciplinary, intersectoral, covering complete industrial value chains);
 - by promoting cross-border and cross-sectoral mobility of researchers;
 - by funding and promoting excellent research, development and innovation throughout the whole programme.
- **Invest** (in future strength), **focus** (e.g., reduce the number of programmes) and **align** (policies – vertically and horizontally);
- **Accelerate** utilization, deployment, commercialization, transformation by ensuring that Europe has the proper capabilities and tools at hand (e.g., new EU strategy on Technology Infrastructures);

- **Combine** investment sources: 1 Euro public (EU, national, regional) RD&I spending to influence the additional investment of 2 Euro of private sector RD&I spending (cf. Finland's R&D Law²⁶)
- **Experiment** (with new instruments and tools, including AI);
- **Unleash the power of demand** (i.e., helping markets emerge) through pre-commercial procurement, needs of and links with defence, market integration, prizes;
- **Compete to win** rather than not to lose;
- **Know** (and build consensus around) Europe's strengths and weaknesses (e.g., technology foresight and monitoring);
- **Strive** for **synergies, Partnerships** (pre-competitive, international, with industry and philanthropy), **Infrastructure** (world class and accessible), **Talent**: attract and nourish (fund and train), **Defragmentation** (RD&I systems);
- **Rely on Europe's commitment to academic freedom** and to a **research culture** which is responsible, open, curious and tolerant;
- **Recognize** that science, research, technological development, industrial competitiveness, societal challenges and innovation form a **continuous RD&I value network** and cannot be tackled in separate silos or be allowed to cannibalize each other.

²⁶ Finlex. (2022). Laki valtion tutkimus – ja kehittämistoiminnan rahoituksesta vuosina 2024-2030. <https://www.finlex.fi/fi/laki/ajantasa/2022/20221092>

The background is a gradient of teal and blue colors, featuring several large, overlapping, wavy shapes that create a sense of movement and depth. The text is centered in the upper half of the image.

BACKGROUND AND EVIDENCE FOR EACH RECOMMENDATION

Recommendation 1

Create momentum through a whole-of-government approach, aligning a transformative research and innovation policy with the EU strategic agenda and recent high-level policy recommendations

WHY?

The Framework Programme for Research and Innovation (FP) is a fundamental building block for a secure and thriving Europe. The ability of the FP to deliver on these goals depends in turn on critical mass and a conducive environment for European researchers, companies, geographies and citizens to turn excellent science and technology into effective solutions for the challenges facing our societies and our planet, and competitive products for global markets.

Three strategic reports and strategies identify key priorities and proposals for, and a high-level political commitment to, realizing the potential of research, technology and innovation in general, and of the European Framework Programme in particular. These are “**Much more than a market**” (the so-called Letta Report²⁷) of April 2024, the EU Strategic Agenda and “**Europe’s Choice: Political guidelines for the next European Commission 2024–2029**” of July 2024²⁸, and “**The future of European competitiveness**” (the so-called Draghi Report²⁹) of September 2024. We wholeheartedly endorse these proposals and priorities as complementing, reinforcing and completing the recommendations of our expert group (see Table 1.1).

The above agendas and reports confirm that **RD&I is a systemic issue**, convergent with the key priorities and proposals mentioned in those documents.

²⁷ See Letta, E. (2024). Much more than a market. <https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>. Enrico Letta is a former Italian Prime Minister, who was invited by the European Council of 30 June 2023 “for an independent High-Level Report on the future of the Single Market to be presented at its meeting of March 2024 and invites the incoming presidencies of the Council and the Commission to take this work forward, in consultation with the Member States”.

²⁸ European Commission (2024), Political Guidelines for the next European Commission 2024-2029. https://commission.europa.eu/document/download/e6cd4328-673c-4e7a-8683-f63ffb2cf648_en?filename=Political%20Guidelines%202024-2029_EN.pdf.

²⁹ See Draghi, M. (2024). The future of European competitiveness. https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en. Mario Draghi, a former Italian Prime Minister, was invited by President Ursula von der Leyen to address emerging challenges in European competitiveness.

Table 1.1. Brief summary of the alignment of this report with recent high-level policy recommendations 1

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
<p>Make Europe more globally competitive, secure, sustainable and resilient through a stronger framework programme (Recommendation 2)</p>	<p>[...] moving away from traditional, siloed approaches, which will be crucial for ensuring research is relevant. (See pg. 22)</p>	<p>[...] Prioritizing “Europe’s competitiveness - and its position in the race to a clean and digital economy – will depend on starting a new age of invention and ingenuity. This requires putting research and innovation, science and technology, at the centre of our economy” (See pgs. 9, 10)</p>	<p>“A Research and Innovation Union should be established and lead to a joint formulation of a common European R&I strategy and policy”. (See part A pg. 29; part B pg. 247, 253) [...] “Public spending on R&I in Europe lacks scale and is insufficiently focused on breakthrough innovation.” (See part A, pg. 25) [...] “The report recommends reforming the EU’s next Framework Programme for R&I in terms of its focus, budget allocation, governance and financial capacity.” (See part B pgs. 245/246 R&I at heart of EU Policy)</p>
<p>Deliver European added value through a portfolio of four interrelated and interdependent “spheres” of action, with a budget for FP10 of at least EUR 220 billion (Recommendation 3)</p>	<p>“A coordinated and comprehensive European technology policy” (See pg. 19)</p>	<p>Prioritize Europe’s competitiveness [...] Increase R&D spending. (See pg. 10)</p>	<p>[...] “Europe must profoundly refocus its collective efforts on closing the innovation gap with the US and China, especially in advanced technologies.” (See part A, pgs. 2,3, 19) [...] “We must unlock our innovative potential. This will be key not only to lead in new technologies, but also to integrate AI into our existing industries so that they can stay at the front.” (See part B, pg. 247) [...] “the budget of the new Framework Programme should be doubled to EUR 200 billion per 7 years.” (See part A, pg. 27; part B, pg. 247)</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
<p>Establish an experimental unit to test new programmes and instruments with fast time to funding (Recommendation 4)</p>	<p>“The integration of the fifth freedom into the Single Market framework reinforces its role as a cornerstone of European integration. It would transform existing dispersed knowledge, fragmentations and disparities into unified opportunities for growth, innovation, and inclusivity.” (See pg. 19)</p>	<p>a Union that is faster... [...] “Turbocharging investment.” [...] “Making business easier” (See pgs. 6, 11)</p>	<p>[...] “Public spending on R&I in Europe lacks scale and is insufficiently focused on breakthrough innovation.” (See Part A, Pg. 29, 31; Part B, pg. 248). [...] “A better financing environment for disruptive innovation, start-ups and scale-ups is needed as barriers to growth within the European markets are removed.” (See part B pg. 85 prize funding for industrial applications of AI. Also pg. 85 pre-commercial procurement in AI)</p>
<p>Promote Competitive Excellence throughout the FP, strengthening the ERC, EIC and MSCA. Launch “Choose Europe” to foster research careers in Europe (Recommendation 5)</p>	<p>“Retaining talents is critical for Europe’s economic resilience, innovation capacity, strategic independence, and societal welfare and should be one of the most urgent priorities.” (See pg. 21)</p>	<p>“Increase our research spending to focus more on strategic priorities, on groundbreaking fundamental research and disruptive innovation, and on scientific excellence. [...] expand the European Research Council and the European Innovation Council”. [...] attracting new talents and retaining the best and brightest minds here in Europe. [...] “Europe must also be at the cutting edge between emerging science, tech and industry, the</p>	<p>[...] “The report recommends doubling the support for fundamental research through the ERC, significantly increasing the number of grant recipients without diluting the amount they receive.” (See Part A, Pg. 29; Part B, pg. 248). [...] “EIC should be reformed to become a genuine “ARPA-type agency”, supporting high-risk projects with the potential of delivering breakthrough technological advances.” (see part B, pg. 247, better funding of disruptive innovation, start-ups and scale ups – leverage funds, pension funds; also pg. 249 increase equity funding and co-operation between EIC Fund and EIF; also, pg. 249 EIB allowed to act as VC; also, pg. 250 increase budget for disruptive innovation ,improve governance of EIC and speed up time to fund)</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
		<p>nexus that will make this tech revolution faster and more transformative.” (See pgs. 10, 11)</p>	
<p>Foster industrial competitiveness and establish a European Technology and Industrial Competitiveness Council (Recommendation 6)</p>	<p>Make European industrial capacity compatible with the goals of the fair, green, and digital transition. the EU's industrial strategy must adopt a more European approach. (see pgs. 12, 26, 28) [...] actively encourage public-private partnerships in strategic areas focused on knowledge exchange and innovation uptake [...] Enhance green and digital industrial public investments. (See pgs. 5, 29, 30) [...] Improve investments in circular economy. [...] Mobilise private capital “European private investments in the space sector continue to be</p>	<p>[...] “Stay the course on (...) the European Green Deal”, [...] Invest massively in our sustainable competitiveness Industrial decarbonization accelerator Act. [...] “Boost productivity with digital tech diffusion.” [...] Help innovative companies grow. (See pgs. 8, 28)</p>	<p>[...] “Europe needs faster productivity growth to maintain sustainable growth rates in the face of adverse demographics.” (See Part A, Pg. 19) [...] “Integrating AI vertically into European Industry will be a critical factor unlocking higher productivity.” (See Part A, pg. 21; Part B, pg. 23) [...] “governance of the programme should be managed by project managers and by people with proven track record at the frontier of innovation and – to maximise access for young, innovative companies – application processes should be faster and less bureaucratic.” (See Part A, pg. 29; Part B, pgs. 23, 248) [...] “establish a multi-purpose Space Industrial Fund that would allow the European Commission to act as an “anchor customer” to jointly purchase space services and products and fund critical technologies, helping the EU industrial base to increase its capacity. Similarly, joint strategic priorities for space research and innovation should be supported by increased coordination, funding and the pooling of resources for the development of new large EU joint programmes.” (See Part A, pg. 57; pgs. 169-174).</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
	<p>substantially smaller than those of the leading space powers, namely the US".</p> <p>(See pg. 76)</p>		
<p>Address societal challenges and establish a European Societal Challenges Council (Recommendation 7)</p>	<p>"Inspired by the success of Europe's Beating Cancer Plan, we urgently need to further address three critical challenges for our future: mental health, antimicrobial resistance (AMR) and neurodegenerative diseases."</p> <p>(See pg. 78)</p> <p>health and safety at work policies must evolve to address issues that have received less attention, such as mental health, including stress and burnout, and the risks associated with climate change.</p> <p>(See pg. 105)</p>	<p>"Sustaining our quality life: food security, water and nature." "Supporting people, strengthening our societies and our social model." [...] "one of our greatest challenges in this decade is protecting the mental health of our children and young people." (See pgs. 9, 18, 20, 21, 30)</p>	<p>[...] "Europe's fundamental values are prosperity, equity, freedom, peace and democracy in a sustainable environment. The EU exists to ensure that Europeans can always benefit from these fundamental rights. [...] The only way to meet this challenge is to grow and become more productive, preserving our values of equity and social inclusion."</p> <p>[...] "Transformation can best lead to prosperity for all when accompanied by a strong social contract."</p> <p>[...] "Decarbonisation will also require new skills sets and job profiles." (See Part A, pg. 1).</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
<p>Strengthen the European RD&I ecosystem (Recommendation 8)</p>	<p>Strong European technology infrastructure. Empowerment of research infrastructures (See pg. 9)</p> <p>“the necessary skills, infrastructures, and investments, to enable widespread prosperity and industrial leadership.” (see pg. 19)</p>	<p>[...] a “strengthened cohesion and growth policy with regions at the centre.”</p> <p>[...] “mobilise reforms and investments to help build what a community needs to thrive: public services and private activities, education and skills, transport and digital connectivity.”</p> <p>[...] “To lead on innovation, we need to create the conditions for researchers to thrive. This means providing the infrastructure and innovative laboratories they need to test and develop ideas through new public-private partnerships, such as joint undertakings.” (See pg. 11)</p>	<p>[...] “Introduce an instrument for supporting excellent research institutions: the ERC for Institutions, ERC-I.” [...] “A world-leading research institution necessitates a critical mass of talent, with a significant number of top-tier researchers collaborating on closely related topics within the same physical space. [...] ERC-I should build on the high number of well-established European research institutions that rank in the middle to high tiers of the global distribution and propel some of them to the very top of academic excellence.” See Part B. pg. 251.</p> <p>[...] “a new EU framework for private funding to enable public universities and research centres to design more competitive compensation policies for top talents and to provide additional support for research.” (see part B pg. 253 European R&I Action Plan)</p> <p>[...] “increased funding and stronger coordination is required to develop world-leading research and technological infrastructures.”</p> <p>[...] “Since the launch of the Euro-HPC Joint Undertaking in 2018, the EU has created a large public infrastructure for computing capacity located across six Member States, which is one-of-a-kind globally. [...] The report recommends building on this initiative by significantly increasing the computing capacity dedicated to the training and algorithmic development of AI models in HPC centres. At the same time, the EU should finance the expansion of Euro-HPC to</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
			<p>additional cloud and storage capabilities to support AI training in multiple locations.” (See Part A, pg. 30; Part B, pgs 78-80)</p>
<p>Guarantee Radical user-oriented simplification (Recommendation 9)</p>	<p>“Prioritising the alleviation of the most burdensome obligations is essential not only for managerial efficiency - optimising the limited resources allocated for simplification efforts - but also for practical reasons.” (See pg. 130)</p>	<p>[...] “A Union that is faster and simpler, more focused and more united, more supportive of people and companies.” “Making business easier.” (See pgs. 11, 12, 22, 24)</p>	<p>[...] The organisation of the programme should be redesigned and streamlined to become more outcome-based and efficient. (See Part B. pg. 247 simpler and more impactful FP10)</p>
<p>Promote Innovation Procurement (Recommendation 10)</p>	<p>[...] “Innovation procurement, especially in green and digital technologies as critical lever to support startups, scale-ups and SMEs in developing new products and services”. (See pgs. 12, 46)</p>	<p>Make better use of public procurement (See pgs. 8, 11, 14, 15)</p>	<p>[...] “Europe must improve the conditions for breakthrough innovation by addressing the weaknesses in its common programmes for R&I.” [...] “multiple different national rules in public procurement generate high ongoing costs for cloud providers. “ [...] “To strengthen Europe’s position at the procurement stage, it is proposed to create a dedicated EU Critical Raw Material Platform.” (see part B, pgs. 247, 248, 255 Increase innovative procurement)</p>

This Report and its recommendations	Much more than a market, April 2024	Europe's Choice, July 2024	The future of European competitiveness, September 2024
<p>Guarantee that the framework programme allows Europe to take the lead in international RDI cooperation and governance (Recommendation 11)</p>	<p>“The rules-based international order faces serious challenges, entering a phase marked by the resurgence of power politics. The European Union has traditionally committed to multilateralism, free trade, and international cooperation, principles that have formed the bedrock of its global governance and economic strategies. (See pg. 4)</p>	<p>“A global Europe: Leveraging our power and partnerships...” (See pgs. 25-28)</p>	<p>[...] “the report recommends adopting EU-wide data security policies for collaboration between EU and non-EU cloud providers, allowing access to US hyperscalers’ latest cloud technologies while preserving encryption, security and ring-fenced services for trusted EU providers.” (see part B, pg. 85 pre commercial procurement in AI)</p>
<p>Embrace dual use (Recommendation 12)</p>	<p>Common market for defence and security industry security must be addressed in a comprehensive dimension (See pg. 72)</p>	<p>“New era for defence and security...” (See pgs. 13-17, 27)</p>	<p>“Together with the urgent need to increase overall defence investment, there is a strong case to reinforce cooperation and pooling of resources for defence R&D at the EU level.” [...] “The report therefore recommends that European funding for R&D is both increased and concentrated on common initiatives. This approach could be developed through new dual-use programmes and a proposed European Defence Projects of Common Interest to organise the necessary industrial cooperation. (see part B, pg. 170 maximise technological spill over between civilian and defence innovation cycles).”</p>

WHAT?

Our Recommendation is to **create momentum through a whole-of-government approach, aligning a transformative research and innovation policy with the EU strategic agenda³⁰ and recent high-level policy recommendations**, including the Letta Report³¹ about the single European market, and the Draghi Report³² about further support for European economic competitiveness.

- **Drive an EU strategic agenda** structured around:
 - **A free and democratic Europe,**
 - **A strong and secure Europe,**
 - **A prosperous and competitive Europe.**
- **Establish a robust Research and Innovation Union** leading to a joint formulation of a common European R&I strategy and policy (Draghi Report).
- **Strive for a simpler and faster Union** that is “more focused and more united, more supportive of people and companies” (Europe’s Choice).
- **Make business easier** (Europe’s Choice).
- **Stay the course on the European Green Deal** (Europe’s Choice).
- **Deepen the Single Market** (Europe’s Choice): in particular, achieve **single markets for finance, energy and electronic communications** (Letta Report)
- Rise to the challenge of **a new era for European defence and security** (Europe’s Choice; Draghi Report)
- **Add a fifth freedom** to the existing four, to enhance research, innovation and education in the Single Market (Letta Report); this
 - “critically entails embedding research and innovation drivers at the core of the Single Market, thereby fostering an ecosystem where knowledge diffusion propels both economic vitality, societal advancement and cultural enlightenment” (p.20)
 - “requires a multifaceted approach encompassing policy initiatives, infrastructure enhancements, collaborative frameworks, and an unwavering commitment to foster innovation, open science and digital literacy” (p.21)
 - “calls for robust data governance that safeguards personal data while facilitating the free flow of non-personal data” (p.23).
- **Unlock our innovative potential**, promoting fundamental science and disruptive innovation, leading to new technologies (Draghi Report).

³⁰ Von der Leyen (2024), “Europe’s Choice”.

³¹ Letta, E. (2024).

³² Draghi, M. (2024).

HOW? – “Put research and innovation at the heart of Europe’s future-oriented policy“

The current European RD&I framework programme (i.e., Horizon Europe, 2021-2027) and its successor FP10 should embrace the recommendations of this report by **considering the following context:**

- **Ensure “political ownership” of RD&I** at the highest European political level by the future new *College of European Commissioners* and **establish the Research and Innovation Union** (Draghi Report)
- **Put research and innovation at the heart of our economy** (Letta Report, Europe’s Choice);
- **Pursue a coordinated and comprehensive European technology policy** (Letta Report, Draghi Report);
- **Increase R&D expenditure** (Letta Report, Europe’s Choice, Draghi Report);
- **Strengthen Research institutions and Universities** (Draghi Report);
- **Make better use of public procurement for innovation** (Letta Report, Europe’s Choice);
- **Improve governance of European research and innovation** across the services of the European Commission in articulation with Member States and the European Parliament (Draghi Report);
- **Invest massively in sustainable competitiveness** (Europe’s Choice);

Recommendation 2

Make Europe globally competitive, secure, sustainable and resilient through a stronger framework programme.

Box 2.1. Quoting Dario Gil, Chair US National Science Board and SVP Research IBM

“Science & Technology now has the same kind of economic and geopolitical importance as trade or military alliances. It is at the heart of national economic and defense competitiveness.”

WHAT? and WHY?

Research, development and innovation are key to Europe’s Industrial Competitiveness and to Europe’s ability to mitigate and adapt to climate change, resource scarcity, geopolitical tensions, the consequences of an aging society and other challenges. Steeman et al (2024) summarise the evidence and rationale for public and private investment in European RD&I and why it matters for a competitive, green and fair Europe. Importantly, as illustrated by the 3 graphs below (Figures 2.1, 2.2 and 2.3), there is a **strong positive correlation** between RD&I investment/innovation capacity and productivity, wellbeing, and economic resilience.

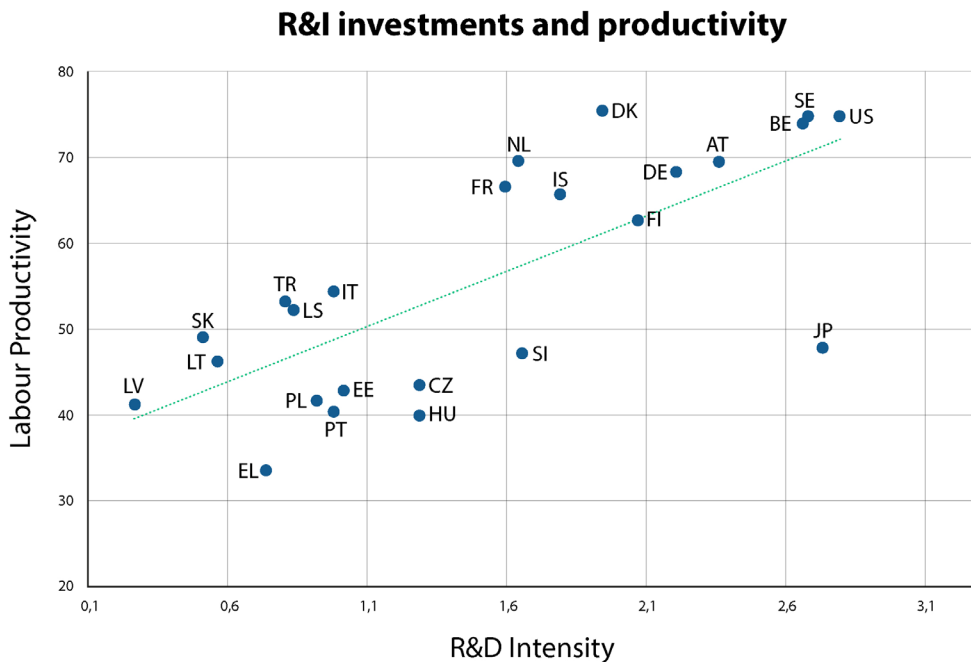


Figure 2.1 R&I Intensity and Labour productivity: an international comparative analysis. Sources: European Innovation Scoreboard, 2023; OECD, 2023; 2023 or last year available

Excellent frontier research, breakthrough innovation, technology development and their translation are intimately intertwined with many feedback loops and an ever-increasing speed of both discovery and translation. In the context of economics and management theory they behave as a “complex adaptive system”³³. Other countries have recognised this, and Europe’s global position is slipping due to their increased investment and performance. This is a wake up, turn around moment for Europe³⁴.

As stated earlier, the EU’s share of total publications declined from 25.5% in 2000 to 18.1% in 2022 –while China’s publications increased by 30%. The EU ranks 3rd globally for publication quality – top 10% of citations in 2022 – at 19.2%, down from 23.4% in 2000 (China is first with 26.7% up from 2.8% in 2000). China leads in applied sciences, enabling and strategic technologies, engineering, ICT, natural sciences (particularly chemistry); the USA leads in biomedical & clinical medicine; the EU leads in historical studies³⁵.

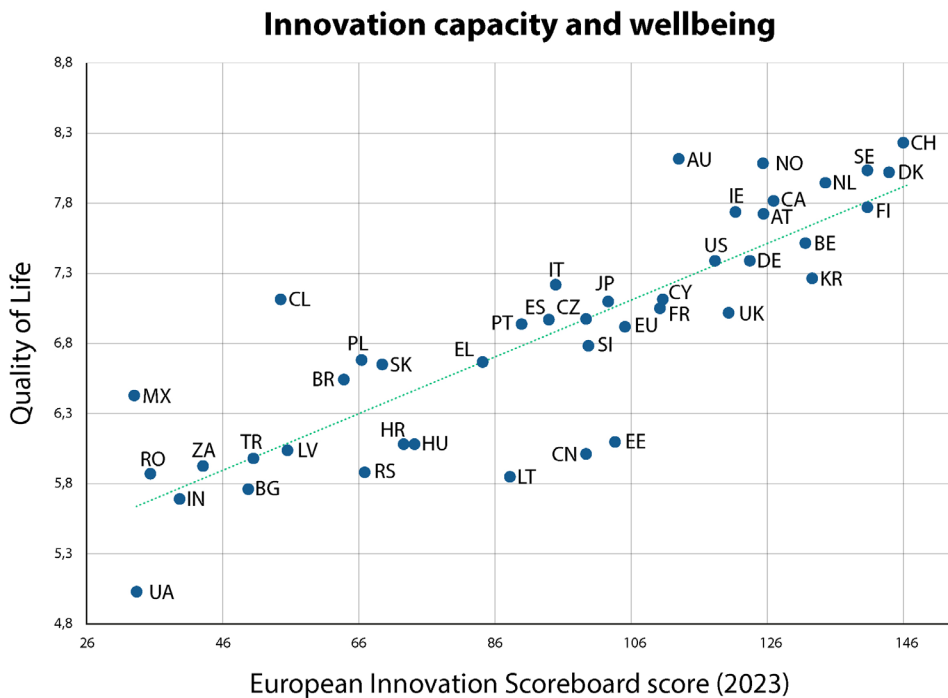


Figure 2.2 European Innovation Scoreboard score (2023) and quality of Life: an international comparative analysis
Sources: European Innovation Scoreboard, 2023; OECD, 2023; data for 2023 or last year available

³³ Gebel, L., Velu, C., & Vidal-Puig, A. (2024). The strategy behind one of the most successful labs in the world. *Nature*, 630(8018), 813-816.

³⁴ See the framing chapter in this report. Also, ERT (2024), “Competitiveness and Industry benchmarking Report 2024”, European Round Table for Industry (ERT), www.ert.eu

³⁵ European Commission (2024), SRIP.

Innovation capacity and economic resilience

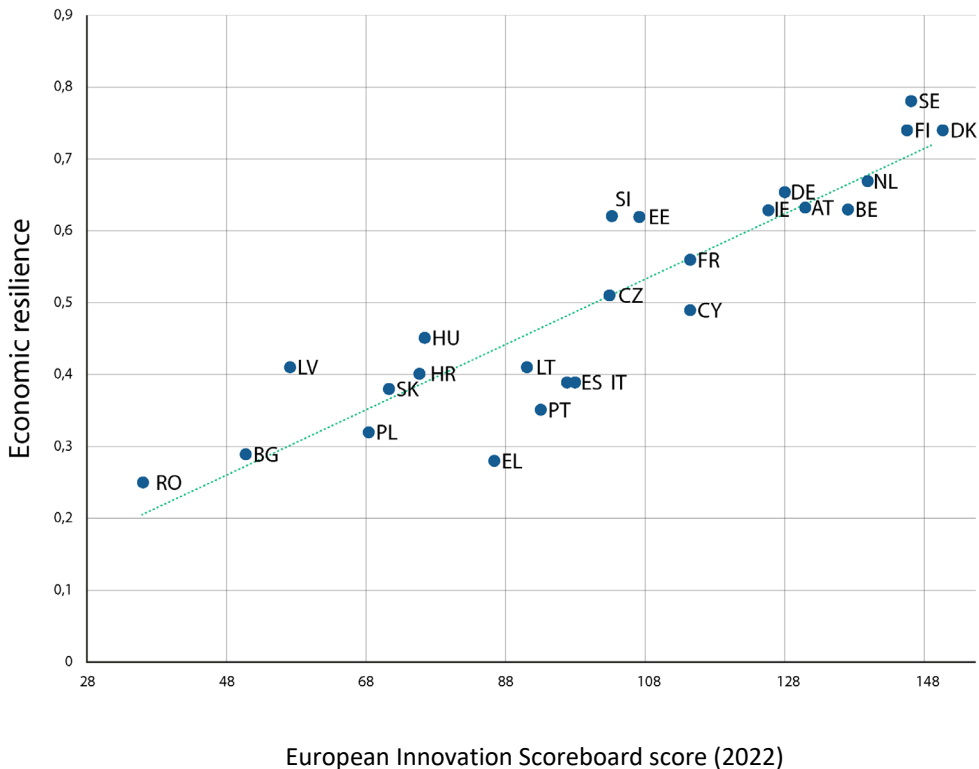


Figure 2.3 European Innovation Scoreboard score (2022) and economic resilience: an international comparative analysis
Sources: European Innovation Scoreboard, 2022; OECD, 2023; data for last year available

Europe is also failing to file and be granted important patents in key emerging and enabling technologies. The EU's share of total world patent applications has been declining from 30% in 2000 to 17.3% in 2021. During the same period, there has been considerable growth from China, particularly in key technologies: in 2022, China accounted for 61%, the USA for 21%, and Europe for a mere 2% of global total granted patents in AI³⁶. With regard to US utility patents granted in semiconductors in 2022, the USA held 22% (3,674), Taiwan, Japan, South Korea & China 68% (11,227), and Europe 8% (1,401)³⁷.

The EU has fewer and fewer knowledge and technology intensive companies in global top listings, and fewer new large companies. Compared to the US, **the EU fails to scale** new innovative companies to become global giants. Additionally, and partly as a result, **the EU has developed undesirable dependencies in certain critical technologies**, compounded by the above-mentioned **decreasing share of global patents in key and emerging technologies**.

³⁶ AI (2024), "The AI Index 2024 Annual Report", Maslej et al., AI Index Steering Committee, Institute for Human-Centered AI, Stanford, University, Stanford, CA, April 2024. The AI Index 2024 Annual Report by Stanford University is licensed under Attribution-N. Derivatives 4.0

International; <https://aiindex.stanford.edu/report/>

³⁷ NSF/NSB (2024), "The State of US Science and Engineering 2024", <https://ncses.nsf.gov/pubs/nsb20243>

At 2.2% of GDP, **public and private investments in RD&I in the EU are significantly below the levels of main competing economies** – South Korea 4.9%, USA 3.5%, Japan 3.3%, China 2.4%. Worryingly the **RD&I investments from businesses in the EU are also the lowest (at 58% of total)** compared to 76% in South Korea, 68% in the USA, 78% in Japan and 77% in China³⁴. It is no surprise that the 2024 European Semester Report blamed the EU's low R&D investment for its economic stagnation. If Europe wants to keep up with what it considers its peers, EU MS urgently need to boost both national and European Commission public investments in RD&I in a co-ordinated approach which incentivises, catalyses and leverages more private RD&I investments including addressing the persistent financing gap to scale up companies.

National RD&I investments are essential and complement European Commission investments: both must increase for Europe to thrive – European Commission funding provides added value (see Recommendation 3) to national investments and cannot substitute for low national investment.

An important concept is “**absorptive capacity**” which refers to the ability of a company/country to absorb a technology from elsewhere based on the prior level of related knowledge and expertise they hold³⁸. National public and private investments are key to developing this base of knowledge and trained personnel. Indeed, the absorptive capacity of EU industry is vital for developing and scaling important discoveries and innovations from basic research. Currently, **US Companies exploit more ERC funded basic research discoveries than EU companies**³⁹, possibly due to the increased density of innovative scaling companies in USA⁴⁰. **Start up** and **scaling innovative companies** are an important way of rapidly translating new discoveries and innovations into competitive commercial products and services.

National investments and capacity are also important for a country's ability to participate in international RD&I collaborations. There is a positive correlation between MS national expenditure in RD&I and their success in winning European Commission Horizon funding (see Fig 2.3). This correlation, notwithstanding the other determinants of national RD&I funding (e.g., size, industrial base, policy priorities, among others), illustrates the importance of a solid national base on which to build EU added value.

Furthermore, the EU RD&I Framework programme must be sufficiently funded and appropriately focussed to ensure maximum added value (see Recommendation 3). A well-funded and well-designed FP10 must be a **game changer for Europe's declining competitiveness**⁴¹.

Securing technology ownership and avoiding future opportunity failures must be recognized as a means of achieving prosperity in harmony with the planet, employment, good quality life, security, strategic autonomy and global relevance. In both Member States and the European Commission actions and funding need to change: as long as “spending too much

³⁸ European Commission (2023), The global position of the EU in complex technologies. <https://data.europa.eu/doi/10.2777/454786>

³⁹ Nagar, J. P., Breschi, S., & Fosfuri, A. (2024). ERC science and invention: Does ERC break free from the EU Paradox? *Research Policy*, 53(8), 105038. <https://doi.org/10.1016/j.respol.2024.105038>

EIB (2024), “The scale-up gap: Financial market constraints holding back innovative firms in the European Union”, <https://www.eib.org/en/publications/the-scale-up-gap>

⁴¹ ERT. (2024). “Competitiveness and Industry benchmarking Report 2024”, European Round Table for Industry (ERT), www.ert.eu

on RD&I is considered a worse mistake than spending too little⁴² our opportunity to create the future we want will be squandered.

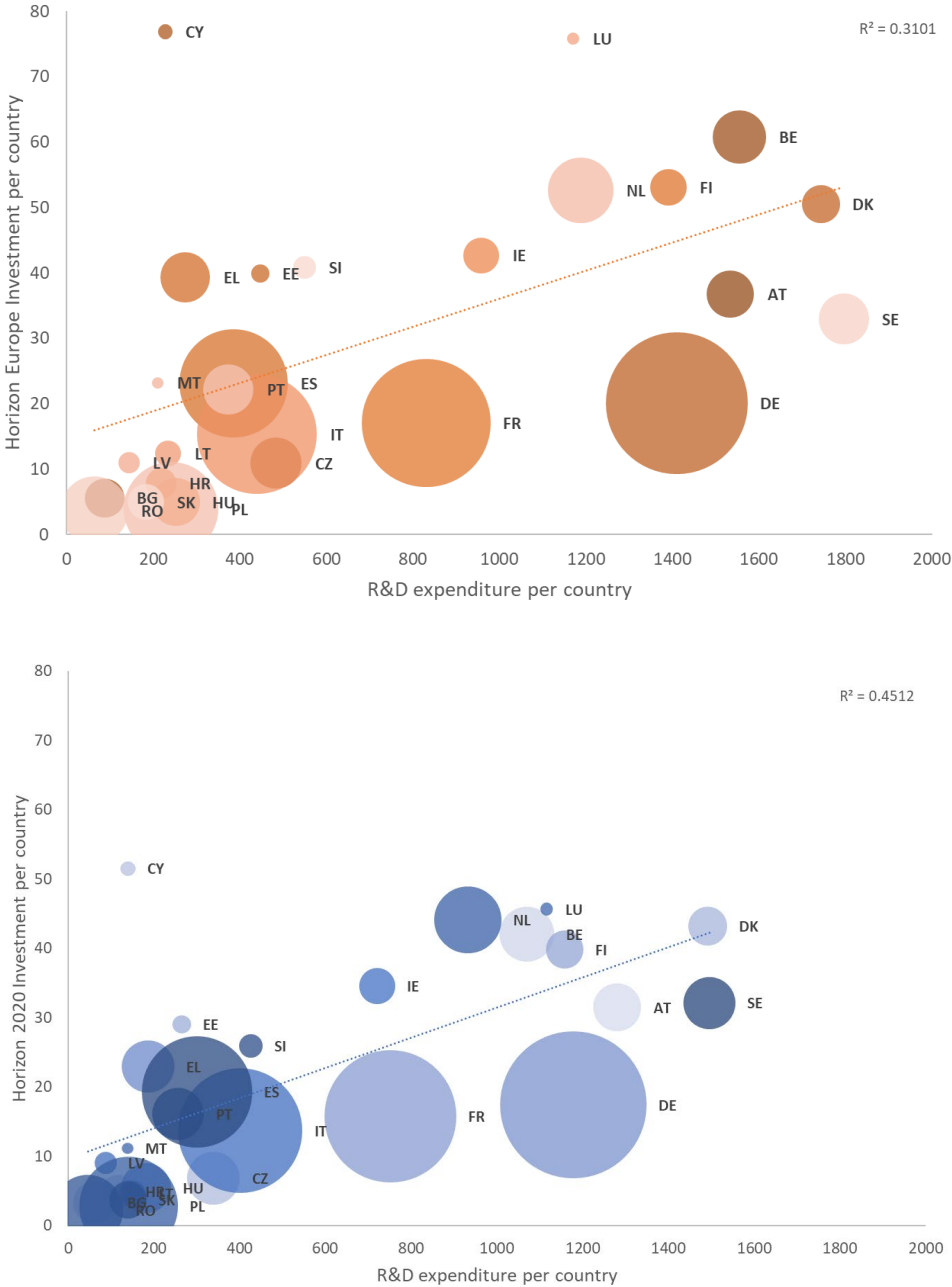


Figure 2.3 European MS expenditure in RD&I and their success in winning European Commission Horizon funding: a) Horizon Europe (2021-2023); b) Horizon 2020 (2014-2020). Sources: EC, 2024; OECD, 2023; data for 2014-2020.

⁴² ERT (2024).

Given the fast speed of modern science, innovation, technology development and diffusion it is more important than ever to try and understand what technologies may be important in the future and what timely policies or investments might be required to ensure that Europe benefits from these new technologies and their application. Effectively this is **Technology Monitoring**⁴³. In his book on AI entitled *The Coming Wave*, the current CEO of Microsoft AI, Mustafa Suleyman sees an urgent need for governments “to better monitor and understand developments in technology. Countries need to understand in detail, for example, what data their populations supply, how and where it is used, and what it means; administrations should have a strong sense of the latest research, where the frontier is, where it’s going, how their country can maximise upsides”⁴⁴. The authors go on to argue:

In the twenty-first century it doesn’t make sense to have cabinet positions addressing matters like the economy, education, security, and defense without a similarly empowered and democratically accountable position in technology. The secretary or minister for emerging technology is still a governmental rarity. It shouldn’t be... (ibid).

The US National Science Foundation recently awarded \$52M to five consortia under a new programme “**Assessing and Predicting Technology Outcomes Awards**” to align US science and technology RD&I with outcomes essential to US competitiveness⁴⁵. These consortia will develop models describing past and future technology outcomes such as their capabilities, production or use and use these models to predict future outcomes of specific technologies and therefore which interventions might change or accelerate beneficial outcomes. This is an important input both to policy makers and research funders and **a similar initiative is advocated for Europe.**

⁴³ See also ESIR (2024), <https://op.europa.eu/en/publication-detail/-/publication/6dc11e64-6bd6-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-340216413>

⁴⁴ Suleyman and Bashkar (2023). “The Coming Wave: Technology, Power, and the Twenty-first Century’s Greatest Dilemma”, Vintage Publishing, p. 260.

⁴⁵ Details at https://new.nsf.gov/funding/opportunities/assessing-predicting-technology-outcomes-pto?utm_medium=email&utm_source=govdelivery

Box 2.2: Evidence of the need to strengthen European RD&I.

- As laid down in the TFEU Article 179, the EU's research and innovation policy has the objective of strengthening the EU's scientific and technological bases by achieving a European research area in which **researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry**. In this respect, EU Framework Programmes for research and innovation have been a great success!
- **The Eurobarometer 2021** survey indicates a **broad consensus among European citizens** about the need to further foster **RD&I in Europe**, as well as to attract and retain the **best talent for research**.
- Research jobs now make up **1% of the EU workforce**, with the number of **full-time equivalent (FTE) researchers** in Europe jumping from 1.38 million in 2011 to **2 million in 2021**. Compared with the situation reported in 2004 (20 years ago), this is a **great success** in terms of **attracting young talent for research**. However, the **quality of RD&I jobs has NOT evolved at the same pace**⁴⁶.
- Still, and despite efforts and incremental improvements, **Europe exhibits an innovation deficit** when compared to the US and China, especially in critical and complex technologies. Turning research outcomes into business opportunities and the scaling up of innovative companies remains a challenge. The next **framework programme should play a leading role in safeguarding Europe's leading position in a world of increasing geo-political and geo-economic competition and multiple global challenges**;
- Research, Development and Innovation Framework Programmes (i.e., FP6, FP7, Horizon 2020, HE) **represent less than 8% of overall, centralised and decentralised, European investment funds**, included in the last **Multiannual Financial Framework (MFF) of the European Union for 2021-2027**⁴⁷.
- Several **synergies have been strengthened** between the Research and Innovation Framework Programme and other funding programmes included in the current MFF 2021-2027, but these **have not been enough** to increase the overall level of RD&I expenditure in Europe, which remains relatively low;
- Research, Development and Innovation Framework Programmes (i.e., FP6, FP7, Horizon 2020, HE) represent **only about 4 to 6% of overall RD&I funding in Europe**, but they have been **critically relevant for building-up European scientific foundations and a unique research, development and innovation collaborative landscape** through the *European Research and Innovation Ecosystem*⁴⁸.
 - About 66% of R&D expenditure was performed in the business enterprise sector, and its RD&I expenditure increased 12.1% over the last decade, from 1.32% of GDP in 2012 to 1.48% of GDP by 2022.
 - **European business expenditure on RD&I is low by global comparison** of 3.90% in South Korea, 2.68% in USA, 2.62% in Japan and 2.26% in Switzerland (2021 data).
- The EC's ex-post evaluation of Horizon 2020 and the recent "Horizon Europe Strategic Plan 2025-2027" include the **necessary evidence** for the need to **double the budget of the FP to guarantee funding all high-quality proposals**.

⁴⁶ ESIR (2024). <https://op.europa.eu/en/publication-detail/-/publication/6dc11e64-6bd6-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-340216413> (ESIR) as recommended the concept of "Industry 5.0"; Also, Rodrik (2022).

⁴⁷ European Commission (2021). The EU's 2021-2027 long-term budget. and NextGenerationEU, <https://op.europa.eu/en/publication-detail/-/publication/d3e77637-a963-11eb-9585-01aa75ed71a1/language-en>

⁴⁸ European Commission (2024), Ex-post evaluation of Horizon 2020, Horizon Europe Strategic Plan 2025-2027 Analysis.

HOW?

- **Increase national expenditure on RD&I and co-ordinate with EU policy through the European Semester process;**
- Incentivise increases in national RD&I investments (to 3% of GDP) by linking EU widening actions to increased national investments.
- Fund the **full spectrum of RD&I** and catalyse private investment.
- Implement the recommendations of this report to ensure that FP10 is a high return investment in Europe's future.
- **Launch a technology monitoring initiative** and ensure that it provides regular inputs to relevant Horizon programmes, councils, agencies, as well as a broader public. The latter is important to create consensus and buy-in on Europe's strengths and weaknesses, but also to mobilize universities, institutes, companies and entrepreneurs to educate, train, invest and seize opportunities in relevant technology areas.

Recommendation 3

Deliver European added value through a portfolio focused on 4 main interrelated and interdependent “spheres” of action

WHAT? and WHY?

A critical *raison d'être* for EU programmes is that they provide added value to national RD&I Programmes. Numerous studies of Horizon programmes have shown clear evidence of such added value. For example, Mitra and Niakaros (2023) showed that companies in the ICT, professional, scientific and technical domains who received Horizon 2020 grants experienced in subsequent years an **average increase of approximately 20% in employment** levels and a **30% rise in both total assets and revenues**. Macro-economic modelling estimated that Horizon 2020 resulted in EU GDP of EUR 15.9 billion, totalling EUR 429 billion over the period 2014-2040 representing an impressive multiplier given its total budget of approximately EUR 80 billion⁴⁹.

We focussed on EU added value by asking the question “**What can EU RD&I programmes do better than national ones?**“. A clear consensus emerged that EU programmes have a unique additive value in the following critical areas:

- Competition and reputation for excellence at European (not just national) level. This is due to Europe wide open competition in both mono-beneficiary and collaborative programmes;
- Multi-country, multi-actor collaborations. Most national programmes can promote bilateral collaborations easily and trilateral ones occasionally but rarely more than that. The EU Horizon Programme is arguably the best in the world for multi-country collaborations – as evidenced by the increasing number of countries wishing to associate with Horizon. Over the course of its existence, it has developed an immense toolbox enabling it to support complex collaborations spanning different sectors, technologies and types of participants.
- Projects of scale/expense;
- Major expensive multiuser research and technology infrastructures (e.g., equipment, facilities, data and specimen banks), beyond the means of a single country especially smaller countries.

⁴⁹ European Commission (2023), The Horizon effect: a counterfactual analysis of EU research & innovation grants. [https://op.europa.eu/en/publication-detail/-/publication/4c198f4b-8a89-11ee-99ba-01aa75ed71a1%22/%22:~:text=The Horizon effect. A counterfactual analysis of EU research &](https://op.europa.eu/en/publication-detail/-/publication/4c198f4b-8a89-11ee-99ba-01aa75ed71a1%22/%22:~:text=The%20Horizon%20effect.%20A%20counterfactual%20analysis%20of%20EU%20research%20&%)

HOW?

This analysis, combined with the importance of addressing both industrial competitiveness and societal challenges, leads us to propose **focusing the EU RD&I portfolio on four spheres of action**⁵⁰:

- **COMPETITIVE EXCELLENCE**, defined as optimal harnessing from a large pool of applications submitted to open calls, to competitively select the most excellent proposals for funding by using appropriate criteria (i.e., ERC, MSCA, EIC);
- **INDUSTRIAL COMPETITIVENESS**, defined as the ability to provide state-of-the-art products, services and technology-based solutions which contribute positively to overall sustainability (economic, environmental and social) for which there is a market demand or that create new markets;
- **SOCIETAL CHALLENGES** defined as complex and interrelated issues that significantly impact the well-being and development of societies. They consider issues that significantly impact fundamental human rights and affect individuals' personal or social lives, underlying well-being of communities, countries and the European Union. These challenges are typically multi-level and multi-dimensional, often coexisting and requiring innovative solutions, transdisciplinary approaches and coordinated efforts from various actors including government, industry, research, and civil society to be effectively addressed. There is usually disagreement about their nature, causes or solutions;
- **A STRONG RESEARCH AND INNOVATION ECOSYSTEM**, defined as a supportive, productive and interconnected interplay between institutions both public and private, infrastructure, researchers, innovators, entrepreneurs, companies and their surrounding communities to foster the creation of breakthrough discoveries and innovations and their rapid translation and scaling to global markets and applications.

The following five paragraphs expand on the sub bullets of Recommendation 3 describing overarching issues that must be addressed.

1. **INCREASED BUDGET: WHAT? and WHY?**

The **consistent view from ALL stakeholders** (see Annex 1) is that the budget of the Framework Programme for RD&I must rise significantly to meet Europe's needs, and the common recommendation is to double the budget to EUR 200 billion – a similar budget doubling recommendation was made, but unfortunately **not** implemented, in 2017 by the Lamy report, (with the adverse consequences for European competitiveness described earlier).

The *Horizon Europe Strategic Plan 2025-2027 Analysis* objectively lays out the **evidence to double the Budget of HE to guarantee funding all high-quality proposals**. Horizon 2020 launched approximately 1,000 calls for proposals which attracted over 285,000 eligible project proposals, of which only 35,426 were funded – a success rate of 12%. Importantly, 74% of proposals rated by independent experts as high quality and worthy of

⁵⁰ Definitions of the four spheres of action developed by the Expert Group.

funding could not be funded due to budget constraints. Horizon 2020 with a budget of EUR 75.6 billion would have needed an additional EUR 159 billion, ie. a total budget of EUR 234.6 billion to fund all the high-quality proposals received.⁵¹

For Horizon Europe the success rate for years 2021 and 2022 is 15.9% and 71% of high-quality projects go unfunded. The additional budget required to fund all high-quality projects is currently estimated at EUR 127 billion and likely to increase as a result of the growing number of applications and decreasing budget of HE from 2024 onwards due to the expiration of *NextGeneration EU* funds and budget cuts to fund other Commission priorities.

More than 20 years ago, EU leaders agreed to increase R&D investments to at least 3% of GDP but efforts have been very slow and uneven amongst Member States. Only Belgium, Sweden, Austria, and Germany reached the 3% target by 2020 according to Eurostat. Accordingly, the EU average R&D expenditure of 2.2% of GDP is EUR 123 billion short of the target 3%⁵². Assuming public investments account for a third of R&D expenditure, the target shortfall for the public funders is EUR 41 billion per annum. Projected over the 7-year Horizon period, the EU public R&D expenditure shortfall would total EUR 287 billion – to be met by European Commission and national budgets.

HOW?

All of these analyses point to a budget for FP10 of at least double that of Horizon Europe (FP9), if Europe is to catch up with our main global competitors: i.e., **compete not to loose**. But **we want Europe to compete to win**, to become a research, technology and innovation leader creating and commercialising technologies that are globally indispensable, shaping and benefiting from early markets to strengthen Europe. RD&I is not a subsidy or an expense – it is an **investment in our future**. As the ERT (2024) observed “with EU economic growth on a downwards slope, FP10 may be the last chance for Member States to think bigger when deciding on budget allocation for science and technology.”

Consequently, we recommend **a budget for FP10 of at least EUR 220 billion**.

This FP10 budget, **ALIGNED** with relevant EU policies, will enable the European Commission to **ACT** on implementing the recommendations in this report, which in turn will **ACCELERATE** breakthrough research and innovations, the scaling of start-up companies, the productivity of established companies, the solutions to urgent societal challenges e.g., climate and demographic changes, meaningful employment, enhanced security, and better quality of healthy lives for all European citizens – so boosting European competitiveness.

⁵¹ European Commission (2024). Ex-post evaluation of Horizon 2020.

⁵² European Commission (2024), Research and innovation for a competitive green and fair Europe.

<https://op.europa.eu/en/publication-detail/-/publication/e830b15b-e4db-11ee-8b2b-01aa75ed71a1/language-en>

2. **BETTER FOCUSED BUDGET**

Given the importance of RD&I and the multiple demands on EU budgets, going forward the framework programme needs to focus on programmes that achieve relevant impact and that create added value. Our recommendations give some guidance as to how to optimise the RD&I budget deployment accordingly. Importantly the overall programme should **cover the full spectrum of RD&I**. It is always difficult to downsize or close existing programmes even if they are not consistently excellent or relevant. Some programmes may be average, outdated or simply of lower priority and heterogeneous (i.e. they have both good and poor parts). Inevitably attempts to downsize or close are met with objections from incumbents, particularly MS or stakeholders who benefit from such programmes and who will emphasise the good parts.

However, managing an instrument portfolio optimally within a fixed budget requires dynamic management, including difficult pruning. We encourage such courageous management from the European Commission combined with support and understanding from MS.

These issues are a current reality as illustrated by recent consultations eliciting considerable criticism of the **European Institute of Technology - EIT** with some (e.g., Submission of Denmark to European Commission consultation) calling for complete closure, while others highlighted successful parts. The RTD evaluation report of the EIT is in marked contrast to the very critical commentary of Fraunhofer – one of the major participants in EIT programmes – which argues forcefully that EIT is past its prime, provides little added value and should be closed. Equally, Fuest et al (2024) argue that much of the **European Innovation Ecosystem - EIE** activities add little demonstrable value beyond those existing in other programmes. Recommendations 8 and 9 expand further on these matters but dynamic management, including pruning, is an essential part of optimally and responsibly focusing a fixed budget on achieving maximum added value, operational efficiency by lowering transaction costs, as well as driving much needed simplification.

3. **RINGFENCED BUDGET**

In recent years the RD&I budget has been raided to fund new priorities. This is not appropriate for a programme that is critical for Europe's future. We therefore recommend that the initially agreed budget is **ring fenced** to prevent it from being cut in future years to fund other activities.

Of course, we support the need for **flexibility WITHIN the RD&I budget** to respond to new opportunities or threats. Recommendation 9 regarding **more open calls** across the entire programme would also help create predictable flexibility.

4. **FUND ALL APPLICATIONS REVIEWED AS EXCELLENT ACROSS THE FRAMEWORK PROGRAMME THROUGH A COMBINATION OF EU FRAMEWORK PROGRAMME, STRUCTURAL, AND MEMBER STATE FUNDS** (e.g., through Seals of Excellence):

WHAT? AND WHY?

As described above over 70% of proposals evaluated as excellent and worthy of funding cannot be funded, due to lack of budget. Approximately 20% of these non-funded high-quality proposals- mostly in the mono beneficiary programmes - were awarded a *Seal of Excellence* to allow the Member State to fund them using national or structural funds without further review and without breaching state aid rules in the case of companies.

This is clearly an efficient process for both the Member State as the European Commission has handled the administration and evaluation of the proposal and for the applicants, since no further proposal writing and submission is required (see Recommendations 8 and 9). According to European Commission data from 2021-2023, under HE 4,622 Seals of Excellence were awarded – 3,616 under MSCA programmes, 842 under EIC Accelerator and Transition programmes, 145 under ERC programmes, 13 under WIDERA Teaming and 7 under Climate Mission. **Only a very small fraction of these Seals of Excellence have been funded by some Member States.**

To give a clear example in the July 2024 EIC Accelerator announcement, 969 deep tech innovative companies submitted an eligible full proposal for grant/equity funding. Following initial expert evaluation, 347 companies were shortlisted for interview and 68 were funded and 273 assessed as worthy of funding and received the **European Seal of Excellence**. This is a success rate of 7% (the lowest in HE where the average is 15.9%) and means that 273 excellent innovative European deep tech scaling companies received no EIC grant or equity funding. Such results stand in stark **contradiction** to the stated priorities of growing European economic and technological competitiveness.

HOW?

We therefore recommend that both the European Commission and MS act to improve this situation by increasing the numbers of high-quality proposals funded both by the Framework Programme itself and by MS using the Seal of Excellence. We further recommend that MS report details of the **Seal of Excellence** proposals they have funded under a revisited **European Semester co-ordination process** (see Recommendation 8).

5. **GUARANTEE THAT THE FRAMEWORK PROGRAMME ALLOWS EUROPE TO TAKE THE LEAD IN INTERNATIONAL/GLOBAL RD&I COLLABORATION AND GOVERNANCE.**

International collaboration is essential to address many challenges including global issues like climate and demographic changes. Europe must have a strong RD&I programme both to be a credible international partner and a strong leader in such global collaborations. We elaborate further on international collaboration in Recommendation 11.

Recommendation 4

Establish an experimental unit to test new programmes, evaluation procedures and instruments

WHAT? and WHY?

There are two main reasons for this recommendation. First, most EU and MS programmes support **incremental** scientific advances, development and innovation. These are important but Europe also urgently **needs to foster disruptive, breakthrough and transformative scientific advances and innovation to catalyse paradigm shifts** (“normal” science is the everyday puzzle solving activities of scientists in the context of a prevailing paradigm⁵³).

Disruptive, paradigm shifting research and innovation is rarer, harder, potentially more impactful than incremental research and innovation. They are also unlikely to be fostered by conventional procedures and programmes that are prevalent in the EU today. There are already organisations, many outside the EU, **experimenting with diverse ways of soliciting and reviewing proposals** (see Box 4.1) some of these should be considered and new ones invented.

Box 4.1. Some examples of diverse soliciting and reviewing procedures

- High divergent reviewer values – Howard Hughes Foundation, USA
- Targetted solicitation – DARPA; NSF; BARDA - USA
- Heilmeier’s catechism – DARPA - USA
- Research with no/little precedent – Israel OCS
- Adversarial collaboration – Templeton Foundation, USA
- Randomized selection/“lotteries” for the selection of high risk/high gain projects. Currently experimenting “distributed peer review” – Volkswagen Foundation, Germany
- Merit review for excellence followed by independent impact ranking of excellent proposals – Science Foundation Ireland Centers, IR; Research Institutions Assessment - (FCT), Portugal
- Sandpit – Ideas factory EPSRC, UK; Takeda-Techno Entrepreneurship, JP
- Proactive call – BP Venture Research, UK
- Unconstrained creativity – Mac Arthur Fellows, USA
- Target Prize Competition – X Prize Foundation, USA
- Ongoing Target Prize Competition – Methuselah Foundation, USA

The proposed experimental unit should also develop ARPA-like programmes, which are currently completely absent from the Framework Programme The description of ARPA-like programmes, their advantages and necessary conditions for success are elaborated in Recommendation 5. We recommend that **ARPA programmes commence within the EIC**, but following successful experience there, are **adopted by other appropriate parts of the Framework Programme**.

⁵³ See, for example, Kuhn (1962). The Structure of Scientific Revolutions.

Second, AI, particularly *Generative Artificial Intelligence, or GenAI*, systems have great potential to support the progress of science, research and innovation and may even change how future research is performed⁵⁴. GenAI systems will have a major effect on how proposals are written and reviewed, how topics are selected for calls, how particular inter- or trans-disciplinary approaches might lead to new insights and how convergent areas/technologies might lead to significant innovations. GenAI systems can streamline processes and increase productivity by automating routine tasks to the benefit of both applicants and funding agencies. GenAI systems can enhance the speed of diffusion of results and their commercial translation⁵⁵.

We consider it absolutely critical that the current and future framework programmes embrace and experiment with AI, in order to learn what works well and what to avoid rather than fear or ban the technology or fail to rapidly capitalise on the potential benefits. Some international granting agencies (e.g., NSF) are already building their own AI platforms, processes and procedures both to prevent public disclosures (e.g., from reviewers using commercially available AI products) and to harness additional value from the applications and reviews.

AI will not only have an impact on procedures and tools, but it also promises to have a major impact on the processes of scientific discovery and as such AI must also be promoted with relevant support for researchers to access appropriate computing resources and data to ensure Europe does not fall behind in the application of this fast moving and potentially transformative technology.

While the promises of GenAI give us the hope of a tremendous acceleration in analyses and discoveries, they also call into question practices and respect for the values of scientific practice like replicability, accountability and scientific integrity⁵⁶. The EU has developed guidelines to support the responsible use of GenAI and the recent editorial of the Proceedings of the National Academy of Sciences (US) proposes five principles of human accountability and responsibility to protect the integrity of sciences and the creation of a *Strategic Council on the Responsible Use of Artificial Intelligence in Science* to analyse and monitor the use of AI in science and provide regularly updated guidelines.

The recent report of the *Scientific Advice Mechanism of the European Commission* “Successful and timely uptake of artificial intelligence in science in the EU”⁵⁷ also argues in favour of the deployment of AI, which has become a geopolitical asset and an opportunity that the EU must seize, warning of the risks and noting the importance of giving clear guidelines.

We are **at the very beginning** of the use of **AI in the sciences**, and at the same time this use is **spreading very rapidly**, so it is important at this stage of its development to put in place the **necessary infrastructure to monitor practices and experiment to rapidly capitalise on the potential benefits and establish the necessary safeguards**. This may no longer be the case in the future, when the use of AI has been mastered, so this subject is completely appropriate for the experimental unit.

⁵⁴ See, for example, Qian, J. (2024), “Unleashing generative AI: funding implications and insights from China”, *Journal of Asian Public Policy*, DOI: 10.1080/17516234.2024.2381549, with reference to emerging developments in China.

⁵⁵ Nature (2024), “Seven technologies to watch in 2024” <https://www.nature.com/articles/s41587-023-01769-w>

⁵⁶ See Kwon, D. (2024), AI is complicating plagiarism. How should scientists respond? <https://www.nature.com/articles/d41586-024-02371-z>

⁵⁷ EC’s Group of Chief Scientific Advisors (2024), *Successful and timely uptake of artificial intelligence in science in the EU: scientific opinion*. Brussels: EC.

HOW?

- Immediately establish an **experimental unit** team within EC's DG RTD, led by a **visionary and effective leader with a clear mandate**. Ensure that this team includes individuals capable of understanding the fast-moving cutting edge of AI application and individuals experienced in funding administration. Insist that this team will work collaboratively with the different Horizon programmes/agencies and that for efficiency (and subsequent rapid adoption if appropriate) all experimental calls will be executed collaboratively with those programmes/agencies.
- Give this experimental unit **MAXIMUM flexibility** from Commission rules and procedures to be able to rapidly experiment with diverse procedures in collaboration with any Horizon programme or agency.
- Give this Unit a **significant budget** which it can use collaboratively with any Horizon programme or agency to rapidly execute these innovative experimental calls and procedures.
- Immediately commence **building an internal closed data base and GenAI system** that can be used both by future reviewers and by the European Commission and its agencies. Understand, engage with and learn from comparable initiatives internationally and where appropriate (e.g., with MS), plan for such a database and GenAI system to be added to and used collaboratively by those countries national funding agencies.
- Immediately **investigate how GenAI systems can be used quickly and reliably** to automate routine procedures and so increase productivity and efficiency for applicants and DG RTD and its agencies.
- Continuously update **appropriate guidance to both applicants and reviewers on the use of GenAI**, based on learnings from the experimental unit and international best practice including stakeholder initiatives (e.g., in MS, research institutes, RTOs, etc.) to rapidly inform and harmonise MS national guidance.

Immediately establish the necessary systems to **monitor internationally** the use of AI in the practice and translation of science, ensure this is rapidly communicated to researchers, informs appropriate guidance and results in the rapid acquisition or adaptation of infrastructures to support researchers use of AI.

Recommendation 5

Strengthen competitive excellence in Research and Innovation

Box 5.1: Definition of Competitive Excellence

Competitive excellence is defined as optimal harnessing from a large pool of applications submitted to open calls, to competitively select the most excellent proposals for funding by using appropriate criteria.

WHAT? and WHY?

To enhance European competitiveness the criteria of excellence in RD&I must be reinforced throughout Horizon Europe and FP10. ERC, EIC and MSCA are globally respected programmes that work, deploy highly professional procedures, and have enthusiastic widespread support from the evaluations and consultations, including from industry who are often indirect beneficiaries⁵⁸. Their outputs show a multiple return on investment and address the wake up call to Europe in terms of our slipping global positions in new scaled tech companies, as well as publication and patent quantity and quality.

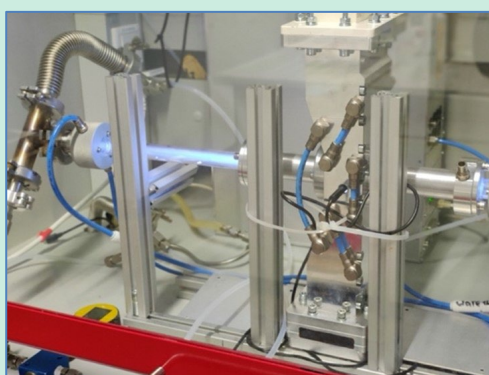
They are synergistic and coherent with each other, for example, **more than half (71 projects) of the funded EIC Transition projects were won by ERC grantees**, and with other framework programmes. The **EIC leverages EUR 3.8 of private VC investment for every EUR1 of EIC investment**⁵⁹. This synergy is evident in the many published case studies (one of which is highlighted in Box 5.2).

⁵⁸ See ERT (2024): also, Analog Devices (2024).

⁵⁹ See, for example, ERC Brochure describing 16 EIC Accelerator funded companies linked to previous ERC funded researchers in quantum and biotech and in the career paths of individuals; European Commission (2024), Examples of ERC-supported research contributing to the creation of companies awarded an EIC Accelerator, ERC, EC. Also, EIC (2023) and EIC (2024).

Box 5.2: Annemie Bogaerts – competitive excellence through MSCA, ERC and EIC

Professor Annemie Bogaerts is Head of the PLASMANT research group (~50 researchers) at the University of Antwerp, www.uantwerpen.be/plasmant. A world authority in plasma research, she focuses on medical applications and sustainable chemistry. She testifies that her research and spin-offs would not have been possible without support from the EU FP grants: “my research was originally focused on computer simulations of plasmas but I gradually broadened my curiosity-driven research. I am the corresponding PI of the ERC Synergy Grant SCOPE, allowing me to design experiments for applied research. My applied research group is supported by **MSCA doctoral networks** and several **MSCA postdocs**.”



In 2022, Bogaert won an **ERC PoC project** to sort out how to use plasmas for sustainable fertilizer production. **Her first spin-off, D-CRBN, won an EIC Accelerator Grant** to scale up plasma technology for reduction of CO₂ emission by converting it to CO for the (petro)chemical and steel industries. Since then, **Bogaerts has founded 3 more spin-offs**, transforming her fundamental ERC research into important applications for today's societal challenges.

Caption: Prototype of Bogaert's plasmareactor for the creation of plasma for energy-efficient nitric oxide production from air, meanwhile serving scale-up and commercialisation to replace non-sustainable resources in the poultry farming sector and fertiliser-production industry.

The deteriorating situation in terms of EU scientific and innovation output (see chapter “Framing and Context” of this report) sharply contrasts with the available talent, e.g., as measured by ***the success of funded ERC teams, who produce about one third of all EU publications and seven times more top 1% cited publications than the worldwide average.***

The **ERC is an essential programme for European universities** enabling them to recruit, support and retain top talent with excellent bottom-up ideas. We strongly support the ERC and the lack of suggested improvements to the programme is simply a reflection that ERC is a mature and well-functioning programme run by an effective Scientific Council working in full independence. **The ERC's success is testimony to the importance of the independence of the Scientific Council which must be maintained.**

The success rate for ERC in Horizon Europe to date is 14% and the oversubscription rate (i.e. % of high-quality proposals not funded) is 43%⁶⁰. This discrepancy underscores the need for a budget increase with a factor of at least two for the ERC, following our analysis

⁶⁰ European Commission analysis. Source: Corda data at 01/01/2024.

of success rates and the impact of ERC publications. This advice to **double the ERC budget** is in line with the Draghi report. Additionally, we note that the ERC budget has not been adjusted for inflation since 2007. Given the uncontested value of the ERC programme for European RD&I this lack of budget needs to be addressed with a significant and much needed increase to fund all proposals ranked as competitively excellent.

The **Marie-Sklodowska-Curie Actions (MSCA)** programme is a similar success story: for Horizon 2020, 62% of all publications resulted from the ERC and MSCA programmes.

The MSCA programme combines research with high-level individual training in academia or in an inter-sectorial way via doctorates with industry. In addition, it fosters collaboration among universities and other research organisations to set up attractive academic career development schemes. **It is exceptionally successful in attracting female researchers (42% of the fellows), as well as in brain-gain, with an influx of 38% in the category of postdoctoral grantees coming from outside the EU** (including many women). The success rate in HE to date for MSCA is 16.5% and the oversubscription rate is 78%.

To address the challenges of scaling and critical technologies the **European Innovation Council (EIC)** was established as a pilot in the closing years of Horizon 2020 and fully in Horizon Europe, with a modest budget of 10B Euros (approximately 9% of the HE budget). The EIC Impact Reports for 2022 and 2023 highlight the achievements and case studies of this young agency which is serving an acute need and establishing an international reputation (see Box 5.3)⁶¹.

Box 5.3. Some EIC Accelerator achievements to date

- Over 500 companies funded;
- Crowding in 3.8 Euros of private investment for every Euro of EIC investment;
- Over 12 billion Euros of follow-on investment in those companies with the current portfolio valued at over 70 billion Euros (150 companies valued over 100 million Euros, 15 over 500 million Euros and 8 over 1 billion Euros);
- A recent report by Jolt Capital's Jolt.Ninja⁶², reported that EIC funded companies raised more capital, created more jobs, developed and invested in better and stronger intellectual property than a comparable group of companies not funded by EIC;
- Increased success rate of female founders/executives from initially low single digit to currently 20%;
- Funded companies address critical technologies, e.g., AI, Quantum Computing, Advanced Materials, Biotech, etc., and EU priorities such as Green & Digital.

The **EIC Accelerator programme** provides grants and/or equity to successful **deep tech** company applicants (see Box 5.3). A key objective of EIC Accelerator is to de-risk the investment for private VC's and therefore "crowd- in" external financing.

⁶¹ European Commission analysis. Source: Corda data at 01/01/2024.

⁶² See details at TechTour. (2024). EIC Catalyzing Change: The Atlas of EIC_Supported Scale-Up Success. <https://techtour.com/news/2024/catalyzing-change-eic-supported-scaleup-success.html>

The **EIC Transition Programme** funds translation projects from research findings to **start up company**. Demand is high, such that, to preserve low single digit success rates, applications were initially restricted.

The **EIC Pathfinder Programme** funds thematic research in **priority areas**, typically in **consortia**. Expert programme managers monitor and manage a portfolio of projects in specific domains such as biotech, materials, food, etc.

The success rate for the EIC is 8% and the oversubscription rate is 72%⁶³. This EIC success rate is the lowest in HE where the average success rate is 16%. The **data emphasise the need to significantly increase the EIC budget** – as also recommended in the Draghi report.

Analysis of the open calls run by both the ERC and EIC reveals a surprising finding, namely that these open programmes fund a high percentage of proposals in areas of European Commission strategic priority⁶⁴. Importantly they typically **fund these proposals earlier and faster than focussed calls** (likely due to the inevitable delay in identifying and agreeing on priorities and then rolling out appropriate focussed programmes). This emphasises the importance of **open, non-prescriptive calls** as a mechanism to **ensure resilience** and a **rapid response to emerging new opportunities and priorities**.

HOW?

- **Keep excellence as the base criteria for all FPs, as it is today.**
- **Preserve and reinforce the structure and governance of the ERC, EIC and MSCA.** Specifically ensure the **independence, authority and quality** of the ERC Scientific Council and EIC Board, who represent **eminent practitioners in appropriate fields** and who play a critical role in steering the agencies programmes and ensuring they are at the cutting edge of best practice internationally and in the private sector. Maintain the successful administration of MSCA and do not merge it with Erasmus+, or ERC.
- **Increase the budget of the ERC, EIC and MSCA and encourage Member States to fund all Seals of Excellence** with national funds and European structural funds, as further detailed in Recommendation 3.
- **Address the unacceptable low success rate of EIC** by increasing the budget initially by restoring recent budget cuts and by boosting the EIC Fund through private investment – see paragraph c below.
- **Introduce the EIC Pre-Accelerator programme to address the low success rates of applicants from widening countries.**
- Further improve **synergies between ERC, EIC and the two Councils** proposed in this report (Recommendations 6 & 7) and **other FP activities** (see Box 5.4).

⁶³ European Commission analysis. Source: Corda data at 01/01/2024.

⁶⁴ European Commission analysis. Source: Corda data at 01/01/2024.

Box 5.4: Life Sciences – an example of an important area ripe for increased synergies and investment across the FP

- Life Sciences encompasses biomedical, medical, biotech and agricultural fields.
- **ERC** receives and funds a large number of applications in this field showing a **high density of excellent European academic researchers**. They represent about 52% of overall ERC investment.
- **EIC** receives and funds the largest number of applications in this field showing a high density of European entrepreneurs and opportunities for enhanced ERC/EIC synergies. They represent about 40% of the overall EIC portfolio.
- ERC and EIC applicants show a good **gender balance in life sciences (e.g., for EIC 30% compared to an average in all fields of 17%)**
- The European Pharmaceutical, Diagnostic and Device Industries are strong investors in RD&I (e.g., Novo Nordisk, Siemens, among others) - **opportunities for synergies with Industrial and Technology Council** - Recommendation 6
- The European biomedical charity sector is strong (e.g., Wellcome, Novo Nordisk Foundation) - **opportunities for synergies with Societal Challenges Council** - Recommendation 7
- Post Covid-19 the European Commission has already commenced pre-commercial procurement in this sector making it a good candidate to expand into **innovative procurement** in the FP programme - Recommendation 10
- USA leads in biomedical and medical publications and patents and UK is strong and prioritises the Life Sciences sector so that meaningful **international collaborations** at scale with the FP programme could be developed - Recommendation 11
- Emerging technologies such as **AI and Quantum computing** applied to life sciences are predicted to lead to important **new discoveries and their rapid translation into economic and societal benefit**. **Europe is advanced in such applications:** e.g., Novo Nordisk Foundation / University of Copenhagen Quantum Foundry and Quantum Computing (NQCP) initiatives.
- New technologies applied to **agriculture** are necessary to reduce its carbon footprint, increase climate resilience and increase food security.
- Societal and economic challenges in life sciences are significant - ageing population, disease prevention and treatment, food supply, and RD&I in this sector has strong public support.

The following paragraphs address sub-bullets of Recommendation 5.

ATTRACTING AND RETAINING TALENT THROUGH AN ENHANCED MSCA PROGRAMME, INCLUDING A NEW INSTRUMENT TO FOSTER CAREERS OF YOUNG RESEARCHERS (“Choose Europe”). Increase the **MSCA industrial network programme for larger cohorts**.

WHAT? and WHY?

Providing opportunities to retain and attract outstanding young researchers in Europe and providing them with the ability to pursue innovative research is important for maintaining and growing the future European talent pool for both industry and universities.

We propose to add to the current portfolio of excellent MSCA and ERC programmes by establishing a new **Choose Europe** instrument specifically focused on **outstanding young researchers** in, or following, their first postdoctoral position to enable them to rapidly

become independent researchers. We believe that by **giving outstanding young researchers an early opportunity** to pursue their creative ideas, Europe will be internationally attractive and benefit from their presence and results.

It should be open for these applicants to conduct their research in any suitable environments: Universities, PROs/RTOs, companies, large or small and in collaborative arrangements between such institutions. To increase the appeal of this programme to the best individuals globally and to maximise the chances of Europe retaining this talent, **the hosting institution, e.g., a university, should commit to advertising an employment position in the successful applicant's field towards the end of the 5 year Choose Europe funding period.** MS wishing to attract such promising young talent should also ensure a smooth, efficient and supportive **relocation process** (e.g., visas for applicants, spouses and children, housing)⁶⁵.

We also recommend that the existing **MSCA programmes (PhD and postdoc) with Industry (both large and small) are enhanced and expanded.** These are appreciated both by industry⁶⁶ and public research organisations⁶⁷.

HOW?

- **Establish a new “Choose Europe” initiative**, under the MSCA programme, to be specifically oriented **to foster careers of young researchers throughout Europe** (i.e., two to three years after doctoral degree).
- Expand the **MSCA Industry programmes.**

STREAMLINING AND BOOSTING THE EUROPEAN INNOVATION COUNCIL FUND BY ATTRACTING SUBSTANTIAL PRIVATE INVESTMENT (E.G., FROM EIB, MEMBER STATE FINANCIAL INSTITUTIONS, PENSION FUNDS)

WHAT? and WHY?

Venture capital (VC) investment in the EU is 0.1% of GDP, whereas in USA it is 10 times higher, at 1% of GDP⁶⁸. In 2023, VC investment in Deep Tech companies in the USA was \$120B, in Europe it was \$45B⁶⁹. Europe's VC assets are one fifth of those in the USA⁷⁰, in part because of investment restrictions on pension funds in Europe.

⁶⁵ See The Economist (2024). “Talent is scarce. Yet many countries spurn it”. Also, National Academies (2024).

⁶⁶ ERT (2024).

⁶⁷ See, for example, EMBL (2024).

⁶⁸ European Union (2024).

⁶⁹ Atomico (2024), State of European Tech 23; Atomico; <https://stateofeuropetechnology.com/>

⁷⁰ McKinsey (2024) Accelerating Europe: Competitiveness for a new era. <https://www.mckinsey.com/mgi/our-research/accelerating-europe-competitiveness-for-a-new-era>

Pension fund investments comprise 20% of the VC capital in USA but only 8% in Europe⁷¹: US Pension Funds hold 5 billion euros of investment in German startups, but German Pension Funds hold less than 100 million euros in German startups⁷². European VC funds are generally smaller than those in USA, so struggle to do significant follow-on funding and large funding rounds. Consequently, Europe's startup boom (Europe created more startup companies than the USA in 2023) meets a funding bottleneck and fails to scale or relocates to the USA. The **USA has 60% (7,500 companies) of all scale up companies in the world, Europe has 8%** (990 companies, of which 623 are in the UK)⁷³. This is especially worrying in important new technologies with massive global markets, e.g., in 2023 a total of 35 generative AI companies scaled in USA while only 3 in Europe, reflecting \$23B VC investment in USA but only \$1.7B in Europe⁷⁴.

In the EU, as companies grow the financial constraints widen – EU scale up companies raise 50% less capital in their first 10 years than their San Francisco peers⁷⁵. The scarcity of EU investors pushes EU companies to seek funding abroad and at exit to look for a foreign buyer or list on a foreign stock exchange. Lead investors play a crucial role in funding rounds – attracting additional, more generalised investors, due to the specialised knowledge and successful track record of the lead investor.

In the EU, 80% of scale up investments involve a foreign lead investor compared to only 14% in San Francisco⁷⁶. Whilst relocating overseas may provide increased market valuation gains and increased financing for EU scale ups, it saps Europe's potential to retain industry leaders and develop new technologies and it weakens the flywheel effect by which new leaders support the next generation of startups, causing entrepreneurial brain drain and missed opportunities for the local European ecosystem.

To begin to address these challenges, the EIC was created and in only a few years has proved to be a much needed and successful programme. Over 90% of applicants seek blended finance of grant plus equity which is a unique and valuable EIC offering. But, as indicated earlier, this huge demand and inadequate budget has resulted in the **lowest success rates** in Horizon Europe (8%) and the award of **841 seals of excellence** to high quality innovative companies evaluated as worthy of funding but for which there was **no money available**. Additionally, as companies in the EIC portfolio grow and scale, so the need for follow on investments increases, to ensure that these companies grow properly in Europe and contribute to European technology autonomy.

It is unreasonable to believe that the substantial additional funds needed could come from the Framework Programme alone. Fortunately, this challenge was planned for when the EIC was established and the EIC Fund was legally established to be able to accept private investment. Given the initial success of the EIC and the clear need for substantially more funding, **it is now time to activate such private investment.**

⁷¹ See detailed analysis in McKinsey (2024).

⁷² Atomico (2024).

⁷³ Start Up Genome (2024), "The Scaleup Report - Discover what leads startups to successfully scale", <https://startupgenome.com/>

⁷⁴ Details in McKinsey (2024).

⁷⁵ EIB (2024), "The scale-up gap: Financial market constraints holding back innovative firms in the European Union", <https://www.eib.org/en/publications/the-scale-up-gap>.

⁷⁶ Detailed data in EIB (2024), "The scale-up gap: Financial market constraints holding back innovative firms in the European Union", <https://www.eib.org/en/publications/the-scale-up-gap>

HOW?

- Immediately the European Commission should start to **attract private investors to the EIC Fund**. Potential investors could include pension funds, insurance funds, family offices, MS Financial Institutions, EU Financial Institutions/Instruments (e.g., EIB, EIF, ETCI, InvestEU). MS Financial Institutions would invest under common standard terms so this can be seen as a pilot promoting common EU financial markets.
- The fund should be a **10-year fund of EUR 30 billion** (based on current demand and anticipated needs for follow on funding). The European Commission should commit that any gains made by its investment in that fund should be invested in the next fund required to replace it in 10 years time – so lessening the financial burden for future FP's. The European Commission should be an **anchor investor** in the fund committing a significant percentage so as to attract other private investors.
- In diversifying and expanding the EIC Fund with additional investors, the European Commission **changes from being the sole investor to a limited partner (LP)**. This means that the EIC Fund management must change from the current clunky process (instituted at the start of HE) involving at least 5 different committees/entities to a **streamlined professional management staffed by individuals experienced in venture and growth financing**. Such professional management structures are common in other funds where a European Institution is an LP (e.g., Marguerite 3 fund).
- The unique **EIC blended finance offering of grant plus equity must be maintained**, but decisions about grant and equity do not need to be taken by the same team.
- The EIC fund should be able to **invest at a wide range of ticket sizes up to EUR 100 million**, but with the clear principle of leveraging in additional private investors and ensuring future European technology competitiveness and strategic autonomy.

Wider Innovation Reforms

Whilst our recommendations are specific to the Framework Programme and EIC, we recognize and strongly endorse the need for wider reforms beyond the FP including those in the Letta⁷⁷ and Draghi⁷⁸ Reports which will greatly benefit EU Innovation (see Recommendation 1).

All improvements in single market harmonisation will greatly ease the ability of scaling deep tech companies to grow and sell in Europe. All improvements in capital markets (e.g., permitting/encouraging pension fund investment in venture capital) will greatly assist in addressing the current dearth of VC funding in Europe as compared to the USA. The adoption by all MS of the **single unitary patent**, the **integration of EU capital markets** and the introduction of “**Innovative European Company**”, as recommended by the Draghi Report⁷⁶, are strongly supported.

An **additional 100 billion Euro scale up fund(s)** – with the majority coming from the capital markets – is necessary to close the gap and remain competitive with the USA. Implementation of a **single market, globally competitive EU company statute** (as also recommended by the Letta report) specifying company establishment rules and regulations (e.g., share options, share classes and rights, capital gains tax for founders and shareholders after a liquidity event - an EU equivalent to the very successful US Delaware Incorporation). This would remove existing impediments, harmonise and simplify the EU for international investors and founders, encourage the movement of capital and people within

⁷⁷ Letta, E. (2024).

⁷⁸ Draghi, M. (2024).

the EU single market and both speed up and reduce the cost of new company formation and scaling.

Virtuous Cycle

Implementing the above recommendations and creating **globally successful, scaled, EU deep tech companies**, will be good for European GDP, employment, productivity, competitive advantage as well as allowing us to address societal challenges more effectively and make better use of the excellent science Europe produces. These companies produce more new innovations⁷⁹, e.g., globally in 2023 the AI companies produced 51 new Machine Learning Models, industry/academic collaborations 21 and academia alone 15. These companies fund significant volumes of basic and applied research – 36% of all basic research in the USA is funded by companies which is close to the 40% funded by the US Federal Government (including NSF, NIH, DoE, DoD)⁸⁰.

Ex-employees of scaled tech companies also create more new companies, e.g., over 20 years Skype alumni started over 900 companies in 50 countries employing 65,000 people⁸¹ and some become VC or Angel investors, e.g., Atomico – a large European VC – was founded (and is managed as CEO) by Niklas Zennstrom, a former Skype founder/CEO. **Scaled deep tech companies have a significant tech, talent and funding flywheel effect.**

INTRODUCING DISRUPTIVE INNOVATION PROGRAMMES INTO THE EIC, TOGETHER WITH THE CAPACITY TO ATTRACT MORE PRIVATE CO-INVESTMENT OF DISRUPTIVE IDEAS AND FIRMS.

WHAT? and WHY?

Currently the EIC has no programmes to **stimulate disruptive innovation**, and these have been advocated in the consultations particularly **to address Europe's middle technology trap**⁸². **Prize funding methodologies**, such as those used by the X Foundation, should be considered in collaboration with the Experimental Unit in Recommendation 4.

ARPA-like programmes are missing within the Horizon Europe Programme (see also Recommendation 4). DARPA has been hugely successful and important in US innovation. There have been a number of attempts to establish ARPA agencies or processes in different domain areas, e.g. energy, health, intelligence and in different countries, with mixed success; none yet achieving the stature or influence of DARPA⁸³. It is widely reported that **DARPA's success** depends on a number of special factors including: the stature, temporary tenure, salary, ambition and power of the **programme managers**, **proactive solicitation and dynamic management** (and funding) of projects, **review using Heilmeier's catechism**, **risk tolerance**, **large military procurement** and an **activist**,

⁷⁹ AI Index (2024).

⁸⁰ NSF/NSB (2024), "A Changed Science and Engineering Landscape", https://www.nsf.gov/nsb/news/news_summ.jsp?cntn_id=309993

⁸¹ Atomico (2024).

⁸² See, for details, Fuest et al. (2024).

⁸³ See, for example, the detailed analysis of Fu et al. (2021).

change agent, high risk high reward culture where many failures can be justified by a single success.

Azoulay et al (2018) define the four characteristics of the ARPA model as

- The flexible nature of its organisation;
- The identification of “technological white space” and design of programmes to fill that void;
- The discretion in selection of projects by programme managers;
- The active management of each project using specific milestones and time commitments.

Goldstein and Kearney (2018) analyse the importance of programme directors at ARPA-E being given a set of real options with which to actively manage projects: abandon, contract or expand project budgets or timelines. Colatat (2015) demonstrates how active project solicitation and management results in a higher likelihood of novel collaborations than conventional funding, whilst Bonvillian (2018) highlights how DARPA and its US clones actively promote the follow-on development and implementation of technologies they support.

In a thoughtful paper, Fu et al (2021) compliment these analyses of the ARPA agency approach by analysing the importance of the innovation ecosystem to which an ARPA approach can be applied. They conclude that the **highly successful DARPA model** is best applied to a targeted problem space that can be matched to a **dense innovation ecosystem of potential solution providers**. This narrow scope/high solution provider density allows sensible portfolio management. For a nascent innovation ecosystem (e.g., an emerging research area where the scope of the problem is broad and solution providers are few), they propose an **ecosystem growth model** which transforms the DARPA model from one focussed on strategic selection to one **focussed on strategic growth** by emphasising programme iteration, solution provider incentivization, portfolio integration, and organisational bandwidth. **Both dense and nascent innovation ecosystems exist within the EU so ARPA approaches should be tailored accordingly.**

The EIC started to introduce ARPA like processes and building on this experience is one of the reasons we recommend that the proposed experimental unit (Recommendation 4) first work with EIC on implementing ARPA projects. In 2020 the EIC published a detailed report⁸⁴ commissioned from ARPA experts outlining how pro-active project management could be introduced to stimulate breakthrough technologies and innovations. Implementation of this report hit a number of challenges e.g., although the EIC has hired **expert programme managers** they have **not** been given the **operational freedom** of their DARPA counterparts, European Commission and RTD budgetary and financial rules and guidelines hampered the implementation of meaningful project management. We recommend that these obstacles are addressed so as to **introduce effective and appropriate ARPA programmes within the EIC.**

⁸⁴ European Commission (2020), Implementing the pro-active management of the EIC pathfinder for breakthrough technologies & innovations: Lessons from the ARPA model & other international practices, EC, June 2020.

HOW?

- The **EIC Board and agency should immediately consider the expert report of 2020** (much of which is still relevant⁸⁵), experience and challenges to date and draw up an execution plan (collaboratively with the experimental unit described in Recommendation 4, if established) to introduce effective ARPA programmes initially in a focussed way.
- The European Commission and DG RTD should permit **MAXIMUM flexibility** in all relevant rules and guidelines. If sufficient flexibility cannot be granted for an effective ARPA programme within the current legislative base, then the necessary legislative drafting should be prepared for full implementation in FP10. The legislation to permit such operational freedom and the corresponding organisational culture has been introduced in MS e.g., in Germany, through SPRIND⁸⁶ and the recent SPRIND D legislation.
- To the maximum extent currently possible **EIC Programme Managers** should agree on a mandate with the Board and Agency to achieve a precise objective within a defined budget and timeframe and be **granted maximum freedom** to use the budget through EIC calls, procurement and prizes, among other instruments.
- The **involvement of a customer** for the output of any ARPA like call is key to success. We recommend the involvement of **business and procurers** so as to help stimulate **European industrial competitiveness** and address the desire expressed in several consultation submissions of existing EU companies to become involved in EIC programmes. Specifically, we recommend that the **EIC Programme Managers each develop a narrow-targeted problem** (as defined above) with the direct involvement of companies or procurers in defining the challenge and a **direct link to future procurements** (e.g., through advance purchase agreements which the European Commission has started in the Health field post covid and in the defence fund but not yet in Horizon Europe).The importance of stimulating innovative procurement is further elaborated in Recommendation 10.
- Explore with the proposed experimental unit (Recommendation 4) the **use of AI and appropriate databases** to both identify appropriate challenges and possible diverse solution providers.

⁸⁵ See European Commission (2020). Implementing the pro-active management of the EIC pathfinder for breakthrough technologies & innovations – Lessons from the ARPA model & other international practices. <https://op.europa.eu/en/publication-detail/-/publication/fee3496e-23d0-11eb-b57e-01aa75ed71a1/language-en>

⁸⁶ Created by the German government in 2019 following US's DARPA, "SPRIND aims to identify and develop research ideas with the potential to produce radical or breakthrough innovation, as well as accelerate the commercialisation and diffusion of highly innovative ideas". Following OECD (2022), the ability of SPRIND "to live up to its mission and mandate is currently hampered by bureaucratic, legislative and institutional factors. SPRIND faces a number of operational barriers that could mitigate its effectiveness". See also Matthews, 2024. The SPRIND D act aims to remove such barriers.

- **Explore with the proposed experimental unit** (Recommendation 4) whether the initial implementation of a strategic growth ARPA programme for nascent innovation ecosystems is best implemented by EIC, or by the proposed two new Councils (Recommendations 6 and 7). In either case, ensure good communication and collaboration between the EIC and the two councils (Recommendations 6 and 7), e.g., to discuss scale-up needs and private investment and to agree on meaningful long-term metrics to measure how new innovations generate market share and revenues e.g., “Sales of new-to-market and new-to-firm innovations” as used in the European Innovation Scoreboard.

Recommendation 6

Stimulate industrial RD&I investment in Europe by creating an Industrial Competitiveness and Technology Council

Box 6.1: Definition of Competitiveness

Competitiveness is defined here as the ability to provide state-of-the-art products, services and technology-based solutions which contribute positively to overall sustainability (economic, environmental and social) for which there is a market demand or that create new markets.

WHY?

In a world defined by disruptive technology, geopolitical tensions and threats to national security, as well as an ageing European population and an accelerating climate crisis, a strong and competitive industry is perhaps more important than ever to ensure a secure, prosperous and sustainable Europe. **The only way to ensure Europe's long-term industrial competitiveness, in turn, is to invest substantially in research and innovation for future technologies, industries and sectors.** Investing in research and innovation must also be a critical component of any industrial policy aimed at raising productivity and driving green growth⁸⁷.

Industry is the largest source of RD&I expenditure: its investments in research, development and innovation are not only critical to the EU's scientific and technological strength: they are essential in turning knowledge into products, services and solutions, in creating value and prosperity, in achieving climate neutrality, and in providing good jobs. Industrial innovative capacity and strength are also critical to avoid problematic dependencies in Europe's economy and security (e.g., in the form of supply chain disruptions), thus ensuring that the EU does not become vulnerable to foreign threats to democracy and freedom; to ensure Europe's ability to protect and defend itself from foreign aggression and nefarious interference; and to combat and mitigate climate change and address other societal challenges.

This is, in many ways, **a critical or 'turnaround' moment for industry in the EU**⁸⁸. It needs to achieve the green transition, embrace and drive the development and uptake of new disruptive technologies (such as AI, quantum technologies and biotechnologies), and transition out of declining industries and sectors into the future. Moreover, it needs to do all this at a time of unprecedented speed of change and turbulence, amidst growing geopolitical tensions and supply chain disruptions and in competition with companies (e.g., in the US and China) which benefit from both larger, more integrated markets, better access to capital and more state protection and support.

⁸⁷ See Bruegel Blueprint 33 080823 web.pdf, IMF (2024), and the chapter by Alessio Mitra, Jan-Tjibbe Steeman in European Commission (2024), "SRIP 2024 - Science, research and innovation performance of the EU – A competitive Europe for a sustainable future", pp. 102-129.

⁸⁸ ERT (2024).

Currently, the biggest challenge to European competitiveness is that **industry invests too little in research, technology and innovation**, particularly when compared to its peers in other regions⁸⁹ (see figure 6.1). This has been called “**the middle technology trap**”⁹⁰.

Of the top ten companies in the world that spent the most on R&D in 2022, only one was from the EU⁹¹. Of the 50 biggest R&D spending companies, 23 were from the US, ten from the EU, and five from China and Japan respectively. These companies accounted for nearly 40% of the total R&D expenditure of the 2,500 companies worldwide that spend the most on R&D (for the ten largest companies, the corresponding figure was 18%). In its latest report, the JRC noted that:

- In the past decade, R&D investments of the EU companies that spend the most on R&D (in absolute terms) have grown less than those of US or Chinese companies
- “the share of EU companies in the top 2 500 R&D investors has fallen over time”.

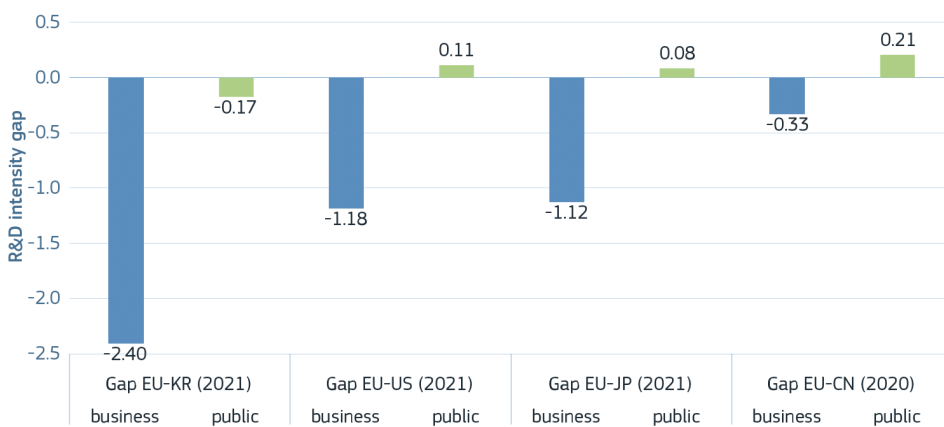


Figure 6.1: Public and private R&D intensity gaps between the US, Japan, China, South Korea and the EU, 2021 or latest year available; Source: European Commission (2024) - SRIP 2024

The EU’s technology portfolio is **more diversified** than the US and China, but the US and China specialize in more sophisticated and thus more high-value technologies⁹². The EU remains strong in technologies related to green transition but weaker in the digital domain (Figure 6.2). Furthermore, the **EU is comparatively weaker than the US and China with regard to the uptake, commercialization and scaling of new technologies**.

⁸⁹ European Commission (2024) – SRIP, Fuest et al. (2024)

⁹⁰ Fuest et al. (2024), p. 3.

⁹¹ Volkswagen; six were from the US and one was Chinese; see European Commission (2023). EU Industrial R&D Investment Scoreboard 2023. <https://op.europa.eu/en/publication-detail/-/publication/1e5c204f-9da6-11ee-b164-01aa75ed71a1/language-en>

⁹² European Commission (2023) The global position of the EU in complex technologies, also, FIW (2024). Innovation, industrial and trade policies for technological sovereignty.

The RD&I Framework Programme has traditionally played a crucial role in strengthening the competitiveness of European industry through collaborative research (Box 6.2). The ex post evaluation of Horizon 2020 concluded that a key strength of Horizon 2020 was multidisciplinary and pan-European cooperation on R&I. This approach proved effective in consolidating expertise, skills and resources from multiple countries, creating a critical mass to raise the quality of research and innovation outputs. The competitive nature of the EU-wide funding process further enhanced quality, ensuring that research was conducted in areas of significant relevance to European society.

- The programme was especially effective in the private for-profit sector, where for every euro of Horizon 2020 funding, project participants invested an additional EUR 0.57.
- The highest degree of financial leverage was achieved in European partnerships: in joint undertakings, private partners' contributions with resources (in cash or in kind) more than doubled or even tripled the volume of EU funding.
- Under Pillars 2 and 3, around one third of publications concerned new and fast-growing research fields, of which 2.2% and 1.3%, respectively, were among the top 1% most highly cited.
- Horizon 2020 has also had a significant impact on the economic performance of participating companies in employment growth, output growth, private-sector funding and investments in intangible assets⁹³.

More than 110 European industrial associations⁹⁴ attest to the critical role of the EU Framework Programme in alleviating market failures and stimulating private RD&I investments by lowering the risks that such investments represent for industry.

⁹³ European Commission (2024), Ex-post evaluation of Horizon 2020.

⁹⁴ SHOs (2024), Joint Statement for an Ambitious FP10, European Association of Research and Technology Organisations (EARTO), <https://www.earto.eu/wp-content/uploads/SHOs-Joint-Statement-for-an-Ambitious-FP10-Final.pdf>

Box 6.2: A typical European collaborative research project: The LigniOx project a European pilot-scale demonstration for industrial competitiveness

The EU project LigniOx⁹⁵ illustrates how long-term EU research, development and innovation funding within public-private partnerships can boost competitiveness and sustainability of European industries and help achieve EU's objectives. **European-wide collaborations for pilot-scale demonstrations** like LigniOx are essential to de-risk innovative technologies, establish critical cooperation networks and build trust along the value chain, ultimately enabling the economic and sustainable commercialization of green deep tech technologies.

Funded by the EU's Horizon 2020 Bio-Based Industries Joint Undertaking, the LigniOx project **leveraged private investments** from research and industrial partners across Europe. The consortium pooled **knowledge and technology infrastructures** to demonstrate the techno-economic viability of converting lignin-side streams into commercial circular bio-based products in line with the European Bioeconomy strategy.

The continued collaboration between project partners after the successful completion of LigniOx led to a subsequent investment to build a demo plant⁹⁶ in Europe for producing a new high-performance lignin-based products as a replacement for fossil-based chemicals in concrete production contributing to the establishment of a more sustainable and low-carbon industry.

"The EU-LigniOx project is an excellent example of how R&D projects can bring together companies in the value chain and initiate further collaboration in advancing – in this case – totally new technology and products." says Anna Suurnäkki, Vice President Research at Metsä Fibre.

In particular, the EU's RD&I programmes appear **fragmented and sub-optimally aligned with broader European policy priorities** and with Europe's needs for industrial leadership and strength. Although Pillar 2 of Horizon Europe covers industry-led activities with the EU Partnerships, due to inflexibility, fragmentation, the lack of focus on future technologies and the administrative burden placed on the partners, there is a risk of "industry walking away from the framework programme" at a time when both industry and the framework programme need each other more than ever and the number of participating companies should rather be strongly expanded. To counteract this, a **strengthening of the programme is needed, focusing on industry-led activities and public-private partnerships**. Bolstering EU's technological capabilities through increased investments along the **entire research, development and innovation continuum in complex technologies**⁹⁷, i.e. not just their development but also their uptake, is crucial to acquire the ability to produce new and more advanced technologies and industries⁹⁸.

Industry participation needs to be increased and diversified so as not to over-support existing players, technologies and sectors. The framework programme must both contribute to **large firms' resilience and renewal** and **enable the growth of new firms and industries**. Ultimately, to ensure future European strength and industrial leadership, the

⁹⁵ Circular Bio-based Europe Joint Undertaking (CBE JU) (2024), LigniOx Project, <https://www.cbe.europa.eu/>

⁹⁶ Metsä Group & ANDRITZ (2024), Metsä Group and ANDRITZ to Construct a Demo Plant for Developing New Lignin Products, <https://www.metsagroup.com/news-and-publications/news/2024/metsa-group-and-andritz-to-construct-a-demo-plant-for-developing-new-lignin-products/>

⁹⁷ Hidalgo, C. A. (2021), 'Economic complexity theory and applications', *Nature Reviews Physics*, 3(2), pp. 92-113.

⁹⁸ See, for example, Edler, Blind and Frietsch (2020), *Technological Sovereignty: From Demand to Concept*. Also, Edler et al. (2023), 'Technology sovereignty as an emerging frame for innovation policy.'

framework programme must serve as **a lever to mobilizing more private and better RD&I than today.**

WHAT?

One of the key priorities of the remainder of the current as well as the next framework programme must be to ensure that it **serves the long-term and strategic needs of industry and industrial competitiveness.** This requires effective instruments and public-private partnerships and working on and with relevant issues and technologies.

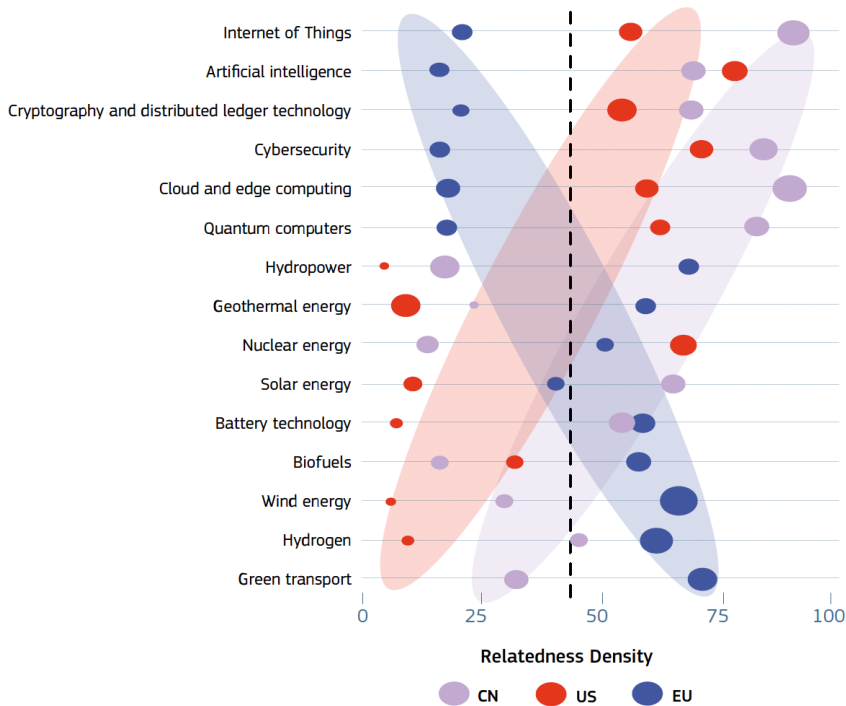


Figure 6.2: The EU position in complex technologies vs. the US and China, 2019-2022;

Source: European Commission (2024) - SRIP 2024; DG Research and Innovation, Common R&I Strategy and Foresight Service, Chief Economist Unit, based on Google Patents data. Note: The x-axis indicates the relatedness density in each technology field considered. On the y-axis, technologies are ranked by complexity level, normalised between 0 and 100. The size of the bubble captures the degree of specialisation that each country reports in a given technology field, measured by revealed comparative advantage (RCA).

To achieve this, there is **a need to improve the strategic orientation of the Framework Programme to prioritize industrial competitiveness in what is currently pillar 2 of Horizon Europe, emphasizing technology development, resilience and the green transition.** While the basic structure emphasizing collaborative projects and partnerships is good, there is a need to consider new ways of involving and committing industry for the smoothest path from idea to demonstration, upscaling and deployment. This is more a question of modification, administrative simplification and adequate public resources to attract companies to invest and co-invest in long-term, ambitious and cross-border cooperation in Europe.

For this reason, we propose establishing a “**European Technology and Industrial Competitiveness Council (ETIC2)**” governed by an **independent board**, following lessons learned from the ERC and the EIC Boards. **It should be prepared from 2025**. It should engage recognized experts from public and private sectors ensuring adequate industry representation as well as technology expertise.

The board will be tasked to make clear recommendations on European industrial competitiveness and technology policy, as well as on the implementation of funding programmes according to EU priorities (e.g., energy, AI and defence policy). Based on a holistic perspective of the range of policies, regulations and framework conditions that shape the EU's long-term industrial competitiveness and technological strength, it should work to strengthen synergies and policy coherence.

The Council should set the general direction for the instruments and themes of the Framework Programme's efforts to promote industrial competitiveness and technology development. It should guide the funding of a substantial collaborative research, development and innovation programme and private-public partnerships in strategic areas. Among other things, it should oversee current and future partnerships and ensure their relevance to industrial renewal and technological development, (including phasing out ineffective partnerships). It should provide the framework for rapidly analyzing and implementing solutions enabling European industries to react and adapt in the face of rapid and profoundly transformative waves of innovation such as generative AI. It should consider the evolving nature of collaborative research specifically oriented towards industrial competitiveness, including missions or challenges (societal, technological, industrial) and pre-commercial procurement (see Recommendation 10). The council should also play an important role in a new programme for Technology Infrastructures to develop, test and upscale technology (which we propose in Recommendation 8). For example, in the case of AI regarding computing resources for which the challenge is not only cost but also availability. In addition, it should collaborate with the Experimental Unit and the EIC (see Recommendations 4 and 5) to introduce “ARPA type” instruments if appropriate.

An increased budget should be guaranteed to fund multinational multidisciplinary collaborations in FP10 to deliver European added value, to counteract the lack of public funding for technology collaborations across national borders, to account for an increased spectrum of activities, a strong partnerships portfolio for strategic areas and raised ambition in developing European Technology Infrastructures.

Over time, the “European Technology and Industrial Competitiveness Council (ETIC2)” should evolve towards promoting Europe as a place of exploration, experimentation and dynamism, and a laboratory of ideas addressing global markets and needs through state-of-the-art products and services, that provide industry with the tools to address the needs and demands of people, planet and prosperity while safeguarding Europe's future and freedom. Thus, **it should serve as a central driver of renewal in a turbulent era and at a critical moment in history.**

HOW?

Inspired by and mirroring the successes of the ERC Scientific Council and the EIC Board, the *European Technology and Industrial Competitiveness Council* (ETIC2) should become **a trusted and recognized authority** and nexus for safeguarding that the Framework Programme substantially contributes to Europe's future industrial competitiveness and technological strength and promote better coherence and synergies across EU policies to that effect. It is not in conflict with the need for simplification (see Recommendation 9),

since it does not add administrative burden or complexity to the applicants to the Framework Programme.

The **Council should consist of eminent practitioners and other experts** who have insight into future technologies and potential markets, e.g., company CEOs or CTO's, research and technology leaders. To ensure the best composition there should be no restriction on companies or other entities applying to, and being funded by, the Framework programme if one of their staff sits on this Council – as the Council does not administer or evaluate projects or make funding decisions, there is **no conflict of interest**. Ensuring the Council has members with a broad vision of the industrial landscape is essential to avoid being dominated by a particular sector or technology.

The functions of the Council should include:

- Ensuring relevance through guidance and advice on strategy, the instrument portfolio and programme calls and objectives, taking into consideration global technology developments;
- Strengthening coherence by exchanging and coordinating with the ERC Scientific Council, the European Strategic Forum on Research Infrastructures and the Board of the EIC and with RD&I flagship projects led by other DGs, and by providing guidance on Technology Infrastructures;
- Improving implementation (e.g., through commissioning evaluations, ensuring appropriate programme and project portfolios, monitoring administrative efficiency and effectiveness; see also ERT 2024).

The proposed Council needs to present effective ways of involving and committing industry in the smoothest path from idea to demonstration, upscaling and deployment. Crucially, this also requires a favorable regulatory environment, further market integration⁹⁹, human capital and alignment and synergies with and of relevant policy areas (climate, public procurement, defence, energy, education, etc) to ensure that Europe not only produces new knowledge but puts it to the best possible use for Europe and the world. It should be **assertive and confident** rather than defensive and protectionist: it should promote an effective policy to foster the ESIR concept of **"industry 5.0"**¹⁰⁰ in Europe, resulting in **good quality jobs**. To this end the proposed Council should **liaise closely** with the EIC Board, the ERC Scientific Council and the European Societal Challenges Council (i.e., Recommendation 7) to ensure coordinated and synergistic programmes which avoid unnecessary duplication. The Council should also liaise with and input into appropriate European Commission policy directorates that affect industrial competitiveness.

⁹⁹ In line with the recommendations of Letta, E. (2024).

¹⁰⁰ See details about the concept of "Industry 5.0" and the need to foster good quality jobs in Europe in European Commission (2023). Industry 5.0 and the future of work. <https://op.europa.eu/en/publication-detail/-/publication/948cbd47-2147-11ee-94cb-01aa75ed71a1/language-en>

Concerning the partnerships in FP10, we recommend the following:

- Co-programmed and Institutionalised Partnerships should have a **stronger focus on EU industrial competitiveness**, for a more focused and stronger impact of joint public & private RD&I investments. The goal should be to leverage private investments by industry.
- **Increase flexibility** in implementation, **transnational (and international) cooperation** and reinforce the instrument's strategic role for policy implementation, capitalising on their critical mass. Partnerships should have a **better portfolio approach and strategic coordination process** aiming at decreasing duplication and fostering synergies between the different partnerships for more impact.
- **Better align EU and national funding** to allow EU-wide transnational collaboration within the co-funded partnerships.

Recommendation 7

Address societal challenges more effectively by creating a Societal Challenges Council

Box 7.1: Definition of Societal challenges

Societal challenges are defined as complex and interrelated issues that significantly impact the well-being and development of societies. They consider issues that significantly impact fundamental human rights and affect individuals' personal or social lives, underlying well-being of communities, countries and the European Union. These challenges are typically multi-level and multi-dimensional, often coexisting and requiring innovative solutions, transdisciplinary approaches and coordinated efforts from various actors including government, industry, research, and civil society to be effectively addressed. There is usually disagreement about their nature, causes or solutions;

WHY?

The climate crisis – and its increasingly devastating effects on places and people, a rapidly ageing population – which exerts increasing pressure on healthcare and on the supply of labour, and rising mental health problems are examples of urgent societal challenges where research, technology and innovation will be critical in addressing them¹⁰¹.

Europe is built on strong promises to its citizens: living at a certain level of prosperity without poverty, growing old with dignity, physical and digital security, healthcare for all, protection against risks and living in a healthy environment. Delivering on these promises, especially in the face of increasing budgetary pressures, requires continuous improvements based on state-of-the art, cross- and interdisciplinary research, technology and innovation. Climate change endangers biodiversity and life in a healthy environment, the aging of society requires additional expenditure for the pension and health system as well as for care, and the diverse threats to internal and external security add new challenges.

Societal challenges represent **an opportunity to empower citizens and regions, increase European well-being, resilience, inclusiveness, and competitiveness**. In many cases, they must engage industry, to address challenges effectively and because they provide significant business opportunities. For example, by **improving mental health**, together with preventing cancer, cardiovascular and metabolic diseases, private and public sectors will benefit from healthy citizens, **boosting economic productivity and wellbeing**.

Research and innovation are a fundamental part of the European fabric and society and as such have a fundamental responsibility to address societal challenges. Addressing societal challenges through research and innovation is **essential** both for the ability to tackle these challenges and for **safeguarding societal acceptance** and **democratizing science**. In addition, RD&I addressing societal challenges is also important for meeting the **EU's**

¹⁰¹ European Commission (2024), "Delivering a Strong Social Europe", https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/economy-works-people/delivering-strong-social-europe_en

objectives and international agreements, such as the Climate legislation, the *Paris Agreement* and *Agenda 2030*.

Addressing societal challenges requires an **effective collaboration** between universities and research institutions, governments, civil society and industry. **This should not be seen as a burden but a chance for continuous renewal and revitalization of the European project, of Europe's institutions, policies and strength and standing in the world.**

WHAT?

The framework programme needs to address societal challenges for the sake of the **legitimacy of science** and for the future of a **strong and sustainable Europe**. But it should also be noted that research and innovation **cannot** solve societal challenges on their own – solutions require articulation and alignment of policies, regulations and actions across different domains. **European RD&I can provide a new understanding of and solutions to tackle societal challenges.** It requires that the European Framework programme in RD&I is better targeted to address **wicked problems** with a **global dimension** and **complex linkages** among several sectors of activity and policy making. Societal transitions are highly complex, characterised by **high levels of uncertainty, trade-offs and non-linear feedback loops** that usually require interdisciplinary and large-scale RD&I efforts to create and co-create (in close interaction with society, industry and the public sector) knowledge and appropriate solutions for action¹⁰². In particular, **Social Sciences and Humanities (SSH) need to be accorded a more central role both in research on and the development and implementation of solutions to societal challenges.**

While some societal challenges (e.g., climate change and the loss of biodiversity, an ageing society, the erosion of democracy) are of a more long-term and pervasive nature, others can appear (and disappear) rather abruptly (e.g., pandemics¹⁰³ or certain threats to national security or specific applications of disruptive technologies). The degree of consensus as to what constitutes a societal challenge (and its potential solution) can also differ or diverge among citizens, experts and policymakers.

Our recommendation is that European RD&I addressing societal challenges in the coming decades should **focus on "secure and thriving citizens"**¹⁰⁴ and the effectiveness of the framework programme should be improved by **gradually adopting a new governance scheme**, together with adequate instruments and policy alignment (see Box 7.2). It should prioritise the mainstreaming of **human-centredness**, especially in the age of rapid technological transformation to ensure societal acceptance of new technologies shaping the future of work and our common security and sustainability. By promoting the creation of knowledge-based solutions, the European Framework programme in RD&I should be

¹⁰² See, for example, the evolution of the context for science, technology and innovation policies (geopolitics, security, transitions, disruptions), as analyzed in OECD (2023).

¹⁰³ See, for example, Mallapaty, S. (2024), "The pathogens that could spark the next pandemic", *Nature*, <https://www.nature.com/articles/d41586-024-02513-3>

¹⁰⁴ See, for example, the Horizon 2020 ex-post evaluation. Also, in European Commission (2023), "Research and innovation to thrive in the poly-crisis age", and in European Commission (2023), "Research, innovation, and technology policy in times of geopolitical competition".

oriented to foster **high quality jobs**¹⁰⁵ and to **produce applicable and scalable solutions** to achieve a significant impact on societal challenges.

Improving the effectiveness the Framework Programme should consider the challenges of implementing a **transformative agenda** with adequate resources and instruments, together with a favourable regulatory environment, enabling the creation of new knowledge-based markets through a holistic view of the full research and innovation continuum¹⁰⁶. But it also requires **social innovations**¹⁰⁷ to address the complex and multi-dimensional translation of research results into policy formulation, regulation and implementation in a wide variety of areas, including civil protection, urban development, agrifood, climate and defence, and public service, to name a few. In turn, this requires better links with other deployment instruments.

For example, **mental health** is becoming an increasingly important societal challenge with more than 1 in 3 Europeans experiencing mental health problems each year, at a cost of an estimated €461 billion per year.¹⁰⁸ Despite this, only €543 million or around 0.68% of the total Horizon 2020 budget was allocated to mental health research. Therefore, as concluded in the report on the final outcomes of the Conference on the Future of Europe, the EU must prioritise investments to “improve understanding of mental health issues and ways of addressing them”.

¹⁰⁵ See details at European Commission (2023), “Industry 5.0 and the future of work – Making Europe the centre of gravity for future good-quality jobs”. Following Rodrik and Stancheva (2019), “good jobs” are meant as “jobs that provide a middle-class living standard, a sufficiently high wage, good benefits, reasonable levels of personal autonomy, adequate economic security, and career ladders”.

¹⁰⁶ See European Commission (2023), “The transformative nature of the European framework programme for research and innovation – Analysis of its evolution between 2002-2023”. Also, OECD (2023), “Agenda for Transformative Science, Technology and Innovation Policies” and OECD (2024) “Declaration on Transformative Science, Technology and Innovation Policies for a Sustainable and Inclusive Future”.

¹⁰⁷ See, for example, OECD (n.d.), Social Economy and social innovation, <https://www.oecd.org/regional/leed/social-innovation.htm>

¹⁰⁸ See, for example, European Commission (n.d.), Mental health, https://health.ec.europa.eu/non-communicable-diseases/mental-health_en

Box 7.2: The increasing societal challenges Europe, and the world, are facing and the related contributions of Horizon Europe, 2021-2023¹⁰⁹

- With 35% of the Horizon Europe budget earmarked to tackling **climate change**, the programme plays an important role in mobilising research and innovation for transitioning to climate neutrality and resilience, notably through its comprehensive portfolio of European Partnerships and missions. Similarly, **Horizon Europe mobilises research and innovative approaches on biodiversity that contribute to the MFF spending target for biodiversity that accounts for 10% in 2026 and 2027**. In addition, an in-depth analysis of all research projects funded by the European Research Council under Horizon 2020 showed that 953 ERC-funded projects, worth EUR 2,039 million were relevant to the European Green Deal in areas such as boosting climate action, clean, affordable and secure energy and sustainable and smart mobility;
- Industry 5.0 is the Commission's policy initiative to provide an **integrated framework for the transition to a future-proof competitive industry that is human-centric**, as well as resilient and sustainable. The first calls on Industry 5.0 were implemented under Horizon Europe and were followed by setting up an Industry 5.0 Community of Practice at EU level¹¹⁰, with a broad range of EU Innovation Ecosystem stakeholders.
- Horizon Europe has introduced **Mission Oriented Innovation Policy (MOIP) through 5 missions** for managing climate, oceans, soils and modern city life challenges, including the prevention of cancer. For example, The Digital Ocean Forum - DOF 2024 included the public exhibition of the first prototype of the European Digital Twin of the Ocean infrastructure. It represents significant advancements towards the sustainable development of blue economies and the management of ocean resources, guaranteeing the implementation the European Green Deal and the UN Decade of Ocean Science for Sustainable Development¹¹¹.
- **In Horizon 2020, the EU dedicated 20% of its budget to SSH-flagged topics** for interdisciplinary research. However, SSH integration was uneven across the programme. **Horizon Europe introduced measures to further enhance SSH integration**, such as efforts to test and develop methods that foster a qualitative leap in interdisciplinary approaches by integrating SSH to achieve more effective responses to complex societal issues and enhance societal resilience. However, the Horizon 2020 ex post evaluation highlighted **weaknesses in the SSH monitoring (flagging) system**, noting that this cross-cutting issue was not among the most frequently flagged ones. Possible reasons for this might be the lack of **ownership thinking for 'cross-cutting' issues** and an insufficient understanding of the definition or scope of cross-cutting issues.
- Preliminary findings of the Horizon Europe interim evaluation show that there is a **need to provide further information and guidance on integrating SSH** to better valorise SSH's potential throughout the project lifecycle and encourage research communities to collaborate more closely.

¹⁰⁹ European Commission (2024). Second Strategic Plan of Horizon Europe. [Horizon Europe strategic plan 2025-2027 - Publications Office of the EU \(europa.eu\)](https://ec.europa.eu/euro-iss/strategic-plan)

¹¹⁰ European Commission (2023). Industry 5.0 and the future of work.

¹¹¹ European Commission (2024), European Commission unveils European Digital Twin of the Ocean prototype, https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/european-commission-unveils-european-digital-twin-ocean-prototype-2024-06-13_en

HOW?

Societal challenges, such as those listed above, should be identified, prioritized and addressed through a systemic approach that **combines both “bottom-up” and “top-down”** approaches in research, innovation and policymaking. By “bottom up”, we mean citizen involvement and public opinion, and bottom-up collaborative research and innovation. By “top down”, we mean legal obligations¹¹², professional expertise, foresight and political processes¹¹³ executed through thematic calls.

Drawing on the success of the ERC Scientific Council and the EIC Board, we propose the establishment of the **European Societal Challenges Council (ESC2) consisting of eminent practitioners** to advise on the (often changing) societal challenges, to address programme execution and results monitoring, together with guaranteeing the implementation and governance of adequate funding instruments as described in Box 7.3.

¹¹² For example, Agenda 2030 and the European Climate Law.

¹¹³ See, for example, ESPAS (2024). “Global Trends to 2040: Choosing Europe’s Future”. Also, the Danish approach to identifying research priorities, RESEARCH2025, https://ufm.dk/en/research-and-innovation/research2025/?set_language=en

Box 7.3: Effectively engaging practitioners to establish the *European Societal Challenges Council (ESC2)*

- To embed effectiveness, equity, dynamism and ensure global relevance, the European Commission should establish ESC2 as a **council of relevant experts, e.g., researchers from academia, charities, policy, aid agencies, industry and those with lived experience globally** who can advise on the Programme instruments and calls, feedback insights, monitor results and adoption/implementation and where appropriate co create with funding partners.
- The ESC2 would be a complimentary and synergistic Council to the proposed ETIC2 and work in close dialogue and collaboration with it and other FP programmes and agencies to avoid unnecessary duplication and inefficiency.
- The Council would be responsible for all RD&I addressing societal challenges, including the research component of Missions and Partnerships, as well as collaborative research under related Clusters without significant industrial potential. It should build on the strength of current initiatives to:
 - Improve the effectiveness of the framework programme by progressively adopting overview/governance of all current instruments, reviewing/adapting these and proposing new ones including any emerging from the Experimental Unit e.g., “ARPA type” instruments;
 - Provide input into other DG’s developing relevant policies and ensure coordination and co funding of any RD&I;
 - Increase engagement of **philanthropy and charities, as well as industry**, and, where appropriate, increase co funding of collaborative research programmes to address societal challenges;
 - Monitor / promote **the circular economy throughout all FP funding initiatives**;
 - **Address regulatory hurdles**;
 - **Engage and empower citizens and regions**, including fostering “**citizen’s engaged research and innovation**”
- The ESC2 would address societal challenges that have **no or limited obvious immediate commercial potential**, or where there is a **need for demand formulation or market creation**. Examples of topics which could fall within this unique remit include **mental health**, care of **elderly (demented) citizens**, **rare and chronic diseases**, **poverty**, **ocean health**, **environmental health** including climate adaptation and behavioural changes to embrace rapid transitions.
- **Where there is a commercial potential that is currently poorly addressed, e.g., new antibiotics the ESC2 and ETIC2 should collaborate to launch single effective programmes and calls for proposals. Where there is an obvious commercial potential – e.g., cancer, metabolic and cardiovascular diseases – the RDI activities will fall under the ETIC2 remit.**

Clearly addressing complex societal challenges has **overlaps** with many other programmes. To simplify and prevent duplication/proliferation of instruments, RD&I addressing a societal challenge with a significant potential for industrial involvement should fall under the remit of the *European Technology and Industrial Competitiveness Council (ETIC2)* and executed using their programmes. If the challenge involves the creation of new companies or targeted innovation, it should be co-funded and executed with relevant EIC programmes. This should increase synergy, reduce duplication and proliferation of instruments, together with providing clarity on the expected adoption of RD&I results.

In addition, it should also be clear that many different mechanisms already exist to identify and describe societal challenges¹¹⁴ and the European Commission should **not duplicate** them but rather **align** and synthesize them to form an effective portfolio and system. What is missing is a body and mechanisms to identify, attract private funding (e.g., from charities and private foundations) and allocate funding to these complex challenges.

The European Societal Challenges Council (ESC2) would be responsible for **RD&I targeting societal challenges without significant industrial potential**, including the research component of **Partnerships**, and **Missions**, as well as **collaborative research** under the existing related Clusters. Recent experiences with **missions as a means of tackling societal challenges** have shown that these can be effective in addressing the need for adequate institutional responsibility by problem solvers¹¹⁵.

Traditional impact assessment frameworks often fail to capture the complex, **dynamic nature of societal challenges**.¹¹⁶ Relying on metrics for patents, publications and GDP does not consider factors influencing well-being, employment, capabilities, and other indicators aligned with the Sustainable Development Goals (SDGs). Horizon Europe therefore introduced a new system of indicators to capture societal impacts, based on so-called **Key Impact Pathways (KIPs)**. However, the ex-post evaluation of Horizon 2020 indicates that the process of **disseminating, exploiting and deploying project results** has been uneven and measuring impact remains difficult. This requires more attention, e.g., through science of science principles. Improvements are also needed to ensure the visibility, spread and practical use of project results to unlock broader economic and societal benefits.

¹¹⁴ See, for example, ESPAS (2024), “Global Trends 2040 Changing Europe’s Future Report”, numerous JRC Reports, EU Foresight exercises, individual country foresight. Also, OECD (2023), “Navigating Green and Digital Transitions: Five Imperatives for Effective STI Policy”.

¹¹⁵ See the recent OECD papers on “Transformative Innovation Policy”, including the “OECD Declaration on Transformative STI policy”, of April 2024.

¹¹⁶ European Commission (2024), Systems based methods for research & innovation policy. Also, European Commission (2024), Unveiling the transformative potential of the European framework programme for research and innovation.

Recommendation 8

Foster an attractive and inclusive RD&I ecosystem in the EU

Box 8.1: Definition of the European RD&I Ecosystem

The European RD&I ecosystem is the supportive, productive and interconnected interplay between institutions both public and private, infrastructure, researchers, innovators, entrepreneurs, companies and their surrounding communities to foster the creation of breakthrough discoveries and innovations and their rapid translation and scaling to global markets and applications.

WHY?

A successful European RD&I ecosystem needs to grow, continuously increase scientific and innovation output and attract new research and researchers (brain drain turns into a brain gain), together with rapidly translating research results into new products, services and policies.

First, Europe needs to **turn the current European brain drain** (mostly to the USA) **into a brain gain** (Box 8.2). The current high levels of European brain drain are partially the **consequence** of relatively low levels of investment in RD&I in Europe compared with those in US¹¹⁷: the framework programme can never solve the issue alone and will **require additional actions at MS level** and an **effective collaborative effort among the European Commission and MS**.

This circumstance is particularly problematic for most eastern and large southern European countries. This has been associated with a strong dependence of institutions on short term project funding (2 to 4 years)¹¹⁸ and we suggest that funding instruments should be diversified, including open competition for longer term competitive projects. MS should guarantee adequate **opportunities for young researchers to thrive** and ensure that institutional co-funding is adequate and includes open competition for research career positions. Concrete initiatives to support stable and well-paid work opportunities and encourage researchers to stay in Europe must be led by all MS and facilitated by EU structural funds in synergy with the FP. Recommendation 5 explicitly includes **the need to foster European research careers through a new initiative “Choose Europe”**.

¹¹⁷ See, for example, National Academies (2024).

¹¹⁸ See Science Europe (2016), “Postdoctoral Funding Schemes in Europe – Survey Report”, DOI: [10.5281/ZENODO.5059938](https://doi.org/10.5281/ZENODO.5059938)

Box 8.2: The need to turn European brain drain into a brain gain, by strengthening the European RD&I Ecosystem

- The figure below documents **European brain drain**, through countries' brain drain in relative terms. A value below 1 implies that more researchers are leaving the country than entering it. While a value above 1 implies that the country has more researchers entering than leaving. During the period from 2001 to 2010, some Member States including Germany, France, Sweden, the Netherlands, Belgium, and Finland experienced significant brain drain, mostly to the USA or UK. In the subsequent decade from 2011 to 2020, Sweden, Belgium and Germany have improved.
- In contrast, large South European countries and most Eastern European countries continue to face long standing challenges related to brain drain.
- For Europe this is a serious problem when talented and well-educated young people leave. This-self-reinforcing process of cumulative causation¹¹⁹ can only be broken if Europe makes a strategic change in its policy to **foster good quality careers for all, in particular for young researchers**.
- It should be noted that the **European brain drain** quantified in the figure is **occurring at the same time as an increase of the number of researchers in Europe**. There were 2.08 million researchers (in Full Time Equivalents - FTE) employed in the EU in 2022, which marked an increase of 648,000 when compared with 2012. They represent **about 2% of the European labour force**. The number of researchers (FTE) more than doubled in Poland, Sweden and Greece between 2012 and 2022. Most researchers (57%) are employed in the business sector, about one third of them (32%) in the academic sector, and 10% in the government sector.
- For comparison, in 2021, **South Korea** had the largest number of scientists and researchers per 1,000 FTE's, with 17.3 people working in research or science field per 1,000 employees. **Sweden** was second, with 16.6. The **European average was 9.4**.
- However, the growth in the number of researchers in Europe has **not** been matched by an increase in the **quality of research jobs** and this has also **driven brain drain**. The need to address the **precarity many researchers now face** was explicitly addressed in the European Council conclusions of May 2021¹²⁰ on research careers and in the 'Pact for Research and Innovation' agreed in November 2021. The **Manifesto on early research careers**, published in September 2022 by the *Initiative for Science in Europe*, calls for urgent action¹²¹.
- Two research projects and consortia funded by the [European Commission](#) provide evidence on the evolving situation in Europe¹²², underlining the **need for better data and for monitoring the quality of research careers**. Analysis has shown that the EU relies on an **unacceptable coupling between "project funding" and "contractual schemes"**, exacerbating precarity for young researchers and leading to diffuse (or even lack of) responsibility, at individual and institutional levels¹²³.

¹¹⁹ European Commission JRC (2018). International migration drivers – A quantitative assessment of the structural factors shaping migration.

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC112622/imd_report_final_online.pdf

¹²⁰ European Council (2021), Improving conditions for research careers in Europe,

<https://www.consilium.europa.eu/en/press/press-releases/2021/05/28/improving-conditions-for-research-careers-in-europe-council-adopts-conclusions/>

¹²¹ Initiative for Science in Europe (2022), A manifesto for early career researchers, <https://initiative-se.eu/2022/09/25/press-release-a-manifesto-for-early-career-researchers/>

¹²² See details in RISIS, <https://www.risis2.eu/2023/05/22/monitoring-and-analyzing-research-careers-for-informed-policy-making-in-the-era/>; and SECURE, <https://secureproject.eu/>

¹²³ See Science Europe (2016), "Postdoctoral Funding Schemes in Europe – Survey Report", DOI: [10.5281/ZENODO.5059938](https://doi.org/10.5281/ZENODO.5059938)

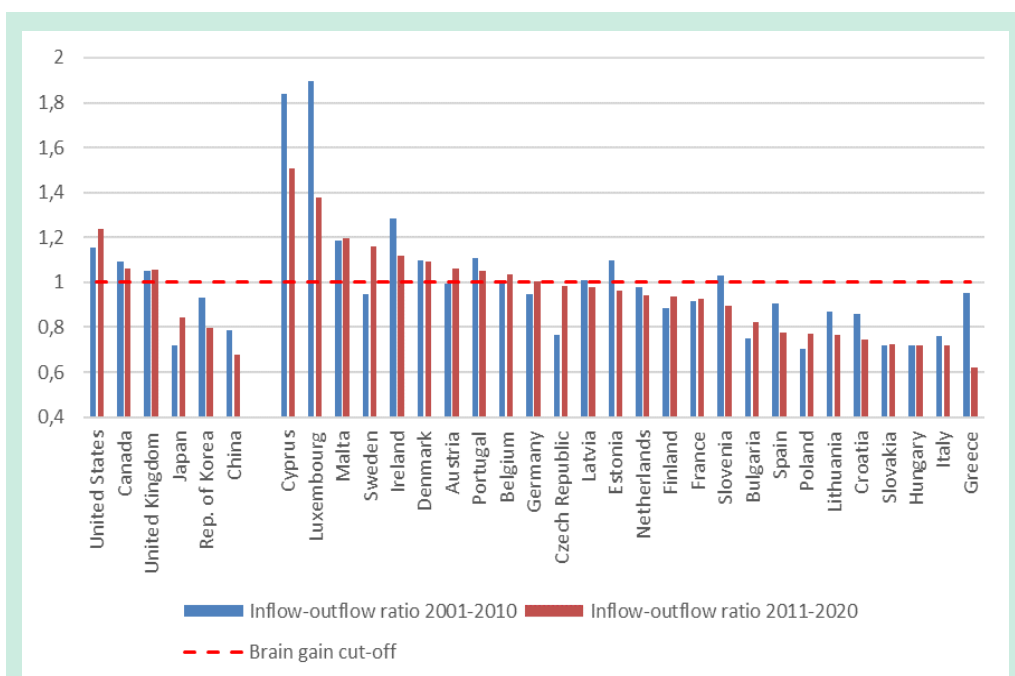


Figure: Brain drain trends for EU Member States and across the world, 2001-2020

Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit based on Science Metrix using Scopus database

Second, for most of the **widening countries**, the challenge is not only to continue increasing the amount of **RD&I expenditure as a function of GDP** (Recommendation 3), but also increase the **intensity of expenditure per researcher**. These are two different issues.

Box 8.3 shows the large disparity of values of “R&D expenditure per researcher” across Europe, when corrected for purchasing power parity (PPP), ranging from maximum European values of around 220 thousand euros per researcher in Germany, Austria and Belgium to values between 65 and 82 thousand euros per researcher in Bulgaria, SK, LV, PT and LT, respectively, with European average values around 161 thousand euros.

Two critically relevant aspects should be understood: First, the **European average RD&I expenditure per researcher is about half of the US average**, which is over 400 thousand euros per researcher per year¹²⁴. This difference can only be effectively dealt with by increasing European competitiveness and fostering high quality business RD&I. Second, there is **persistent inequality across Europe**. The total RD&I expenditure per full time researcher is too low in many European MS, particularly in widening countries, but also in some of the large European countries. Reducing inequalities requires improving the quality of jobs/employment and salary levels in the public and private sectors, as well as improving research career pathways, together with technical careers supporting research.

¹²⁴ Details in OECD, Main S&T indicators, with values in PPP, corrected for 2020.

Box 8.3: The need to increase the expenditure per researcher in Europe by strengthening the European RD&I Ecosystem

- Following OECD and Eurostat well established methodologies over the last 60 years, **research expenditure is mainly characterized by human resources related expenditures**, which account for about 90% of total expenditure¹²⁵. Therefore, increasing the expenditure in RD&I in most European MS and regions in the next decade is associated with **attracting and retaining adequate concentrations of researchers**, together with **three other critical issues**: i) Adequacy of **salary levels** throughout the labour force; ii) Modernizing **research careers**; and iii) Considerable expansion, structuring and modernization of **technical careers supporting RD&I activities** (i.e., S&T technicians and managers). Fig 1 quantifies changes over the last 3 decades.

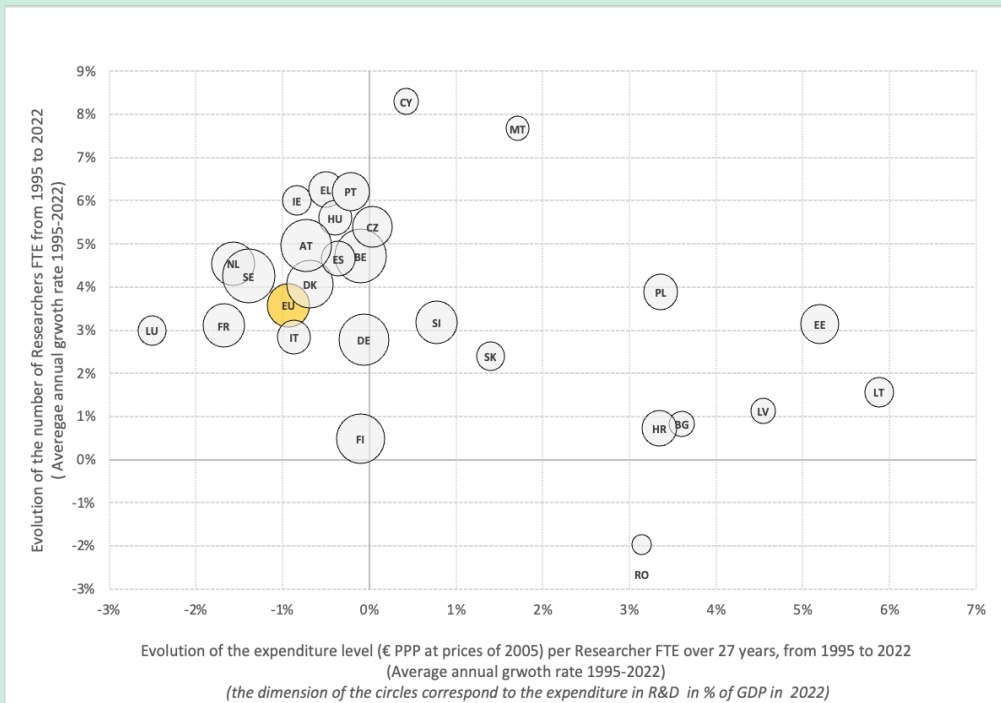


Figure 1. Evolution of the number of Researchers (FTE) and the Expenditure per Researcher in Europe, between 1995 and 2022 (or last year available)

Source: Eurostat | Initial Year: LT: 1996; EE, CY & AT: 1998; EU27 & LU: 2000; HR & MT: 2002; FI: 2004

- Europe is characterized by **large disparities** in the evolution of the **number of Researchers (FTE – Full Time Equivalent)** and the evolution of **RD&I expenditure per Researcher** in Member States over the last 3 decades. Fig. 1 shows a clear decrease of the **expenditure per Researcher** in European average terms and in most of the MS, including some large countries.
- In PL, EE, LT and LV RD&I expenditure per researcher has risen together with the number

¹²⁵ See details in the OECD's Frascati Manual, the internationally recognised methodology for collecting and using R&D statistics since 1964, with its sixth revision in 2015, https://www.oecd.org/en/publications/2015/10/frascati-manual-2015_g1q57dcb.html

of researchers.

- The **growth in the number of researchers** in many MS in recent decades occurs associated with a **relatively low expenditure per researcher** in many European MS, fig. 2. For example, Slovenia and Portugal exhibit some of the highest growth rates in the number of researchers, reaching about 11 per thousand inhabitants in 2021 and similar to the concentration of researchers in Germany and Austria. But the disparity in salary levels and support staff leads to large differences in the levels of funding per researcher among those MS.
- MS with the lowest RD&I expenditure per researcher are characterized by only one technician for every 4 to 5 researchers in 2022. This ratio is particularly low compared with the 1 technician for every 1.7 researchers in Germany and around 1 technician for every researcher in the US.
- The **lack of technical careers** over the last few decades in many MS and, above all, the **relative absence of research management careers** in many widening countries, has resulted in a growing inequality in professional support for research and innovation activities, with important consequences in terms of the intensity of expenditure per researcher.

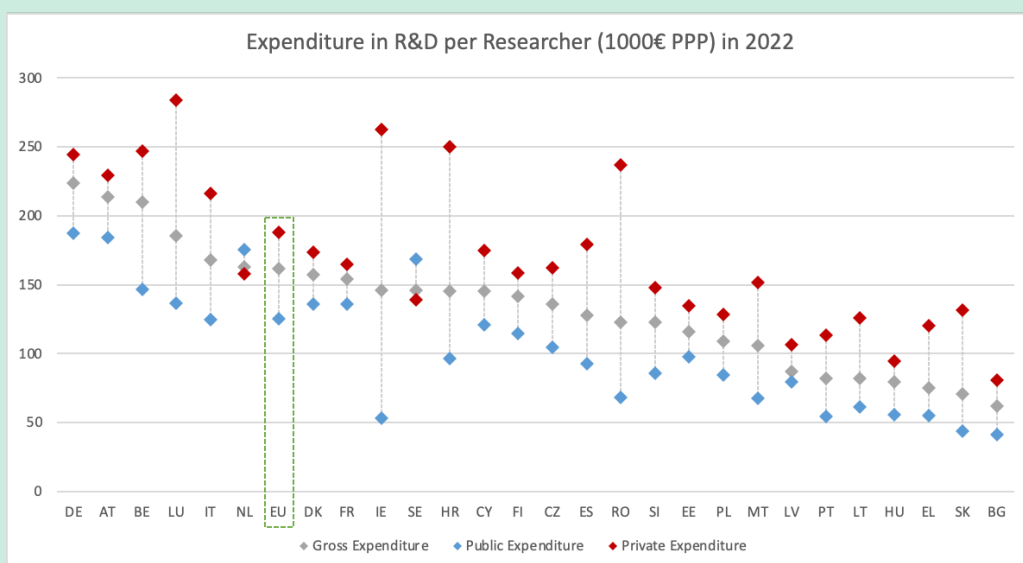


Figure 2. R&D expenditure per Researcher in European Member States in 2022 (PPP per researcher, corrected to 2005 prices); Source: Eurostat (Data available in December 29, 2023)

Many MS must simultaneously increase **RD&I expenditure as a function of GDP**, as well as the **intensity of RD&I expenditure per researcher** - a **critical issue in European research and industrial policies**.

This requires a new structuring and social valorisation of scientific and technical careers in the public and private sectors. This is important because the OECD has associated low research expenditure per researcher with constraints that affect research activities and their results¹²⁶.

¹²⁶ OECD (2023). Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption. <https://www.oecd.org/sti/oecd-science-technology-and-innovation-outlook-25186167.htm>

WHAT?

Research and Technology infrastructures should be prioritised throughout Europe in order to foster the European RD&I ecosystem, attract and retain researchers. Infrastructures can be either physical hardware, such as synchrotrons, remote sensing satellites or offshore sensors, or reference collections, such as biobanks, sociocultural archives, computing systems and communications networks, data banks and data clouds. Both have professional networks supporting and using them. Our analysis has witnessed some ambiguities (see Box 8.4):

1. First, a clear definition and implementation of diversified programmes to co-fund and promote **Research Infrastructures** and **Technology Infrastructures** is missing and the question concerning selection, access and sustainable financing by the European Framework Programme is unanswered. Research and Technology Infrastructures are increasingly expensive to establish and maintain as scientific and technological developments grow more complex. Individual Member States can no longer finance some of these infrastructures alone, making pan-EU coordination of investments even more crucial;
2. Second, while the concept of “**Research Infrastructure, RI**” is well established and recognised in RD&I policy and amongst the RD&I stakeholders across Europe (see Box 8.5), attention towards **Technology Infrastructures** is more recent. The strategic development of a European approach for **Technology Infrastructures** by the European Commission currently ongoing within the EC’s *Expert group on Technology Infrastructures*¹²⁷ should be supported. Our Recommendation is that the concept of **RI needs to be widened and diversified to properly address Technology Infrastructures (TI)**, including consideration of the growing importance of **digital infrastructures**;
3. Third, there is a need to **harmonize the two current different processes for defining and further promoting European Research Infrastructures**: i) ESFRI and ii) RI-Programmes in HE INFRA-Calls.

¹²⁷ European Commission (2024), “Register of Commission Expert Groups and Other Similar Entities”, <https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupID=3928&fromCallsApplication=true>

Box 8.4: Definition of Research Infrastructures (RI) and Technology infrastructures (TI)

- **Research Infrastructures (RI)** means facilities that provide resources and services **for the research communities** to conduct research and foster innovation in their fields, including the associated human resources, major equipment or sets of instruments; knowledge-related facilities such as **collections, archives or scientific data infrastructures; computing systems, communication networks** and any other infrastructure of a unique nature and open to external users, essential to achieve excellence in RD&I; they may, where relevant, be used beyond research, for example for education or public services and they may be 'single sited', 'virtual' or 'distributed'¹²⁸.
- **Technology infrastructures (TI)** are understood as facilities, equipment, capabilities and support services required to **develop, test and upscale technology** to advance from validation in a laboratory up to higher TRLs prior to competitive market entry¹²⁹. They are typically used by industry, together with RTOs.

The EU needs a strategic concept of **shared “Research Infrastructures (RI)”** and **“Technology Infrastructures (TI)”** with a process of establishing and long-term financing of diversified world-class infrastructures with European added value, using national, FP and European structural funds¹³⁰. It should consider their mutual collaboration to increase access and services for research, development and innovation. The infrastructure activities of ESFRI, INFRA call within HE, other calls within HE (e.g., pilot lines, Open Innovation Test Beds, Testing and Experiment Facilities, demonstration facilities), ERIC (European Research Infrastructure Consortium), ERA and those based on international treaties should be coordinated and clearly adopt the principles associated with the 5th freedom described in the Letta report¹³¹.

Our recommendation is that the current European RD&I framework programme (i.e., Horizon Europe, 2025-2027) and its successor FP10 should support a set of **world-class, diversified infrastructures in Europe**. As an example, the increasing importance of **data science** for industry and academic/research communities requires further support of the **European Open Science Cloud**. It clearly has the **potential to become the most widely used infrastructure in Europe**, if developed properly.

¹²⁸ Horizon Europe Regulation (2021).

¹²⁹ See European Commission Staff Working Document on Technology infrastructures, Publications Office, 2019, europea.eu/doi/10.2777/83750). This led to the development of Technology Infrastructures action plans in EU policy documents such as ERA Communication (2020), the Pact for Research and Innovation in Europe and the accompanying ERA Policy Agenda (2021) and the Council Conclusions on Research Infrastructures (2022).

¹³⁰ See, for example, Draghi, M. (2024), part B, page 251.

¹³¹ Letta, E. (2024).

Box 8.5: Research Infrastructures (RI) in Horizon Europe, 2021-2023, and the need to better prioritize a diversified approach to Research Infrastructures (RI) and Technology infrastructures (TI) from 2025

- Ongoing evaluation studies show that current research infrastructure (RIs) programmes play an important role in opening up, integrating and interconnecting RIs, contributing to RIs being accessible to researchers from across Europe and beyond. **Longer-term roadmaps** could facilitate a higher level of continuity in integrating RIs and consider the balance between world-class RIs on the ESFRI (the European Strategy Forum on Research Infrastructures) roadmap and smaller RIs.
- Enhanced **synergies with national funding and European structural funds should be explored**.
- Solutions to further **strengthen the connection with the private sector** should be sought, such as implementing a European programme for Technology Infrastructures, **better connecting research and technology infrastructures**, increasing RIs' participation in Horizon Europe, and incentivising co-development with industry.
- The **Pact for R&I identifies Research Infrastructures (RI) and Technology Infrastructures (TI) as a priority area for joint action**.
- The **European Open Science Cloud (EOSC)** is a key enabler of the digitalisation of research infrastructures while delivering the European Data Space for research data. It has **potential to become the most generally used infrastructure in Europe**.
- The **Digital and Industrial transition evaluation study** highlighted the value of the **creation of Technology Infrastructures** (such as European Digital Innovation Hubs and open innovation test beds). A clear example includes the EU *Health Data Space* to ensure better access to health data for citizens, health professionals and researchers across borders. In addition, analysis has shown the need for digital infrastructures for digital twin development (see Recommendation 7) to model future trends of major global challenges.

Second, our analysis aligns with that of many stakeholders (see Annex 1) about the critical role of **universities** and **university alliances** across Europe. They have effectively promoted the basis for the 5th Freedom of Letta¹³² through student and researcher mobility, building on successful track record of Erasmus+. They enable universities to collaborate more deeply across Member States, sharing knowledge and resources to achieve common goals. Securing sustainable financial support across all university missions is vital to unlock the transformative potential of these Alliances¹³³.

European Universities Alliances have achieved significant progress, despite their project-based funding and a rather fragmented approach by different Commission's Directorate-Generals. They have become **platforms for pan-European experimentation** and institutional engagement for higher education and have started to integrate research and innovation activities. The initiative has proven its potential for advancing a European approach to higher education and to strongly contribute to the building-up of the European R&I ecosystem.

¹³² Letta, E. (2024).

¹³³ See, for example, EUA analysis, <https://www.eua.eu/publications/policy-input/european-universities-initiative-towards-a-holistic-approach-for-assessing-progress.html> . Also, in other leading university associations, such as LERU, <https://www.leru.org/news/keynote-speech-on-european-university-alliances-by-jean-chambaz>, CESAER, <https://www.cesaer.org/news/empowering-excellence-european-universities-alliances-as-laboratories-for-success-stories-1777/>; Coimbra Group, <https://www.coimbra-group.eu/european-university-alliances-drivers-of-change-and-innovation-in-higher-education-summary-conclusions-and-recommendations/>

Going forward, University alliances should be encouraged to adopt high-risk, high-gain experimental approaches, transforming Alliances into **laboratories for knowledge development, learning across barriers** and **establishing good practices**. This may include tackle the challenge of *joint recruitment* of young researchers/academics, together with *joint governance systems* across multiple universities in Europe. Focus should be in postgraduate studies and research across all fields of knowledge oriented towards **high European added value**¹³⁴. To achieve this goal, **Universities should be empowered** to undertake an iterative experimental cycle, allowing them to abandon areas that do not work and communicate these as 'lessons learned'¹³⁵.

Third, a dedicated **widening package** was introduced under Horizon 2020 to improve the connectivity of the European RD&I ecosystem, to increase their attractiveness and to build research and innovation capacity in MS (that joined the EU more recently). This programme was financially and instrumentally enlarged in Horizon Europe. Consequently, Horizon Europe work programme '**Widening participation and strengthening the European Research Area**' (WIDERA WP) supports the priorities set out in the Pact for R&I and related policy agenda. In the meantime, **beyond the WIDERA** work programme, many thematic actions have been launched through the widening package, but the large number of diverse instruments has led to a **fragmented funding and opportunity landscape** undermining efficiency and effectiveness.

Existing widening instruments – such as Teaming, Twinning, ERA chairs, Excellence Hubs, European Excellence Initiative, Hop-on, ERA fellowships and talents – should be critically evaluated and streamlined¹³⁶. Our analysis aligns with that of many stakeholders (see Annex 1) and we recommend that widening instruments should be **focused on excellence building, preserving and reinforcing initiatives that work** (e.g., Teaming, MSCA including Staff exchange, among others) and ensure a clear evolution towards an inclusive European RD&I ecosystem. This also means discontinuing those **instruments that the review of Horizon Europe shows to be of limited effectiveness or efficiency. Equally those instruments that have demonstrated efficiency or good potential should be strengthened.**

The paradigm of “supporting” schemes for “widening countries” should be **transformed to a paradigm of “Advancing Europe” for an inclusive European RD&I ecosystem that emphasises empowerment and strengthening research excellence in all Member States.**

Fourth, the **European Semester process should include detailed reporting and analysis of public and private expenditure in RD&I across MS**, including not only public and private expenditure on RD&I but also synergies with European structural funds and funding European Seals of Excellence projects.

To make the RD&I investments impactful, **many regional and national RD&I systems need modernisation**, as already pointed out in the European Semester process, but **not** effectively tackled in most of the cases. While there are measures in Horizon Europe that aim to raise access to excellence, there are currently no financial incentive measures that could facilitate the adoption of reforms with long-lasting effects in regional and national ecosystems throughout Europe. Consideration should be given to implementing such

¹³⁴ Draghi, M. (2024).

¹³⁵ See, for example, the position of The Guilds university association, <https://www.the-guild.eu/blog/european-university-alliances-must-not-become-a-po.html>, See also Draghi, M. (2024), part B, page 251.

¹³⁶ European Commission (2023), Widening in Horizon Europe: state of play of the implementation. Brussels.

incentivisation programmes through national investments and European Structural Funds, in potential interaction with the Framework Programme in RD&I (e.g., through Seals of Excellence; see Recommendation 5). But our main recommendation is about the absolute need to **revise the reporting procedure associated with the European Semester** to include a critical reflection of **national RD&I plans and related expenditure**. This should include a stronger dialogue-based process between MS and the EC, involving Heads of State and Finance Ministers.

HOW?

1. Promote effective **synergies between the FP and European structural funds**¹³⁷, particularly to stimulate **public and private expenditure in RD&I** across all of Europe towards a more inclusive European RD&I ecosystem;
2. Develop a pan-EU strategy for **Technology Infrastructures (TI)** and modernize the current **Research Infrastructures (RI)** policy with ESFRI and relevant stakeholders, as well as a streamlined methodology for co-funding the diversified establishment and maintenance of RIs and TIs through a combination of FP, MS, European Commission Structural and industrial or philanthropic funding.
3. Strengthen **university alliances** across Europe, promoting the 5th Freedom of Letta¹³⁸ through student and researcher mobility, joint degrees and to better embrace the challenge of joint recruitment of young researchers/academics by multiple universities.
4. Concentrate current “supporting” schemes under Horizon Europe – especially for **Widening Countries** - towards an effective concept of **“Advancing Europe”** by focusing on initiatives that work (e.g., Teaming, MSCA) or for which there is an *evidence-based rationale* (e.g., EIC pre accelerator programme);
5. Promote efficient and collaborative funding between the FP and national/regional funds including structural funds, e.g., through the **effective funding of “Seals of Excellence”** (Recommendations 3 and 5)¹³⁹.
6. **Drive radical innovation on the reporting and assessment of the European Semester to better consider the evolution of public and private expenditure on RD&I in each MS.** The need to revise and better include in the European Semester a critical reflection of the **national RD&I plans and related expenditure** requires a stronger, dialog-based process between MS and the EC. This should include the use of European structural funds to support RD&I and report on MS funding of European Seals of Excellence projects (see Recommendation 5). The European Semester process should be used to improve coordination and alignment between MS and European Commission programmes and to increase RD&I investment in both the public and private sectors.

¹³⁷ Maximising synergies between Horizon Europe and European structural funds (notably, the European Regional Development Fund - ERDF) calls for several political measures, as indicated by the European Court of Auditors in their report of 2022 on strengthening synergies. In particular, cumbersome administrative barriers (e.g., reporting mechanisms) or the alignment in time of Horizon Europe and ERDF calls still present challenges.

¹³⁸ Letta, E. (2024).

¹³⁹ See Annex 1.?. Also, Dell’Aquila et al. (2024), Centre for European Policy Studies, CEPS.

Recommendation 9

Drive radical simplification, user orientation and efficiency

WHY?

Europe needs a **framework programme that unleashes the scientific, technological and innovative power of its researchers, companies and entrepreneurs**, allowing them to explore uncharted territories, create and seize commercial opportunities and provide solutions to society's most pressing challenges.

Currently, the **administrative burden, complexity, transaction costs and over-regulation undermine the efficiency, effectiveness and attractiveness of the framework programme**. At the same time, we see the emergence and evolution of research and innovation programmes that are setting new standards in terms of simplicity, user orientation and transformative ambitions¹⁴⁰. Among other things, private foundations as well as government research funders in the US and China, are exploring innovative and AI-based approaches.¹⁴¹

Against the backdrop of global competition (also in research and innovation funding), urgent challenges and budgetary pressures, **radical simplification and user orientation** with a clear focus on efficiency and impact can, and must, make the framework programme a flagship for promoting research, technology and innovation, not just in terms of size but also in terms of execution (or implementation).

In spite of continued efforts, evaluations and applicants point to significant scope and an **urgent need for further and drastic simplification** of the framework programme. The ex-post evaluation of Horizon 2020 concluded that **"the complexity of administrative procedures to apply for funding and take part in the framework programme were identified as the biggest obstacle to implementation"**¹⁴². The need for simplification revolves around several problem areas (see Box 9.1). The first is the costs and time required to prepare an application.

According to an evaluation study of Horizon 2020, "a median coordinator in EIC (Pathfinder and Transition) and EIE application takes 36 to 45 person-days to prepare an application" while [a] median value for contributing partners is between 16 to 25 person-days in addition to the coordinators¹⁴³. Furthermore, more than 70% of all pillar 3 applicants used external help to prepare applications. Among those, almost half employed external consultants while the remainder relied on dedicated departments within their organisations and/or National Contact Points (NCPs)¹⁴⁴. In addition to the significant time spent by applicants and support organisations, **the use of external consultants involves substantial costs for**

¹⁴⁰ See Box 4.1. with sample examples of diverse soliciting and reviewing procedures, including those of BARDA (Biomedical Advanced Research and Development Authority - USA) and Howard Hughes Foundation. Also, RORI - Research on Research Institute, <https://researchonresearch.org/> is participating/promoting experiments to implement new assessment methods.

¹⁴¹ See National Science Foundation (NSF) (n.d.). Notice to the Research Community on AI, https://new.nsf.gov/news/notice-to-the-research-community-on-ai?utm_medium=email&utm_source=govdelivery

¹⁴² European Commission (2024). Ex-post evaluation of Horizon 2020. (p. 14)

¹⁴³ European Commission (2024). Evaluation support study: Innovative Europe, p. 51.

¹⁴⁴ European Commission (2024). Evaluation support study: Innovative Europe, pp. 54-55.

applicants, with some applicants reporting paying up to 12% of the total grant in ‘success fees’ to consultants (ibid).

A second problem area concerns the **efficiency of the application selection and project implementation process**. In the first period of Horizon Europe, the time between the call closing date and the signing of the grant agreement (‘Time-To-Grant’, TTG), was 278 days¹⁴⁵. This was 78 days longer than for Horizon 2020 and exceeded the target of eight months set by the European Commission (ibid). A change in management of the EIC Fund partially explains the increase in TTG compared with the previous framework programme, and the Commission has been working to improve the efficiency and time of processing applications. However, **the time and cost of selecting and implementing projects continue to impose an undue burden on both the Commission and the beneficiaries**, as consistently pointed out by both evaluations and stakeholders. They are also out of step with the reality and development pace of not least the business sector, with some beneficiaries pointing out that by the time they are informed of the funding decision or by the time they receive their first payment (‘time-to-payment’, TTP), the project proposal or the consortium are outdated.

A third area concerns the **onerous reporting requirements and high administrative costs** (see Box 9.2). According to a survey conducted in mid-2023, administrative costs amounted to between 6-12% of total project budgets¹⁴⁶. About 10% of respondents reported administrative costs of more than 20%

¹⁴⁵ Innovative Europe, p. 57.

¹⁴⁶ Innovative Europe, p. 58.

Box 9.1: Main funding instruments in Horizon 2020 and Horizon Europe

- **Collaborative projects accounted for 78%** of the funding under Horizon 2020, involving an average of **11 participants** in nearly 15 000 projects, with an **average funding level per partner of (only) 127 K euros for about 3 years** (with some projects running between 2 to 5 years).
- **Single beneficiary grants accounted for 22%** of the funding but 59% of all grants, primarily for ERC, MSCA and SME instrument¹⁴⁷.
- The average grant size in Horizon Europe is EUR 2.9 million, considerably higher than under Horizon 2020 (EUR 1.8 million). Across all pillars of Horizon Europe, the average EU funding allocated to mono-beneficiary grants (44% of the number of grants) is around EUR 1.2 million while it is around EUR 4.2 million for collaborative grants (56% of the number of grants).
- Most of the assessment procedures and funding tools have remained unaltered and based on “**short term collaborative projects**”, with the **notable exceptions of ERC, MSCA and EIC**¹⁴⁸.
- This includes **European Partnerships and Missions**, which are key instruments in Horizon Europe’s toolbox, including to address societal challenges. Combined, **up to 59.9% of HE Pillar II’s global budget** may be implemented through these instruments:
 - Up to now, almost EUR 65 billion has been committed to European **Partnerships** launched between 2021-2024: EUR 24.8 billion from Horizon Europe and EUR 35.6 billion from the partners other than Union, out of which almost 65% come from industry. Areas for improvement for European Partnerships include their complexity and fragmentation, limited flexibility, the need for **further leverage of cash and in-kind contributions**, the need for the **deployment and use of results**, and the need for **transparency and reinforced openness to new players**, in terms of sectors, scientific disciplines and geographies.¹⁴⁹
 - A Communication on **Missions** was adopted in July 2023 by the College of Commissioners. The need to strengthen the **political leadership** has been identified to facilitate access to resources and actions to implement the missions, together with ensuring **coherence with other related policy initiatives** and reaching out to other **sources of funding**, notably private investment.
- Some **EU Innovation Programmes**, such as **EIE - European Innovation Ecosystem** and **EIT- European Institute of Technology**, provide general widespread training and network opportunities. Some programmes may have passed their peak effectiveness (e.g., by raising awareness) whilst there may be overlaps with both EU and MS programmes. **Discontinuation of earmarked funding is recommended**, together with the full independence of EIT KICs from the Framework Program, aiming to both streamline and reduce the number of existing programmes:
 - We noted that 140 companies supported by EIT’s KICs and national support systems went on to successful funding in the EIC Accelerator Programme – representing approximately 25% of the 550 companies who were successful in the EIC Accelerator Programme from 2021-2023. There was a **marked variation in the number of successful companies from each KIC** – Health 62, Climate 29, Food 18, whilst the other KICs had very few – approximately 6 each for Energy, Digital, Raw Materials, Urban Mobility and Manufacturing.
 - A few activities of EIT’s KICs should be continued through open competitive funding from the FP through a revisited and enlarged MSCA to better support **entrepreneurial training and re/up skilling the non-doctoral workforce** with a clear eye on the immediate and future needs of industry and society. This also applies to current activities supported through the EIE initiative. Instead of a standalone programme those activities should be subject to open competitive calls in an **enlarged MSCA programme**.

¹⁴⁷ European Commission (2024). Ex-post evaluation of Horizon 2020.

¹⁴⁸ See, for example, Fuest et al. (2024).

¹⁴⁹ The mid-term evaluation of the partnerships is expected in mid-2025, and its results should be taken into account when revisiting the partnerships.

The addition of new instruments to the Framework Programme has contributed to creating fragmentation, duplication and overlap. In addition to making it more difficult for potential beneficiaries to navigate the ever-growing landscape of instruments and initiatives, it reduces predictability and undermines administrative efficiency, as several under-critical programmes overlap and compete with each other.

Box 9.2: Transaction and administrative costs in Horizon 2020 and Horizon Europe

- The Horizon 2020 ex-post evaluation found that the efficiency of the Framework Programme is **very sensitive to the scale of administrative costs of beneficiaries and particularly of applicants**.
- The ex-post evaluation of Horizon 2020 found that the programme registered **EUR 4.4 billion in administrative expenditure (EU institutions), administrative costs for beneficiaries in an approximate range of EUR 135-215 million, and (transaction) costs for applicants in the order of EUR 5 - 10 billion**. Overall, **all these costs represent between 12% to 19% of total budget**¹⁵⁰
- A targeted survey of unsuccessful and successful applicants to Horizon Europe shows that the median cost of proposal preparation of (successful and unsuccessful) **consortium coordinators** range between **36 to 45 person-days**, while **consortium partners** involved in the application typically spend an additional **16 to 25 person-days each**. The cost of coordinators is most clearly correlated with an increase in the size of the consortium.
- In many areas, it is well-known that **applications are prepared through specialized consultants**, involving **high transaction costs for proposers**, in addition to the administrative costs of the Commission services.
- **Horizon Europe has so far observed a slight increase in the average success rate of proposals to 17.3%** (as compared to 15.9% end of 2022 and 11.9% in Horizon 2020) with considerable variation between programmes.
- According to preliminary findings of the interim evaluation of Horizon Europe, the administrative performance of the evaluation and grant agreement preparation processes has **not** met the targeted time values and also does **not** reach the efficient levels achieved under Horizon 2020 for its first two years.

The cumulative effect of the evolution of the framework programme over the last two decades is twofold:

a. First, the FP **focus has been on R&D inputs and “market failures”**. Insufficient attention has been paid to the **creation of new and knowledge-based global markets**, and to addressing effectively the complex non-linear interactions between RD&I investment and the creation of new ideas, their implementation, innovation and diffusion¹⁵¹. This requires a radical shift in the assessment process in the last three years of HE and, above all, in FP 10, allowing for a more **holistic approach to future RD&I and innovation policy**, emphasizing the importance of supporting the **whole research and innovation continuum**.

b. Second, although the European Commission has been able to keep administrative cost at reasonable levels below 6% of the total budget (see Box 9.2), the

¹⁵⁰ Details at European Commission (2024), "Horizon 2020 evaluation shows that investment in EU research and innovation greatly pays off", https://ec.europa.eu/commission/presscorner/detail/en/IP_24_461. Also, in European Commission (2024). Ex-post evaluation of Horizon 2020.

¹⁵¹ See, for example, the analysis of Fuest et al. (2024).

cumulative transaction and administrative costs in Horizon 2020 and Horizon Europe have exploded because applications are often prepared through specialized consultants, involving high transaction costs for proposers. They include the need to **manage increasingly larger consortia** and **to handle increasingly complex application forms**, including the need to consider the social and economic impact of the proposed ideas. This calls for a **radical simplification to decrease transaction costs, particularly for applicants**.

Overall, **complexity, bureaucracy and transactions costs undermine the efficiency, effectiveness and attractiveness of the Framework Programme** – particularly to beneficiaries who can secure desirable funding from alternative sources. By putting an onus on ex ante scrutiny and prescriptive requirements – rather than on ex post impact evaluation – it creates unnecessary and unhelpful rigidity and administrative burden. Moreover, it stifles the **responsible risk-taking** that enables the disruptive research and innovation¹⁵², that will be required to take Europe out of what Fuest et al (2024) call the “**middle-technology trap**” (see Recommendations 4 and 5).

As detailed in Recommendation 4, **AI has the potential to massively increase the efficiency of application and review processes** and should be immediately investigated and implemented.

The full **effects of the next framework programme**, which will run from 2028-2034, **will probably not be felt until the 2040s** since the outcomes of the implementation, structure and content of RD&I in the EU and its economic and societal impact take time to materialize. In setting the priorities and modalities for the next framework programme long-term challenges and perspectives therefore need to be carefully considered¹⁵³.

WHAT?

Guarantee **four basic principles**:

- a. **Reduced transactions costs**, including in the preparation of research and innovation proposals;
- b. **Less complexity, more agility and user orientation**¹⁵⁴, with faster speed of implementation;
- c. **Better alignment and coherence in policy governance and implementation**, less duplication, reduced number of similar instruments, better coordination and synergies;
- d. **More and better engagement and buy-in of industry, philanthropy and charities**, with better and faster engagement of practitioners in priority setting and programme execution.

¹⁵² See, for example, European Commission (2023) – ESIR.

¹⁵³ European Commission (2024). Ex-post evaluation of Horizon 2020, Also, SRIP 2022, Chapters 2 and 8.

¹⁵⁴ Users being defined here as those who apply for funding and those who translate or implement the results of projects, with clear overlaps between the two.

These principles should be implemented together with **stepwise changes in a few critical issues**:

1. **Modernize Assessment, strengthening independent peer review** to consider not only the quality and impact of the proposed research, but also the research environment, institutional support including **quality of research jobs and research support**, in addition to better alignment with **COARA principles**;
2. Thoroughly **assess “Simplified Cost Options”**, namely “Lump Sum financing” and optional “Unit Costs for Personnel”, or the mandatory use of unit costs for personnel, which were introduced under Horizon Europe but have been **criticized by a large number of institutions in Europe**. These types of measures should effectively limit the administrative burden on beneficiaries and contribute to decrease complexity and increase agility.
3. **Decrease administrative burden to account for the “in-kind”/cash contributions** would allow partnerships and missions to focus on the implementation, on building synergies and on the acceleration of results and impact. Consider “In-kind” as a financial contribution (e.g., the cost of people’s working time, the use of equipment, and the own funding), as industry is not funded at full costs.
4. **Foster the use of Artificial Intelligence**, as proposed in Recommendation 4.

Regarding the current structure of Horizon Europe, our recommendation is as follows (see also Recommendations 5, 6 and 7):

- a. **Clusters**, as currently existing, are mainly used to manage and govern the Framework Programme among the services of the EC. Their role should evolve to consider synergies and efficiency among the four main Councils to be considered after 2025 (i.e., ERC, EIC, ETiC2 and ESC2), including nurturing excellence and promoting ex-post-assessment procedures.
- b. **Partnerships**, as currently existing, should further leverage cash and in-kind contributions from industry, the need for the deployment and use of results, and the needs for reinforced openness to new players, in terms of sectors, scientific disciplines and geographies.
- c. **Missions**, as currently existing (i.e., Cancer, Sustainable Cities, Soil Quality, Ocean/Water Sustainability and Climate Change), should be **taken out of the Framework Programme on RD&I and be governed at an adequate top level of “political ownership” by the future new College of European Commissioners**. Such high-level political ownership should guarantee the appropriate engagement and responsibility of the respective DGs to address policy and implementation actions (as opposed to RD&I issues). We recommend that the Framework Programme on RD&I should **exclusively** consider the **RD&I component of each Mission**.

Recent policy experiences with **Mission-Oriented Innovation Policy - MOIP** (see Box 9.3) as a means of tackling industry competitiveness or societal challenges have shown that they require **political ownership and stewardship by problem owners to be effective**,

together with adequate institutional responsibility by problem solvers¹⁵⁵. This points to the limitations of Missions that are driven by research or innovation directorates or agencies without the ownership or buy-in of problem owners, or the institutional engagement of research performers.

Box 9.3: Mission-Oriented Innovation Policy (i.e., MOIP), through European Partnerships and Missions

MOIP has been used under Horizon Europe to deliver on industry competitiveness and societal challenges:

- They represent about up to 60% of HE's Pillar II's global budget. This is because Mission-oriented policy has been a response to the ever-growing complexity of economic and societal challenges that transcend traditional policy boundaries;
- They focus on setting and pursuing ambitious, targeted, time-bound goals to address a need for societal transitions;
- Up to now, almost **EUR 65 billion** have been committed to European Partnerships launched between 2021-2024: EUR 24.8 billion from Horizon Europe and EUR 35.6 billion from the partners other than Union, out of which almost 65% come from industry.
- In addition, the current portfolio of **Partnerships** (co-funded, co-programmed, institutionalised) addresses four main thematic areas: **climate change** and the degradation of the environment, **accelerating technology change** and hyperconnectivity, **mitigating resource scarcity**, and shifting **health challenges**¹⁵⁶. Out of the 49 partnerships identified during the first half of Horizon Europe, 44 contribute to the green transition, 30 to the digital transition, and 25 to health-related resilience¹⁵⁷;

A Communication on European Missions was adopted in July 2023 by the College of Commissioners, **highlighting a number of areas where Missions will have to step up efforts, including ensuring coherence with other related policy initiatives, boosting citizens' engagement and raise public awareness**¹⁵⁸ and, above all, reaching out to other sources of **funding**, notably public and private investment;

Regarding the proposed two new Councils in this report, the **European Technology and Industrial Competitiveness Council** (ETIC2; see Recommendation 6) and the **European Societal Challenges Council** (ESC2; see Recommendation 7), we strongly recommend they should ensure streamlining, synergies, efficiency, clarity, agility, speed and focus by co-funding with each other and other programmes where appropriate and would increase engagement and, where appropriate, co-funding processes from industry, charity and philanthropy.

¹⁵⁵ See the recent OECD papers on "Transformative Innovation Policy", including the "OECD Declaration on Transformative STI policy", of April 2024. Also, Larrue (2022), "Do mission-oriented policies for net zero deliver on their many promises?", OECD, Paris.

¹⁵⁶ European Commission (2023), "Assessing European Partnerships Against European Policy Priorities", <https://data.europa.eu/doi/10.2777/62770>

¹⁵⁷ Note that individual partnerships may contribute to several objectives.

¹⁵⁸ Further supported by the January 2024 European Commission (2024), "Commission Expert Group to Support the Monitoring of EU Missions" (p. 9), <https://data.europa.eu/doi/10.2777/076494>, which finds that beyond traditional engagement practices as part of policy making and implementation, citizen and stakeholder engagement in the implementation of EU Missions is rather limited and requires further elaboration and conceptualization.

HOW?

Recommendations for the short-term, to be piloted under HE (2025-2027) and further improved and enlarged in FP10 should consider:

- **Eliminating non-core, redundant and underperforming programmes:**
 - One instrument in this category is the **European Institute for Innovation and Technology (EIT)**. In view of the widespread criticism the European Commission needs to urgently develop a clear plan for the radical reform of the EIT including significant reductions (or elimination) of FP funding;
 - The **European Innovation Ecosystems Programme (EIE)** might be redundant, of limited hard to measure impact, duplicative of MS and EIT initiatives and despite allocating limited funding costly in administrative resources. It should be reviewed and any activities worth preserving incorporated within European R&I ecosystem programmes;
 - As per Recommendation 8, **current widening instruments** should be **concentrated and simplified**;
 - Overall, the elimination of non-core, redundant and underperforming programmes should occur throughout the current HE programme.
- Adopting a **portfolio approach to agile project funding** that accepts responsible risk in return for **reduced administrative burden and transaction costs**. This requires:
 - A **radical reform of the application system** to “**trust first/evaluate later**” and become more applicant-friendly, Commission-efficient, impact-oriented and ensure a reduced time to fund.
 - **Priority should be given towards simplification for beneficiaries**;
 - A **radical reform in engaging practitioners** in the governance of the programme, notably through the proposed two new Councils in this report, the **European Technology and Industrial Competitiveness Council** (ETIC2; Recommendation 6) and the **European Societal Challenges Council** (ESC2; Recommendation 7), together with leveraging and strengthening the **independent role of active researchers and practitioners in ERC and EIC** (Recommendation 5).
- More **open, non-prescriptive calls** across the framework programme aiming to:
 - Provide an efficient and predictable **instrument to capture opportunities** in the more uncertain and fast-moving scientific, technology and business environment;
 - **Decrease administrative** and, above all, **transaction costs**;
 - Contribute significantly to simplification, **avoiding the systematic use of complex application forms with analysis of economic and social impacts**;
 - Facilitate engaging industry, innovators and philanthropy.
- Clearly adopt and effectively implement an **adequate MOIP- Mission Oriented Innovation Policy** (i.e., Partnerships and Missions) towards **three integrated main**

goals: i) the **creation of new markets of high added value based on new frontier research**, instead of focusing on collaboration to address market inconsistencies; ii) Cover the **whole research and innovation continuum**, and **involve industry and RTOs in the early phases of development**, including to build **digital twins**; and iii) promote the **circularity of the economy at a European level**.

- Preserve the actions taken under Horizon Europe to reinforce **gender balance throughout the programme with a target of 50% women in all related boards**, expert groups and evaluation committees. Also preserve the **eligibility criterion for promoters to have a Gender Equality Plan (GEP) in place** (i.e., for research organisations, universities and public bodies from Member States and Associated Countries).

Recommendation 10

Unleash the power of demand by developing an innovation procurement programme

Box 10.1: Definition of Innovation Procurement

Innovation procurement is defined as a policy where the state “uses procurement strategies and procedures to lower the risk for innovators and spark innovation. In this context, the state either defines new functionalities as a buyer or is open to innovative solutions”¹⁵⁹.

WHY?

The critical importance of demand for innovation is widely acknowledged: “the effects of innovation demand, and of public demand in particular, on innovation dynamics and on broader economic benefits, and thus potentially on transformation, are immense”¹⁶⁰. Consequently, “governments need to recognize that for firms, the incentive to innovate stems from their expectations regarding the acceptance and absorptive power of the market”¹⁶¹.

Public procurement provides a critical vehicle for the state to stimulate demand for societally desirable solutions and at the same time promote competitiveness¹⁶². According to the OECD (2023), it can and should play an essential role in reducing carbon emissions towards net zero, among other things by driving “radical, regime-changing innovations”¹⁶³. It also contributes to maximizing the impact of more supply- or input-oriented research and innovation funding.

Through public procurement, governments “can influence the market directly by demanding something new or absorbing innovations that struggle to take off, but are potentially of broader benefit to societies”¹⁶⁴. Conversely, traditional public procurement can actively undermine or hinder innovation and market creation by favouring ‘off-the-shelf’ products¹⁶⁵. Therefore “[a]ll policy domains across government should take responsibility for innovation and should reflect on how asking for and diffusing innovation can support the delivery of public services and policies”¹⁶⁶.

¹⁵⁹ Edler (2019), p. 9.

¹⁶⁰ See Edler (2023), p. 4; see also Mowery and Rosenberg (1979), Boon and Edler (2018), Edquist et al (2015).

¹⁶¹ Edler (2019), p. 5.

¹⁶² Edler (2023).

¹⁶³ OECD STI Outlook (2023), p. 88.

¹⁶⁴ Edler (2023), p. 1

¹⁶⁵ Edquist et al. (2015).

¹⁶⁶ Edler (2019), p. 17.

However, when it comes to promoting innovation, governments tend to focus more heavily on the supply side than the demand side¹⁶⁷. In particular, for various reasons, they struggle to unleash the potential of public procurement. Thus, Edler (2023) considers public procurement as “the most direct lever of state action, and one of the most neglected” (p.4). The neglect of both demand-side innovation policies, and public procurement of, and for, innovation also applies to EU policies¹⁶⁸. Efforts have been made to address the deficit in the EU research and innovation policy toolbox, but with limited success (Box 10.2)¹⁶⁹. Among other things, the EU struggles with linking public procurement to support for the development of new solutions and products – referred to as pre-commercial procurement – to a commitment to purchase the final solutions at scale¹⁷⁰. The latter is sometimes referred to as “catalytic” public procurement for innovation¹⁷¹. As a result, the EU is still underutilizing public procurement as a lever for promoting innovation and competitiveness, as well as addressing societal challenges, both with regard to the potential of such policies and compared to other countries or regions.

In Europe¹⁷², **public procurers still find it too risky to undertake innovation procurement** with their regular procurement budgets and they face **difficulties in using existing financial products** (such as standard bank loans) for innovation procurements (see Box 10.2). Both the Letta Report¹⁷³ and the Political Guidelines for the Next Commission¹⁷⁴ point to the importance of making better use of public procurement as a driver of innovation.

¹⁶⁷ See Edler and Georghiou (2007) and Boon and Edler (2018).

¹⁶⁸ Edler and Georghiou (2007) define demand-side policies as “a set of public measures to increase the demand for innovations, to improve the conditions for the uptake of innovations or to improve the articulation of demand in order to spur innovations and the diffusion of innovations” (p. 952).

¹⁶⁹ See European Commission (2021). The strategic use of public procurement for innovation in the digital economy and European Commission (2022). Pre-Commercial Procurement. <https://digital-strategy.ec.europa.eu/en/policies/pre-commercial-procurement>

¹⁷⁰ Caranta and Gomes (2021).

¹⁷¹ Edquist et al. (2015).

¹⁷² Details of DG RTD action at European Commission (2024), “New Financial Products to De-Risk Innovation Procurement”, https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/new-financial-products-derisk-innovation-procurement-2024-07-03_en

¹⁷³ Letta, E. (2024).

¹⁷⁴ Ursula Von der Leyen (2024), “Europe’s Choice”.

Box 10.2: Challenges for Public procurement to promote disruptive innovation and European added-value – the last few years

- The **European investment in innovation procurement is relatively small** (although it has increased to about 14% of European GDP, from 9.37% in 2021; EC, 2021). Germany invests in innovation procurement with the same intensity as the EU average. Other EU Member States have taken action in this area, setting quantitative targets. These include Finland (5% target for innovative public procurement), France (2% of procurement for innovative SMEs), the Netherlands (2.5% of procurement for innovation) and Spain (3% new investment for innovation procurement; OECD, 2017). In 2021, the Lithuanian government also increased its target for the share of innovation in total public procurement as part of the National Progress Plan for 2021-30 (OECD, 2021). Encouraging contracting authorities to adopt a strategic perspective to innovation procurement is also fundamental, as is collaboration with different actors around public needs.
- Several projects funded under the two previous Framework Programmes have demonstrated that the strategic use of innovation procurement results in significant positive impacts in record speed (e.g., in European partnerships). However, despite noticeable progress over the past decade, **innovation procurement expenditures across Europe are still two times lower than in other leading global economies**.
- The EIC instituted an annual competitive prize for innovative procurement by public bodies in the hope of inspiring others by example – this has had limited impact.
- DG RTD has allocated in July 2024 an advisory assignment to the **European Investment Bank** to explore the potential for creating a new, easy-to-use financial product that financial investors under the **InvestEU programme** could offer to public procurers across Europe to **de-risk innovation procurements**, so that they would be more inclined to undertake both **R&D procurements to develop and test innovative solutions** and **public procurements to deploy innovative solutions**:
 - The assignment will investigate the viability of introducing different financial instruments to mitigate the risks associated with innovation procurement. This could take the form of **loans, guarantees, performance bonds or other alternatives (insurance, equity ventures), risk sharing funds** etc. The conclusions and recommendations of the assignment will outline the specific characteristics of such an instrument or combination of instruments, whether they are still to be developed or already offered, albeit potentially requiring improvements, by financial institutions such as the EIB or other banks, or alternative financial investors or agents.
 - The assignment has a duration of 12 months (March 2024 - March 2025) and starts with a market analysis conducted through a comprehensive approach including surveys, desk research, interviews and focus groups. This multi-faceted approach ensures a thorough understanding of market dynamics and insights from diverse perspectives. The analysis starts with two questionnaires that investigate respectively the barriers that firstly public procurers experience in the financing of innovation procurements and secondly the challenges that suppliers experience in trying to sell innovation solutions to the public sector in Europe.

In using public procurement to promote innovation, policymakers can avoid important pitfalls, such as distorting competition, by ensuring that tenders are open, and by identifying needs and functions rather than prescribing solutions and technologies¹⁷⁵.

¹⁷⁵ See, for details, Edler (2023) and Edquist et al (2015).

WHAT?

Develop and implement a strategy or programme for **innovation procurement**. The strategy or programme must go beyond merely supporting the development of and purchasing prototype solutions (precommercial procurement) to serving as an effective and efficient demand-side innovation policy instrument, contributing to creating markets for societally relevant and desirable solutions, such as achieving net zero, strengthening Europe's security and defence capabilities and the provision of public services (e.g., healthcare). Such a strategy or programme should span relevant policy areas, ensuring coherence, effectiveness and efficiency.

An example of innovation procurement may be the European Commission soliciting a tender for the best solutions to **decarbonise critical infrastructures** (e.g., airports, railways, ports), rather than procuring a specific technical solution (such as carbon capture, or alternative fuels). In this way, public procurement can act as a powerful demand-side driver for innovative solutions, lowering the risks inherent to investment in novel areas of research and eventually creating new markets for products or services that can support overarching policy objectives. Other examples include **profiling tumours at the molecular level** and creating **platforms for distance (tele-)rehabilitation services for patients in remote areas** (e.g., EC's open pre-commercial procurement tenders through the Horizon Europe programme, since 2022). Box 10.3 provides sample evidence of critical areas benefiting from innovation procurement.

Box 10.3: Some success cases of public procurement to promote European added value

- The European Commission supports innovation procurement as a tool to deliver solutions to economic and societal challenges. Currently however, compared to other parts of the world, the **two main forms** of EC's support (PCP and PPI) are **underutilised in Europe**:
- **Pre-Commercial Procurement (PCP)** can be used when **there are no near-to-the-market solutions yet** and **new research and development is needed**. PCP can then compare the pros and cons of alternative competing solutions. This will in turn de-risk the most promising innovations step-by-step via solution design, prototyping, development and first product testing:
 - the **Norwegian oil and gas operators Equinor and Gassnova** successfully completed two consecutive pre-commercial procurements that developed and tested cost effective solutions for full-scale **carbon capture, transport and storage**¹⁷⁶;
 - In 2014-2017, the **Danish start-up Blue Ocean Robotics** created a **self-driving disinfection robot** in a pre-commercial procurement for a buyers group from several Danish regions. Since then, the Danish start-up attracted \$48,7M USD Venture Funding, experienced a steep growth to over dkk 850 million valuation and +200 employees¹⁷⁷;
 - In 2014, the **smart mobility scale-up Be-Mobile** (<https://be-modile.com>) created a **real-time traffic solution** for the 'shockwave traffic jam' pre-commercial procurement (PCP) of road authorities in Benelux. Since then, Be-Mobile has more than maximised its results: the company employs 300% more employees, was partially acquired by Belgium's biggest telco operator Proximus and expanded its activities in over 30 countries beyond the Benelux borders¹⁷⁸.
- **Public Procurement of Innovative solutions (PPI)** is used when challenges can be addressed by innovative solutions that are nearly or already in small quantity in the market and **don't need new research and development**. Sample examples¹⁷⁹:
 - Application of **Artificial Intelligence to job-matching system** in the **Flemish Public Employment Service**;
 - **X-Road project in Estonia**, aiming to develop comprehensive software able to connect all public databases and guarantee the highest **security standards**;
 - **Swedish energy agency** forms buyers groups to make the procurement of **intelligent energy management** for public buildings easier for Swedish local authorities.

¹⁷⁶ European Commission (2021), "Creating the world's first and largest full-scale carbon capture, transport and storage facility", <https://digital-strategy.ec.europa.eu/en/news/creating-worlds-first-and-largest-full-scale-carbon-capture-transport-and-storage-facility>

¹⁷⁷ European Commission (2020), "Danish disinfection robots save lives in the fight against the Corona virus", <https://digital-strategy.ec.europa.eu/en/news/danish-disinfection-robots-save-lives-fight-against-corona-virus>

¹⁷⁸ European Commission (2020), "Smart Mobility Company Be-Mobile Leverages PCP to Accelerate Growth Track", <https://digital-strategy.ec.europa.eu/en/news/smart-mobility-company-be-mobile-leverages-pcp-accelerate-growth-track>

¹⁷⁹ Details at European Commission (n.d.), "Public Procurement of Innovative Solutions", https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda/innovation-procurement/public-procurement-innovative-solutions_en

HOW?

- Immediately initiate effective **capacity-building and training of staff in charge of public procurement, notably at DG RTD** (i.e., starting in 2025);
- Seek **inspiration from good practices** (e.g., DARPA) to establish the necessary preconditions that allow the European Commission to move from pre-commercial public procurement to public procurement for and of innovation;
- Develop and **test possible initiatives in and with the experimental unit** (see Recommendation 4).
- Identify and address **obstacles** to public procurement for innovation;
- **Improve synergies and coherence** across EU policy domains to better utilize public procurement to stimulate demand and create markets and thus to serve as an effective driver of innovation and competitiveness, and for addressing societal challenges;
- Ensure that public procurement does **not distort competition** (and incur losses in economic welfare) or overprescribe technological choices or specific products, focusing instead on identifying societal needs and functions;
- **Engage practitioners** and other experts in the **definition and launch of innovation procurement programmes**, by involving ERC, EIC and the councils for industrial and technology competitiveness and societal challenges in designing PPI initiatives (See Recommendations 5, 6 and 7);
- **Leverage the experience of European “New Own Resources”**, such as the Emissions Trade System – ETS and the related *Innovation Fund* (managed by DG CLIMA), as well as the *Next Generation EU Programme* (managed by the *Recovery and Resilience Facility* - RRF and *National Recovery and Resilience Plans* - RRFs). This should involve a close and immediate articulation of the FP with the **European Innovation Fund**, as well as with ‘**Next Generation EU**’. Our recommendation involves the assessment of potential new forms of procurement for innovation, based on auctions of increasingly stringent needs for large and medium firms in Europe to increase their RD&I expenditure (see Box 10.4).

Box 10.4: Where the money comes from to foster effective innovation procurement in Europe?

- **Insisting on increased national public and private co-funding** alone to fund innovation procurement is unrealistic.
- **Promoting European “New Own Resources”** beyond MFF and leveraging on current initiatives is the **most realistic recommendation**, although it also faces enormous **challenges**, as follows:
 - In 2020, the EU set up the **“Recovery and Resilience Facility”** and the related ‘Next Generation EU’, a programme financed by selling bonds on the international financial markets, which provided additional funds for the regular EU budget of around €702 billion. This additional money went partly into national post-Covid recovery plans and partly into existing EU funding programmes such as Horizon Europe. The catch is that Next Generation EU is intended as a one-off programme, it is expiring and the debt has to be repaid/rolled over. Resistance to any new EU borrowing can be expected from a few MS and finance ministers in ECOFIN, in association with the emerging polemic against an “EU debt union”, unless the funding is deployed in programmes with the potential for demonstrable returns e.g., innovation procurement or EIC Fund (Recommendation 5).
 - From 1 January 2021, a contribution from EU countries based on the quantity of **non-recycled plastic packaging waste is a new EU own resource**;
 - In December 2021, the Commission proposed a first basket of new own resources. This would include auctions of increasingly stringent emissions allowances linked to the **EU Emissions Trading System (ETS)** and a **Carbon Border Adjustment Mechanism (CBAM)** to deter ‘carbon leakage’ beyond the union. It includes three new own resources to be introduced starting in 2024:
 - an ETS-based own resource, consisting of 30 per cent of auctioning revenues from the ETS and yielding €7 billion per year as of 2024 and €19 billion per year as of 2028;
 - a CBAM-based own resource, based on 75 per cent of revenues from the CBAM, from which a yearly amount of €1.5 billion is expected as of 2028, and
 - an own resource stemming from levying 0.5 per cent on the gross operating profit of corporations, which should generate yearly revenues of €16 billion.
 - Altogether, this adjusted first basket of new own resources is expected to yield €23 billion annually as of 2024 and up to €36.5 billion annually from 2028. They are expected to be deployed through the **European Innovation Fund**, managed by DG CLIMA.
 - In addition to the European Innovation Fund, the development of advanced forms of “smart regulation” in Europe could consider the **design and assessment of a new “Knowledge Trading System (KTS)**, leveraging on the experience of ETS, but based on auctions of increasingly stringent needs for large and medium firms in Europe to increase their R&D expenditure.

Recommendation 11

Adopt a nuanced, granular and purpose-driven approach to international cooperation

WHY?

A combination of factors is significantly changing the context for international cooperation in science, technology and innovation. Firstly, we are in the midst of a dramatic shift in the global distribution of knowledge resources. Whereas wealthy democracies have dominated knowledge generation for much of the past century, the beginning of the 21st century marks the rise (and return) of China as a global scientific power (see framing chapter and recommendations 2 and 3)¹⁸⁰. Between 1996 and 2020, China's RD&I expenditure increased by 3299%, compared with 227% for the US¹⁸¹. As a result, China is now the second-largest RD&I spender in the world (after the US) and accounts for the largest number of scientific papers. China's RD&I expenditure as a share of GDP increased from 0.94% in 2001 to 2.43% in 2021, and now exceeds that of the EU which grew from 1.70% to 2.16% in the same period (Figure 11.1).

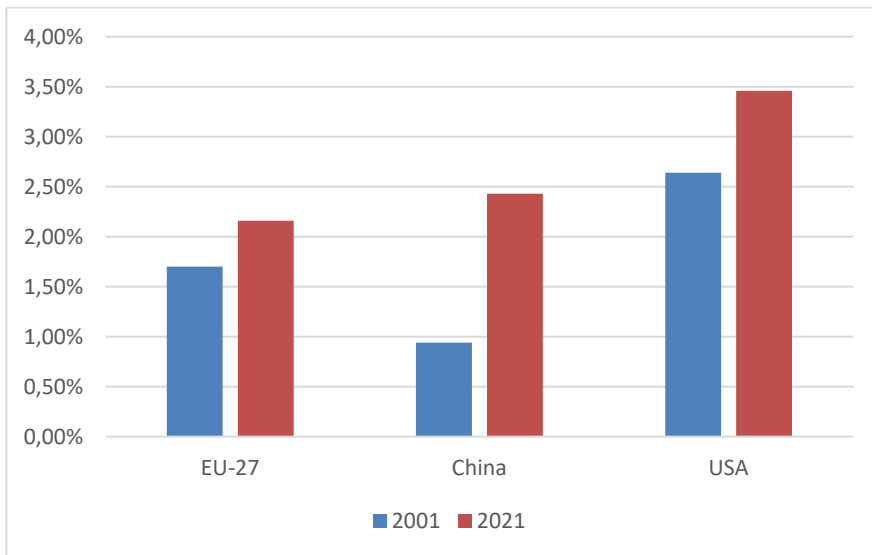


Figure 11.1: R&D expenditure as a share of GDP for EU-27, China and the US, 2001-2021

Source: <https://nces.nsf.gov/pubs/nsb20246/cross-national-comparisons-of-r-d-performance#global-r-d-and-top-r-d-performing-countries>

¹⁸⁰ See, for example, National Academies (2024).

¹⁸¹ Rathenau Institute (2024), "China: A Scientific Superpower in the Making", <https://www.rathenau.nl/en/science-figures/process/collaboration/china-scientific-superpower-making>

Secondly, over the past decade, economic and political relations between China and the USA and its allies have become more fraught. China's growing scientific and technological power play a significant role in this changing relationship. Thus, according to the OECD, "China's growing technological capabilities have also ushered in a new era of intensified strategic competition with liberal market economies"¹⁸². As a result, **US-China research cooperation** has gone from being perhaps the most important single motor of international scientific cooperation – measured in terms of co-publications between the two countries – to being characterized by increasing caution, tension and even confrontation.

As a result of the above-described changes, the period that began in the late 1980s, described as an era of "unprecedented openness"¹⁸³ or "the collaborative era of science"¹⁸⁴ is being replaced, or at least significantly reshaped, by "**strategic competition**".

Overall, national security and economic concerns, geopolitical tensions and competition for the mastery of core technologies – all of which are interlinked – increasingly cast a shadow over international research collaboration and its undisputed benefits to scientific excellence and innovation¹⁸⁵, leading to calls for **focusing**, or even **limiting cooperation to 'like-minded countries'**. However, ignoring one of the largest RD&I spending and producing countries also seems unwise. At the same time, the economic weight of low and particularly middle-income countries has rapidly grown in the past two decades (see figure 11.2 on GDP development). The combination of rapid economic, scientific and technological development makes these countries **increasingly important markets** for European companies but **also knowledge and innovation hubs and partners** for European science and technology actors.

¹⁸² OECD (2023), Science, Technology and Innovation Outlook 2023. p. 45.

¹⁸³ Benner (2022).

¹⁸⁴ Wagner (2018).

¹⁸⁵ See Wagner (2008) and (2018) for an analysis of the dynamics and benefits of international research collaboration.

Percent of World

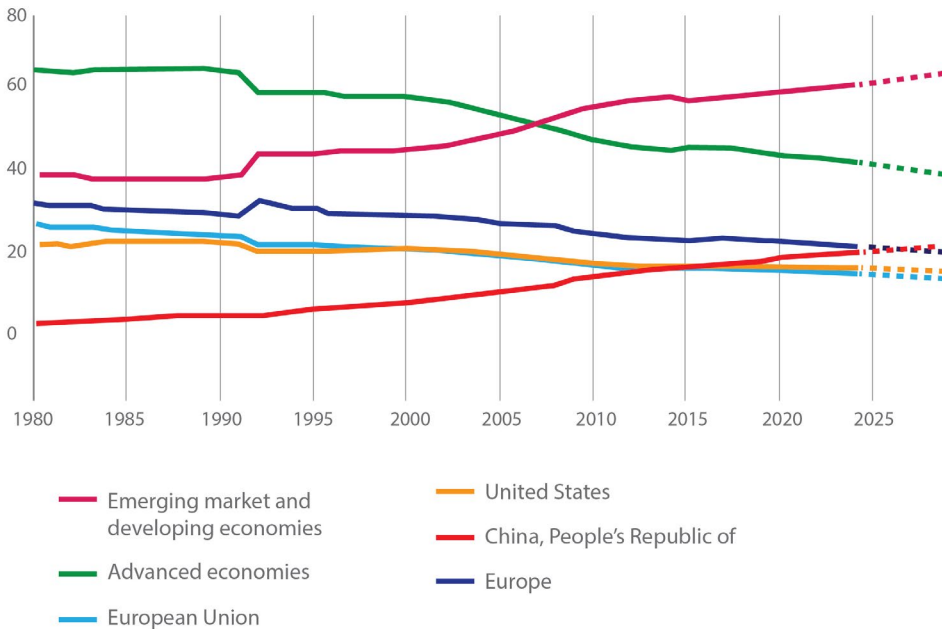


Figure 11.2: GDP based on PPP, share of world total

Source: IMF Data Mapper

<https://www.imf.org/external/datamapper/PPPSH@WEO/OEMDC/ADVEC/WEOORLD/EU/USA/CHN/EUQ?year=2024>, accessed June 17, 2024.

In the EU context, calls for **strategic autonomy**¹⁸⁶ and concerns over foreign interference but also ‘economic security’ have led to a recalibration of the stance on openness and international cooperation. Thus, the approach “**open innovation, open science, open to the world**”, coined by then EU Commissioner for Research, Science and Innovation Carlos Moedas in 2015 has been replaced by a more cautious approach summarized as “**as open as possible, as closed as necessary**” in the “Global approach to Research and Innovation - Europe’s strategy for international cooperation in a changing world” adopted by the Council of the European Union in September 2021¹⁸⁷. This approach was further developed in the Commission Staff Working Document on “Tackling R&I Foreign Interference” published in January 2022¹⁸⁸, and was formalized in May 2024¹⁸⁹. Box 11.1 provides evidence of instruments used in Horizon Europe.

We acknowledge and strongly support **the need for a recalibration of international cooperation** in science, technology and innovation and we call upon EU research and

¹⁸⁶ See, for example, Burgelman and Soete (2023). Also, European Commission (2023). Research, innovation and technology policy in times of geopolitical competition. <https://data.europa.eu/doi/10.2777/745596>.

¹⁸⁷ Council of the European Union (2021), Document 12301/21, “Council Conclusions on the Global Approach to Research and Innovation – Europe’s Strategy for International Cooperation in a Changing World”, <https://data.consilium.europa.eu/doc/document/ST-12301-2021-INIT/en/pdf>

¹⁸⁸ European Commission (2022), “Tackling R&I Foreign Interference”, [C:\Users\lpi-ssg\Work\Folders\Downloads\tackling_r&i_foreign_interference-KI0922004ENN\(1\).pdf](C:\Users\lpi-ssg\Work\Folders\Downloads\tackling_r&i_foreign_interference-KI0922004ENN(1).pdf)

¹⁸⁹ Council of the European Union (2024), “Council Recommendations on Enhancing Research Security”, Document 9097/1/24 REV 1, <https://data.consilium.europa.eu/doc/document/ST-9097-2024-REV-1/en/pdf>

innovation performers and funders to think carefully about the purpose, and the possible consequences and risks, of the cooperations and interactions they undertake or support.¹⁹⁰ However, we are concerned that the current approach is leading to an **excessive and costly deterioration in European scientific relations** with countries that are not fully or formally aligned with the European Union's interests or values.

Box 11.1. European instruments for external cooperation in research and innovation

- The openness of Horizon Europe to **international cooperation** has had a considerable positive impact on tackling societal challenges globally. Some examples include the work under the *All-Europe Ocean Research Alliance*, the *Partnership on Research and Innovation in the Mediterranean Area (PRIMA)*, the *EU-Europe Union cooperation* under the *Food and Nutrition Security and Sustainable Agriculture partnership* and the *EIT Food protein diversification think tank*¹⁹¹.
- In addition, open cooperation in S&T has allowed the EU to join forces with countries with a strong RD&I capacity to pursue solutions to global challenges more effectively¹⁹². Furthermore, Horizon Europe supports key *multilateral scientific bodies* like the *Intergovernmental Panel on Climate Change (IPCC)*, the *Intergovernmental Science Platform on Biodiversity and Ecosystem Services (IPBES)* and the *Group of Earth Observations (GEO)*, to name a few.
- Following European Commission (2023), "it can be foreseen that the upcoming **EU Raw Materials Act will move in this direction**, together with calling for increased international cooperation to increase diversity of EU raw material imports. However, it is of utmost importance that it **fosters new RD&I** and that **international cooperation in S&T takes up the economic interests of the developing countries**.
- The EC's expert group on "Economic and Social Impact of Research", ESIR, calls for a **balanced approach of de-risking and responsible risk taking**, which takes the different rationales for openness into account. Such responsible risk taking is in the self-interest of Europe to tackle global challenges and forge new geopolitical cooperation.

When such countries are becoming scientific and strategic markets, Europe cannot afford to adopt a simplistic or black- and white approach. Comparisons between EU-China and EU-US S&T cooperation illustrate our point. While formal relations between the US and China are fraught with conflict and the rivalry between them, ideologically, militarily and technologically, defines our current era, the two countries continue to cooperate closely academically, and are each other's largest partners in internationally co-authored papers. Thus, **the share of US publications in science and engineering involving a co-author with a Chinese affiliation has grown from 7% in 2004 to 24% in 2022**. In comparison, in

¹⁹⁰ See also Arcesati, Hors and Schwaag Serger (2021), "Recalibrating the EU's Research and Innovation Engagement with China", <https://merics.org/en/comment/recalibrating-eus-research-and-innovation-engagement-china>

¹⁹¹ See details at EIT Food (2024), "EIT Food Protein Diversification Think Tank", <https://www.eitfood.eu/projects/eit-food-protein-diversification-think-tank>, in that protein is an essential part of a healthy human diet, but the overproduction of animal-based protein is damaging to the environment. Furthermore, with the expected increase of the global population, the world needs sustainable ways of producing new, high-quality, safe and healthy proteins to ensure adequate nutrition for the planet. Protein diversification has the potential to alleviate many of the current food system's challenges and new R&I in EU needs to consider these advancements.

¹⁹² Where Pillar II is the focus on these countries' association.

the same time period, the share of US publications involving a co-author with a UK affiliation has grown from 13% to 14% (NSF).¹⁹³

Table 11.1 shows how much selected countries co-publish with authors with Chinese affiliations. EU countries tend to collaborate primarily with each other and other mature democracies. In comparison, China is a more important cooperation partner for Australia, Canada, Japan, South Korea, the UK and the USA.

Clear mutual benefit is to be gained from European collaborations with international partners including those in RD&I-intensive third countries such as Switzerland, newly associated countries in Horizon Europe such as the UK, Canada, New Zealand and South Korea, or emerging partners in the Global South.

In a changed and complex world, European companies and researchers need to operate in key markets and cooperate with the **best scientists** even when they are in countries with which the EU competes politically, economically, technologically or militarily. They need to do so precisely to avoid isolation and marginalization, and to ensure Europe's future security, prosperity and competitiveness. They also need to manage potential risks with such collaborations and operate with **caution, clarity and with purpose**. This, in turn, requires different forms of and approaches to cooperation and new support functions to help assess and manage them, and to mitigate risks. The European Commission must increase awareness and offer customised guidance, support and coordination on challenges related to international scientific engagement¹⁹⁴.

¹⁹³ NSF (2024), "A Changed Science and Engineering Landscape"
<https://www.nsf.gov/nsb/publications/2024/changedlandscape.pdf>

¹⁹⁴ See Schwaag Serger and Shih (2024), forthcoming, for a discussion on how to develop effective approaches for international cooperation in the changed international environment. In this context, it is also interesting to note the conclusion drawn in a policy brief published by the NSF on "A Changed Science and Engineering Landscape": "[s]taying at the frontiers of discovery requires leaning into internationalism. What are the most beneficial and strategic international collaborations, and how should they be sustained?" NSF/NSB (2024), <https://www.nsf.gov/nsb/publications/2024/changedlandscape.pdf>

Table 11.1: Co-publications of selected countries 2021-24
 Source: Scival, accessed August 6, 2024

	total co-publications	co-publications with at least one author with a Chinese affiliation	share of internationally co-authored papers with at least one author with a Chinese affiliation	top collaborating countries
Australia	269724	69475	25.8%	US, China, UK, Germany, Canada
Austria	82645	6412	7.8%	Germany, US, UK, Italy, Switzerland
Belgium	105335	10403	9.9%	US, UK, France, Netherlands, Germany
Canada	271718	48373	17.8%	US, China, UK, Germany, Australia
Denmark	87277	11889	13.6%	US, UK, Germany, Sweden, Netherlands
France	269921	27092	10.0%	US, UK, Germany, Italy, Spain
Germany	396203	47501	12.0%	US, UK, Italy, France, China
Italy	271969	21963	8.1%	US, UK, Germany, France, Spain
Japan	126369	40567	32.1%	US, China, UK, Germany, France
Netherlands	174548	18683	10.7%	US, UK, Germany, Italy, France
Poland	87546	9505	10.9%	US, Germany, UK, Italy, France
Spain	223834	16949	7.6%	US, UK, Italy, Germany, France
South Korea	125242	27489	21.9%	US, China, India, UK, Japan
Sweden	123315	16248	13.2%	US, UK, Germany, China, Italy
UK	539939	89612	16.6%	US, China, Germany, Italy, Australia
US	996512	213492	21.4%	China, UK, Canada, Germany, Italy

WHAT?

Global shifts in economic, but also scientific and innovative power – towards emerging markets and developing economies in Asia and the Global South and away from mature democracies – combined with increasing geopolitical competition, and the urgent need to tackle common societal and planetary challenges, recommend that the EU **adopt a nuanced, granular and purpose-driven approach to international cooperation** to successfully navigate a more complicated and changing geopolitical environment:

- a. **Recognise that countries can be partners, competitors or systemic rivals** and that the same country could be all of these in different domains of RDI (e.g., climate change, electric vehicles or high technology semiconductor chips). This requires a **utilitarian approach**, asking “Who are our partners for which RDI domain/question?”.
- b. **Develop a purposeful (asking Why?) approach to collaboration** e.g., countries with strong research systems, like-minded countries, developing countries, joint interests and mutual benefits, **access to an international pool of talents** – some of whom we may wish to attract to Europe.

Such an approach requires **going beyond guidelines, recommendations, checklists or blacklists** (of technologies, topics, institutions or countries). Currently, many researchers, institutions and companies shy away from partners, subjects and projects that involve potential risks, even if this means forgoing important scientific, commercial or other gains. As a result, Europe risks insulating itself from relevant research and innovation hubs, with negative consequences for its future competitiveness, prosperity but also security.

Ensuring that Europe is at the forefront of critical technologies and can develop attractive solutions for relevant markets requires understanding and interacting with scientific and innovation leaders, not least if they involve complex countries and sensitive topics. Such interaction or cooperation in turn requires **resources, competencies and coordination** to identify relevant cooperations, and manage, mitigate and share their possible risks.

We thus call for a **proactive, strategic approach to international cooperation, which effectively combines offensive with defensive instruments**. Offensive elements include identifying and initiating strategic collaborations, investing in future technologies and competitiveness, and building relevant alliances, while defensive instruments can take the form of awareness-building, advisory and knowledge support functions for research performers, aimed at bolstering Europe’s ability to protect itself against vulnerabilities and threats.¹⁹⁵ The approach we propose would ensure that Europe can effectively weigh, and manage, the risks arising from certain collaborations (to science, security or competitiveness) against the costs (to science, security or competitiveness) of foregoing such collaborations.

A **nuanced, granular and purpose-driven approach** to international cooperation should be based on a **balance of defensive and offensive policy interventions**, along the principles proposed by the OECD (2023) of “protect, promote and project”:

¹⁹⁵ The latter is particularly important when considering how China strategically, often opaquely and in a zero-sum fashion, deploys an array of instruments to acquire foreign technology, restrict foreign access to its own technology, strengthen China’s supply chain dominance and boost its domestic innovation and industrial capacity. See, for example, Arcesati, Chimits and Hmaid (2024), https://meric.org/sites/default/files/2024-08/MERICS_Report_Export_controls_August_2024_0.pdf

1. **Protection:** *restricting technology flows and reducing dependency risks*, e.g., through regulatory policies like export controls, supply-chain diversification measures, etc.;
2. **Promotion:** *enhancing domestic innovation capabilities and performance*, e.g., through holistic innovation policies, mission-oriented innovation policies, national industrial strategies, etc.;
3. **Projection:** *extending and deepening international STI linkages*, e.g., through international technology alliances, active participation in international standards setting bodies, etc.¹⁹⁶.

HOW?

We propose the following measures towards establishing and implementing a nuanced, granular and purpose-driven approach to international cooperation:

- **Invest in and pool knowledge resources to understand and successfully navigate a more complicated and changing geopolitical environment.** This should also include the **establishment of a knowledge and advisory support function and platform** for institutions and Member States to share information and insights and coordinate themselves (e.g., vis-à-vis third countries). The aim should be to **adopt a more informed, strategic and effective approach to interacting and cooperating with complex countries and partners**, with clear benefits for Europe. Inspiration could be drawn from the initiative by the US National Science Foundation entitled **“Safeguarding the Entire Community of the U.S. Research Ecosystem (SECURE)”** announced in July 2024 to invest 67 M\$ in “a clearinghouse for information to empower the research community to identify and mitigate foreign interference that poses risks to the U.S. research enterprise. The SECURE Center will share information and reports on research security risks, provide training on research security to the science and engineering community and serve as a bridge between the research community and government funding agencies to strengthen cooperation on addressing security concerns.”¹⁹⁷. The experiences gained from the **EU R&I Knowledge Network on China (EU-KNOC)** launched by the EC’s Directorate General for Research & Innovation in June 2020 could also serve as a useful reference point.
- **Establish a system, platform or network for technology monitoring** which monitors and compares (and projects) the development, diffusion and uptake of critical technologies in the EU and other relevant countries and regions - see also Recommendation 2 and Wagner (2018).
- **Strengthen cooperation with science and innovation powers outside the EU**¹⁹⁸.

¹⁹⁶ OECD (2023). Science, Technology and Innovation Outlook 2023. p. 47.

¹⁹⁷ NSF (2024), “NSF-backed SECURE Center will support research security, international collaboration”, National Science Foundation, <https://new.nsf.gov/news/nsf-backed-secure-center-will-support-research>, see also Science|Business (2023), “National science funders eye setting up international network to share research-security information”, <https://sciencebusiness.net/news/international-news/national-science-funders-eye-setting-international-network-share-research>

¹⁹⁸ In accordance with European Commission (2021) - The *Global Approach to Research and Innovation* (2021), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0252>

- Devise and fund **a strategy to advance the EU as a setter of global standards**¹⁹⁹.
- Strengthen the EU's position as a **global leader** in pooling global efforts to tackle global challenges together and in particular in efforts towards a **just green transition**²⁰⁰.

¹⁹⁹ Also, in accordance with *Global Approach to Research and Innovation (2021)*.

²⁰⁰ Also, in accordance with *Global Approach to Research and Innovation (2021)*.

Recommendation 12

Embrace dual use as inevitable by exploiting dual use both ways

WHY?

A recent European Commission White Paper on options for enhancing support for RD&I involving technologies with dual-use potential highlights the **unexploited potential** for spin-out from civil R&D to deliver defence applications and from defence R&D to generate civil applications. It points out the need for enhanced internal coordination and coherence between EU and national funding programmes to mitigate fragmentation within the security and defence sector²⁰¹.

At the same time, given the current geopolitical circumstances, policymakers may be inclined to allocate a disproportionately high share of European research and innovation funds to narrowly defined defence related topics and high-TRL research. Such a development creates the risk that Europe prioritizes the development of incremental solutions for the short-term future and immediate dangers at the expense of building long-term competitiveness and resilience. Therefore, a suitable balance needs to be maintained between satisfying short-term and legitimate security and defence needs while continuing to invest in long-term prosperity and sustainability.

WHAT?

The European Commission launched a **wide public consultation** on this topic, which concluded on 30 April 2024. Respondents were invited to share their views on three options for how to enhance support for research and development involving technologies with dual-use potential: 1) going further based on the **current set-up**, 2) **remove the exclusive focus on civil applications** in selected parts of future Framework Programme and 3) **create a dedicated instrument** with a specific focus on research and development with a dual-use potential.

The analysis of the results of the public consultation shows a **wide diversity of opinions across stakeholder groups**. This indicates a tendency mostly favourable to Option 1 among research institutions, NGOs and expressed citizens, and more openness to Option 2 among some public authorities, business associations and private companies subject to further discussion on the details of the implementation."

HOW?

The current debate about "dual use" technology commonly, and erroneously, assumes that one can easily identify and segregate it. We believe that adhering to a strict dichotomy

²⁰¹ European Commission (2024). SRIP.

between dual-use and civil research is **not** the ideal way forward and should **not** be used as a framing differentiation in the European context for two main reasons:

1. First, given the **ubiquitous nature** of many new technologies by definition, almost all RD&I is “dual use” (e.g., consider the internet, AI, mobile phones, drones). For example, few would have predicted the importance of cheap drones versus expensive military weapons in the current Ukrainian war;
2. Second, given the nearly ubiquitous and comprehensive requirements of any modern military, almost any research area is by definition “dual-use” (e.g., health, nutrition, human performance). For example, an army needs its soldiers to be healthy, therefore all health research is dual use. Whilst this might seem perverse, the evidence supports it²⁰². So, instead of trying to identify and classify “dual use”, we advocate embracing that it is **ubiquitous** and **inevitable**. We advocate instead a focus on optimizing the benefits both ways. The economic peace dividend from countries decreased military expenditure is over. The challenge for European RD&I is to realize a new innovation dividend from the inevitable increase in military expenditure.

In this context, our main recommendation for the current European RD&I framework programme (i.e., Horizon Europe, 2025-2027) and its successor FP10 is to embrace the fact that **dual use is inevitable given the ubiquitous nature of modern technology** (e.g., internet, drones) and the broad **needs of a modern military** (e.g., health, fitness). Therefore, the European Commission should administer programmes as “military RD&I” and “everything else” (i.e., civilian, dual use) and **optimise the innovation dividend arising from the need for increased national security and defence expenditure by exploiting dual use both ways**.

In addition, the European Commission should establish the necessary safeguards to:
i) ensure an ethical, transparent approach to foster public support to RD&I in Europe;
ii) earmark sufficient budget for civilian research (including but not differentiating dual use) and optimize synergies with military research (i.e., EDF programme); and iii) keep the framework programme open for international collaboration following Recommendation 11.

Our recommendation implies that **research calls should NOT distinguish “dual use”, because of its “ubiquitous nature”**. All research calls should be open to universities, RTOs and institutions with civil clauses and should **NOT** differentiate “dual use” technologies or systems. Applicants should not be asked to specify potential future dual use except where legally required although they can elect to do so if they wish. Programmes should avoid using the term “dual use” but in cases where it is used for any specific reason, it should **NOT** require new contracting conditions and procedures.

Many stakeholders (see Annex 1) advocate the need for the current European RD&I framework programme (i.e., Horizon Europe, 2025-2027) and its successor FP10 to **enhance cyber and other security measures** (including training and awareness-raising) in the whole RD&I process to protect uncontrolled flow of technologies with potential for military use. This should be established on a “**project basis**” without any further increase in bureaucracy.

²⁰² For example, US DARPA have and continue to fund significant health research, including in breast cancer, regenerative medicine, vaccines and diagnostic tests, among many other areas.

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ANNEX 1: POSITION PAPERS BY STAKEHOLDERS

(received between January and September 2024)

This report was developed together with access to a large amount of data, including the EC's post assessment of Horizon 2020 and the interim evaluation reports on Horizon Europe. In addition, all members of the expert group involved key **stakeholders** in the work to benefit from their insights and feedback.

Our analysis benefits from that of the *Center for European Policy Studies* - CEPS²⁰³, which we have complemented by asking all interested stakeholders to address the following **four questions** in a maximum of 2 pages of response:

- What major challenges (scientific, social, economic, technological) should still be attempted to be addressed in the second half of HE (2025-27) and further addressed by a future FP (FP10)?
- Which are the major successes of the current HE (2021-2023) and which are the major “roadblock”/threats for success?
- Which sub programmes of HE should be preserved and strengthened in a future FP (i.e., FP10) and which should be altered? How far a future FP (i.e., FP10) should keep/alter the current basic three-pillar architecture of HE (i.e., Pillar 1: Excellent Science; Pillar 2: Global Challenges and European Industrial Competitiveness; Pillar 3: Innovative Europe)?
- What would be a catalyst to overcome current roadblocks of HE and be implemented in a future FP (i.e., FP10)? What should be the most important innovations to be considered in a future FP (i.e., FP10)?

Below is the list of stakeholders that contributed to the process.

List of contributors²⁰⁴ (from January to September 15, 2024; alphabetic order):

Aalto University
Aeneas, EPoSS and Inside
Aerospace, Security and Defence Industries Association of Europe (ASD)
AFM Cluster
Agence nationale de la recherche et la technologie (ANRT)
Agenzia per la Promozione della Ricerca Europea (APRE)
Alliance for Life Sciences
Analog Devices
Animal Task Force (ATF)

²⁰³ Dell'Aquila et al. (2024), Centre for European Policy Studies, CEPS.

²⁰⁴ a = Meetings notes only; b = No written document.

Asociación de Empresas de Energías Renovables (appa renovables)
Asociación Española para la Economía Energética (AEEE) / Spanish Association for Energy Economics
Association nationale de entreprises de services énergétiques (anese)
Austrian Science Fund (FWF) ^b
BASF
Bill and Melinda Gates Foundation
British Academy (The)
BusinessEurope
Centre national de la recherche scientifique (CNRS)
COCIR
Coimbra Group ^b
Conference of European Schools for Advanced Engineering Education and Research (CESAER)
Conseil Européen pour la Recherche Nucleaire, European Organization for Nuclear Research (CERN)
Council for Research, Science, Innovation and Technology Development (FORWIT-Rat)^b
Culture Action Europe
Danish Academy of Technical Sciences ^b
Danske Professionshøjskoler - University Colleges Denmark
Danske Universiteter - Universities Denmark (UNIDK)
Digital Europe
Ettevõtluse ja Innovatsiooni Sihtasutus – Estonian Business and Innovation Agency
EU STEM coalition
EU-LIFE
Eureka
European Association of Innovation Consultants (EAIC)
European Association of Research and Technology Organisations (EARTO), BusinessEurope et al
European Consortium for Ocean Research Drilling (ECORD) and International Continental Scientific Drilling Program (ICDP)
European Molecular Biology Laboratory (EMBL)
European Plant Science Organisation (EPSO)
European Regions Research and Innovation Network (ERRIN)
European research infrastructure for bioranking and biomolecular resources in health and life sciences (The) (BBMRI-ERIC)
European Round Table of Industry (ERT)
European Society for Medical Oncology (ESMO)
European Society of Paediatric Endocrinology (ESPE)
European University Association (EUA)
Eurosace
Federal Ministry of Education, Science and Research (BMBWF) ^b
Federation of Austrian Industries (IV) ^b
Federation of European Academies of Medicine (FEAM)
Flemish Public Administration - Department of Economy, Science and Innovation
FoodDrink Europe
Forskningsrådet - Research Council of Norway
Fotoplat

France Digitale ^a
Fraunhofer
Fuest, Clemens, Gros, Daniel and Tirole, Jean
Fundacion Iberoamericana del Conocimiento (GECON)
Good Food Institute Europe
Gothenburg (City of)
Graz University of Technology (TU Graz) ^b
Guild of European Research-Intensive Universities (The)
Helmholtz
High Level Groups on EU Policy Innovation
Informatics Europe
Initiative for Science in Europe (ISE)
Institut Mines Telecom
Institute for Systems and Computer Engineering, Technology and Science (INESC TEC)
Instituto Superior Técnico
International Agency for Research on Cancer (IARC) ^a
International Center for Future Generations (ICFG)
IQM Quantum Computers
Irish High Level Groups on Horizon Programmes
Johnson & Johnson
Jožef Stefan Institute
Jožef Stefan Institute & National Institute of Chemistry
Københavns Universitet - University of Copenhagen ^b
Latvijas Jauno zinātnieku apvienība – Latvian Association of Young Researchers (LJZA)
League of European Research Universities (LERU)
Lithuania (Ministry of Education, Science and Sport of the Republic of)
MedTech Europe
MONDRAGON Corporation
Neth-ER
Northern Sparsely Populated Areas network (NSPA)
Norwegian University of Science og Technology (NTNU)
Novo Nordisk Foundation ^b
OHB
Orgalim
Ostrobothnia (Region of)
Plataforma Tecnológica Española de Eficiencia Energética
Plataforma Tecnológica Española de la Construcción (PTEC)
Plataforma Tecnológica para la difusión y promoción de las TICs (PLANETIC)
Politecnico di Milano
Polska Izba Gospodarcza Zaawansowanych Technologii - Polish Chamber of Commerce for High
Technology (IZTECH)
Rizzuto Carlo - Chair of Gen. Ass. CERIC-ERIC
Rodrigues, Carlos, Holmes, Dwayne, Ferreira, Frederico and Camphuis, Kevin
Rolls Royce

Royal Danish Academy of Sciences and Letters ^b
Royal Society (The)
Russel Group
Sadales tīkls AS
Science Europe
SERNAUTO and Spanish Automotive and Mobility Technology Platform
SSH RAAD
Stockholm Region Association for European Affairs
Technische Universiteit Delft - Delft University of Technology (TU Delft)
Teknikföretagen - Association of Swedish Engineering Industries
UK Academy of Medical Sciences
UK Research and Innovation (UKRI)
UK Research Councils
UnLiON University Network
Unión Española Fotovoltaica (UNEF)
Universities Austria (UNIKO) ^b
Universities of Applied Sciences for Europe (UAS4Europe)
Universities of Applied Sciences Netherlands (UASNL)
University Alliance Stockholm Trio
University of Bergen
Vetenskapsrådet är Sveriges - Swedish Research Council
VKR Group (Villum and Velux Foundation) ^b
Vlaamse Interuniversitaire Raad – Conseil des rectrices et recteurs francophones (VLIR-CReF)
Vrije Universiteit Amsterdam
Wellcome
Wirtschaftskammer Österreich - Austrian Federal Economic Chamber (WKO)
Young European Research Universities (YERUN)
28 Presidents of National Academies of Sciences
4 Portuguese agencies: FCT (Portuguese Science and Technology Foundation), ANI (Portuguese Innovation Agency); PT SPACE (Portuguese Space Agency) and Portuguese Erasmus+ Agency

ANNEX 2: TERMS OF REFERENCE OF THE EXPERT GROUP

The report considers the following four questions included in the terms of reference from DG RTD:

1. The extent to which Horizon Europe is on track to deliver seamless funding of research and innovation that covers the whole value chain, addresses market failures and contributes to the EU's major policy objectives.

We find that Horizon Europe has made considerable progress in delivering seamless funding of research and innovation that covers the whole value chain, addressing market failures and contributing to the EU's major policy objectives. We also see a number of areas where further improvements can and should be made to improve the effectiveness and impact of the programme but also in light of a changed context for the world we live in and the planet we inhabit, as well as the context for Europe, and for research, technology and innovation. We make concrete recommendations to further enhance Horizon Europe's and a future framework programme's ability to deliver on its ambitions, on EU's major policy objectives and for a better future.

2. The extent to which Horizon Europe is on track to achieve its general, specific and operational objectives, as set out in Horizon Europe's legal basis.

Horizon Europe is on track to achieve its general, specific and operational objectives. We provide recommendations to help ensure delivery, e.g., with respect to simplification, use of AI, time to grant, co funding, more effective synergies and optimisation of some programmes.

3. Horizon Europe's added value given the needs and objectives of the EU.

We note and describe in our report the clear, unique and critical added value of Horizon Europe given the needs and objectives of the EU. We also make proposals as to how this value added could be further increased for the remainder of Horizon Europe and a future framework programme.

4. The internal and external coherence of Horizon Europe, and its articulation and synergies with other EU and Member State programmes.

We underline a need and potential for improvements in the internal and external coherence of Horizon Europe, and its articulation and synergies with other EU and Member State programmes and we make some recommendations to that effect.

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This independent expert report provides strategic recommendations on maximising the impact of EU Research and Innovation programmes in the future. It is based on the preliminary findings and data on Horizon Europe and findings and conclusions stemming from the ex-post evaluation of the Horizon 2020 programme, and on other sources. It advocates that Europe should pursue a transformative agenda to address four critical and interdependent core spheres of action. This transformative agenda should be implemented in the short term, through specific actions in the last three years of Horizon Europe, 2025-2027, and embedded in future EU support to research and innovation.

Studies and reports

