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A New ERA for Research and Innovation

Staff Working Document

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Policy paper

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[1] https://ec.europa.eu/info/research-and-innovation/strategy/era_es

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1 CONTEXT

1.1 The European Research Area (ERA)

1.1.1 Origins and development of the ERA

The **concept for a European Research Area** was proposed by the European Commission in 2000 with the Communication "Towards a European Research Area"[2]. The Lisbon European Council in 2000 supported the initiative, as it envisaged to overcome fragmentation and isolation of national efforts and systems and to reduce disparities of regulatory and administrative frameworks[3]. ERA, together with the 3% Barcelona objective and the accompanying 3% action plan, was part of the new Lisbon Strategy, which aimed to turn the EU into the most competitive and dynamic knowledge based economy of the world.

At that time, the overall aim of the Commission's approach was to achieve "a better organisation of research in Europe" by addressing the "fragmentation, isolation and compartmentalisation of national research systems" and "the lack of coordination in the manner in which national and European research policies are implemented".

ERA was underpinned by **several principles**, such as:

(i) a common approach to financing large research facilities;
(ii) more coherent implementation of national and European research activities; more mobile human resources, including a European vision for research careers;
(iii) greater European cohesion in research;
(iv) improving the attractiveness of Europe for researchers from the rest of the world;
(v) promotion of common social and ethical values in scientific and technological matters.

Additionally, a number of actions around the themes "infrastructures", "coordination of programmes", "private investments", "mobility & careers", "regional & international aspects", "society & values", and "improve evidence-based policy-making" were proposed.

In 2002 the Commission identified insufficient Member State engagement as an obstacle towards the achievement of ERA and sought to identify what needed to be done to give new momentum to the ERA initiative by strengthening efforts where

[2] COM(2000) 6. For the historical background see also European Parliamentary Research Service (2016), European Research Area - Cost of Non-Europe Report; European Parliamentary Research Service (2016), The European Research Area - Evolving concept - implementation challenge, In-depth Analysis.

[3] Council Resolution of 15 June 2000 on establishing a European area of research and innovation; Lisbon European Council conclusions (24/3/2000).

necessary and defining new perspectives which would provide the initiative with more effective means of implementation.[4]

Box 1. Era and the subsidiarity principle

The european research area is a multi-level governance initiative. It comprises policy actions in the areas providing most of the eu added value building on and synergetic to the national and regional research and innovation policies and initiatives, fully in line with the subsidiarity principle and the autonomy of research funding and research performing organisations.

In the following years, the Commission published a series of Communications, expert reports and working documents on the various dimensions of the ERA concept. The 6th Research Framework Programme (2002-2006) and its new instruments were positioned as an important vehicle to implement ERA and some major achievements during this period include: ERA-NETs (2002), EURAXESS (2003), European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (2005)[5], Article 185 initiatives (2003) and Article 187 initiatives (Joint Technology Initiatives - JTIs) (2007).

From 2007 onwards a stronger partnership between the Commission, EU Member States, countries associated to the Framework Programme and stakeholders was sought to revive the ERA process. The Green Paper "The ERA: new perspectives", published in April 2007, opened this avenue around six priorities[6]. Three additional principles were defined: (i) European research policy should be deeply rooted in European society; (ii) the right balance should be found between competition and cooperation; (iii) full benefit should be derived from Europe's diversity.[7] In 2008, the Council took ownership of the ERA process based on an agreed process (so-called "Ljubljana Process") and setting out a "vision for the ERA in 2020".[8]

The Council also endorsed concrete initiatives to achieve the ERA: a Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations; Communications on a European Partnership for Researchers; Towards joint programming in research; and a strategic European framework for international

[4] COM (2002) 565.

[5] 2005/251/EC , OJ L 75, 22.3.2005, p. 67–77 http://data.europa.eu/eli/reco/2005/251/oj

[6] (i) An adequate flow of competent researchers; (ii) World-class research infrastructures, integrated, networked and accessible; (iii) Excellent research institutions; (iv) Effective knowledge sharing; (v) Well-coordinated research programmes and priorities; (vi) A wide opening of the European Research Area to the world.

[7] COM (2007) 161 Green Paper - The European Research Area: New Perspectives.

[8] Council Conclusions on the launch of the "Ljubljana Process" - towards full realisation of ERA (30/5/2008); Council Conclusions on the definition of a "2020 Vision for the European Research Area" (2/12/2008).

science and technology cooperation; a Council Regulation for a Community legal framework for a European Research Infrastructure Consortium (ERIC).

The Lisbon Treaty modified the articles related to research and technological development. Article 179 TFEU explicitly introduced ERA as an objective for the Union:

> *"The Union shall have the objective of strengthening its 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, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaties."*

Article 182(5) opens up the possibility to adopt legislation to enforce the implementation of ERA:

> *"As a complement to the activities planned in the multiannual framework programme, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure and after consulting the Economic and Social Committee, shall establish the measures necessary for the implementation of the European Research Area."*

Although the Treaty does not define a "completion date" for ERA, in 2011 the European Council endorsed the objective of ERA to be "completed by 2014 to create a genuine single market for knowledge, research and innovation"[9]. The Commission announced in its Innovation Union Communication that it would propose an ERA framework in 2012[10].

As proposed in the Communication of 2012 and endorsed by the Council, ERA is implemented through six priorities: (i) more effective national research systems; (ii) optimal transnational cooperation and competition, including "jointly addressing grand challenges" and "research infrastructures"; (iii) an open labour market for researchers; (iv) gender equality and gender mainstreaming in research; (v) optimal circulation, access to and transfer of scientific knowledge, including "knowledge circulation" and "open access"; (vi) international cooperation (see following section).

The Communication also specified concrete commitments linked to competitiveness and to maximising excellence and returns of public R&I and kept the emphasis on the knowledge triangle and the interlinkage between policies. It reinforced merit-based recruitment to make research careers more attractive, it asked for brain circulation and it linked ERA to the European Semester and its national reform programmes. Stakeholder organisations' involvement in the governance system of ERA became more formalised through the ERA Stakeholder Platform.

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[9] European Council Conclusions of 4/2/2011.
[10] COM (2012) 392 A Reinforced European Research Area Partnership for Excellence and Growth.

Moreover, the Council invited "Member States to identify the national reforms and actions needed for achieving the ERA [...] and to present these reforms and their subsequent implementation [...] where appropriate in the National Reform Programmes starting from the 2013 European Semester"[11].

In its Conclusions of 30 November 2018, the Council invited the Commission "to publish by mid-2020 a new ERA Communication for the period beyond 2020, based on sound evidence, which may propose revised ERA policy priorities and ERA governance and monitoring mechanisms at national and EU level".[12]

1.1.2 ERA progress: achievements and shortcomings[13]

As mentioned above, in 2012 the Commission proposed to achieve ERA with reference to six priorities. This approach has been endorsed by the Council and has since 2015 been implemented through an ERA Roadmap[14]. These six agreed and current ERA priorities are the basis for the following stock-taking of ERA achievements and shortcomings.

Achievements

Figure 1. ERA achievements

Source: DG Research and Innovation, European Commission.

[11] https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/134168.pdf.

[12] Council Conclusions on the "Governance of the European Research Area", adopted by the Council at its 3655th meeting held on 30 November 2018, p. 12.

[13] For an Impact Analysis of the ERA until 2012, see SWD (2012) 212.

[14] Council Conclusions on the European Research Area Roadmap 2015-2020, doc 8975/15, 19 May 2015.

ERA is an established and well-recognised political framework, which has acted as the policy counterpart of the funding provided through the Framework Programme. Looking back, it is possible to identify a number of success factors. ERA has advanced most through pragmatic and concrete initiatives, which offer valuable tools to policy makers and other stakeholders. In more general terms, ERA contributed to creating a community of research funders and research performers, it served as a basis for sound mutual learning amongst its governmental actors, and ERA has provided the space to raise awareness concerning the divergent research performances in Europe. Achievements include:

- **More effective national research systems:** indicators show that research excellence in the EU has increased steadily over time, even if progress has slowed down since 2013[15]. Reforms of national R&I systems are encouraged through the **European Semester** of economy policy coordination, in which R&I policy has gained increased prominence in recent years. The Semester constitutes the basis for an in-depth policy dialogue with national authorities and stakeholders based on factual evidence and cross-country benchmarking: the analysis of the capabilities and performance of the different components of each national R&I system and of the interlinkages between enables to identify the key bottlenecks impeding the full contribution of R&I to growth and national competitiveness. This approach led to targeted Country-Specific Recommendations on issues such as the fragmentation of the public research system, science-business cooperation, the availability of skilled human resources in science and technology, the balance between direct and indirect public support and the broadening of the innovation base. The Semester's analyses can trigger a request for assistance by Member States through instruments that support national reforms such as the **Horizon Policy Support Facility (PSF - see Box 2)**. The recurrent feedback on the PSF work received from national policy-makers has shown that the operational guidance formulated by leading experts and practitioners proves extremely valuable as enabler of national R&I reforms.

Box 2. Policy Support Facility

The policy support facility (PSF) is an instrument created in 2015 to help member states to improve their R&I policies. The PSF uses funding from Horizon 2020 (and Horizon Europe in the future) to support Member sStates (MS) and Horizon Associated Countries in reforming their R&I system.

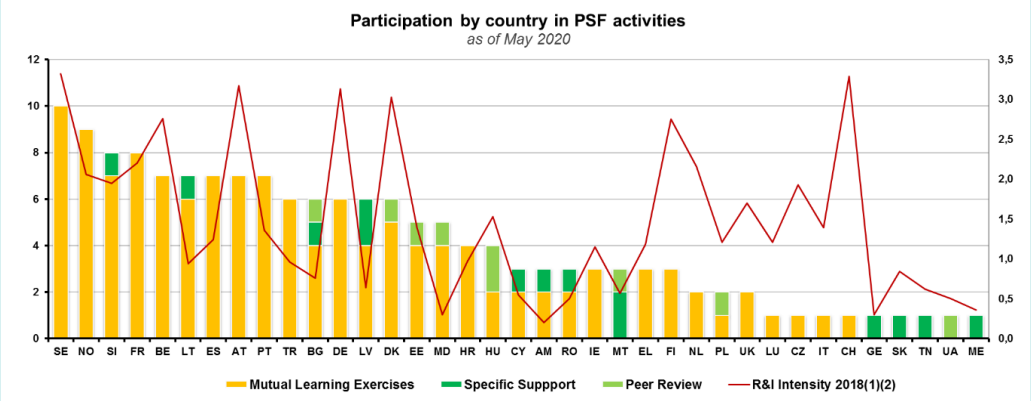
Its methodologies allow drawing on the combination of the high potential of learning between peers (i.e. policy-makers) and of high-level independent expert advice. Country-specific projects provide national authorities with operational recommendations on how to strengthen their R&I system[16] and tackle specific R&I policy challenges[17]. In Mutual

[15] +2.3% over 2013-2018 but +1.5% over 2016-2018 (source: European Commission, DG JRC).
[16] Through 'Peer Reviews'.
[17] Through 'Specific Support'activities.

Learning Exercises focused on a particular policy challenge of interest to several countries, hands-on country visits and discussion among peers on national experiences allow participants to identify good practices and success factors.

As visible in the figure below, all Member States participated to at least one PSF exercise and intensive users of the PSF include both countries with high and low R&D intensities.

Figure 2 Participation in PSF activities



Source: eurostat, world bank. Note: ch, me, tr: 2017.

The main challenges concerning the PSF are now to:

- Strengthen its impact (overall dissemination of results, ownership and implementation of the recommendations at national level, synergies with other tools).
- Strengthen the design stage of each project (considering the critical role of this stage for the success of the project).
- Extend the range of policy needs that it can address (notably how to unlock the potential of R&I for systemic transformations towards sustainability) and in synergy with the new technical support instrument [18].

- **Jointly addressing grand challenges**: national administrations work ever more closely together in public-public partnerships (such as ERA-NETs, Article 185 initiatives, and Joint Programming Initiatives) to jointly address global challenges. Joint Programming and other public-public Partnerships allow the development of joint R&I agendas and coordinated implementation of activities. A sign of this is that the share of GBARD (government budget allocations for research and development) allocated to transnationally coordinated research has been constantly increasing since 2012[19], although it has been slowing down over the recent years. Pooling resources and

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:0409:FIN
[19] See ERA Progress Report 2018, Technical Report, p. 44.

research capacities to more effectively address common challenges is one of the main perceived and actual benefits of EU transnational cooperation[20]. It is one of the most frequently mentioned strategic goals in the National ERA Action Plans. This ERA priority is one of the most successful with the ERA headline indicator growing at 3.9% annually between 2014 and 2016[21], resulting in more than 700 joint calls with a cumulative budget of more than EUR 7 billion in national investments since 2004, and current annual spending of EUR 700-800 million.

- **Research infrastructures**: over the last twenty years, a collective approach towards the joint investment in and the efficient use of new and existing European research infrastructures has been developed. As a result of the close cooperation of the national governments, the European Commission and the scientific community within the European Strategy Forum for Research infrastructures (ESFRI), the ESFRI Roadmap facilitates and promotes joint European investments in world-class infrastructures, which complements the closer cooperation with the large European intergovernmental organisations. The five editions of the ESFRI Roadmap to date (2006, 2008, 2010, 2016 and 2018) have resulted in the joint planning and development of 55 European Research Infrastructures, of which 37 have already been implemented, across all fields of science and technology, mobilizing close to €20 billion in investments. Among these, 21 new Research Infrastructures were established as European Research Infrastructure Consortia (ERIC) – a legal entity based on the only EU Regulation (2009) in the ERA framework. Moreover, this has had an important impact to the strategic approach to Research Infrastructures at national level, as 22 Member States have prepared national roadmaps in recent years, many of them following the ESFRI methodology and in increasing alignment with European priorities. This work has radically transformed the availability of state-of-the-art facilities for scientists and engineers to carry out their work across Europe, reinforcing Europe's strong research performance.

- **Open Science and knowledge circulation:** Open Science has increasingly become policy practice across Europe. There is an increased share of open access publications. In 2017, the total share of EU Open Access papers was 46%[22]. In 2018, the European Open Science Cloud (EOSC) as a common, federated, European framework for storing and sharing publicly-funded research data and related services has been established. It promotes FAIR[23] principles as an important element of Open Science and was implemented as a common initiative of European and national partners. Starting from 2020, all European researchers and research organisations should be able to

[20] See ERA Progress Report 2018, p. 6.
[21] See ERA Progress Report 2018, p. 6.
[22] Source: Science-Metrix.
[23] Findable, accessible, interoperable and reusable.

deposit, access and analyse European scientific data through the EOSC[24] . Knowledge transfer has always been an important objective of ERA. The 2008 Commission Recommendation on the management of Intellectual Property (IP) in knowledge transfer activities[25] was a game changer for many publicly funded knowledge producers. Some EU Member States have made strategic investments in knowledge transfer infrastructures and services such as Technology Transfer Offices (TTOs) and other intermediaries; and some have implemented dedicated policies like the National IP Protocol in Ireland. Despite of these achievements the EU is still lagging behind its global competitors in turning science-based ideas to innovations[26], and the diffusion of knowledge remains unequal in the Union. Digitalisation, Open Science and Open Innovation have changed the ecosystem in which R&I actors operate.

- **Mobility, careers, and an open labour market for researchers:** the European dimension of research careers and mobility has been a cornerstone of ERA since its start. According to ERA Priority 3, a truly open and excellence-driven ERA is determined by highly skilled and qualified people who can move seamlessly across borders to where their talents can be best employed. Driven particularly by the EURAXESS pan-European network of support services for researchers and its portal of research jobs[27], significant progress has been made in removing the geographical barriers to researchers' mobility and opening up the recruitment process to non-nationals, while facilitating open, transparent and merit-based recruitment processes.

    - The support for the training, and career development and mobility of researchers through the funding of excellent doctorates, the provision of fellowships and collaborative research under the Marie Skłodowska-Curie Actions (MSCA) has been remarkable. For the period 2014-2020, MSCA will fund the training and intersectoral, interdisciplinary and international mobility of 65,000 researchers, including 25,000 PhD candidates, and more than 1,000 international doctorates, supporting a new generation of excellent, creative and innovative researchers contributing to important scientific breakthroughs, and allowing universities to set up sustainable partnerships with non-academic partners.

    - The Standing Working Group on Human Resources and Mobility of ERAC (SWG HRM) supported the implementation and the monitoring of progress in the implementation of this ERA priority 3 (open labour market for researchers) at EU and national level (e.g. European

[24] ERAC Opinion on the Future of the ERA, Annex 1, p. 9.
[25] C(2008) 1329: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32008H0416
[26] As measured by the Innovation Output Indicator 2016: Japan 121.9, US 107.8 and EU 99.4
[27] https://euraxess.ec.europa.eu/.

Charter for Researchers and Code of Conduct for the Recruitment of Researchers, Innovative Doctoral Training, Career Development, EURAXESS activities), as well as the attractiveness of Europe to researchers in general. The SWG HRM also issued a comprehensive toolkit for assisting research performing organisations to implement open, transparent and merit-based recruitment (OTM-R) practices[28,29].

- The 2018 ERA Progress[30] revealed that in terms of the number of researcher job postings from a given country that are advertised through the EURAXESS job portal per 1 000 researchers in the public sector, the EU Member States appeared to be positioned in a downward trajectory with annual average declines of 5 % for the whole country group since 2014. This average annual decline reversed a previous course of positive growth over the 2012 to 2014 period. Results at the aggregate level contrasted sharply with a few very strong growth rates that stood out from the portrait of individual countries (i.e. Finland, Germany, Latvia, Turkey and Luxembourg), whereas decreases were driven by Bulgaria (61 % average annual decrease), Greece (45 % decrease) and Sweden (44 % decrease).

- While the last ERA Progress Report, based on MORE3 survey results found that 65 % of respondents in EU Member States were satisfied with the hiring procedures in their institution, qualitative analysis confirmed that a large gap still exists between EU countries in terms of the open labour market and career development opportunities provided to researchers. This concerns the availability of opportunities for learning, research funding opportunities, financial security, salaries and shares of fixed-term contracts. This heterogeneity reflects different higher education and research systems, as well as economic developments influencing public budgets for research and hence research funding and working and employment conditions for researchers. In addition, different employment status of researchers across different European countries and the resulting limited portability of social security and pension schemes across borders remains one of the key barriers for international mobility of researchers.

- The growing share of doctoral students with citizenship of another Member State is a positive sign of international mobility. Since 2013,

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[28] https://euraxess.ec.europa.eu/content/open-transparent-and-merit-based-recruitment-researchers-otm-r

[29] It is based on a checklist for institutions as a self-assessment tool to benchmark their current practices. The implementation of OTM-R ensures that the best person for the job is recruited, guarantees equal opportunities and access for all, facilitates developing an international portfolio (cooperation, competition, mobility) and makes research careers more attractive.

[30] 2018 ERA Progress Report, chapter 3.3 Priority 3, page 54

the EU has experienced an annual average growth rate of 3.9% for this indicator[31]. Instruments to foster structural institutional change in higher education institutions, research and technology organisations have been introduced, such as the Principles for Innovative Doctoral Training. Moreover, with the RESAVER programme, the first pan-European multi-employer occupational pension fund was launched in 2017. Since mobile researchers experience significant difficulties accumulating adequate pension provisions, RESAVER intends to tackle this barrier to mobility by allowing researchers to remain affiliated to the same pension fund while moving between countries. For the employer, the pension fund is an attractive solution in terms of fees and features.

- **Gender equality and gender mainstreaming in research:** positive changes in terms of gender equality are under way in many countries, in which the drafting of an ERA National Action Plan was an opportunity to define gender equality objectives and measures. However, despite the continuous policy attention for gender equality, overall progress has been slow. To support Member States in this ERA objective, in 2016 the Commission launched the Gender Equality in Academia and Research (GEAR) tool to provide guidance on how to develop Gender Equality Plans. The 2018 "She Figures" report on gender in R&I[32], shows overall improvement. Gender balance has practically been reached in terms of PhD graduates, and the share of women in the highest-level research positions is constantly increasing[33].

- **International cooperation**: international cooperation activities between ERA and non-ERA countries[34] is on the rise[35]. ERA countries use different tools to promote international cooperation, from bilateral agreements and dedicated R&I centres to appointing R&I advisors and specialists in their consulates and embassies worldwide. Countries with more developed R&I systems have more collaboration opportunities, and they are also better equipped to sustain and initiate new partnerships. International mobility and training of researchers, and international doctoral networks are promoted at the EU (EURAXESS and Marie-Sklodowska Curie Actions as key programmes) and national level. There is a particular need to facilitate international brain circulation by creating a more diverse set of incentives while foresee and deploy mitigation actions to tackle potential negative effects of mobility, notably in the sending countries.

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[31] See ERA Progress Report 2018, Technical Report, p. 57.

[32] https://ec.europa.eu/info/publications/she-figures-2018_en.

[33] See ERA Progress Report 2018, p. 9.

[34] Third countries that are not associated to the Framework Programme.

[35] Average growth of co-publications with non-ERA partners per researchers in the public sector is 4.2% since 2007, and average growth of non-EU doctorate students as a share of all doctorate students is 3.8% since 2013.

Manifesting a clear EU added value, the European Research Council, as well as the forthcoming European Innovation Council, can be judged as achievements serving the objectives of ERA at the level of the individual researcher and innovator[36].

ERA implementation gaps[37]

ERA monitoring reveals that ERA has been lacking most so far in reforming national R&I policies, in attuning national and EU policies, and in ensuring co-evolution of all R&I policies towards common objectives.

- **Progress on ERA implementation has slowed down since 2015 and major disparities still exist between countries, or are growing**[38]. For example, the balance between competitive funding and institutional funding still varies greatly between countries, with less developed R&I systems and research performing organisations relying mainly on institutional funding. This often affects their ability to attract the best talents[39]. There is also a persistent fragmentation of the science base in these countries. Moreover, a large gap still exists between EU countries in terms of an open labour market and career development opportunities provided to researchers. This results in large differences in the attractiveness of research careers among different countries and regions in Europe[40]. Similar differences also exit for industry-academia-collaboration. The transfer of research results to the market and closer collaboration between industry and academia is still underdeveloped in many ERA countries[41].

- To achieve alignment between national policies and policies agreed with Member States at the EU level, **more systemic coordination between the priorities of public-public partnerships and national research agendas and programmes is still required**. Even for European research infrastructures, where a substantial level of coordination has been achieved, the ERA Progress Report 2018 recommends that "to further increase the effectiveness of research infrastructures in Europe, there needs to be a better exchange of information on the actual infrastructure capacity, funding priorities, plans and strategies — both across countries/regions and between research organisations"[42].

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[36] ERAC Opinion on the Future of the ERA, Annex 1, p. 9.

[37] In 2012, the Commission identified the following problems hampering research performance in the ERA: insufficient competition in national research systems, barriers to pan-European cooperation and competition, persisting distortions among national labour markets for researchers, limited progress on gender equality and gender content in research, and restricted circulation of and uneven access to scientific knowledge (see SWD (2012) 212, pp. 7-16).

[38] See ERA Progress Report 2018, p. 4.

[39] See ERA Progress Report 2018, p. 5.

[40] See ERA Progress Report 2018, p. 8.

[41] See ERA Progress Report 2018, p. 11.

[42] See ERA Progress Report 2018, p. 8.

- **The persistent lack of a strong European dimension in national policies to ensure a co-evolution towards common objectives** indicates that the current ERA framework could have reached its limits with respect to ensuring strong political ownership and commitment[43]. The current national priorities are simply juxtaposed, each developing at its own pace, with different ambitions, actors and mechanisms. They work in silos, which challenges the core foundation of ERA, i.e. its self-conception of being a "single market for research".

- **ERA lacks a systemic approach for policies and reforms**, which is key in order to address the current challenges. There is need to have a well-geared *transition agenda,* supported by the European Commission at all levels of governance.

- **Priority setting in research & innovation was not considered part of ERA.** Hitherto the concept of ERA was used to address mostly horizontal issues relevant for the R&I landscape. In particular it does not capture important developments, such as the digital economy and artificial intelligence, and it could strengthen relations with, for example, competition policies, state aid, innovation policy, education, skills and other policy areas.

- Regarding **international cooperation**, despite many positive developments, ERA countries still face several challenges, including a lack of financial and human resources dedicated to establishing and managing international partnerships. Efforts to attract the best international talent with the objective to overcome labour shortages, strengthen research capabilities, boost innovation and deal with grand challenges need to be increased[44].

- **Besides, ERA also lacks recognition of its achievements**. Such missing or reduced attribution of success – which is linked to the lack of clear and quantifiable objectives as well as poorly developed monitoring and assessment practices – "limits the ownership of actors in the complex multi-level system"[45]. As the recent ERAC Opinion on the Future of ERA pointed out: "The actual and perceived contributions of effective ERA policies at EU, national and regional levels to competitiveness and 'welfare' (quality of life for EU citizens) cannot be attributed and consequently, additional coordination efforts are often seen as a burden and not as an asset. Empirical evidence suggests that this attribution challenge can eventually be overcome by demonstrating the added value through joint actions"[46].

To sum up, 20 years after its launch, ERA is an established, well-known political framework that stimulates cross-border joint R&I action and provokes policy reform

[43] ERAC Opinion on the Future of the ERA, Annex 1, p. 11.
[44] See ERA Progress Report 2018, p. 13.
[45] ERAC Opinion on the Future of the ERA, Annex 1, p. 11.
[46] ERAC Opinion on the Future of the ERA, Annex 1, p. 11.

as the section on ERA achievements has shown. It has provided important building blocks for ensuring the free circulation of researchers, knowledge and technology. However, ERA needs to adapt continuously to changing social, ecological, and economic circumstances as it otherwise loses attention, commitment, and purpose, and, most importantly, it also needs to deal with priority setting in R&I policies.

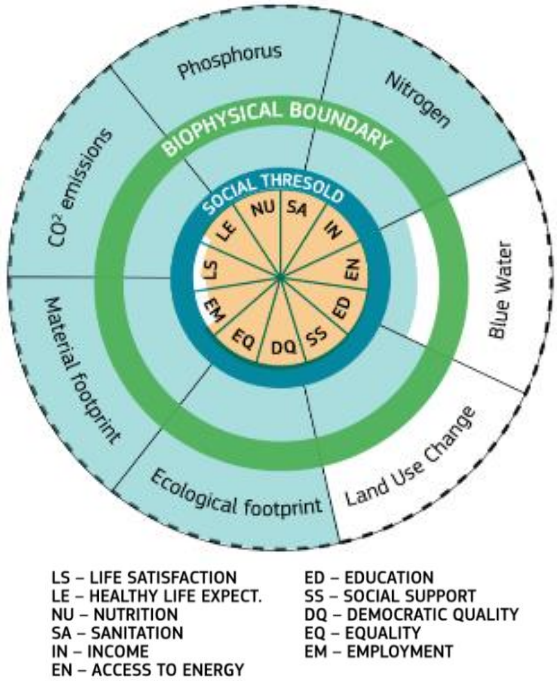
1.2 A changing world

R&I activities are carried out and R&I policies and ERA measures are developed in a context that has changed dramatically over the past years. While the Covid-19 pandemic has been disrupting our society only during the past months, Europe has been facing global long-term changes that are reducing our choices for the future. These changes include climate change, loss of biodiversity, ageing population, and increasing inequalities. The EU has committed to climate neutrality by 2050, and recently proposed[47] an EU-wide, economy-wide greenhouse gas emissions reduction target by 2030 compared to 1990 of at least 55% including emissions and removals. Accelerating research and innovation and improving the collaboration between the private and public R&I in the Member States towards early market deployment of clean technology solutions is vital for reaching this target and provides an economic opportunity for the EU.

Against this backdrop, the current way we produce and consume is not sustainable: currently, no country in the world seems to meet basic needs for its citizens at a globally sustainable level of resource use (see Figure 3), and industry is often more part of the problem than part of the solution. It is crucial that we understand what these changes mean for R&I: how they affect R&I, but also how R&I can contribute to addressing the challenges they entail, by providing solutions, by enabling a better understanding, and by making our society more resilient in the long term (Ricci et al., 2017).

[47] COM(2020) 562 "Stepping up Europe's 2030 climate ambition – Investing in a climate-neutral future for the benefit of our people"

Figure 3. Doughnut representation of biophysical boundaries and social thresholds (EU)



Source: https://goodlife.leeds.ac.uk/

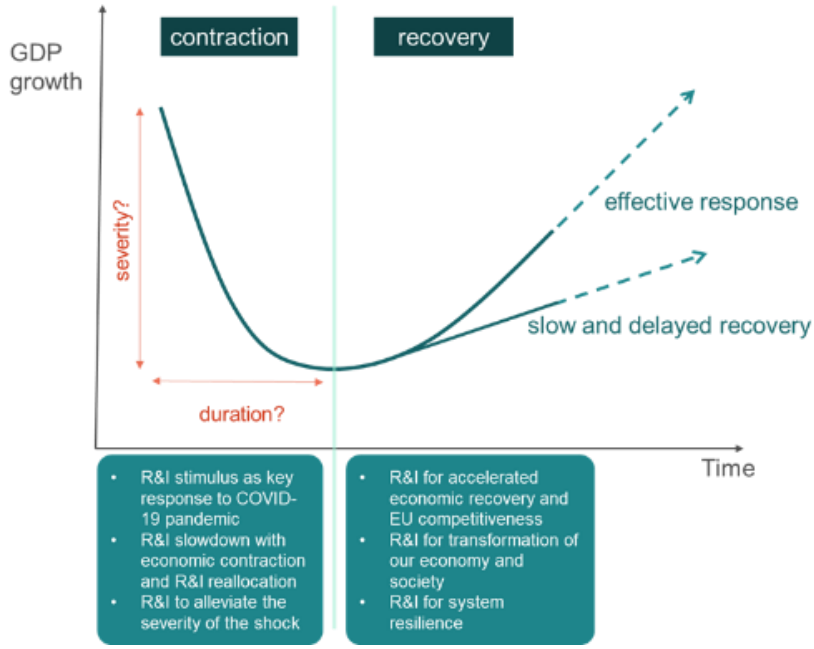
Note: Orange wedges show social performance relative to a threshold associated with meeting basic needs (blue circle), light blue wedges show resource use relative to a biophysical boundary associated with sustainability (green circle). Wedges with a dashed edge extend beyond the chart area. Ideally, a country would have orange wedges that reach the social threshold and light blue wedges within the biophysical boundary. This graphic is based on Kate Raworth's work on Doughnut Economics

Europe is facing several **deep changes that are relevant for R&I policy**, including the following:

- **The COVID-19 crisis is unprecedented** and the world has been struggling to contain the pandemic. It has disrupted our lives, economy and society. While **R&I is at the core of the response** to the pandemic itself in the areas of virology, vaccines development, treatments and diagnostics (see Box 3 for a first coordinated response under the ERAvsCorona Action Plan), it will be crucial also in the economic recovery from the crisis, not only to spur economic activity, but also accelerate the twin transitions that our planet and society need - a new economy for health, wellbeing and equality in a broad sense (physical, mental, skills, gender, social, environmental and economic aspects**). R&I can also help building system-wide resilience**. Technologies already help alleviate, at least partially, the severity of the

economic shock, with digital technologies being at the core of business continuity in several sectors. It is of paramount importance to invest in making our society and economy stronger, more resilient, sustainable and capable of a rapid and integrated response drawing on the latest scientific discoveries, ensuring equal access to healthcare, education and ICT across the EU, and social and economic support to its most vulnerable populations (Borunsky, Correia et al, 2020).

Figure 4. R&I and the economic recovery from the Covid-19 crisis[48]



Source: Science, Research and Innovation Performance of the EU, 2020 (European Commission, 2020)

Box 3. ERAvsCORONA

The first ERAvsCORONA action plan is a pragmatic[49] and coordinated response to the Covid-19 crisis and results from dialogues between the Commission services and the national ministries. Also Associated Countries are consulted and contribute with concrete actions. It covers first short-term coordinated actions only. It sets out key measures the Commission services and the member states are activating now to coordinate, share and jointly increase support for research & innovation, in line with the objectives and tools of the European Research Area. Coordination is also an important prerequisite for stepping up global cooperation, essential to tackle corona-related issues. It will be updated regularly by the Commission services and national

[48] The Summer 2020 Economic Forecast of the European Commission projects that the EU economy will experience a recession of historic proportions in 2020, with a forecasted contraction of 8.3%.

[49] During an informal videoconference of 7 April 2020, Ministers responsible for research and innovation supported the first 10 priority actions of the first ERAvsCorona Action Plan.

administrations with other R&I coordinated actions that can be taken in the short, medium and longer term.

It includes **10 priority actions** for coordinated R&I actions:

1. Coordination of R&I funding against the Coronavirus
2. Extending and supporting large EU wide clinical trials for clinical management of Coronavirus patients
3. New funding for innovative and rapid health-related approaches to respond to Coronavirus and deliver quick results relevant to society and a higher level of preparedness of health systems
4. Increasing support to innovative companies
5. Creating opportunities for other funding sources to contribute to R&I actions on Coronavirus
6. Establish a one-stop shop for Coronavirus R&I funding
7. Establish an ad-hoc High Level R&I Task Force on the Coronavirus
8. Access to research infrastructures
9. Research data sharing platform
10. Pan-EU hackathon to mobilise European innovators and civil society

- **Climate change poses an existential threat and requires enhanced ambition and greater climate action by the EU and at the global level**[50]**.** The past five years were the warmest on record. Global average temperature increased by 1.1°C above pre-industrial levels by 2019. The impacts of global warming are beyond dispute, with droughts, storms, and other weather extremes on the rise. We must take urgent and sustained action to preserve the health, prosperity, and well-being of people in Europe and all over the world. The recent reports of the IPCC on climate change and 1.5°C global warming, land, ocean and cryosphere underlined the dire impacts if climate change would not be halted. EU citizens are increasingly, and rightly, worried. Nine out of ten see climate change as a serious concern. A business-as-usual scenario, with continued pollution and greenhouse gas emissions[51], largely driven by economic and population growth, will lead to a further increase in global warming, ocean acidification, desertification and changing climate pattern. **R&I as well as the development and uptake of eco-innovations will be key to achieving the climate goals.** Yet, there is an overall decrease in national budgets devoted to R&I in clean energy technologies and a lack of national objectives and funding targets that show concrete and relevant pathways to 2030 and 2050[52]. There is a need for a

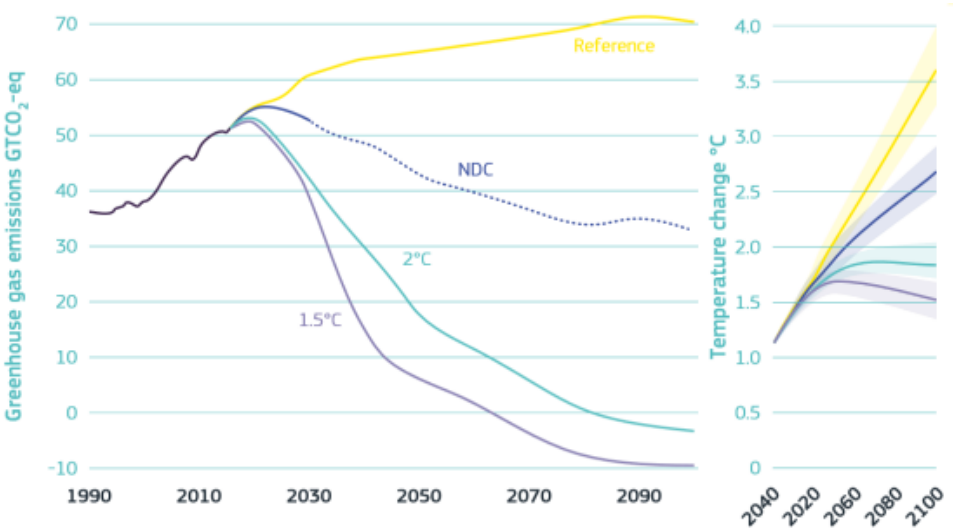
[50] https://www.consilium.europa.eu/media/41123/17-18-euco-final-conclusions-en.pdf

[51] Greenhouse gas emissions increased by 100 % since 1980, raising average global temperature by at least 0.7 degree (IPBES, 2019).

[52] Communication COM(2020) 564 final "An EU-wide assessment of National Energy and Climate Plans – Driving forward the green transition and promoting economic recovery through integrated energy and climate planning"

new strategic approach to clean energy R&I and competitiveness to rebuild the European economy and accelerate the innovation and market uptake of new technologies and innovation for climate neutrality. Developing low-carbon technologies and solutions for decarbonisation are needed – at affordable cost - to limit global climate change to well below 2 °C, pursuing efforts to limit it to 1.5 °C, and thus to mitigate the consequences of climate change, but also to ensure that Europe emerges as a technological and industrial leader in the green transition. R&I can provide a better understanding of the challenges related to climate change and the ongoing degradation of the natural environment, including loss of biodiversity. It can also provide better comprehension of the economic and social impacts of climate change, promote the shift from linear production to a circular economy, and support the development of inclusive solutions ensuring just transition to a resilient, climate neutral economy.

Figure 5. Global GHG emissions and global average temperature change (with median probability)

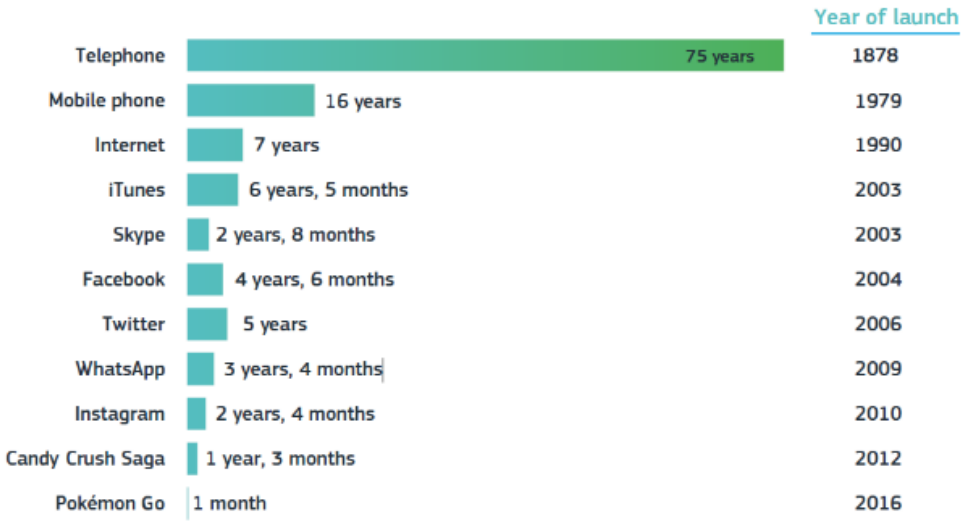


Source: GECO 2018 (POLES-JRC 2018; MAGICC online) Note: The NDC scenario assumes that the global average rate of decarbonisation implied by the NDCs in 2020–2030 is maintained over 2030–2050.

- **Digital technologies,** including notably artificial intelligence (AI), are revolutionising at an unprecedented speed the way we live, work and innovate (Figure 6) and pose challenges in terms of data privacy and security. **Digitalisation is also transforming R&I**. All areas of research are becoming data-intensive, increasingly relying upon and generating big data. Technology, notably in the business-to-consumer (B2C) segment, is spreading faster than ever due to the transition from physical to digital goods combined with network effects in the age of digital transformation. The convergence of the digital and physical worlds is increasing innovation

complexity and leading to deep-tech science-driven innovations (European Commission, 2020). There is increasing industry (sales) concentration and markups over time (in North America and to a less extent in Europe), not confined to digital-intensive sectors (Calligaris et al., 2018). Digitalisation is also having major educational and social impacts, demanding increased efforts in the development of digital skills, in particular women and girls', and close attention paid to ensuring a just transformation, as well as unbiased and fair AI processes.

Figure 6. Time for new products and services to reach 100 million users, by year of launch

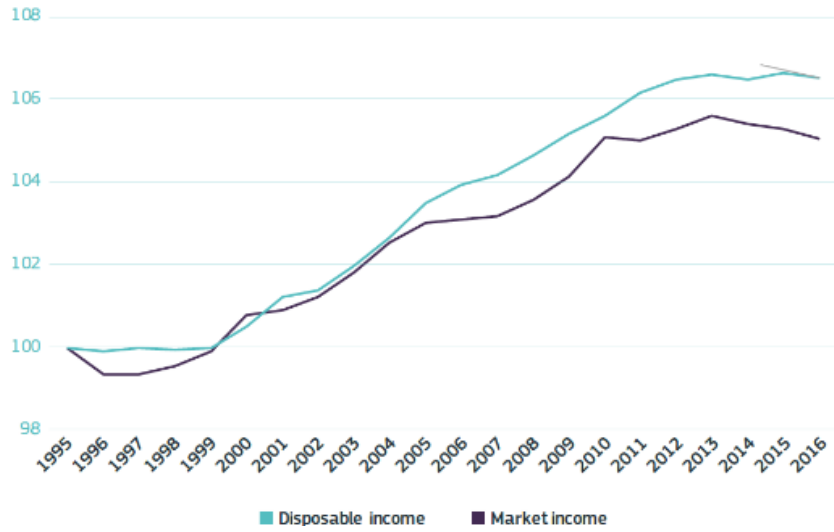


Source: DG Research and Innovation, adapted from BCG (2015) and based on ITU (Telephone and Mobile phone), Scientific American (World Wide Web), Internet Live Stats, Fortune (iTunes), Facebook, Wired (Whatsapp), Techcrunch (Instagram), AppMtr.com (Candy Crush Saga), arinsider.co (Pokemon Go), Searchengineisland (Twitter). Note: iTunes: number of accounts; Facebook: monthly active users; Whatsapp: active users; Instagram: monthly users; Candy Crush Saga: Facebook users only; Pokemon Go: number of downloads; Twitter: active users; Skype: registered users.
Note: The Internet was the driver of many developments in the digital sphere.

- People are increasingly worried that **new technologies may exacerbate social and geographical inequalities** through job and wage polarisation, income disparities, regional disparities, and 'winner takes most' markets and industries. Overall, compared to other countries, Europe is a relatively equal place to live. This situation is largely driven by Europe's distribution of incomes and resources. Nevertheless, EU income inequality has increased

during the last two decades (Figure 7)[53] and the gender pay gap and gender employment gap remains significant[54] including in R&I[55]. **These evolutions challenge the view that high competitiveness and strong investments in R&I automatically lead to more equality, driven by higher growth and more jobs with benefits for all.** There is growing awareness that competitiveness and inclusiveness must go hand in hand. Recent evidence suggests that overly high levels of inequality are not economically, socially or politically sustainable (Iammarino et al., 2019; IMF, 2018; OECD 2019). If there is no diffusion of innovation, there is a risk that the benefits of innovation will be limited to skilled individuals, areas or companies with strong R&I assets. Evidence focusing on top income inequality and its interplay with innovation shows that technological change is associated with a higher share of income for the entrepreneur, at the expense of workers' compensation hence increasing the top inequalities (Aghion et al., 2016).

Figure 7. EU - Gini index of inequality - market income and disposable income (1995 = 100), 1995-2016



Source: Science, Research and Innovation Performance of the EU, 2020 (European Commission, 2020) based on Eurostat.
Note: EU is the weighted average of the values for the 27 EU Member States

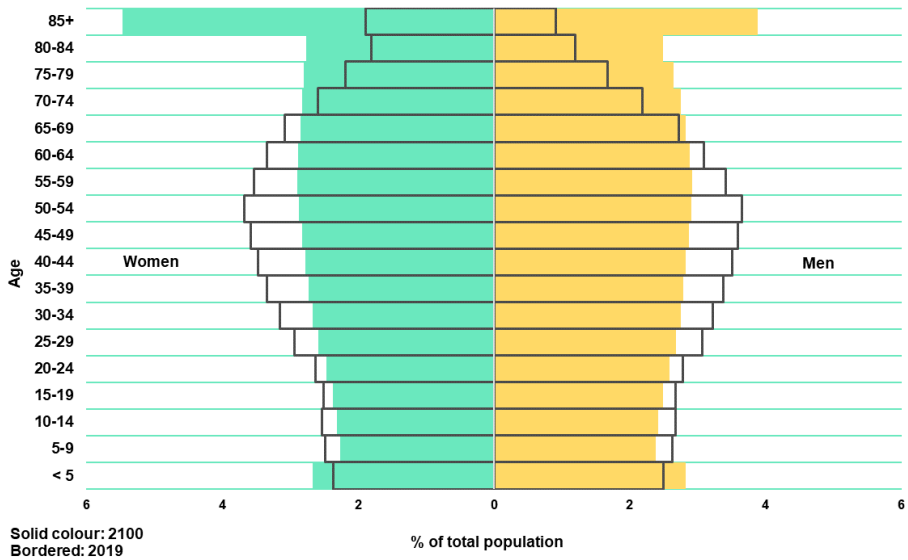
[53] The Gini Index for market income (before taxes and social transfers) in the EU rose from 46 in 1995 to 48.4 in 2016, being larger than Japan (42 in 2015) and Korea (34 in 2016) but lower than the United States (50.8 in 2016).

[54] In 2017, the gender employment gap stood at 11%, with 68.2 % of women across the EU being employed compared to 79.2 % of men. The gender pay gap in the EU stands at 16% and has only changed minimally over the last decade. Source: Eurostat.

[55] Women employed in scientific R&D activities earned on average 17% less than their male colleagues in 2014. Ref. She Figures 2018: https://op.europa.eu/en/publication-detail/-/publication/9540ffa1-4478-11e9-a8ed-01aa75ed71a1/language-en

- Another trend that directly relates to R&I is **demographic change, in particular the EU's ageing population**. In 2018, 20% of the EU population was aged 65 years or over. By 2100, the share of people aged 80 years or more is expected to more than double, reaching 14.9% of the entire population[56]. An ageing population is not a phenomenon specific to the EU as the entire planet is ageing. However, one continent stands apart: Africa, in particular sub-Saharan Africa, presents very young demographics and will be the demographic engine of the world in the 21st century (EPRS, 2020). **This trend has several consequences for R&I.** First, it means that R&I will be increasingly expected to address the need for ageing-related innovations, as ageing will involve changes in lifestyle and a growing demand for specific products and services. There will be a greater need for R&I to address ageing-related illnesses, support active ageing and foster technologies such as robotics and neurosciences which can provide support to the elderly[57]. Second, productivity will need to increase to compensate for the declining share of the population in working age, together with inflows of high-skilled migrants, especially in the case of an ageing R&I workforce.

Figure 8. EU age pyramid, 2019(1) and 2100(2) (as % of total population)

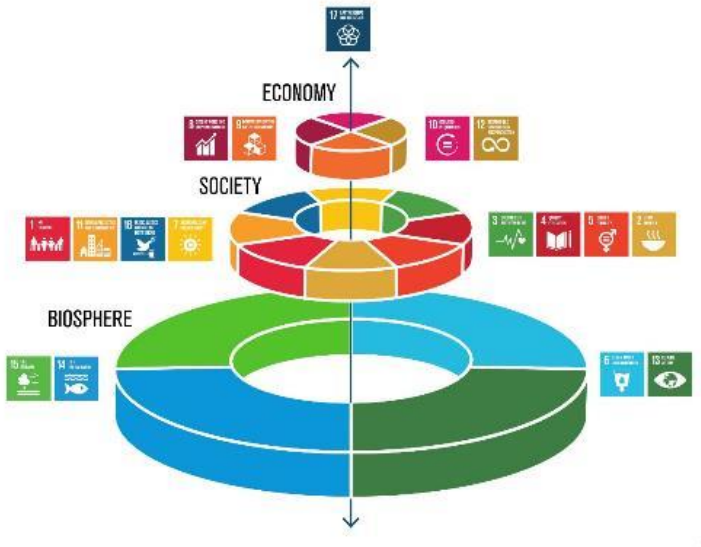


Source: DG Research and Innovation based on Eurostat. Notes: (1)Provisions (2) Projections (EUROPOP2019).

[56] Eurostat.
[57] OECD STI Outlook 2016.

The **Sustainable Development Goals** provide an overarching framework for action to address these changes (Figure 9). In this framework, economic, social, and environmental sustainability aspects are not separate and build upon one another: a prosperous and efficient economy thrives within a healthy, inclusive and resilient society, and both depend on a healthy biosphere. **The interconnected nature of these issues calls for a deep transformation of our systems**, in particular agro-food, energy and transport systems. This sustainability transformation is an unprecedented governance challenge at all levels, from local to global. It results from the combined effect of the urgency, the scale of the necessary transformations, the complexity and the interdependence of issues in a context of fragility and unpredictability. It is essential that this transformation is founded on education that will empower and equip current and future generations with knowledge, skills, values and behaviours for sustainable development.

Figure 9. Sustainable Development Goals



Source: Stockholm Resilience Centre

R&I are key levers for the transformation required to address SDGs. It will need to interact with other levers, such as governance, economy and finance, and individual and collective action, in order to bring about this transformation (United Nations, 2019). Hence, R&I is a cornerstone for a robust European project in a global context that can accelerate the transition to sustainable development, while improving our well-being, reducing inequalities and ensuring longer-term prosperity:

- R&I is needed to produce novel solutions in areas like health, digital technologies, industrial transformation, resilient societies, natural resources, energy, mobility, environment, food, low-carbon economy and security. R&I solutions also enable both economic and environmental efficiency to be

improved while developing new sustainable ways to satisfy human needs and wellbeing, in an inclusive manner, leaving no one behind.

- R&I helps to build the necessary knowledge and understanding of the phenomena to be addressed.

- R&I, in particular frontier research, can strengthen the resilience of our economy and society by building a reservoir of knowledge over the long term (Ricci et al., 2017).

R&I can become a compass helping the EU to co-create a common route. R&I can also be the engine room for answers and solutions in the transformation towards sustainability, contributing to solving challenges at the global level.

2 SETTING OBJECTIVES FOR R&I UNDER ERA

R&I policy plays a pivotal role in the transition towards competitive sustainability, in line with President von der Leyen's Political Guidelines and the new strategy for Europe's Growth laid out in the European Green Deal and elaborated in the New Industrial Strategy and the Digital Package. R&I acts both as driver and enabler for addressing the global challenges Europe is facing, and for grasping the opportunities ahead. A renewed transformative R&I policy could pave the way for sustainable, inclusive and competitive European societies and economies of the future. Indeed, a new strategic approach to clean energy R&I and competitiveness is needed to rebuild the European economy and accelerate the innovation and market uptake of new technologies and innovation for climate neutrality. Both EU and national R&I policies as well as funding and national industrial strategies need to be better aligned with energy and climate objectives.

Recent literature shows there is increased awareness that a new R&I policy framework is required to bring the transformation needed to face the global megatrends that are changing our societies and economies at an unprecedented speed. Neither the 'market failure approach' rationale nor the 'systemic failure approach' that shaped traditional R&I policy – aiming at delivering economic growth and jobs – do allow to coordinate and drive the direction of change. While economic growth has substantially improved living conditions worldwide, lifting millions from poverty, it has often failed to be inclusive[58] – leaving some people and regions behind (Iammarino et al., 2019; European Commission, 2020) or to respect the boundaries of our planet (Raworth, 2017). Similarly, the view that all innovations are necessarily good, i.e. leading to economic growth with benefits for the whole society, has proven to be misleading (Kalff and Renda, 2019). Therefore an R&I

[58] Similarly, a R&I system exclusively seeking excellence without being wholly inclusive may have negative consequences on long term cohesion of societies and European regions. See the ERAC opinion on the future of ERA on the need for an inclusive R&I policy: https://data.consilium.europa.eu/doc/document/ST-1201-2020-INIT/en/pdf.

policy aiming at delivering accelerated transformative change to address social, economic and environmental challenges would need to strive for more than to provide a level playing field to and foster linkages between R&I performers (Biggeri and Ferrannini, 2020).

A transformative R&I policy framework enables the shaping of technological and societal change, focussing R&I efforts on achieving sustainable development for all (Lundin and Schwaag Serger, 2018; Mazzucato, 2018; Biggeri and Ferrannini, 2020). A transformative policy framework aiming at achieving the SDGs, would foster a competitive economy, while preserving our planet and making sure not to leave anyone behind. This includes not only developing new solutions, technologies and inventions, but also changing production and consumption systems, including mobility, energy production, food and agriculture and other resources throughout society and industry (Schot and Steinmueller, 2018). A transformative framework presents several characteristics:

- **Directionality.** A transformative R&I policy framework identifies, shapes and adjusts the direction R&I efforts should follow to bring the transformative change required by the transition towards sustainable development. Tackling the grand challenges of our time requires a clear "design" process developed in the public sector, aimed at translating ambitions and aspirations in clear missions and pathways that will channel the allocation of resources. For example, missions define clear objectives providing the framework for R&I transformative policy actions, without being prescriptive in the way these objectives will be achieved by research innovative efforts (Mazzucato, 2019).
- **Whole of governance approach.** Ensuring that policies are aligned at different levels of governance) and across policy domains[59] – i.e. a whole of government approach – is of paramount importance for an integrated transition towards sustainability and to ensure an EU-wide systemic change. This approach is in line with the principle of **subsidiarity** that the European Research Area was founded on. It would also ensure that R&I policy works in close synergy across all levels of government (local, regional, national and global), introducing initiatives with the most EU added value at the European level linked to and building on national and regional policy responses,. This would require a stronger governance framework to align and fully exploit the capacities and opportunities of action at every level of R&I policy.
- **Experimentation, multidisciplinarity and foresight.** Public institutions need to be flexible, experiment[60], anticipate and swiftly react to the challenges ahead. While there always will be need for evidence-based policy,

[59] This requires coordination between R&I and other sectoral policies (from industrial policies to education, finance, enterprise, trade, regional or employment), engaging both a wider set of stakeholder and society in the policy making process, and alignment between all levels of governance (local, regional, national and European).

[60] Experimentation could be applied in trialling and assess new instruments to assure the effectiveness of the policy (Bravo-Biosca, 2016).

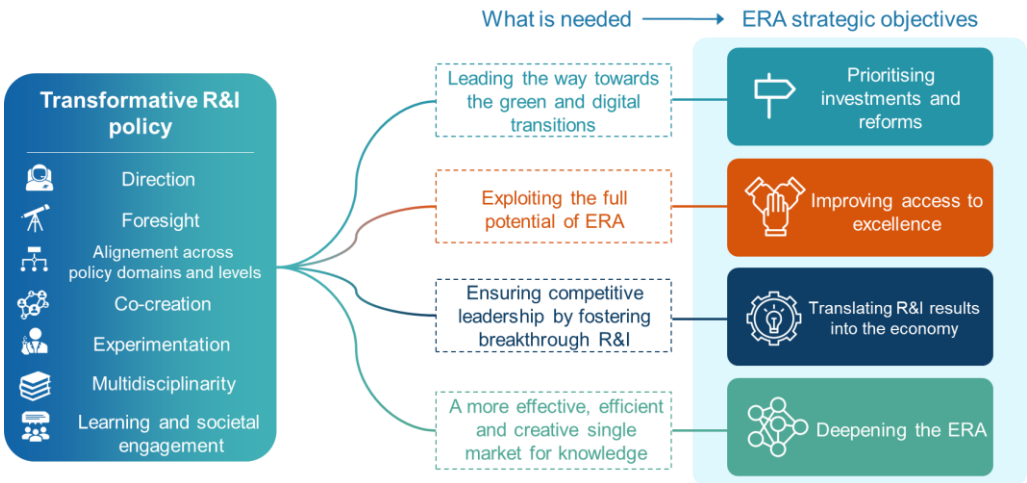
transformative policymaking requires a different mindset to be able *to create landscapes* rather than purely fixing markets (Mazzucato, 2019). Policy actors will benefit from a multidisciplinary approach, while using strategic foresight to anticipate changes and experiment with new policy tools.

- **Co-creation, learning and societal engagement (see also Box 4)**. A continuous engagement with civil society and the R&I community strengthens directionality and stimulates experimentation. It enables a collective discovery process that builds approved and achievable pathways to sustainability, thriving in diversity without looking for consensus (Schot and Steinmueller, 2018). While the identification of a direction takes place at the policy level, a transformative R&I policy is a larger partnership with citizens, stakeholders, industry and other actors. The move from communicating the research results and delivering innovations to an active engagement with society and industry allows for a better monitoring and assessment of policy design, implementation and results as well as delivering genuine social innovation (Mazzucato, 2019), including enhanced trust in new solutions.

Box 4. Citizen's engagement under the new ERA

The commission will organise with member states and stakeholders europe-wide participatory citizen science campaigns to raise awareness and networking, crowdsourcing platforms and pan-european hackathons, in particular in the context of horizon europe missions. The commission will develop with member states best practices to open up science and innovation to citizens and youth. (action 13 in the communication)

Figure 10. Transformative R&I policy for ERA



Source: DG Research and Innovation, European Commission.

So how can ERA help address these important challenges? In order to become transformative, ERA needs to both deepen and broaden its scope. Transformative R&I policy calls ERA to aim for four strategic and interdependent objectives, which are developed in the next sections:

1. ***Prioritising investments and reforms*:** an essential element of a transformative R&I policy will be to put in place the necessary tools for R&I to lead the way towards the green and digital transitions of Europe's society and economy.

2. ***Improving access to excellence***: competitiveness and inclusiveness are two sides of the same coin and must go together. A transformative R&I policy needs to embrace this and strive towards excellence by exploiting the full potential of the ERA, tackling existing R&I divides between and within Member States.

3. ***Translating R&I results into the economy***: a transformative R&I policy needs to build on a competitive leadership in the global race for technology by fostering disruptive and breakthrough research and innovation that will contribute to a concept of competitive sustainability.

4. ***Deepening the ERA:*** R&I policy will not be able to drive the transformation of Europe if it does not manage to make decisive progress on deepening and completing the single market of knowledge in order to make it far more effective, efficient and creative.

ERA will continue being underpinned by the **principle of excellence**. This means supporting the best R&I efforts to push out the frontiers of knowledge and ensuring that the best entrepreneurial minds can connect to the outcomes of research and turn them into innovations that are beneficial to our society and our economy in the most efficient way possible.

Several **instruments** at the EU, national and regional level will contribute to implement a future transformative ERA (see Box 5).

Box 5. Instruments for a transformative ERA

Different EU instruments will contribute to the development of a transformative ERA. Among them, the EU's R&I Framework Programme is the main instrument for investing in R&I at the EU level and directing investment towards EU political priorities. There are also strong synergies between R&I policy and Cohesion policy, notably to address the R&I divide, roll-out and deployment through smart specialisation strategies. The following table highlights the **main EU instruments** that will support the transformative ERA.

Figure 11. Main instruments that will contribute to the development of a transformative ERA

Instrument	Link to R&I	Budget 2021-2027 based on European council agreement[61]
Investment		
Horizon Europe, including	The main EU instrument for investing in R&I	EUR 90.955 bn
- *Missions*	*Providing direction to funding without prescribing the exact ways and means*	
- *European partnerships*	*Providing a framework for programme level collaboration in the EU*	
- *European Innovation Council*	*Supporting innovators with breakthrough ideas and market creating innovations*	
- *Widening*	*Increasing the link of underperforming Member States with their better performing peers*	
Euratom Research and Training Programme	Developing comprehensive actions to support nuclear research and training activities	EUR 1.981 bn
Cohesion policy via European Regional Development Fund (ERDF)	Supporting "A smarter Europe by promotive innovative and smart economic transformation"	EUR 322.285 bn
European Agricultural Guarantee Fund (EAGF) and European Agricultural Fund for Rural Development (EAFRD)	Fostering and promoting the use, implementation and deployment of innovative solutions in agriculture, forestry and rural areas	EUR 291.089 bn EUR 95.640 bn
European Social Fund Plus (ESF+)	Investing in human capital and skills development, as well as in social innovation	EUR 99.261 bn
Connecting Europe Facility (CEF)	Supporting the deployment of innovative technologies in the fields of transport, energy and digital physical infrastructures	EUR 12.830 bn (Transport) EUR 5.838 bn (Energy) EUR 2.065 bn (Digital)
Erasmus+	Supporting mobility, cooperation and policy initiatives -that integrate higher education, research and innovation	EUR 24.017 bn
Just Transition Fund	Ensure that the transition towards a climate-neutral economy happens in a fair way, leaving no one behind, supporting R&I investments that foster the transfer of advanced technologies	EUR 19.321 bn

[61] Current prices.

European Space Programme	Developing breakthrough solutions through research and innovation, in particular for sustainable food and natural resources, climate monitoring, smart cities, automated vehicles, security and disaster management. Contributing to the European Open Science Cloud	EUR 14.880 bn
InvestEU Fund	Providing blended finance for innovators, where there is a high level of risk	EUR 9.142 bn
Internal Security Fund and the instrument for border management as part of the Integrated Border Management Fund	Supporting the deployment of innovative new technologies and solutions in the field of security research	EUR 1.931 bn (Internal Security Fund) EUR 6.248 bn (Integrated Border Management Fund)
Digital Europe Programme (DEP)	Ensuring a wide use of digital technologies across the economy and society and integrating digital across all the relevant policy fields	EUR 7.588 bn
European Maritime and Fisheries Fund (EMFF)	Supporting the rolling out of novel technologies and innovative products, processes and services in the fields of marine and maritime policy	EUR 6.108 bn
Programme for Environment and Climate Action (LIFE)	Taking up and applying R&I results for environment and climate policy and helping deploying them at national and regional scale	EUR 5.432 bn
Single Market Programme	Promoting entrepreneurship and the creation and growth of companies	EUR 4.208 bn
Reforms		
European Semester	Guiding investments and support the necessary reforms in Member States and regions.	
Policy Support Facility (PSF)	Supporting policy mutual learning and helping Member States to improve their R&I policies and reform their R&I system	
Structural Reform Support Programme (SRSP)	Helping EU countries to design and carry out structural reforms as part of their efforts to support job creation and sustainable growth	
Regulation		
Innovation principle	Helping to ensure that EU legislation is analysed and designed so as to encourage innovation to deliver social, environmental and economic benefits	

A central part of the funding from Next Generation EU (EUR 750 bn[62]) will consist in supporting public investment and key structural reforms in the Member States. This covers most notably the Recovery and Resilience Facility (budget of EUR 672.5 bn[63]) that will fund Member States recovery and resilience plans.

At the national level, most national public funding consists of 'block' funding to

[62] Budget agreed by the European Council in 2018 prices.
[63] Budget agreed by the European Council in 2018 prices.

universities and public research organisations and only a fraction is in the form of project-based competitive funding similar to the EU R&I Framework Programme. Increasingly, Member States complement direct R&D funding with indirect support in the form of tax incentives to promote business R&D and stimulate innovation and economic growth (see section 2.1.1). The amount of foregone revenue varies across member states, ranging from 0.30% of GDP in countries strongly relying on tax incentives, e.g. France and Belgium, to shares below 0.01%, e.g. Sweden and Poland[64].

Figure 12. Overview of main instruments used at national level

Direct and indirect financing	Grants and matching grants for innovation and/or R&D projects Vouchers for innovation and collaboration Loans & guarantees for innovation tax incentives for R&D (e.g. tax credits) Equity finance for innovative enterprises
Demand pull instruments	Public procurement for R&D Pre-commercial procurement Supplier development programmes Corporate open innovation
Technology adoption and generation instruments	Business advisory services Technology extension services Technology centres
Early-stage support for innovative ventures	Incubators Accelerators
Cooperation	Supporting clusters and networks for innovation
Framework conditions	Inducement (incentive setting); recognition awards; appropriate IPR; standard setting; quality infrastructure; investing in education / skills; 'green cards' for highly skilled immigrants

Source: EC-OECD STIP Compass, https://stip.oecd.org/stip.html

[64] Source: OECD R&D tax incentives database, http://www.oecd.org/sti/rd-tax-stats.htm

2.1 Prioritising investments and reforms

Box 6. ERAC opinion on prioritising investments and reforms

The **ERAC**[65] recommendation on the new ERA paradigm is to underline the importance of ambitious and sustained investments in R&I, possibly applying a 'smart directionality'[66] policy approach for knowledge production and exploitation. It should embrace societal goals and place a greater focus on responsible use of knowledge and research results for societal purposes in order to ensure the long-term sustainability of national, including regional, R&I systems.

What is it about?

Steering and alignment of public and private investments with mission-setting and societal engagement in the definition of collective priorities is the starting point of transformative R&I policy in the SDGs framework (Schot and Steinmueller, 2018; Biggeri and Ferrannini, 2020). Such directionality, shaping the evolution of R&I pathways, needs to be based on sound evidence drawing from current and past trends or to be nurtured by foresight exercises (Schaper-Rinkel, 2013). This implies steering R&I activities in strategic technological fields to address specific challenges without prescribing the way they should be addressed.

National funding targets should refer to concrete and relevant climate pathways to 2030 and 2050. The Commission proposed that Horizon Europe includes a 35% funding target for climate change, and that there is a substantial increase in investment in core digital technologies. Member States should consider replicating this ambition for green and digital investment in their national programmes.

In this context, an agile, responsive and socially accountable transformative R&I policy must encompass the coordination of instruments, an alignment of objectives and the synchronisation of investments. In the European case, this calls for a partnership of the European Commission, Member States and Associated Countries and strengthened coordination between local, national and EU policies building on commonly agreed priorities. This translates into co-creation processes, which allow policy makers, stakeholders, citizens, industry and capital markets to ensure that a directional R&I policy foregoes costly solutions not delivering to societal needs.

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[65] ERAC 1201/20. ERAC Opinion on the future of the ERA https://data.consilium.europa.eu/doc/document/ST-1201-2020-INIT/en/pdf

[66] The role of policy as setting the direction of change beneficial to society. Mazzucato, M. (2015b). *From Market Fixing to Market-Creating: A New Framework for Economic Policy* (No. 2015-25). SPRU-Science and Technology Policy Research, University of Sussex.

Box 7. National policy examples related to investment prioritisation

Sweden

In 2017, Sweden adopted a new climate policy framework that consists of a climate act, climate targets and a climate policy council. Sweden's long-term target is to have zero net greenhouse gas emissions by 2045 at the latest[67]. The last national R&I strategy of 2016-2020 already aimed at directing 3% of total government budget allocations for R&D (GBARD) towards six prioritised areas, including "Climate" and "Sustainable Spatial Planning". In 2015, Sweden allocated 1.5% of total GBARD to environmental topics.

France

A recent French law, 2019-1147 on energy and climate, in its article 1 aims to promote an R&I policy that favours the adaptation of business sectors to the energy transition[68]. The French National Research Strategy 2015-2020, among its nine strategic areas, stipulates the priority of "Clean, safe and effective energy". In 2015, environmental research in France accounted for 3.3% of GBARD, clearly above the OECD average of 1.7%.

The Netherlands

In 2019, the Dutch Cabinet decided to implement a mission-driven innovation policy. In total, eight ministries, together with entrepreneurs and knowledge institutions from nine selected sectors, have established 25 missions. These will strengthen the Dutch economy within four societal challenges: 1. Energy Transition & Sustainability, 2. Agriculture, Water & Food, 3. Health & Care, and 4. Security & Key Enabling Technologies.

"Mission-Driven Top Sector Policy" was launched to work on concrete Knowledge and Innovation Agendas (KIAs), one for each of the challenges, and an additional one on key enabling technologies. On the basis of the KIAs, Knowledge and Innovation Contracts were drawn up.

Germany

In 2018, the German Federal Government has adopted its new High-Tech Strategy 2025 (HTS 2025). Since 2006, the High-Tech-Strategy defines the strategic framework of the Federal Government's research and innovation policy. It has three fields of action, namely i) tackling societal challenges of our time, ii) developing Germany's future competencies and iii) establishing an open innovation and venture culture. In the HTS 2025, the Federal Government has set six thematic priorities: 1. Health and Care, 2. Sustainability, Climate Protection and Energy, 3. Mobility, 4. Urban and Rural Areas, 5. Safety and Security, and 6. Economy and Work 4.0. Twelve missions have been set under the new HTS 2025.

[67] http://www.lse.ac.uk/GranthamInstitute/climate-change-laws-of-the-world/.
[68] http://www.lse.ac.uk/GranthamInstitute/climate-change-laws-of-the-world/.

2.1.1 Facilitating EU and national investment towards the EU's priorities

INDICATOR[69]	LATEST VALUE	INTERNATIONAL COMPARISON	TREND	ASSESSMENT OF TREND
R&D intensity	2.18% of GDP (2018)	Lower than US, JP and KR. Similar to CN.	+1.3% per year since 2010 +1.4% per year since 2015	↗
Business R&D intensity	1.45% of GDP (2018)	Lower than US, CN, JP and KR	+2.2% per year since 2010 +2.4% per year since 2015	↗
Public R&D intensity	0.72% of GDP (2018)	Higher than US, CN and JP. Lower than KR	-0.2% per year since 2010 -1% per year since 2015	↘
Government budget allocations for R&D (GBARD)[70]	0.64% of GDP (2018)	Lower than KR and JP. Higher than US.	-1.6% per year since 2009 +0% per year since 2015	↘
Tax incentives [71]	0.106% of GDP (2017)	Lower than KR and JP. Higher than US and CN.	+4.9% per year since 2010 +6% per year since 2015	↗↗
GBARD (EUR) allocated to Europe-wide transnational, as well as bilateral or multilateral, public R&D programmes per FTE researcher in the public sector	3120 (2018)	/	+2.8% per year since 2012 +0.6% per year since 2015	↗ but SLOWDOWN

Progress so far

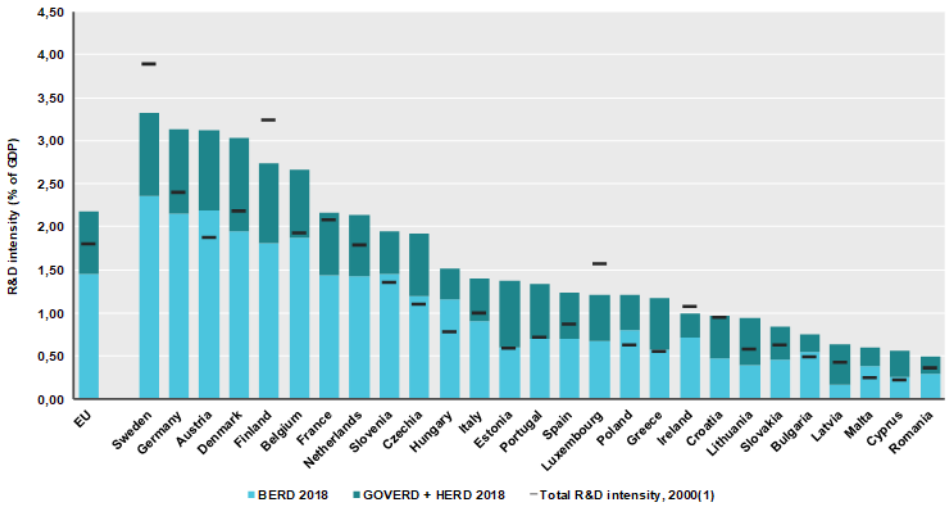
One of the key goals of the EU during the last couple of decades has been to increase the levels of R&D and innovation investment, to provide a stimulus to the EU's growth and competitiveness[72]. At the 2002 Barcelona Summit[73], the

[69] All indicators are drawn from Eurostat, unless differently specified. EU figures.
[70] Government budget allocation for R&D.
[71] Note that GBARD is not capturing indirect government funding for R&D, such as R&D tax incentives, which are increasingly used by a number of ERA countries. Hence, to complement GBARD, tax incentives are included as a separate indicator. Source: OECD R&D tax incentives database, http://oe.cd/rdtax.
[72] R&I are drivers of industrial competitiveness, job creation and labour productivity growth. R&I accounted for 62% of EU productivity growth between 2010 and 2016 (European Commission, 2020).

European Council agreed that the EU should set the objective of devoting 3% of its GDP to R&D activities by 2010. In 2010 this target became one of the five headline targets of Europe 2020 Strategy[74].

Although R&D expenditure in the EU has been increasing annually by 1.3% since 2010, it remains lower than the 3% target, and visibly below the performance of most of its main competitors, especially in terms of private investments. At the EU level, R&D intensity increased from 1.97% in 2010 to 2.18% in 2018, leading to a persistent EUR 110 bn gap vis-à-vis the 3% target (Borunsky, Dumitrescu Goranov, et at., 2020). Asian countries, in particular China and South Korea, are increasing their investments at a rate that is eclipsing both the EU and the United States. Similarly, the European companies among the top 2500 global industry investors in R&D have been losing ground to Chinese and US businesses on key future technologies, in particular in the digital sector (Hernandéz et al., 2019). At the national level, **R&D intensity increased over the 2000-2018 period in 24 Member States** (Figure 13) but significant heterogeneity persists across European countries. Only seven member states stand above the EU average intensity (Sweden, Austria, Germany, Denmark, Belgium, Finland and France).

Figure 13. Public and business R&D intensity 2018 and total R&D intensity 2000



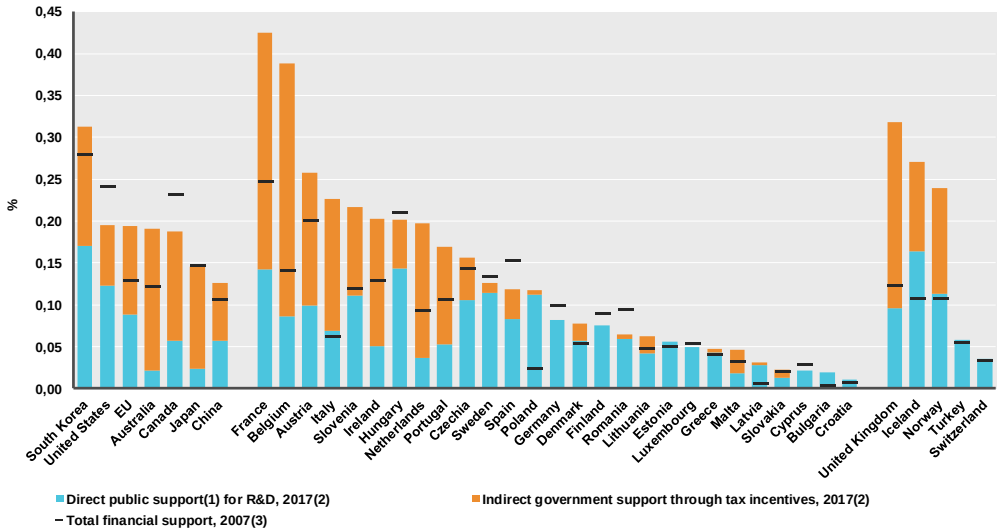
Source: DG Research and Innovation based on Eurostat
Note: (1) EL, SE: 2001. HR, MT: 2002.

[73] Barcelona European Council 15-16 March 2002. Presidency conclusions. http://europa.eu/rapid/press-release_PRES-02-930_en.htm

[74] COM(2010) 2020 final. 'EUROPE 2020 A strategy for smart, sustainable and inclusive growth'.

EU business R&D intensity (at 1.45% of GDP) **is significantly lower** in comparison to other main economies. To promote business R&D and encourage innovation, apart from direct support in the form of subsidies and grants, governments are increasingly using R&D tax incentives. **Total public support for business R&D[75] increased substantially in the EU, from 0.13 % of GDP in 2007 to 0.2% of GDP in 2017**. Figure 14 shows that the level of public support for business R&D grew in most Member States between 2007 and 2017, particularly through the greater use of R&D tax incentives. In 2017, tax incentives for R&D in the EU accounted for 55% of all public support for business R&D. **The level of the forgone tax revenues in EU almost tripled since 2007, from 0.04 % of GDP in 2007 to 0.11% in 2017**. In the EU, the number of countries offering R&D tax relief increased from 12 in 2000 to 21 in 2018 (Appelt et al., 2019).

Figure 14. Public support for business R&D as % of GDP, 2007 and 2017



Source: DG Research and Innovation, based on Eurostat and OECD
Notes: (1) Estimated direct public support for business R&D includes direct government funding, funding by higher education and public sector funding from abroad. (2)US: 2014 for tax incentives only; AU: 2015; FR: 2016 for tax incentives only; RO, UK: 2016; EL: 2015. (3)CH, TR: 2008; CN, MT: 2009; DE, EL: 2011. (4)The following countries have no tax incentives for R&D: BG, DE, EE, HR, CY, LU, CH. (5) Elements of estimation were involved in the compilation of the data.

Direct project funding is used more often than other instruments to support R&I policies for sustainable development. In addition to direct measures, some countries are considering the possibility **to use tax incentives to incentivise private actors' behaviour towards SDGs**. For instance, Belgium introduced a tax credit for

[75] Total public support for business R&D is comprised of direct funding (e.g. grants, loans, procurement) and indirect support (R&D tax incentives).

environmentally friendly R&D investments[76]. However, the tax incentives regime may make it difficult for governments to have the desired impact on steering private investment towards sustainability and systemic change.

With a value of 0.72% of GDP in 2018, the **EU has one of the highest public R&D intensities worldwide**. **Public efforts** are of a critical importance. They raise the quality of public science and contribute to advance the overall stock of publicly available knowledge, leveraging and benefitting private investments, most notably in the more innovative and dynamic industries (Dosi and Stiglitz, 2014; Mazzucato, 2013; Archibugi and Filippetti, 2018).

Public investments also demonstrate commitment to R&I as an engine of prosperity and affect the direction of further research. **These positive effects of public R&D investments may rise the case for further increasing the current public R&D efforts in the EU**. At the EU level, gross domestic expenditure on R&D (GERD) financed by public sector[77] in 2017 was 0.7% of GDP. In addition, tax incentives accounted for 0.106% of GDP in 2017. Hence, **publicly funded R&D in the EU equalled 0.81% of GDP** in 2017.

Already in 2009, in the Lund Declaration[78], the European Research Area was called to address grand challenges and to turn Europe into an eco-friendly economy. This became a second ERA Priority with a focus on transnational scientific collaboration to address grand socioeconomic challenges[79]. The national GBARD allocated to EU-wide transnational public R&D has an annual growth rate of 2.8% in 2012-2018, resulting in more than 700 joint calls with a cumulative budget of more than EUR 7 billion in national investments since 2004. However, almost all countries have seen a slowdown in recent years.

At the national level, many Member States have taken policy initiatives in support of R&I for SDGs. Many of these initiatives combine the objective of addressing sustainability challenges with strengthening industry competitiveness. In most countries, science, technology and innovation strategies address demographic change, health, environment, and smart transport and cities (OECD, 2018).

Member States are slowly steering their finances towards societal and environmental challenges. Figure 15 shows an increase in energy-related R&D budget appropriations (GBARD)[80] at the European level. Growth in the budget allocation for total civil, health and environmental-related R&D is more modest. In contrast, the R&D budget for defence has decreased significantly in recent years.

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[76] https://www.oecd.org/sti/rd-tax-stats-belgium.pdf.

[77] GERD financed by GOV, ABR_EC and ABR_INT.

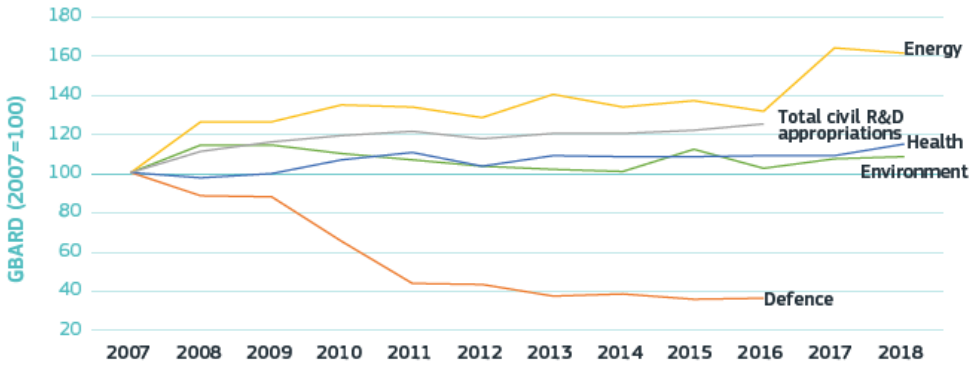
[78] https://cordis.europa.eu/article/id/31013-swedish-presidency-research-must-focus-on-grand-challenges

[79] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/5641328c-33f8-11e9-8d04-01aa75ed71a1

[80] As GBARD measures only direct budget provisions it does not account for the R&D performed.

Yet, most R&I strategies of Member States are not clearly linked to the SDGs Agendas, the Green Deal or other relevant EU priorities[81].

Figure 15. Evolution of government budget allocations to R&D in the EU (2007 = 100), 2007-2018



Source: Science, research and innovation performance of the EU, 2020 (European Commission, 2020), based on Eurostat.

At the EU level, **R&I plays a prominent role in the President's Political Guidelines and in the European Green Deal as a driver and enabler of the economic, environmental and social transitions.** President von der Leyen's Political Guidelines call explicitly for the need to invest record amounts in R&I for Europe to become the world's first climate-neutral continent and to achieve the Sustainable Development Goals (SDGs). The European Green Deal is the most prominent and important initiative to achieve these goals – it is the new European Strategy for Growth. The Sustainable Europe Investment Plan, which will trigger EUR 1 trillion of investments over the next decade, is a key component of this strategy. Moreover, the European Commission will develop an EU R&I investment agendas in areas with a focus on enabling better market uptake of innovative technologies and solutions. These agendas will encompass the whole set of funding instruments (from grants to financial instruments) and relevant EU programmes[82] (e.g., the InvestEU Fund, VentureEU, the Digital Europe Programme, the EU Structural Funds, the Budgetary Instrument for Convergence and Competitiveness) in an integrated fashion, offering connections to national or regional funding.

The vast majority of the Horizon 2020 programme investments foster the Sustainable Development Agenda. Potentially, 84% of the Horizon 2020 investments relate to at least one of the SDGs. Horizon Europe will put greater

[81] While R&I strategies have more general objectives, the sustainability turn is more visible only on the specific programme level with environmental sustainability being more prominent than the societal and economic dimensions (green growth, smart cities and energy technologies).

[82] Box 8 presents main EU instruments to support the transformative ERA.

emphasis on directionality through Missions and European Partnerships, with the aim to prioritise R&I investments in areas of high EU added-value (Box 8). Additionally, the target for climate action is proposed to remain at 35%. The Knowledge and Innovation Communities (KICs)[83] run by the European Institute of Innovation and Technology (EIT), also contributed to this agenda.

Box 8. Approaches and modalities in Horizon Europe in support of directionality – Missions and European Partnerships

Missions will provide direction to funding without prescribing the exact ways and means. Strongly factoring the SDGs into their design and implementation, missions will be excellence-based and impact driven R&I actions across disciplines and sectors.

Horizon Europe introduces a limited number of R&I Missions (e.g. On climate change, healthy oceans, climate neutral and smart cities, and soil health and food) to replace and build on the Horizon 2020 Focus Areas[84]. Missions will be more closely co-designed with end-users and citizens, thus prioritizing public engagement and involvement. The mission-oriented approach will work across clusters to promote system-wide transformation (European Commission, 2018c).

European Partnerships provide a framework for **programme level collaboration** in the eu. They allow to **translate common eu priorities into concrete roadmaps and coordinated implementation of activities**. A common r&i agenda, shared and committed by all partners in the partnership, is a key feature that distinguishes european partnerships from other collaborative research instruments and places them in a unique position to address transformational failures. Partners can represent a broad range of public and/or private actors, such as research funders and organisations, universities, industry, bodies with a public service remit at local, regional, national or international level or civil society. Compared to the past[85], **horizon europe introduces a more strategic approach to partnerships** allowing a new quality in programme level collaboration and ensuring that partnerships are better equipped to deliver on eu priorities. To deliver on the eu-wide transitions, the commission proposes to step up joint efforts in aligning investments by doubling the share of competitive r&i funding invested through r&i partnerships in transnational calls by 2030.

The horizon europe part 'reforming and enhancing the eu research and innovation system" also opens up a possibility for **programme level collaboration between research and innovation programme of member states on priorities of their**

[83] KICs promote climate change, sustainable energy, food for the future, and smart, environmentally-friendly and integrated urban transport.

[84] They will be well-defined and self-standing programme parts, as opposed to the Focus Areas.

[85] Taking also into account Council conclusions (2017) "From the Interim Evaluation of Horizon 2020 towards the ninth Framework Programme" and ERAC recommendations (1210/18), http://data.consilium.europa.eu/doc/document/ST-1210-2018-INIT/en/pdf

choice, with a clear focus on the implementation of transnational joint activities including calls.

National funding targets should refer to concrete and relevant climate pathways to 2030 and 2050. The commission proposed that horizon europe includes a 35% funding target for climate change, and that there is a substantial increase in investment in core digital technologies. Member states should consider replicating this ambition for green and digital investment in their national programmes.

Finally, **top industry R&D investors appear to be major players in the development of green inventions** at EPO[86] and USPTO[87]. Based on the EU Industrial R&D Investment Scoreboard (Hernández et al., 2019), more than half (53%) of the still limited share (9%) of green patents registered at these offices between 2012 and 2015 belongs to the top R&D companies. **Environmental regulations seem to play an important driving role also for top R&D investors.** The intensity of green over total patents of these top players is the largest in regulatory driven sectors, such as transport-related industries. EU companies show comparative advantages in most green technologies, with the exception of ICTs for energy.

Outstanding challenges

Although **the EU has not fulfilled its R&D investment ambition**, the 3% target is a strong indicator within the European Semester that has provided a stimulus to EU's R&I, growth and competitiveness policy. It is also an essential compass that can help accelerate the transition towards an environmentally, socially and economically sustainable Europe. Hence, continuation of the 3% R&D investment target and joint reflection with MS on the qualification of EU and national R&I investment targets is crucial. The EU R&D intensity would need to increase by 37% to reach 3% of GDP[88]. Applying this increase to public R&D effort means that R&D public support, direct and indirect, would represent more than 1% of GDP.

A whole of a government approach[89] required by the transformative change and the transition towards sustainable development is a significant challenge for policy. Efforts to better coordinate relevant national policies and resources will need to be increased if maximum advantage is to be taken from a

[86] European Patent Office
[87] United States Patent and Trademark Office
[88] R&D represents 2.19 of EU GDP (2018).
[89] This requires coordination between R&I and other sectoral policies (from industrial policies to education, finance, enterprise, trade, regional or employment), engaging both a wider set of stakeholder and society in the policymaking process, and alignment between all levels of governance (local, regional, national and European).

simpler and more impact-oriented EU R&I partnership landscape. This requires clear national governance structures and a robust and comprehensive framework for evaluating and monitoring the impact of P2P networks at national level[90,91]. **Participation in transnational R&I initiatives, such as European Partnerships** – precisely due to their cross-cutting nature – **requires significant coordination effort across ministries and sectors to ensure a strong link between the common ambition and national policies.** While countries have been taking steps to improve their participation, there are still important challenges such as securing funding, as the average annual investment in joint programmes and partnerships in the period 2015-2018 was just **below 1% of total public funding[92] for R&D in the EU**. Other outstanding challenges include commitments and robust evidence on impacts, weak links with national policy priorities and end-users.

Reducing the innovation gap between European regions is a key task of EU Cohesion policy, where in the 2014-2020 programming period about EUR 65 billion has been mobilised in support of R&I, which is about 30% of all Cohesion Policy funding. This was used to support the implementation of smart specialisation strategies that provide direction for R&I funding by exploiting the strengths and potential of the regions. Greater effort has been put into creating the eco-systems that encourage innovation, research and development and entrepreneurship by mobilising the quadruple helix.

Besides investments efforts, the European Commission has **refocused the European Semester into an instrument that integrates the SDGs**[93,94]. The European Semester has increasingly recognised the role of R&I to stimulate productivity, economic growth and job creation in Europe. Integrating the SDGs could encourage Member States to foster the transition towards a sustainable economy and society underpinned by stronger investments in R&I and identifying country-specific R&I investment needs. The **Recovery and Resilience Facility** should also contribute to encourage Member States to undertake reforms and investments in new technologies and in a number of European flagships initiatives.

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[90] https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/5641328c-33f8-11e9-8d04-01aa75ed71a1

[91] https://ec.europa.eu/info/sites/info/files/research_and_innovation/era/era_progress_report_2018-technical.pdf

[92] Annual investment in the period 2015-2018 was around € 800 million, https://www.era-learn.eu/documents/annualreport2019

[93] See "Political Guidelines" of the new Commission President.

[94] The adoption of the Autumn package on 17 December 2019 included the Annual Sustainable Growth Strategy, replacing the Annual Growth Survey.

Expected implications under a new ERA

Actions under a new ERA

The Commission:

- Proposes that Member States re-affirm the 3% GDP EU R&D investment target and update it to reflect new ER priorities, including a new EU 1.25% public effort target to be achieved by Member States by 2030 in an EU coordinated manner, to leverage and incentivise private investments. (Action 1)

- Support Member States in the coordination and prioritisation of national R&I funding, and reforms, between countries and with the EU through dialogue and a dedicated ERA Forum for Transition[95]. This will focus Member States common efforts, to voluntarily commit 5% of national public R&I funding to joint programmes and European partnerships by 2030. (Action 2)

Expected implications:

- **Increased impact on global challenges and EU policy priorities**: Coordination and alignment of policies and investments will increase societal impact for end-users and citizens, by prioritising investments and setting directions to achieve the SDGs (European Commission, 2018c). R&I also holds an intergenerational responsibility: cooperation on concrete topics of technological innovation of low-carbon technologies, climate science and policies as well as adaption, amongst others, will not only contribute to global solutions, but also provide a basis for progressive exchanges between science and policy-making.

- **More efficient EU R&I funding**: the EU will increase the impact of its co-funding by focusing on the agreed EU strategic priorities, including Missions and European Partnerships. Hence the overall impact of EU R&I funding is expected to increase by leveraging additional investments on EU policy priorities, by providing 'directionality' to these investments, and by reaching out to a broader set of stakeholders, including investors seeking sustainable solutions and markets.

[95] A Commission-driven forum for discussion with Member States of the 4 priorities of the new European Research Area. It would help focus the new European Research Area process by working with the Member States to prepare the research and innovation angle of the national recovery plans, to maximize the benefit from cohesion funds, to implement the industrial strategy through work on industrial ecosystems and to discuss regulatory and non regulatory initiatives to create a favorable framework for research and innovation in the EU. It will complement the Horizon Europe Strategic Programming process and offer a platform for the development of ambitious joint policy and funding actions in strategic areas and their alignment with other policies.

- **Improved cross-sectoral and cross-disciplinary cooperation**: The achievement of the ambitious goals of Horizon Europe, including its research infrastructures, missions and European Partnerships will require expertise from different sectors and disciplines to come together, resulting in system-wide transformation. For example, climate action requires meaningful collaboration across sectors such as urban planning, construction, energy efficiency in buildings, mobility, behavioural aspects, food, environmental capacity, and in many other areas (European Commission, 2018c).

- **More links between science and society**: R&I should mobilize citizens, local communities, stakeholders and users in their co-design and co-creation, building on already existing initiatives. Missions are a good way to mobilize citizens and promote experimentation. Also, R&I partnerships can act as experimental platforms to at the local level[96]. This increases the relevance of science and innovation for the society and it can stimulate the societal uptake of innovative solutions and leverage business investment.

2.2 Improving access to excellence

Box 9. Council and ERAC on improving access to excellence

Council conclusions[97] note with concern the unequal development across the european research area and in this context underline the need for making ERA better equipped to address the challenges. **ERAC**[98] stresses that inclusiveness must be based on a broad understanding and applies with regard to geography, culture, people and institutions from academia, RTOs and industry as well as from the public sector and society. ERA policies and actions at all levels should increase inclusiveness, openness, brain circulation and integrity, pursuing scientific excellence throughout Europe.

What is it about?

There are concerns that changes in innovation dynamics coupled with changes on the labour market contribute to growing social and geographical inequalities. The observed changes are driven by **technology-induced long-term structural changes, as well as cumulating skills gaps and mismatches** accompanied by higher increasing income disparities and mobility of skilled professionals (Sekmokas et al., 2020). Moreover, economic activity and innovation have become more **concentrated in core cities and regions**, while others face

[96] E.g. BBI bioefinery flagships, or FCH, which has supported the deployment of Fuel Cell buses in nine cities and refueling stations serving bus fleets in cities across Europe. There is also a new partnership on agro-ecology living labs aiming to co-create solutions with users and integrate results in real life settings.

[97] 14989/18 Council Conclusions on the governance of the European Research Area (30 November 2018).

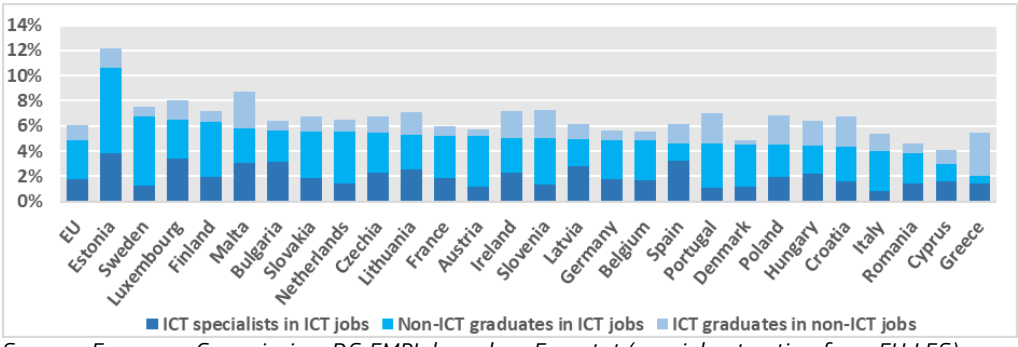
[98] ERAC 1201/20 ERAC Opinion on the future of the ERA (23 January 2020).

difficulties to develop home-grown innovation and to maintain or strengthen the skilled labour force. Since the impact of these challenges on R&I systems varies across Member States, there is a need to devise different measures for strengthening excellence across the EU.

Persistent challenges, such as various R&I performance across EU countries, regional-specific competitive advantages and synergetic approaches to R&I funding remain at the top of the agenda. In order to support innovation and growth in Europe's countries and regions, the challenge remains to strengthen their competitiveness through smart prioritisation of R&I investments and to approach investment strategies with an inter-regional perspective. A broader strategic planning and implementation in synergy with other R&I relevant programmes, policies and activities at all levels has a potential to improve efficiency of R&I investments, strengthen excellence, and align actions with the broader goals of EU policy.

On-going changes in the economy, transforming skills demand, coupled with slow reaction time in education and training systems may result in cumulating skills gaps and imbalances that require increased intersectoral mobility. This could be particularly the case when technological changes transform skills demand faster compared to supply-side changes. It may also happen when the changes between supply and demand are not fully symmetrical. In general, innovation patterns and economic performance across countries are determined largely by their ability to ensure overall high level of standard in the initial education as well as by effective workforce skills formation systems (Toner, 2011). Comparing the share of young individuals having a formal qualification with the share of ICT jobs suggests that only slightly over a third of ICT jobs are occupied by individuals with a degree in ICT. Even in countries with a large number of ICT jobs (i.e. Estonia or Sweden), there seem to be only relatively few individuals with ICT education (Figure 16).

Figure 16. Mobility of young professionals (15-34 years) in ICT sector, 2019



Source: European Commission, DG EMPL based on Eurostat (special extraction from EU LFS)
Note: Comparison of shares of individuals holding a formal qualification with the share of ICT jobs (though limited to 15-34 year old job holders).

2.2.1 Advancing Europe together

INDICATOR	LATEST VALUE	TREND	ASSESSMENT OF TREND
Share of Horizon 2020 funding to Widening Member States[99]	8.4% (2019)	+1.9 p.p. since 2015 (6.5% in 2015)	
Seal of Excellence awards[100]	209 (2019)	+7.2% compared to 2015	
Share of developing ESFRI Projects and operational ESFRI Landmarks in which a Member State/Associate Country is a partner[101]	35% (2018)	+15% since 2016	

Progress so far

Increased inequalities as well as underperforming productivity and growth dynamics were among the main challenges on Europe's political agenda in recent years. The outbreak of coronavirus and the resulting economic contraction will only underline the sheer magnitude of these challenges. The digital transformation of our economy and society coupled with strong and rising network effects lead to "winner takes all" dynamics. In particular, the tendency to concentration of innovative activities stands in contrast to the variety of European research and innovation systems, which have the potential to reduce the existing inequalities and reinforce complementarities across Europe. Nevertheless, to fulfil this potential and to **advance Europe together**, R&I systems need to maximise the effectiveness at all levels and strengthen their quality in a way that encompasses inclusiveness and collaboration.

Low investments in intangible assets and low overall quality of the scientific and technological systems hinder strong innovation performance in many countries. Although some low-performing countries managed to increase their R&D investment, many of these rely predominantly on foreign financing and government financing, with weaker contributions from private R&D investments (European Investment Bank, 2018). The translation of R&D investment into high quality scientific and innovation output is lagging, for instance when compared the share of national scientific publications with the top 10% most highly cited publications. The low innovation performance caused by insufficient quality of

[99] DG Research & Innovation, Corda database. Current Widening Member States are Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia and Slovenia.

[100] DG Research & Innovation, Corda database

[101] ERA progress Report 2018. Data provided by the ESFRI Executive Secretary.

innovation systems may further exacerbate due to limited availability of highly skilled or educated workers. About a half of Member States registered faster declines in university students between 2013 and 2017 than the EU average, in case of Central and Eastern European states due to weak demographic developments. (European Commission, 2020). Such developments pose a challenge to maintain and strengthen the skilled labour force, while further improving quality of scientific excellence and support home-grown innovation.

Intra-EU differences persist in investments in the so-called "economic competencies"[102]**,** which may hinder future productivity developments and exacerbate innovation inequalities (European Commission, 2020). The shares of investments in economic competencies show wide intra-EU disparities with investments above 3 % of GDP between 2009 and 2017 in the Netherlands, Belgium, and Ireland and shares of investments below 1.5 % of GDP in Croatia, Spain and Greece. An assessment of the bottlenecks to firm investments in the lowest-investing countries is crucial to boost both absorption capacity and the uptake of new, productivity-enhancing technologies both in research and innovation activities.

Differences in the take-up of digital technologies also persist across countries, industries and firms. Slightly more than 1 in 10 enterprises in the EU performed big data analyses as part of their work in 2018. In Malta, the Netherlands, Belgium and Ireland, 20 % or more of all enterprises performed some sort of big data analysis, while in Cyprus, Austria and Hungary, less than 7 % of enterprises did so (Eurostat). In most Member States, big data practices seem less diffused, and with differences by firm size, with large companies clearly making more use of big data analytics than medium-sized and, in particular, small firms. 26 % of EU enterprises used cloud computing in 2018, mostly for e-mail and storage of files (Eurostat). However, EU disparities are quite significant, ranging from over 55% uptake in Finland, Sweden and Denmark, to less than 15% in Latvia, Greece, Poland, Romania and Bulgaria.

Economic activity and innovation have become more concentrated in core cities and regions, which could potentially lead to a less economically and socially cohesive Europe. Capital cities are then the headquarters for large organisations and tend to have a relatively high concentration of graduate jobs in dynamic or well-paid areas (Eurostat, 2019). Many of the new jobs were created in new industries, e.g. the number of jobs in the ICT sector for the period 2010-2017 increased by 72 % in Bucharest, 31 % in Berlin and 27 % in Stockholm[103]. Metropolitan areas in general tend to offer environment conducive to the introduction of new ideas, products and processes (European Commission, 2017). The divide is most apparent in the increasing gap between capitals and metropolitan areas, where most of economic

[102] Such as management quality, flexible organisational structures, workforce training, and brand and market research which are essential ingredients for reaping the full productivity benefits from investments in both tangible and intangible assets such as R&D (Corrado et al., 2005)

[103] Employment by economic activity in NUTS2 regions. Estonia and Malta show even higher increases in ICT jobs.

and innovative activities are concentrated, on the one hand, and declining industrial and peripheral areas experiencing skilled emigration and being less resilient to change, on the other hand.

Participation patterns in the EU R&I Framework Programme suggest a concentration of funding that may slow down countries and regions in their efforts to narrow the R&I gap between countries:

- An analysis of the network of participations across Framework Programmes (European Commission, 2018d) shows a very dynamic structure, which is gradually opening towards the participation of newer Member States and where the most connected countries are also the largest ones. Although the participation network is becoming relatively open, there is still room for improvements in connectivity and centrality of several countries with lower R&I performance (European Commission, 2018b).

- Newer Member States[104] currently represent 8.3 % of the participations in Horizon 2020 and receive 5.6 % of the overall funding, which shows a slight improvement from the 7th Framework Programme with 7.9 % of participations and 4.2 % of funding. Insufficient R&D investment levels, lack of synergies between certain Member States' research systems and EU research, limited access to existing networks or differential wage levels between countries belong to the main causes of low participation(European Commission, 2017a).

Targeted widening actions, consisting of Teaming, Twinning and ERA Chairs, COST networking actions and MSCA Widening Fellowships[105], are in place to increase the link of underperforming Member States with their better performing peers through activities, such as short-term staff exchanges, network seminars or communication activities as well of the development of new or modernisation of existing centres of excellence. Ongoing projects capitalise on countries' individual strengths with the objective of allowing the European Research Area to function in a more efficient and homogenous way (European Commission, 2019). Furthermore, widening countries received 1065 'Seal of Excellence' quality labels that help proposals to find funding elsewhere and thus support synergies with other funding programmes.

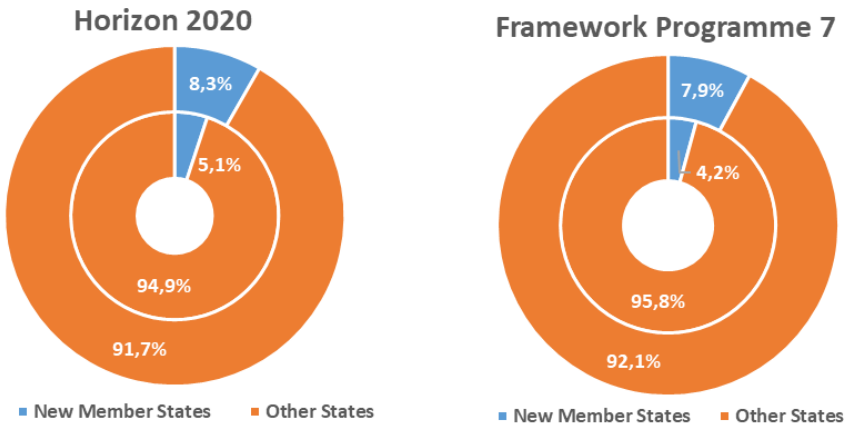
Other instruments target low-performing countries and regions by dedicated activities. European Institute of Innovation and Technology (EIT) developed an outreach strategy through Regional Innovation Scheme (EIT RIS), which is carried out through the activities of the knowledge and innovation communities (KICs). Its main objective is to support countries and regions that lag

[104] Defined as Member States accessing after 2004. On the other hand, Widening Member States are Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia and Slovenia.

[105] Established as a successful pilot project in 2018.

behind in innovation performance[106] by strengthening their capacity for innovation and by bringing the EIT model to these regions. As part of the actions aiming at increasing the regional impact of KICs in Horizon Europe, Regional Innovation Scheme activities shall become mandatory in Horizon Europe and an integral part of the KIC's multi-annual strategy.

Figure 17. Share of New Member States in Horizon 2020 and Framework Programme 7 funding (inner circle) and participations (outer circle)



Source: European Commission, DG Research and Innovation- R&I Strategy and Foresight Unit, based on Corda.

Outstanding challenges

Box 6. Examples of synergies

- **The Bayerische Forschungsallianz (BayFor)**, a public body in Bavaria (DE) provides comprehensive advisory services on EU research and innovation funding, helps putting together applications and looks for suitable project partners in order to achieve potential synergies. BayFor has succeeded in supporting **H2020 applications in combination with regional research and innovation programmes** through the European Structural and Investment Funds (ESIF) in connection with Smart Specialisation Strategies (S3). It has ensured cooperation and coordination among different ERA-NETs and/or JPI to increase synergies between cross-cutting issues. Finally, it has fostered synergies between BBI JU actions and regional spending activities under ESIF as well as opportunities given by public financial instruments (e.g. EIB)[107].
- **The projects JIVE and MEHRLIN run in parallel and work in close**

[106] Modest and moderate innovators as indicated by the European Innovation Scoreboard.
[107] Source: Dr. Thomas Ammerl (BayFor) - Synergien nutzen – Möglichkeiten und Praxis.

cooperation to promote, deploy and commercialise hydrogen as alternative fuel, contributing to the European alternative fuel implementation strategy. This effort to develop hydrogen buses (JIVE) and refuelling stations (MEHRLIN) includes operating real-pilot hydrogen refuelling stations at seven locations along four core Network Corridors of the trans-European Transport Network (TEN-T). Most of the buses co-funded under JIVE will refuel at stations co-funded under MEHRLIN. The JIVE and MEHRLIN projects will deploy in total 144 hydrogen fuel cell buses and seven large-scale hydrogen refuelling stations across five EU countries, more than doubling the number of fuel cell buses operating in Europe. While both project received **EU funding (below)** the project mobilised additional fund through **national funding programmes, regional and local funding** and the city of Riga secured **European Investment Bank financing**.

- JIVE project: €32M from the FCH2 JU under the EU horizon 2020
- MEHRLIN project: €5.5M from the Connecting Europa Facility

The key challenge is to address the differences in innovation performance across Europe, which requires long-term national and regional strategies that would maximise synergies. Since 2007, a number of instruments targeted reinforcement of R&I capacities in low performing countries. The main expected outputs from these activities related to improved institutional, scientific and networking capacities of centres of excellence and research institutions. Specific measures introduced by Horizon 2020, such as teaming (aiming at institution-building) or twinning (aiming at networking) increased the attractiveness of the participating institutions for international excellent researchers and boosted its capability to compete for international funding. Furthermore, instruments such as the Policy Support Facility provided on-demand advice to policy makers on national R&I systems and thus allow to strengthen framework conditions for R&I. Horizon Europe should reinforce the European Research Area through continuation of all these activities that pursue sharing of excellence together with research and innovation policy reforms (European Commission, 2018c).

Moreover, increased synergetic approach to other EU funding programmes and EU policies could particularly capitalise on R&I capacities built over the past decade in low performing countries. This requires combining resources in support of activities promoting human capital development, introduction of innovative technologies and new business models as well as supporting infrastructure maintenance and development. An effective combination of the ERDF innovation investments under the smart specialisation priorities with world-class research and innovation initiatives supported by the Framework Programme could significantly improve the performance of lagging regions and strengthen the European Research Area as a whole. Cohesion policy develops new tools in order to offer opportunities to regions with similar smart specialisation priorities to develop complementary cooperation, share infrastructure, increase impact and develop joint investment projects. Following the success of the Vanguard initiative and Thematic Smart Specialisation Platforms (European Commission, 2017b), the newly proposed

Cohesion Policy rules create the 'Interregional Innovation Investments' instrument, that provides new possibility for regions to develop joint investment projects (European Commission, 2018a). This could further allow regions with matching 'smart specialisation' assets to access more financial support and involve further policy-makers, researchers, businesses and other innovation actors.

Synergies need to be understood broadly as, for example, synergetic approaches can ensure that education and training initiatives complement and leverage the efforts of R&I for greater impact. Such a systematic approach needs to make use of packages of support instruments at the European level covering different stages of research and innovation developments, drawing upon multiple funding sources. The European Universities initiative is one example that links education, research and innovation at policy and programme levels. This initiative is a test bed for the transformation of higher education institutions in Europe to empower European citizens with the high-level competences (knowledge, skills, attitudes) necessary for their personal, social, civic and professional development in a fast changing society. European Universities is an Erasmus+ led initiative supporting EU and national reforms, which R&I transformation part is supported by a top-up from the R&I programme. Alliances of higher education institutions also receive support through national funds and have the potential to secure funding from other European Funding programmes in order to achieve their ambitious long-term joint strategy and deep cooperation. In this respect, the European Universities is a prime initiative to ensure a broad and coherent approach across policy fields of long-term national and regional strategies in order to maximise synergies.

Given the limited number of instruments enhancing synergetic approaches at the European level, the development of synergies between national and EU R&I programmes requires a substantial amount of work and efforts starting from the strategic programming phase up to the implementation. European partnerships will be one of the key tools for developing synergies between the activities at the EU and national level as they allow long-term planning and have resources to facilitate this work. The new opportunity under Horizon Europe to co-fund national participation from Cohesion policy funds could increase the participation rate of less active member states since a significant part of R&I funding in many of these countries stems from the Structural Funds. Besides encouraging certain countries to participate more broadly in the Framework Programme, it allows to concentrate efforts on common objectives while remaining focused on priorities identified in smart specialisation strategies via a strong bottom-up participatory process (entrepreneurial discovery process, Foray and Geogana, 2013). Member States and regions could profit from the improved strategic planning by reflection of European Partnerships' priorities when developing their national programmes and Smart Specialisation priorities. Such an approach offers more possibilities for alignment of priorities, complementarity in funding and strengthening excellence.

Another challenge is the promotion of innovation combined with more focus on the local context, which would trigger economic dynamism in less-developed regions. Place-based approach in promoting innovation, especially the diffusion and commercialisation of existing innovation in lagging regions, is essential and should be supported in line with the specificities of each region and its current or possible comparative advantages as mapped in 'smart specialisation strategies'. Effective public support for innovation must reflect the specificities of both the national and regional innovation systems and build on these. The next generation of Cohesion policy programmes should allow for targeting of specific resources to regions with specific focus on governance of smart specialisation (via its updated enabling conditions) and economic transformation. The overall effectiveness of the Cohesion policy investment in the domain of R&I should increase as the enabling condition relating to smart specialisation will also focus on effective functioning of national R&I systems. Nevertheless, institutional quality and administrative capacity remain a fundamental factor behind the performance of public support as the management of Cohesion policy involves a complex ecosystem of actors – from multiple levels of government, to private firms and non-profit entities (OECD, 2020). In addition, when setting out their recovery and resilience plans with reform and investment agendas, Member States should address the challenges identified in the context of the European Semester. The new Recovery and Resilience Facility will financially support such reforms and investments undertaken by Member States to mitigate the economic and social impact of the coronavirus pandemic, strengthening resilience and sustainability.

Although innovation performance has increased for the European Union, disparities are growing in a number of lagging countries. The EU improved its performance by 8.8 percentage points since 2011 and so did the majority of Member States, but the performance of modest innovators declined between 2011 and 2018, thus increasing the performance gap with the group of moderate innovators. For example, Bulgaria recently improved its performance by 2.4 percentage points, but the result is still below the level from 2011 (European Commission, 2019b). In many cases, the root cause lies in a lack of vibrant and robust science base and higher education systems. The fragmentation of the public science base along with sub-optimal funding and deficient governance regimes damage the effectiveness and efficiency or research and education (Nedeva, 2020). Weak science-business links presents another issue that is pursued by governments in order to catch up with innovation leaders (Spiesberger, 2019).

Expected implications under a new ERA

Action under a new ERA

The Commission:

- Proposes that Member States lagging behind the EU average R&D investment over GDP direct their investment efforts to increase their total investment in R&D by 50% in the next 5 years. The Commission will support Member States to reform their R&I policies, also by targeting technical

assistance to this end. It will facilitate the coordination and complementarity of national and EU programmes, and contribute to the deployment of the recovery package. (Action 3)

Expected implications:

- **Improved conditions for Framework Programme participation:** An efficient use of cohesion policy funds and better governance policies would allow countries to reform their R&I systems. A solid national system together with the R&I capacities built over the past decade could significantly improve conditions for participation in the Framework Programme projects (European Commission, 2018c).

- **Improved use of Cohesion policy and the Recovery and Resilience Facility for R&I funding** could redirect more resources towards national participation in European Partnerships, leading to a higher involvement of certain countries and to concentration of efforts on common objectives.

- **Complementary and sequential funding promoting interregional innovation investments and improving local capacities for R&I:** Synergies across funding programmes will allow for complementary sources of funding and thus more efficiently fund available R&I potential of Member States and regions (European Commission, 2017c). Furthermore, it could help valorising knowledge produced through Horizon Europe locally.

2.2.2 Nourishing talent_for excellence

INDICATOR[108]	LATEST VALUE (EU MOVES)	INTERNATIONAL (NON-EU MOVES)	TREND (EU MOVES)	ASSESSMENT OF TREND
Forced moves of researchers (research options lack)	8.9 % (2019)	2.2 % (2019)	-3.6 p.p. since 2016 (12.5% in 2016)	↗
Forced moves of researchers (career progress)	6.2 % (2019)	6.7 % (2019)	-0.2 p.p. since 2016 (6.4 % in 2016)	=

[108] Source: DG Research and Innovation, MORE survey. Distribution of >3 month mobile researchers in post-PhD career over applicable situation for their last instance of mobility, for EU and non-EU moves. Based on question 72: "Which of the following situations would you say is most applicable to your last instance of mobility?" and question 62: "Please indicate the 3 most recent international steps/moves in the last ten years of your research career after your PhD up to (but excluding) your current position in which you are employed." (n=1,572).

Progress so far

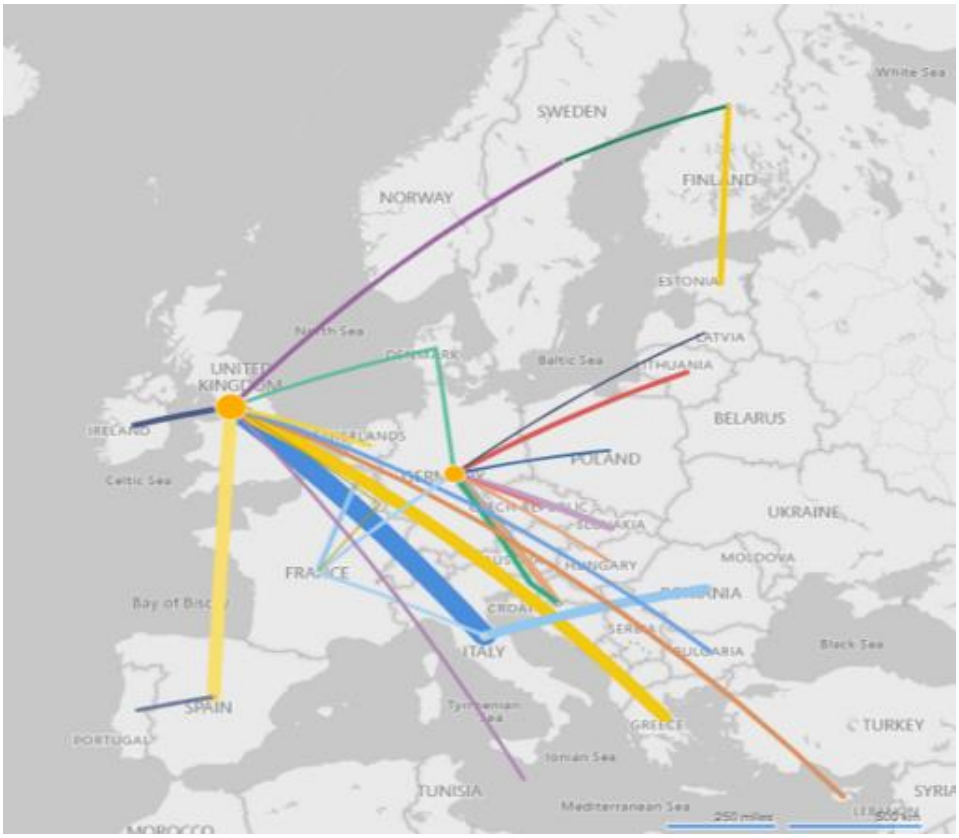
Circulation of talents across countries and regions continues to be unbalanced. There are vast differences between countries, with a higher share of inflow of researchers observed in higher-performing countries and an overall higher mobility of researchers from smaller R&I systems. Malta, Greece and Iceland have the highest share of researchers who have obtained PhDs in a foreign country, as well as lower inflows of foreign researchers. At the same time, Austria, Switzerland and the United Kingdom, have the highest share of inflows of researchers. Luxembourg, Ireland and Cyprus present both high inflows of researchers and high mobility during PhD programmes. In general, **countries with higher R&I performance tend to have a higher share of researchers who have obtained their PhD in another country, and higher researcher inflows.** The size of the national research system also has an impact on researchers' mobility. The asymmetry in mobility flows, while highly beneficial for hosting countries, may prove detrimental to lower-performing research systems if mobility is one directional (Veugelers, 2017).

Escape mobility occurs when a researcher is 'pushed' away from his or her environment because of lack of funding, of positions, etc. The concept of 'escape mobility' entails that researchers are mobile because they need to be so if they want to pursue a career as a researcher. These specific examples mobility concepts aim to capture the phenomena of human displacement, which understanding and quantifying is often challenging. This is not only due to the legal limitations allowing the processing of personal data but also in view of the asymmetries of information existing between the relevant entities and public services. Nevertheless, throughout the dedicated MORE studies, certain concepts have been developed that can account for the very plural reality of the phenomenon. About 6% of the researchers who have been mobile for more than 3 months in the last ten years indicated they felt forced to move because there were no options for a research career in their home country. This value presents a decline of 3 percentage points compared to the previous MORE3 survey from 2016. Another 6% felt forced because international mobility is a requirement for career progression in their home country (similar to the share of 7% observed in 2016).

While the concept of forced mobility takes into account the more radical side of the phenomenon, there are other forms of mobility, such as "exchange mobility", that cover larger groups of researchers. Exchange mobility refers to those situations in which a researcher chooses to move (positive motivation, self-chosen) with the aim of exchanging knowledge and work in an international network, or with the aim to use international experience as a way to boost his or her career. Researchers, who decided to move because of the opportunities derived from international mobility in terms of networking and knowledge exchange represent the largest group of mobile researchers (47% in 2019). These values present averages at the Union level, but a closer look at certain areas shows strong disparities and a fragmentation of ERA.

In 2019, about a third of the non-mobile researchers[109] in PhD have ever considered to take part or all of their PhD in a country other than that in which they obtained their previous degree. More precisely, 18% of them never searched for concrete opportunities (22% in 2016), 7% undertook efforts to become mobile (9 % in 2016) and 3% were offered a position in another country, but turned it down (3% in 2016). On the other hand, 72% of all non-mobile researchers indicated that they not even have considered to take part or all of their PhD in a country other than that in which they obtained their previous degree (66% in 2016). The most frequent mobility patterns of post-PhD's at both European levels (Figure 18) show a central position of Germany and United Kingdom, suggesting that these countries are attractive for mobile researchers.

Figure 18. Map of international mobility flows (>3 months) in post-PhD career stages



Source: European Commission, DG Research and Innovation – MORE4 study (forthcoming).
Note: The maps shows the flow of each nationality to the most common destination.

[109] Non-mobility for PhD is defined as the experience of a researcher who has undertaken neither PhD degree mobility nor >3 month mobility during PhD.

In the multipolar landscape, knowledge production and technological development by means of international collaborative research continue to grow as scientists and innovators benefit from access to resources, international mobility and the increased impact and reach of their scientific results. Bibliometric studies show a higher citation impact of researchers with international experience (OECD, 2017), while international co-publications, whose share has doubled during the last 20 years, tend to be more often cited. Moreover, since 2000 international co-invention of patents has significantly increased across almost all technologies[110]. The number of foreign nationals enrolled in universities has more than doubled in the last 20 years[111] and more and more universities and research organisations are developing internationalisation strategies[112].

Attracting young talents to EU R&I is key to sustain EU excellence in R&I and to counter-act demographic developments as other countries are expanding their pools of talents. As in the United States, the European student population has been progressively becoming more international, showing to some extent that European universities are attractive on the global stage. The number of mobile students from abroad increased in Europe from 1.43 million in 2013 to 1.64 million in 2015 (+14.6%). The largest groups of non-European students in 2017 descend from Asia (267.000) and Africa (180.000). At the same time, there was an increasing demography of tertiary students in China and India. In terms of the absolute number of tertiary students, the EU and the United States lately show similar levels of participation in tertiary education. While the EU had 16% of the world's tertiary student population at the beginning of the millennium, the share went down to 9% in 2017. The share of China and India over 2000-2016 increased by 6 and 13 percentage points to reach the value of 15% for India and 20% for China.

EU countries keep increasing the number of researchers, but so do their global competitors, which requires the EU to attract and retain researchers from all over the world. For example, the EU share of researchers in total employment still lags behind the United states, Japan and, in particular, South Korea. In 2012, the Commission adopted the Communication "Enhancing and focusing EU international cooperation in research and innovation: a strategic approach[113]", presenting a new strategy for international cooperation notably regarding the implementation of Horizon 2020. Horizon 2020, as all other Framework Programmes did before, demonstrates broad international outreach attracting talent from around the world. Countries with strong R&I performances, such as Switzerland, Norway and Israel, are the most active associated countries in Horizon 2020, while almost one third of the participation from non-associated third countries comes from the United States.

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[110] OECD Science Technology and Industry Scoreboard (2017); European Commission (2020)
[111] UNESCO Institute of Statistics, Outbound internationally mobile tertiary students studying abroad.
[112] See e.g. Zacharewicz, T., Sanz Menendez, L., Jonkers, K., JRC (2017)
[113] COM(2012) 497

Artificial intelligence is an example of a research field and disruptive technology where the EU needs to boost its efforts to promote talent production and retention in the EU, while attracting foreign talent. Currently, AI talent is relatively scarce worldwide and appears more predominant in the United States (J.F. Gagné, 2018). AI-related jobs seem harder to fill compared to the 'average job'[114], which hints at a limited pool of AI talent worldwide resulting in a global "race" for attracting AI professionals. For the EU, this means it is important to increase the number of students and professionals with an AI-related academic background and/or AI technical competences and skills acquired, for instance, in trainings that also reflect the potential risks of AI technologies. At the same time, the EU should enable the right environment for them to work in the EU (i.e. to retain AI talent) and attract more talent from abroad, as highlighted in the 2018 European Commission Communication on 'Artificial Intelligence for Europe', for example through the 'Blue Card scheme'. This is important because the Global AI Talent Tracker[115] found that around 60% of top-tier AI researchers worldwide work at US universities and companies, with two thirds having obtained degrees in other countries (11% are "affiliated" to Europe).

Outstanding challenges

Although researchers' mobility remains key to knowledge diffusion, stark disparities remain between countries in international and intersectoral mobility patterns in the EU. In general, countries with a higher R&I performance tend to have higher inflows and outflows of researchers and the size of the R&I system also plays an important role. Those divergences call for a better understanding of drivers of and barriers to international and intersectoral mobility as well as the implementation of policies to foster brain circulation. At the same time, there is a need for a strengthened role of place-based innovation based on the enhanced partnership of enterprises, universities and government.

Dedicated studies report various factors that prevent researchers' international mobility, such as personal or family reasons, funding, and finding a suitable position. The evidence shows that 16 % of mobile researchers have experienced 'forced mobility' – i.e. the extent to which researchers feel forced to move to another country due to the lack of career options in their home country or the requirements of the system (IDEA consult et al., 2017). In the EU, 16 % of the researchers report international mobility during their PhD and 13 % are employed currently in a country other than their country of citizenship. Specific EU schemes, such as **Marie Skłodowska-Curie Actions, support intersectoral mobility** through all its actions: its doctoral programmes (Innovative Training Networks), its co-funding mechanism for doctorates and post doctorate fellowship (MSCA COFUND), its Individual Fellowships and the Innovation Staff Exchange (RISE).

[114] Priceconomics data studio – Which Industries are investing in Artificial intelligence (18 November 2018) based on Indeed data

[115] https://macropolo.org/digital-projects/the-global-ai-talent-tracker/

Expected implications under a new ERA

Action under a new ERA

The Commission proposes to:

- Institute a dedicated work stream in the ERA Forum for Transition (i) to promote and monitor access to excellence of researchers and institutions from Widening Countries, with Cohesion Policy support, (ii) to support Member States to better integrate researchers in smart specialisation strategies in cooperation with industry, and (iii) help them design measures to support researchers in Widening Countries to improve their skills for excellence in the labour market. This should support low R&I performing countries to increase the excellence of their R&I systems. Member States lagging behind the EU average on highly cited publications should reduce the gap to the EU average by at least one third in the next 5 years. (Action 4)

Expected implications:

- **Improved attractiveness of the researchers' career** across the entire ERA: The deployment of the European framework for researchers', a dedicated monitoring and reporting system on remuneration for researchers, and activities to stimulate knowledge transfer will considerably improve the attractiveness of the entire ERA for talents from within EU and worldwide.

- **Boosted and balanced circulation of R&I talents:** Better access to mobility funding programmes together with better employability of R&I talents across sectors and more coordinated training and career development actions would increase and strengthen the different flows of highly-skilled talents within, to and across the EU.

- **Strengthened transnational ties with scientific communities abroad:** Physical and virtual networking and knowledge-sharing through the joint effort of EURAXESS services network and EURAXESS Worldwide could strengthen S&T links with home countries through policy feedback tools and dialogues. Secondly, it could facilitate knowledge transfer, scientific collaboration and recruiting processes and thus alleviate obstacles to return.

2.3 Translating R&I results into the economy

Box 11. ERAC on translating R&I results into the economy

The **ERAC**[116] notes the importance of achieving a dynamic and integrated knowledge circle, promoting and enabling collaboration to find solutions to global challenges and realising the full potential of a knowledge-driven society. Involving institutions from academia, research & technology organisations, the public sector, society and industry is key for Europe to be fully effective in its capacity to create value and deliver innovation-led sustainable development. ERAC also stresses[117] the importance of putting a greater focus on promoting and enabling collaboration with all relevant third countries to find solutions to global challenges.

What is it about?

EU R&I policy can set the direction for public actors and industry to generate knowledge and solutions for a competitive and sustainable Europe, with people and their well-being at the centre of policy design. Transformative R&I policy can be a key enabler of the European process for achieving the SDGs. A new transformative R&I policy will also need to engage with other actors in society to deploy new solutions on a massive scale, in particular the radical innovations required for such a transformation.

Europe's industry plays a key role in delivering on the environmental and digital transitions while boosting the resilience and the competitiveness of our economies. While R&I are the key engine of productivity and competitiveness of our economies, the EU still lags behind its main competitors in business R&D investments and performance, in particular in high tech sectors, and in scaling-up innovative SMEs.

A European Research Area that 'delivers' requires that all the R&I actors, systems, and geographies are connected to generate critical mass in strategic areas with economic and societal value. Considering the urgency of the global challenges we face- the COVID-19 pandemic and the threats posed by climate change and rising inequalities-, a full mobilisation and alignment of priorities, actions and instruments is, more than ever, an imperative. At the same time, these are also the conditions required for ensuring a competitive Europe.

Although several EU Member States are making numerous efforts to increase the effectiveness and performance of their public research systems (European Commission, 2020), further efforts are needed to introduce the necessary **policy reforms to boost their impacts and contributions to the society and the**

[116] https://era.gv.at/object/document/5133/attach/Opinion_Future_of_ERA_adopted.pdf
[117] ERAC 1201/20 ERAC Opinion on the future of the ERA (23 January 2020).

economy. ERA Priority 1 recognises this by calling for more effective national research systems and richer R&I policy mixes geared towards making a stronger impact. Many Country-Specific Recommendations made in the context of the European Semester[118] show that in a number of countries it is essential to make further progress in relation to connectivity issues such as collaboration and knowledge transfer between public research institutions and businesses in view of enabling a fully functioning, high quality and high performing innovation ecosystem, creating a continuum from basic research over applied research to uptake by industry.

Knowledge circulation between knowledge creators and knowledge users is paramount in creating solutions to the challenges that Europe and the world are currently facing and in ensuring the competitiveness of European companies. Knowledge has to be managed in a smart way and protected, where appropriate. Knowledge sharing and knowledge protection are not opposites, they reinforce each other and together they ensure value creation and benefits for society in the Union. Knowledge flow is closely linked to the tightly knit pan-European and global networks across the entire value chain, from curiosity driven creation of fundamental knowledge to the development of innovative applications and solutions for society. The diffusion of knowledge and technology across companies, regions and countries helps to address differences in productivity growth and the uptake of digital and industrial technologies, and is a pre-requisite to cope with the growing complexity of innovation processes. There is a broad need to boost circulation, permeability, diversification and employability of especially early career talents as well as to **leverage continuous inter-sectoral brain circulation** that improves and diversifies the individual's career prospects and strengthens talent permeability across society.

Europe has a strong knowledge community composed of highly competitive, research-intensive and entrepreneurial universities, increasingly networked with businesses and society, active along strong common values and principles and empowered with missions for education, research, service to society and innovation. Working together in a structured way, this community has the potential to further strengthen its contribution to society, operating around SDGs and Missions, across languages, borders, disciplines and sectors, pushing the barriers of fundamental research and applied science, mobilising innovation ecosystems, supporting the emergence of innovative initiatives and enterprises and empowering engaged and active citizens to transform the way we live and work.

[118] https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester_en

2.3.1 Competitiveness of European industry

Indicator	Latest value	International comparison	Trend	Assessment of trend
European Innovation Scoreboard Summary Innovation Index[119]	0.51 (2019)	Lower than JP, higher than US and CN'	+1.2% per year since 2011 +2.1% per year since 2015	↗
Scaleups in Europe[120]	7034 (2018)	Lower than US and CN		
Share of knowledge-intensive sectors in the economy[121]	50% (2018)	Lower than US	+5% since 2000	↗
Share of exports of medium/high-tech products in product exports[122]	61.5% (2018)	Higher than US and CN, lower than JP	+0.5% per year since 2011 +0.7% per year since 2014	=
Share of knowledge-intensive services in services exports[123]	74.8% (2018)	Higher than JP, US, CN	+0.2% per year since 2011 +0.3% per year since 2014	=

Progress so far

Within the context of the global productivity slowdown, there is a lack of high-growth firms in knowledge intensive activities in Europe, which would boost EU competitiveness in the medium and long term. Firms experiencing high-growth contribute significantly to job creation and output growth, while also creating positive spillovers for other companies along the value chain (Daunfeldt et., 2014; Goswami et al. 2019). While the share of high growth companies has increased across the EU Member States, only a relatively small share (12%) of those belong to knowledge intensive sectors. Improving this trend is of paramount importance in order to support Europe's transition towards a technology-based economy.

Similarly, Europe´s scaling-up performance[124] for companies and strategic technologies is lagging behind in global perspective. Figures for tech scaleups –

[119] EU28. Source: European Commission (2019a). European Innovation Scoreboard 2019.

[120] EU + 18 third countries (LI, NO, CH, RS, ME, BA, MD, XK, AL, IS, UA, BY, MK, UK, SM, MC, AD, VA) Source: Mind the Bridge (2019).

[121] EU. Source: Eurostat.

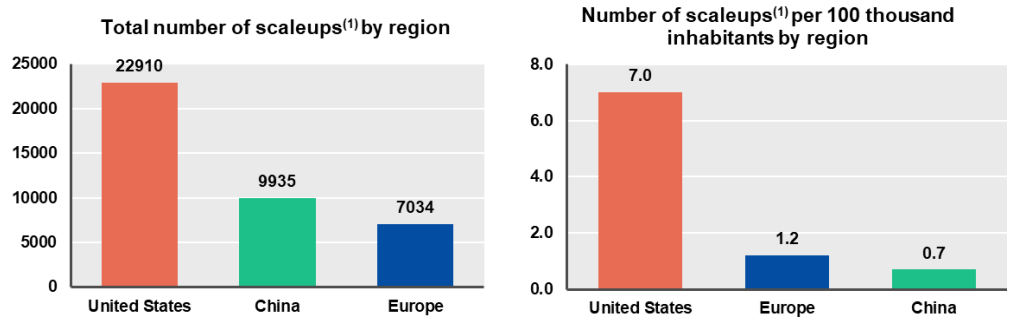
[122] EU. Source: Vertesy and Damioli (2020).

[123] EU. Source: Vertesy and Damioli (2020).

[124] A legitimate argument is that scaleups may not be the unique and most appropriate indicator to measure progress in terms of technological uptake and transition towards a sustainable framework. However, scaleups (and unicorn companies) contribute to the creation of new technologies, and have an economic and employment impact in society and are key contributors to technological sovereignty in the current global landscape. There is also a rising awareness that new business models need to embrace the three dimensions of sustainability, to which a fourth technological dimension can be added in the digital era. See for instance

defined as tech companies having raised more than EUR 1 million in funding (Mind the Bridge, 2019) – are lower in the case of Europe vis a vis other countries, most notably the United States and, to a certain extent, China (Figure 19). Europe has only 1.2 scaleups per 100 thousand inhabitants compares with 7 scaleups in the United States. Substantial disparities can be observed across Member States, with more than half of all scaleups in just three countries: France, Germany and Sweden.

Figure 19. Scaleups in Europe, United States and China, 2018



Source: The Science, research and innovation performance of the EU2020, based on Mind the Bridge data.
Note: (1)A scaleup is a tech company (i.e. a company - operating in Tech & Digital industries, founded in the New Millennium, with at least one funding event since 2010. Biotech, Life Sciences and Pharma, Semiconductors are currently not included in the scope of research) which has raised more than €1mn funding raised as defined by Mind the Bridge (2019). (2) Europe includes EU Member States, and 18 other European countries (LI, NO, CH, RS, ME, BA, MD, XK, AL, IS, UA, BY, MK, UK, SM, MC, AD, VA). Removing the Top 5 non-EU Member States reduces the number of scaleups in the European aggregate substantially, to 4295.

Europe is transforming into a knowledge-driven economy at a slow pace, slowed down by the deindustrialisation process. While more than 40% of EU economic activities belong to knowledge-intensive services, the share of knowledge-intensive activities has increased only by 5% since 2000, including in medium-high- and high-tech sectors (European Commission, 2020). Furthermore, the growth of knowledge intensive exports of both products and services has been almost null in the last decade (+0.7% since 2011 and +0.3% since 2010 respectively). These trends may have negative bearings on European long-term competitiveness, most notably due to the deep digital transformation that industry is undergoing, revolutionising production systems and business models.

These issues can be magnified in a context of rapid speed of technological development worldwide that creates concerns in terms of technological sovereignty. The EU is a renowned global research powerhouse, accounting for almost 20% of worldwide R&D with less than 7% of the world's population, but it

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https://sloanreview.mit.edu/article/corporate-responsibility-in-the-digital-era/. Another issue is the lack of diffusion of technologies from the frontier to the rest, i.e. companies and regions, limiting the uptake of innovations across European economies. See also European Commission (2020).

lags behind global competitors for various indicators, including in terms of investment in R&I and other intangibles, especially when considering the private sector. This creates concerns for the ability of EU industry to access and use raw materials, technologies and services that are safe and secure, also in virtue of the European long-standing openness approach for knowledge and brain circulation.

A well-designed regulatory framework contributes to making the best out of innovation. The quality of the regulatory framework is correlated with innovation performance. This is not only true for the EU and its Member States, but also for the peer economies, including other European countries and the United States, with the notable exception of China (European Commission, 2020). A fit-for-purpose, forward-looking and overall innovation-friendly regulatory framework will ensure well-functioning markets that incentivise, maximising the impact of EU R&I investments across sectors. Regulation, when featuring adequate levels of stringency and appropriate timing, can steer innovation towards addressing societal needs.

Currently, Europe is developing and building capabilities to be a global leader in the development of breakthrough technologies while at the same time being the first climate neutral economy by 2050. The new EU Industrial Strategy aims at increasing the competitiveness and sustainability[125] of European industry, driving its transformation to cope with and lead the twin green and digital transformation that is changing business and societies. R&I and industrial policies will ensure sustainable competitiveness of European industrial fabric[126] with various instruments, such as the **innovation principle**[127], the building of technology infrastructures and the important projects of common European interest (**IPCEI**). In addition, the **European Innovation Council** will support innovators with breakthrough ideas and market creating innovations that currently face high risks due to the fragmentation of the innovation eco-system, lack of risk finance and risk aversion. These policies include comprehensive measures to modernise and decarbonise industries, invert the deindustrialisation trends and increase the long-term competitiveness of EU industry while achieving a sustainable transition.

Outstanding challenges

Developing an overarching strategy, bridging long-term competitiveness with sustainable development for all, will be key for driving European economies and societies into the sustainable **transition**. Similarly, cooperation between the

[125] The EU Taxonomy on sustainable finance is a big step in this direction.

[126] European partnerships and industrial alliances are key for transformative innovation policy, as they strengthen large scale directionality of R&I efforts. See Box 8.

[127] The Innovation Principle is a tool to help achieve EU policy objectives by ensuring that legislation is designed in a way that creates the best possible conditions for innovation to flourish. The innovation principle is applied for: (1) agenda setting on emerging technologies and new business models through horizon scanning and the guidance of a Regulatory Advice Mechanism to assess their impact on EU rules; (2) fostering innovation in EU legislation through impact assessment; and (3) addressing perceived regulatory obstacles to innovative solutions in existing EU rules through innovation deals.

European Commission, Member States and European industries will ensure coherence and a more efficient pursuit of EU policy objectives.

Transformative innovation policy can promote a 'tech-with-a-purpose' approach, leveraging innovation efforts to create the solutions needed to address the challenges of our time. While technological progress is behind scientific and technological breakthroughs, historically driving economic growth and improving living standards worldwide, there is an increasing debate to whether all innovation has and can create value for society (Kalff and Renda, 2019). An innovation policy framework grounded on directionality would allow to pursue and promote technological change which is relevant for society. This could ensure that entrepreneurship and innovation efforts will address the most pressing challenges of our time and contributing to the achievement of the social good. This aim is at the heart of social economy, which plays an important role in developing technology that is relevant for the society, and ensuring that the digital transformation is inclusive. This will also be highlighted in the context of the Social Economy Action Plan, due to be published in 2021.

Integrating directionality in innovation policy is not an easy task, but it can improve the performance of European businesses in the changing global landscape. This is particularly relevant for technologies such as artificial intelligence and its applications, where strengthening EU capabilities will be crucial to keep pace with the main global competitors. Innovation policy needs to take into account the fabric of European industries and businesses, and to develop tools that are suited for the challenges ahead. However, neutral and horizontal policy actions aiming at just fixing existing market failures will not be enough to achieve the target.

Factoring in beneficial innovation throughout the policy cycle constitutes an additional challenge. The innovation principle can support policy-makers in steering innovation towards the EU's sustainable objectives in a systematic and evidence-based manner. An interim evaluation[128] of the innovation principle found that its application has potential to improve the link between innovation and regulation. Similar good practices exist at national level, for example the Dutch Green Deals[129] scheme or the German strategy for regulatory sandboxes[130].

Ensuring a strategic direction to international cooperation in the field of R&I is another key challenge to secure EU technological sovereignty in the global technological race. The EU approach to R&I has long been one of openness to the world to facilitate brain and knowledge circulation, combined with strategically targeted actions with key partner countries. Yet, the rapid pace of technological development of global competitors creates concerns in terms of technological sovereignty. Against this background, ensuring multilateralism and purposeful

[128] https://ec.europa.eu/info/publications/study-supporting-interim-evaluation-innovation-principle_en
[129] https://www.greendeals.nl/english
[130] https://www.bmwi.de/Redaktion/EN/Dossier/regulatory-test-beds-testing-environments-for-innovation-and-regulation.html

openness, while assertively negotiating a global level playing field should be at the heart of the EU approach to strategic international cooperation.

Expected implications under a new ERA

Action under a new ERA

The Commission will, in cooperation with Member States and stakeholders:

- Support the implementation of the new industrial strategy by jointly developing common industrial technology roadmaps by the end of 2022 to align and link industrial results from Horizon Europe, including key partnerships under Horizon Europe with industrial alliances and ecosystems, so as to ensure that efforts team up and that research results are known and rolled out faster in the economy. (Action 5)

Expected implications:

- **Increased scaled up and innovative companies in Europe:** policy instruments targeting bottlenecks for innovative companies will boost the competitiveness of the European economic fabric. For example, the EIC will support late stage innovation activities and market deployment for the most promising ideas. It will also target innovative companies with a great potential for scaling up, offering them co-investment to become larger and expand their markets.

- **Reinforced technological sovereignty**: strategic investment targeted at reducing Europe's dependence on others for the things it needs the most, particularly with regards critical materials and technologies, and in sectors of systemic or critical importance (including food, infrastructure, or security), together with multilateralism and purposeful openness, can leverage European innovative outcomes and ensure technology sovereignty in strategic fields.

- **Enhanced "tech with a purpose" approach**: making full use of R&I efforts centred on the social, environmental and economic challenges of our time, in line with our values, will spur innovative solutions that will ensure that Europe will be on the path of sustainable development. This will allow R&I to drive the transition in key sectors as energy, health, food system and mobility among others. The co-creation approach of transformative R&I policy will also ensure a search and learn process across different pathways, boosting diversity and favouring societal uptake.

2.3.2 Strengthening innovation ecosystems for knowledge circulation and valorisation

Indicator	Latest value	International comparison	Trend	Assessment of trend
Share of product and/or process innovative firms cooperating with universities, government, public or private research institutes[131]	15% (2014)	/	+4.0% per year since 2012	↗
Share of public research financed by the private sector[132]	7.24% (2017)	/	-0.2% per year since 2007 -0.1% per year since 2014	=
Number of public-private co-publications per million population[133]	81.9	Lower than US and JP, higher than CN	+6.4% per year since 2008 +2.4% per year since 2015	↗ but SLOWDOWN
Patent applications under PCT per million inhabitants[134]	109.7	Lower than JP and US, higher than CN	+1.5% per year since 2010	↗

Progress so far

Collaboration between enterprises and with public research-performing organisations enables faster knowledge diffusion and valorisation, and drives innovation. However, patterns show that a few large innovative companies are making the most of international and intersectoral cooperation. Companies can benefit from highly qualified human resources, access to knowledge and technology, and from using research infrastructures. Higher education institutions can gain additional revenue streams from consultancy work, licensing or patenting, and benefit from new skills and insights into the innovation process (Rybnicek and Königsgruber, 2018). The relatively low propensity of academic researchers to cooperate with researchers in non-academic sectors limits knowledge circulation[135] as well as the lack of capacity of SMEs to engage in R&I collaborations. The geographical proximity of academia is paramount for industry's innovative activities – in spite of digitalisation – so the 'physical' interaction between industry and academia remains an important channel of diffusion.

In all EU countries, the number of public private co-publications continues to rise although the EU still lags behind the United States and South Korea. The EU's good standing has to be considered in the context of important differences

[131] EU28. Source: Science-Metrix based on Eurostat.
[132] EU28. Source: Eurostat.
[133] EU. Source: European Commission (2020).
[134] EU. Source: OECD, World Bank and Eurostat.
[135] Only 35% of academic researchers report cooperation with researchers in non-academic sectors (IDEA Consult et al., 2018).

between the Member States: while Denmark, Sweden and Austria feature impressive rates, Eastern and Southern European countries are mainly situated at the bottom of the ranking with Poland, Romania, Bulgaria and Lithuania registering the lowest rates. The Associated Countries are also divided between high rankings, such as Switzerland, Iceland and Norway and very low rankings, such as Albania, North Macedonia and Ukraine. These stark differences may be due to the quality of the science base, the absorptive capacity of the private sector and its R&D intensity.

In some European Member States, as well as globally in catching-up economies, knowledge diffusion and technological transformation are driven by foreign business research investment and foreign direct investment (FDI). The foreign value-added share of gross exports in high-tech and medium-high-tech sectors is still very important in Europe, notably for southern and central eastern European countries. For Slovakia, Hungary and Czechia – with its strong manufacturing base – FDI is still a major source of external R&D financing. With their open economies, both Malta and Luxembourg attract foreign investment in specific tech sectors.

Technological innovation as a result of investment in R&I is reflected to a certain extent in the patenting activities of R&I actors. In 2017, the EU accounted for 20%[136] of patent applications filed under the PCT[137], a decrease from 30% share in 2000. While the share of PCT applications has been growing quickly in East Asian countries, mainly in Japan and China, in Western countries such as United States, European Union and United Kingdom, the share has been declining. In relative terms, however, a different picture emerges. When normalised by population, PCT applications in Japan and South Korea improved remarkably over time. The EU's performance has been rather stable, increasing the gap with Japan, South Korea and United States, but ahead of Canada. Comparing these figures with research production in terms of scientific publications, one however concludes that the EU is not capable of capturing the full value of its excellent science. If the EU wants to remain competitive and catch up with its main competitors, it needs to make extra efforts, especially in reinforcing science-industry interaction and in improving intellectual property management.

Efficient management of intellectual property (IP) fosters not only innovation, creativity and knowledge sharing, it also improves the chances of knowledge reaching the market faster and benefiting society in the EU. Intellectual property protection, management and utilisation are an essential tool to balance the interests of both society and innovators, as well as to strengthen the bargaining position of smaller innovators in cooperation with larger partners. The most common forms of IP used by innovative companies in the EU are trade secrets and trademarks and, to a lesser extent, patents[138]. Applications to the European

[136] European Commission (2020)

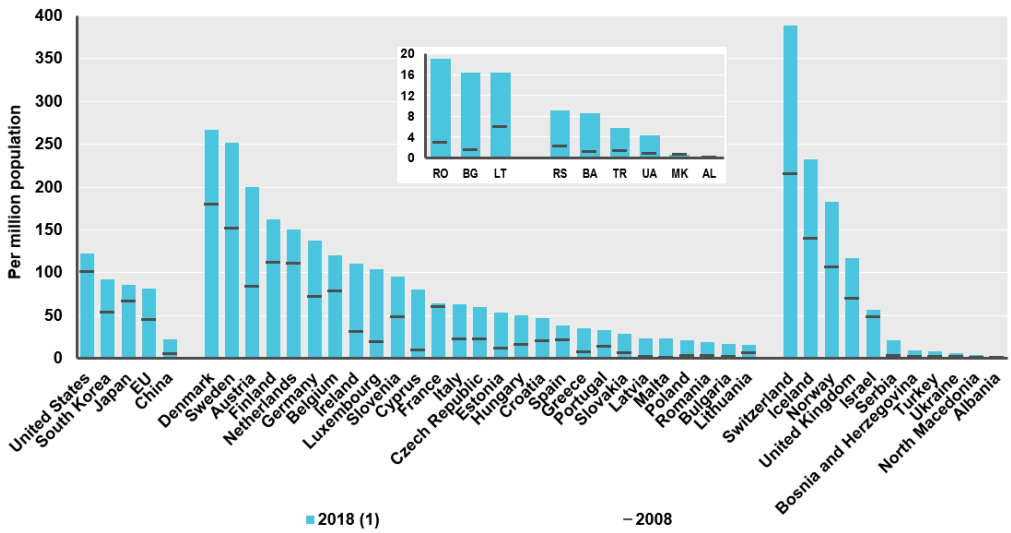
137 Patent Cooperation Treaty

[138] European Commission (2020) based on Eurostat - Community Innovation Survey 2016 (online data code: inn_cis10_ipr)

Patent Office[139]originating from European countries have been predominantly filed by large companies (72%) followed by SMEs (18%) and only 10% came from universities and public research organisations.

A stronger knowledge valorisation policy requires moving towards a more holistic approach in order to create value from knowledge and turn the results into sustainable solutions with economic value and societal benefits. Many strategies, instruments and measures have been developed at the European, national and regional level, by private and public players, to enhance knowledge transfer and valorisation. For instance, the EU Framework Programmes and Member States support collaborations through, for example, collaborative research, public-private partnerships, mobility programmes, knowledge clusters, start-up finance schemes, etc. **Citizen engagement** is also fundamental to take up knowledge based solutions to address societal challenges, while strongly relying on citizens' involvement in this process (societal pull for solutions). This would also contribute to the objective of the new Industrial strategy that place-based innovation and experimentation should be encouraged thereby allowing cities and regions to develop and test new solutions with SMEs and consumers. **Standardisation,** based on robust research results, facilitates the access to and spreading of new products in the market. Standards help building confidence among industries and consumers and reduce production costs thereby facilitating market penetration of innovative solutions.

Figure 20. Public-private co-authored scientific publications per million population, 2008 and 2018



Source: European Commission, DG Research and Innovation, based on Science-Metrix using data from the Scopus database, Eurostat and World Bank data

Note: (1)US, JP, CN, KR: 2017.

[139] European Patent Office Patstat Spring 2019 database

Outstanding challenges

There is still room to improve knowledge transfer and valorisation in Europe. A comprehensive European valorisation strategy is lacking that provides directionality, sets objectives and gives guidance on R&I relationship management to foster valorisation collaborations, including advice on IP management and use. It could build on the achievements of the 2008 Commission Recommendation on the management of intellectual property in knowledge transfer activities, but it would need to take account of the more complex R&I eco-systems with a wider set of stakeholders and actors as well as the new paradigm of dynamic knowledge flows underpinned by Open Science and Open Innovation. Deploying research results in a way that is driven by the needs of citizens and industry requires experimentation and testing new approaches. A structured exchange of experiences and good examples would help to multiplying successful knowledge valorisation practices across the Union and to strengthen valorisation capacities and skills. The fragmentation of policies and practices of IP management in the Member States in combination with the limited expert resources constitute a major bottleneck preventing effective IP management by R&I actors. A change in the approach to IP management linked with an increase in IP literacy is needed, in particular among universities and SMEs.

Encouraging the **creation of innovation-intensive sectors and upgrading the technology profiles** of countries would definitely help Europe to have more innovative enterprises that can boost jobs and economic growth. Given the importance of innovation and technological progress in addressing the SDGs, the ERA countries should not only continue to **invest in scientific leadership in these areas but should also promote a culture of knowledge valorisation** able to benefit fully from its research results.

The complex nature of R&I ecosystems and the broad diversity of their activities at European, national and regional levels, asks for more interlinkages that would **connect their talents, spread best practice, increase their interoperability and encourage higher degree of coordination.** There are multiple challenges to regional innovation systems that can be addressed by policymakers (Box 12).

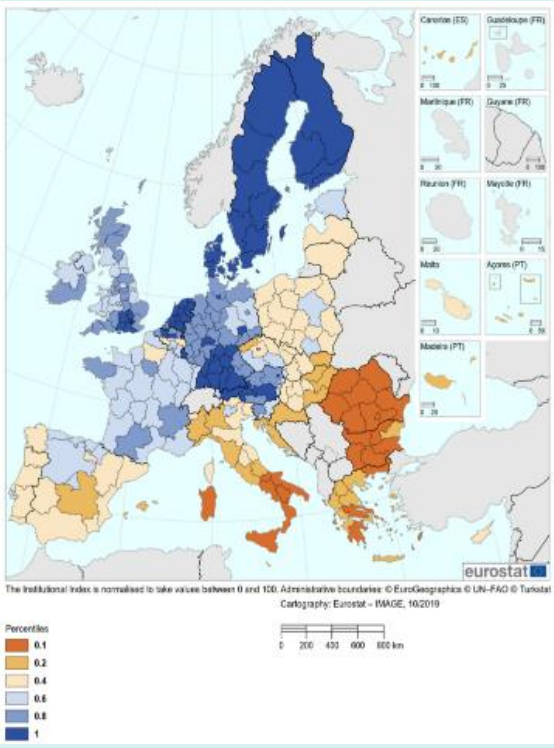
Box 12: Strengthening regional innovation systems

A group of low-performing European regional innovation regions has barely improved and has slowed down the convergence process. The overall dispersion of regions in terms of innovation performance declined between 2011 and 2019[140], but only 45 % of regions within the modest-innovator category improved their performance. The comparison with improved shares of 64 % among the strong-innovator regions and 80 % in the moderate-innovator category shows a larger group of persistently lagging performers among the least developed regions[141]. Moreover, the lagging regions tend to have more small firms, which inhibits integration of new technologies and connections to global value chains. The lack of large firms in these regions may reduce technology transfer and innovation activities in general (European Commission, 2017a).

Figure 212. Institutional quality-Regional disparities(1)

Source: European Social Progress Index, based on Bianchini, Llerena and Martino (2019), https://ec.europa.eu/regional_policy/en/information/maps/social_progress

Note: (1) The indicators refer to 2013 or are built as an average over the period 2011-2013.



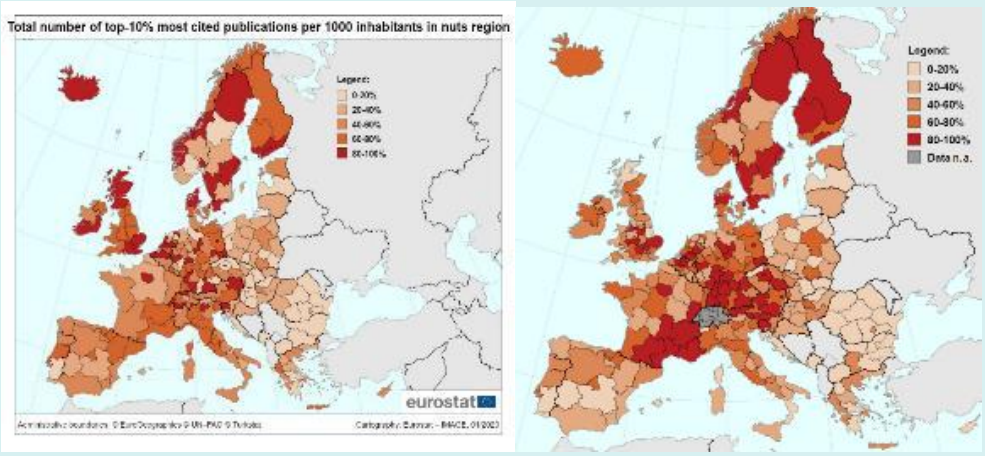
Furthermore, the access of scientists from and in different parts of Europe to high quality resources is not always homogenous. Access to research infrastructures, together with research funding and quality of peers, belong to basic working conditions that can influence scientific productivity of researchers (IDEA consult, 2017). An asymmetric access to resources does not only limit the performance of existing scientific staff, but also decreases attractiveness of a research system leading to a lower mobility of researchers. More broadly, less developed regional economies require sufficient knowledge spillovers that could slow down the trend to concentrate knowledge and highly skilled people in particular areas (Iammarino et al., 2019). **Institutional quality is high in the core of the EU and in capitals, but with a high degree of regional variation and heterogeneity**. Good institutional frameworks improve

[140] The coefficient of variation of the regional scores was 0.314 in 2011 and 0.300 in 2019.
[141] In total, the performance increased in two thirds of the regions (159 out of 238).

economic and innovation prospects as they reduce uncertainty on the appropriability of the returns on investment, which is already higher in the context of R&D and innovative activities. Good institutions are characterised by an effective and generalised protection of property rights, effective control of corruption within a reliable legal framework, and efficient delivery of public goods and services, including education at all levels and the public infrastructure needed for the diffusion and use of technology. At the country level, southern and central-eastern Member States lag behind, with a few exceptions, suggesting that institutional quality undermines countries' performance in several dimensions, including economic and innovation (Rodríguez-Pose and Di Cataldo, 2014). At the regional level, Bianchini, Llerena and Martino (2019) found that **EU regions differ significantly in terms of institutional quality, confirming the overall low performance on europe's periphery while also revealing considerable heterogeneity within countries**, such as, in Italy and Spain.

There is a need to boost underutilised regional potential and strengthen regional innovation systems, which implies an important role for further place-based policies. While measures such as technology transfer in general help to decrease the productivity gap, a gradually increasing role for local innovation is necessary to maintain economic convergence (EIB, 2018). The transfer of skills and knowledge from mature industries often enables the emergence of new industries, but in cases of more radical technological change, the newly emerging industries draw directly from R&D activities (Storper et al., 2015). Therefore, a stronger role for home-grown innovation to increase productivity is a key element of the new growth model for lagging countries and regions.

Figure 13. Share of top-10% most cited publications per 1,000 inhabitants in 2015 (left) and R&D intensity 2017 or latest available (right)



Source: DG Research and Innovation, based on CWTS using data from Web of Science database and Eurostat data

Expected implications under a new ERA

Actions under a new ERA

The commission will:

- Develop and test a networking framework in support of Europe's R&I ecosystems, building on existing capacities, in order to strengthen excellence and maximise the value of knowledge creation, circulation and use by 2022 (Action 6)
- Update and develop guiding principles for knowledge valorisation and a code of practice for the smart use of intellectual property, by the end of 2022, including facilitating the implementation of the unitary patent, to ensure access to effective and affordable intellectual property protection. (Action 7)

Expected implications:

- **Diffusion of knowledge, best practice and tools:** The mobility of human resources can lead to greater diffusion of knowledge, new insights and also tools and instruments for more effective research and knowledge valorisation.

- **More efficient valorisation of science-based solutions in Europe:** A comprehensive European valorisation strategy can engage R&I actors to co-create and implement guiding principles for improving the uptake and deployment of science-based solutions and new technologies in the Union. It can facilitate companies, citizens, cities and communities, especially in catching up regions, to take full advantage of European R&I in meeting their needs.

- **Efficient management and protection of intellectual assets:** Common principles, guidance and best practices can sensitize R&I actors and foster a new culture of efficient IP management in an increasingly competitive global environment. R&I actors should move from a focus on IP protection into active use and valorisation of their IP assets.

- **Reinforcement of the links between standardisation and R&I:** Standardisation should be better recognised as a tool to valorise R&I results to make sure that the European standardisation system is an integral part of the European research and innovation landscape.

- **Increased co-creation with regional R&I actors:** Although the impact of measures will depend on the local context, increased collaboration across regions would have positive impacts on implementation of best practices across all the Member States.

2.4 Deepening the ERA

Box 13. Council and ERAC on deepening the ERA

Council conclusions[142] stress the crucial role of concerted actions and good coordination between ERA and the Framework Programme, including the future Horizon Europe, the development of a labour market for researchers in Europe, and for Open Science policy on improving recognition and reward mechanisms as well as skills development schemes for researchers. They also call on all involved parties to acknowledge the cross-cutting nature of equal opportunities and open science in particular as regards early stage researchers and doctoral candidates. **ERAC**[143] notes the importance of achieving a dynamic and integrated knowledge circle, promoting and enabling collaboration with all relevant third countries to find solutions to global challenges, realising the full potential of a knowledge-driven society, encompassing knowledge co-creation, dissemination and use/exploitation, as well as their interactions, based on effective Open Science and Open Innovation approaches. Improving the circulation of researchers, knowledge and technologies ERAC also stresses[144] the importance of putting a greater focus on promoting and enabling collaboration with all relevant third countries to find solutions to global challenges.

What is it about?

Advances in technology enable science to become both an increasingly open and global enterprise. Technological advances, including, world class research and industrial infrastructures, digital or non-digital technology, strong open science policies and bottom-up activism as well as funders and institutional policies, drive these changes in science practices. Sharing and reusing publicly funded research results openly makes R&I better, more accurate, reliable and efficient, 'democratises' the access to science across countries and widens it to companies and citizens. Open access and trans-disciplinary data reuse and interoperability (FAIR principles) are vital for addressing the interconnected and pressing socio-economic and environmental challenges we are currently facing. While open access policies are progressing rapidly within existing European, national and institutional policies, advances in data sharing still face many obstacles, given the lack of data sharing valorisation (journal impact factors and citations; Scheliga and Friesike, 2014) and research systems that for the greatest part do not incentivize and reward data sharing.

Changing the reward and incentive system for researchers, research and institutions would ensure the higher uptake of open science practices, also

[142] 14989/18 Council Conclusions on the governance of the European Research Area (30 November 2018).
[143] https://era.gv.at/object/document/5133/attach/Opinion_Future_of_ERA_adopted.pdf
[144] ERAC 1201/20 ERAC Opinion on the future of the ERA (23 January 2020).

by involving major stakeholders (i.e. researchers, universities, research and higher education institutions, funding organisations, ministries of science, research and higher education). Research integrity is a foundation of excellent science and the cornerstone of societal trust in researchers and research institutions.

At the same time, despite some progress, women remain underrepresented in science, technology, engineering and mathematics (STEM) fields and research activities, in the creation of innovative startups, at the top management levels of higher education institutions and of the largest publicly-listed companies in the EU. The average EU gender pay gap of 16% also showed only very slow progress over time (European Commission, 2019c).

Box 14. National policy examples related to Open Science

The Netherlands

Since its first Open Access policy in 2013, Open Science, including Open Access, is a top priority of the Dutch government. As response to the 'Amsterdam Call for Action on Open Science' in 2016, the National Plan Open Science (NPOS) was developed in 2017, of which research assessment and rewards for researchers is a focal point.

The Dutch knowledge sector has taken a major step forward in a new approach to recognising and rewarding academics. The focus of the Strategy Evaluation Protocol (SEP) has shifted away from numerical indicators and moved towards the goals and the strategies of the research unit. Criteria include research quality, social relevance and viability with special attention to Open Science, PhD policy and training, academic culture and HR policy. Also, the Protocol for Research Quality Assurance in Higher Professional Education (BKO) for universities of applied sciences contains elements of open science and DANS, in collaboration with DTL, is developing a system for the assessment of research data in accordance with the FAIR principles for research evaluation systems.

At the institutional level, for instance, Utrecht University Medical Center had made Open Science part of their evaluation even earlier, stating that "the unit of assessment promotes open data and reproducibility". It further proposed a number of indicators such as "Availability of data management plans" and "Publication of raw data or availability of data for external use".

Finland

After an initial Research Data Initiative in 2011-2013, the Ministry of Education and Culture of Finland launched the Open Science And Research Initiative (ATT) in 2014. Aim of the initiative was to create a national open access and open science policy as well as building the necessary infrastructure to make Finland a leader for openness in science and research. In the framework of ATT, objectives and indicators have been defined. The progress is monitored in a periodic evaluation of the institutes' openness culture. To highlight best practices, awards are being given to organisations for their activities to promote the culture of openness. The ministry has transferred the coordination of Open Science in Finland to the Federation of

Finnish Learned Societies (TSV). In 2019, a national policy for open access to scholarly publications has been published.

To promote and reward Open Science practices further, a special coefficient for open access publications is added into the funding model of the universities, starting from 2021. As additional incentive, the Ministry of Education and Culture funds infrastructure and services that enable digital preservation, and Open science education and skills are provided in many research institutions.

2.4.1 A European Framework for Research Careers

Progress so far

Still today, assessments and rankings are based on inappropriate indicators rewarding publication in prestigious venues, and favouring quantity of results over quality and priming individualism over open collaboration[145]. Changing the reward and incentive system for researchers, research and institutions would ensure higher uptake also involving major stakeholders. Open access and data sharing, reuse and reproducibility of research results, academia-industry collaboration, societal engagement and impact, and bridging research and advanced data skills and training are often not rewarded. The Commission will incentivize and reward open science practices by including them as elements in the evaluation of project proposals in Horizon Europe. The recent survey of European universities on research assessment, released by the European University Association (EUA)[146] shows the predominance in 2019 of publishing and attracting external research funding for building research careers in universities, over research impact, societal outreach or the practice of open science.

There is now a coherent corpus of recent reports and recommendations[147], with a broad consensus among researchers and policy makers that changes in the evaluation of research and researcher's performance are necessary and that the development of open science is closely linked to the modernisation of the system of recognition and rewards. The San Francisco Declaration on Research Assessment (DORA)[148], signed by several thousands of

145 See for example the conclusions in the H2020 Policy Support Facility Mutual Learning Exercise on Open Science- altmetrics and rewards: https://rio.jrc.ec.europa.eu/policy-support-facility/mle-open-science-altmetrics-and-rewards

146 EUA report "*Research assessment in the transition to Open Science*", 2019, https://eua.eu/downloads/publications/research%20assessment%20in%20the%20transition%20to%20open%20science.pdf

147 2017 Commission report "*Evaluation of research careers fully acknowledging Open Science practices*" https://doi.org/10.2777/75255; 2018 "*Open Science Policy Platform recommendations*" https://doi.org/10.2777/958647; 2019 Commission report "*Indicator frameworks for fostering open knowledge practices in science and scholarship*" https://doi.org/10.2777/445286 2018 LERU report "*Open Science and its role in Universities*" https://www.leru.org/files/LERU-AP24-Open-Science-full-paper.pdf

148 https://sfdora.org

institutions and individuals, calls for stopping the use of JIF in the assessment of research and researchers. The Leiden manifesto for research metrics[149] proposed 10 principles for the measurement of research performance. The "Hong Kong principles for assessing researchers: fostering research integrity"[150], sets principles on how to assess researchers to strengthen research integrity. These declarations and principles have brought global attention to the need of transforming the assessment of research and researchers, but need to be translated into actions. A few institutions in Europe, including some Universities, are now taking steps in this direction[151].

A partnership framework between the Commission and the Member States has been initiated in the past years, **building upon several ERA policy implementation instruments, which have yielded results so far in removing mobility obstacles and creating more attractive research careers.** The main instruments that have been in place include the Charter & Code (Council recommendations, European Charter for Researchers and a Code of Conduct for the Recruitment of Researchers) and its implementation mechanism HRS4R (Human Resources Strategy for Researchers), EURAXESS – Researchers in Motion (pan-European gateway delivering information and support services to professional researchers), RESAVER (the first multi-country multi-employer supplementary occupational pension fund for mobile researchers in Europe), the Marie Skłodowska-Curie Actions (MSCA) which responds to the challenges faced by researchers, offering them attractive working conditions and the opportunity to move beyond academia, and the European Research Council (ERC) which has become a benchmark for research excellence.

Outstanding challenges

Occupations commonly considered as highly skilled, such as researchers, are in need of additional skills in the EU. Low absorptive capacity of firms coupled with rising and unmet skills demands of specialised labour on the labour market constitute the main barriers preventing the spread of complex, close to market innovations. Cedefop forecast of expected job openings in the EU until 2030 projects 45 % of jobs to be created within the highly skilled occupations[152]. Education and skills development policies should encompass broad skill-sets to support competitiveness and innovation, including transversal[153] and digital skills, which are increasingly determining our ability to adapt, progress and succeed in a fast-moving labour market. Higher levels of skills and supply of talents are often associated with

149 http://www.leidenmanifesto.org
150 https://osf.io/m9abx/
151 For example: Dutch public knowledge institutions and funders of research (VSNU, NFU, KNAW, NWO and ZonMw), cf. https://www.scienceguide.nl/wp-content/uploads/2019/11/283.002-Erkennen-en-Waarderen-Position-Paper_EN_web.pdf; Ghent University, cf. https://www.ugent.be/en/research/research-ugent/research-strategy/open-science.htm
152 Defined by ISCO groups 1-3.
153 In general, skills which have been learned in one context or to master a special situation/problem and can be transferred to another context are relevant to jobs and occupations other than those they currently have or have recently had (as broadly defined by Cedefop).

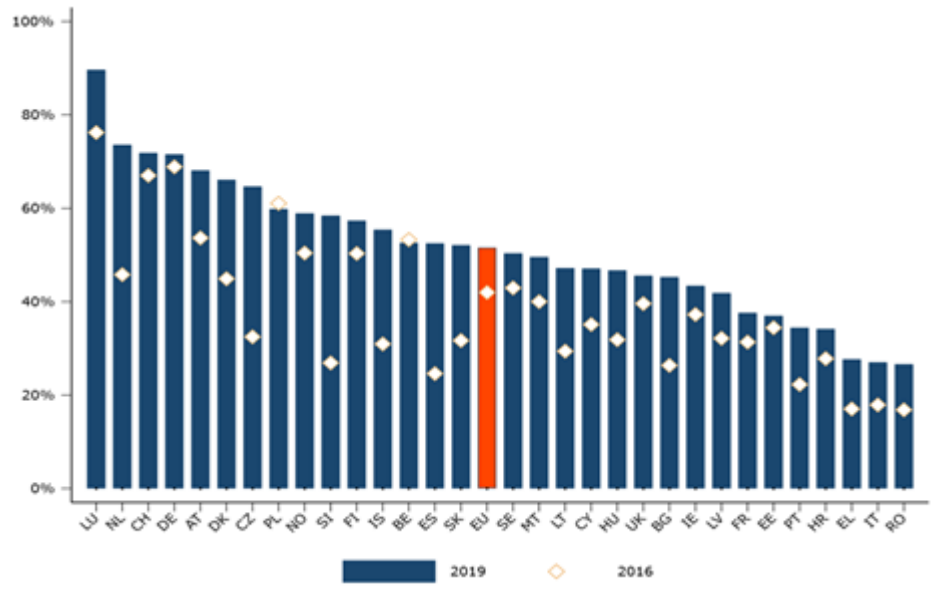
higher education institutions, though centres of vocational excellence also play a role, not least because of their closeness to industry. Therefore, stronger synergies between the European Education Area and the European Research Area are essential to ensure a relevant talent flow in research and innovation careers. An extended toolkit of arrangements and support measures should manage and optimise the talents flow, diversify the careers of researchers, and improve employability in- and outside academia. Moreover, these efforts should include development of transversal skills, including the entrepreneurial thinking among researchers and support of researchers job mobility across Europe and especially also across sectors as academics and early career researchers could benefit from exposure to R&I in the business context. While the engagement of society in the R&I process is increasing, the skills to further boost such proximity could positively influence research career perspectives and improve public recognition of R&I careers.

To achieve and sustain competitive advantage in today's global markets, EU academic organisations must stand out at attracting, developing and retaining talents from all over the world. Finding the right talent is challenging for any organisation in any form of academia as well as in the industry, but when operating in an academic and technical field that requires highly skilled workers, it can be even more difficult. Along with the understanding of the need to have access to a pipeline of talented people, organisations are also aware that they must produce and manage talent as a critical resource to achieve the best possible results. In this context, talent management becomes a strategic driver in the research-researcher-research environment equation. Workforce demographics and skills shortages are likely to make the "war on talent" fiercer than ever before making effective talent management a competitive necessity.

Stark differences continue to exist in terms of the attractiveness of research careers across the EU. An important element of this is researcher's remunerations, where there are not only important divergences between Member States, but also between researchers in the public sector and people with a similar skill set in the private sector. For an effective ERA talent pipeline several obstacles hampering the professional development of researchers need to be solved, in both the attractiveness and the upskilling dimensions. The majority (70%) of researchers in EU28 countries consider themselves well paid or paid a reasonable salary – a slight increase of around 3 percentage points since 2016. However, there was a great heterogeneity between countries with respect to researchers' satisfaction with remuneration. The indicator scores were the highest in Luxembourg, Germany, the Netherlands, Belgium and Austria/Ireland. The indicator scores were the lowest in Greece, Slovakia, Lithuania, Estonia and Poland.

Yet, while remuneration is a major element in the attractiveness of ERA, so too are other socio-economics variables. Against this background, it must be noted that a round 43% of all researchers consider that availability of research funding is better in non-EU countries than in the EU. The share of researchers considering social security and pension plan better in non-EU countries than in the EU was even smaller (29% and 32% respectively).

Figure 22. Individual satisfaction with research funding, by country (MORE3/MORE4)



Source: MORE survey.

There is a set of obstacles hampering the attractiveness of research careers. First, there isn´t a clear legal definition of the research profession itself, which means there is still a lack of transparency and clarity on research career structures, the recognition of the diverse roles talents trained as researcher take up (e.g. knowledge brokers, data stewards, research infrastructure operators, talent managers, etc). Second, the situation of precariousness of the employment situation of researchers (notably postdoctoral researchers in academia who are often faced with consecutive temporary contracts) has not been duly addressed. Third, the remuneration packages for researchers remain heterogeneous across the EU, namely salaries, social security systems and pension. Fourth, the attractiveness of research careers is also hampered by the narrow focus of current researcher career assessment systems, as flexible career paths in terms of interdisciplinary, intersectoral, and international mobility are insufficiently enabled or rewarded. Although interdisciplinarity may be well suited to addressing complex ethical and societal challenges while fostering academic excellence and innovation, the development of policies pursuing interdisciplinary careers is hampered by the absence of a clear-cut definition and promotion of greater awareness of interdisciplinarity and its benefits.

In addition, **the absence of open access to job opportunities is a disincentive to starting or remaining in a research career in Europe**. Recruitment is characterised by many national and institutional-level specificities. Institutional and cultural barriers remain in a number of countries and institutions, sometimes in

sharp contrast to the perceptions of researchers regarding fair, equal treatment and opportunities for the benefit of all. More progress is needed to set conditions for **open, transparent and merit-based recruitment** (i.e. advertising research positions more widely and in English on EURAXESS or other international or national online job boards), also to set clear procedures on the composition of selection panels, transparent selection criteria, as well as having in place feedback and complaint mechanism offered to applicants.

Indeed, the European Charter and Code for Researchers and its *HR excellence in research award* have been an effective tool in strengthening the commitment of research organisations towards human resources as well as improving the researcher-employer relationship, with more than 500 research institutions and universities having obtained the award since 2010. However, **more efforts are needed to ensure common standards for researchers working conditions and to render researchers' careers attractive and sustainable across all EU.** A more ambitious and visible Charter and Code for researchers with a flexible and solid implementation mechanism suitable for all research performing and funding institutions becomes paramount.

There is a limited awareness of benefits stemming from intersectoral mobility in the industry and variety of approaches in promotion of mobility among Member States. A recent assessment of existing provision of **EU schemes promoting intersectoral mobility**[154] **assessed both, supply and demand side of mobility. On the demand side,** countries with long-established industry-academia cooperation show strong demand for PhD and post-doctoral researchers, in particular in STEM fields. Such demand is particularly strong in areas with shortages of specialist skills, especially programming and cryptography within the ICT domain. The demand can also vary by the size of businesses, with larger firms being more aware of benefits that recruitment of researchers bring. Although not fully realising the potential of such recruitments and perceiving research skills as 'too theoretical', the general attitudes of these businesses seem to be changing. **Research on the supply side** showed a variety of intersectoral mobility schemes across the European countries.

Furthermore, there are also expectations on shifting role of the employer as family, well-being, mental health, and work-life balance interplay with professional matters. Examined patterns of mobility have also revealed that the so-called "soft-factors" such as the **relocation experience** can influence the decision-making and researcher's willingness to relocate (IDEA consult et al., 2017). These become rather strategic factors in institutional and human resources strategies to attract the right people in a competitive environment, where family life

[154] Study on Fostering Industrial Talents in Research at European Level (CSES, 2019). It covered the Marie Skłodowska-Curie Innovative Training Networks (MSCA ITN), the SME Associate Pilot, and the European Institute of Innovation & Technology (EIT)'s Knowledge and Innovation Communities (KICs), which offer Masters and Doctoral courses and the European Structural & Investment Funds (ESIF) to facilitate researcher mobility

also matters. Family status plays a role in PhD mobility, whose international mobility reaches 26% when having children, compared to 38% for researchers without children. The barriers to mobility perceived by non-mobile PhD researchers have not change over time and are comparable to the post-PhD mobility barriers.[155] Family can determine the mobility readiness and influence other factors, such as culture or international networking. Given that many researchers return to their countries due to lack of opportunities for the accompanying partner, **integration services for researchers and their families, as well as dual career and spouse career orientation and guidance** become an investment into the R&I system and a key enabler of brain and knowledge circulation. The EURAXESS network of support services improved the relocation experience of internationally mobile researchers through assistance with issues such as accommodation, visa and work permits, or recognition of diplomas. The network deals with about 450.000 mobility cases per year and leveraging its existing capacities to better address the physical and social integration of researchers could provide a transformation and scale-up mechanism ensuring inclusive, healthy and attractive work environment for research in ERA.

These changing researchers' expectations go hand in hand with a growing interest among universities and publicly-funded research institutes in using intersectoral mobility as a mechanism to strengthen cooperation with industry and with individual companies. There is an increased pressure on researchers at all levels to open their horizons to a non-academic career. There is also evidence of growing awareness and increasing demand, particularly among larger firms and SME's as to the benefits of taking part in mainly one-direction intersectoral mobility, to be able to identify the brightest industrial research talents, where only very few return to academia at a later stage in their career.

Expected implications under a new ERA

Action under a new ERA

The Commission will:

- Deliver, by the end of 2024, in partnership with Member States and research organisations, a toolbox of support for researchers' careers with the following components: (i) a Researchers Competence Framework, (ii) a mobility scheme to support exchange between industry and academia, (iii) targeted training under Horizon Europe and (iv) a one-stop shop portal. The toolbox will lead to the creation of a pipeline for talent. (Action 8)

[155] Emphasis is on personal or family related reasons (58%), the ability to obtain funding for mobility (44%) or for research (43%) and finding a suitable position (42%) rank among the top barriers.

Expected implications:

- **Acceleration of the achievement of a knowledge-based society and economy:** An enhanced framework for researchers' careers within the EU will contribute to a pipeline of highly skilled, creative, and resilient talents.

- **Updated frameworks for how researchers are rewarded, and broadening researchers´ skill sets:** The toolbox will allow to better connect high-quality scientific knowledge production, open access and data sharing, open collaborative work, societal concerns and engagement and impact to boost the recognition of 'open scholarship'. This will lead to an academic reward system that prioritises quality, openness, creativity, collaboration also with non-academic sectors, sustainability and reusability over quantity.

- **More equal treatment in recruitment, working conditions, promotion, pay, access to vocational training, occupational pensions and dismissal:** These actions will have as their ultimate objective to incentivise Member States to put in place competitive remuneration packages for their public researchers.

- **Increased circulation and mobility of R&I human resources worldwide and reinforced international partnerships for the training of researchers:** With new arrangements and global partnerships and efforts it is expected that the mobility of researchers worldwide will increase, as well as knowledge diffusion. This would also build upon the very strong international dimension of MSCA to ensure mobility flows of researchers are based on mutual interests, and reciprocity when relevant, and to have institutional impact, notably for inter-sectoral collaboration or the development of international doctoral programmes.

2.4.2 Open Science

Indicator	Latest value	International comparison	Trend	Assessment of trend
Share of publications available in Open Access[156]	46.1% (2017)	Lower than US and JP, higher than CN and KR	+2.6% per year since 2000 +0.4% per year since 2010	↗

[156] EU. Sources: Science-Metrix based on Web of Science and 1findr.

Progress so far

All areas of research are becoming data-intensive, increasingly relying upon and generating big data. Digitalisation has the potential to promote collaboration as well as improve the efficiency of scientific research (OECD, 2019a). The most noted potential, which applies across all disciplines, concerns exploiting data and machine-learning techniques in the research process (OECD, 2019b). Avenues to **promote the digitalisation of scientific research** include boosting researchers' digital skills and ethical awareness, promoting open science, ensuring appropriate investments in digital infrastructures for research (e.g. platforms for sharing data and supercomputing facilities for AI), and creating incentives for interdisciplinary research.

The European Commission has co-designed and co-implemented an ambitious and holistic open science policy, as an integral part of EU policy. Open science is emerging globally as the new modus operandi for R&I, as researchers share and use knowledge and data early in the process, in collaboration with all relevant knowledge actors. The Commission, a global leader in open science, has been supporting open access to research outputs, including full and immediate open access to scientific publications (as of Horizon Europe) and, where possible, open access to research data, a Web of FAIR (Findable, Accessible, Interoperable and Reusable) research data, and a closer collaboration between science and society. By mobilising collective intelligence, including citizens and end-users, and empowering interdisciplinary research, open science also increases creativity, leads to more relevant and responsive research, and reinforces trust in the science system.

The revised 'Recommendation on access to and preservation of scientific information' (2018) provides guidelines on how publicly funded research should be made openly available. The 'EU Copyright Directive' (2019) establishes rules regarding Text and Data Mining that allow research organisations and cultural heritage institutions to dig deeper into the existing knowledge base with greater legal certainty. The 'Open data Directive' (2019) helps increase the amount of public sector data available for re-use in Europe, and now includes research data under its scope. The open access policy for Horizon Europe will maintain some of the Horizon 2020 core elements such as the obligation of all beneficiaries to deposit in trusted repositories and make their peer-reviewed scientific publications available in open access. Beyond this, it will mainstream research data management and the proliferation of FAIR data by making Data Management Plans mandatory for all projects producing data with no exception. It will also require open access to research data through trusted repositories under the principle 'as open as possible, as closed as necessary'.

The programme will present a comprehensive approach to open science, also focusing on incentivising open science practices by considering them in the evaluation of proposals, such as for example the early open sharing of research and the engagement with local communities and society at large. Engaging and involving citizens and civil society in co-designing R&I agendas and co-

creating R&I content will be an integral part of Horizon Europe implementation. The EU has made significant investments to build up competences, capacities, networks of practice and knowledge on how to successfully engage quadruple helix actors, including citizens and civil society, in R&I. In parallel, the EU continues to incentivise citizen engagement in R&I, including in preparations for Horizon Europe Missions, Partnerships and Clusters.

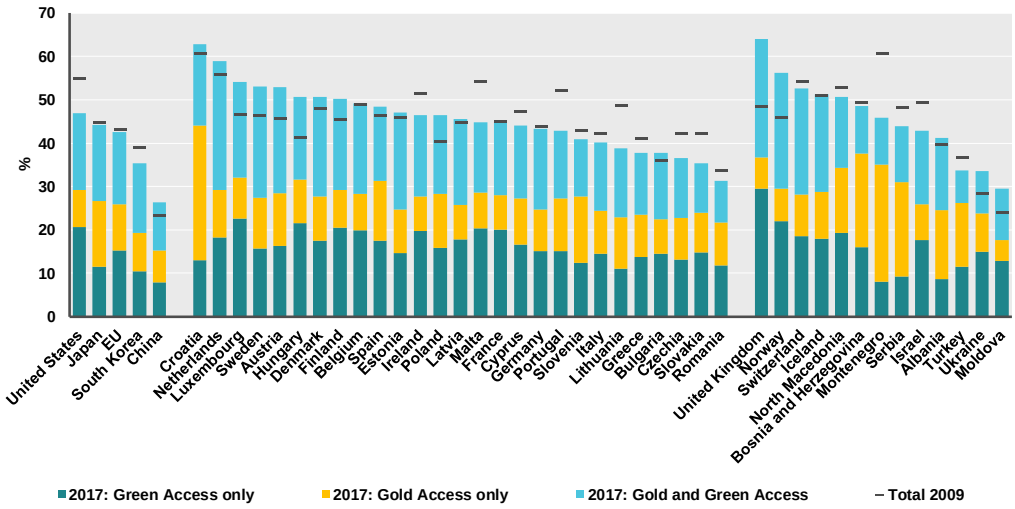
The EU has made significant investments to build up competences, capacities, networks of practice and knowledge on how to successfully engage quadruple helix actors, including citizens and civil society, in R&I. The open access policy for Horizon Europe will maintain some of Horizon 2020 core elements such as the obligation of all beneficiaries to deposit and make their peer-reviewed scientific publications available in open access, but will also request that a beneficiary deposits its research data in a trusted repository and makes them openly available, in line with the principle 'as open as possible, as closed as necessary', under the FAIR principles. The programme will also incentivise open science practices such as engagement with local communities and society at large.

The European Open Science Cloud (EOSC), as a common, federated, European framework for sharing research data, plays a central role to accelerating the production, circulation and uptake of knowledge by enabling a European data commons and by providing seamless access to existing capacities to store, access, combine, analyse and process research data and preserve them in the long term. The European Commission enhanced the contribution of European R&I infrastructures to the development of the European Open Science Cloud, in particular fostering the development and connectivity of data resources and services of a distributed nature. These European data services form an ecosystem aimed at enabling open access of researchers to data across borders and science fields. The effective and sustainable long term operation of these European data facilities is crucial for the realisation of the EOSC.

At national level, policies for open access to scientific publications have progressed rapidly over the last decade and the majority of ERA countries have now adopted strategies and also some legal measures. However, even in countries that have adopted legislation, enforcement varies greatly. Regarding open access to research data, progress has been much slower across ERA, and there is a great diversity of approaches across countries and disciplines. The progress both in open access and in data production and its availability is increasing quality and speeding up the research process, addressing also issues of reproducibility (e.g. Ioannidis and Khoury, 2011) and increasing the efficiency of public investment in research. Recent evidence has found that – as a direct result of directional policies by research funders – open science activities have structuring effects on both scientific outputs and knowledge flows, as well as on institutional research structures and practices, increasing research performance and economic performance (Tennant et al., 2016; Fell, 2019).

The EU is also cooperating globally (for example with OECD, the G7, and bilaterally with many countries amongst which the US, China, India) to accelerate the transition to full and immediate open access to scientific publications, to ensure that FAIR and open data becomes the standard, and to drive policy agendas for rewards and incentives, open science skills, opening science to society, and reducing inequalities in opportunities for practicing open science.

Figure 23. Open access scientific publications with digital object identifier (DOI) as % of total scientific publications with DOI, 2009 and 2017



Source: DG Research and Innovation, European Commission.
Note: Data produced by Science-Metrix using data from Scopus and 1findr databases. The full counting method was used.

Outstanding challenges

A pandemic such as COVID-19 has shown the importance of rapid collection and comprehensive sharing of research data and other research output, including not only the development of effective diagnostics, treatments and vaccines and the monitoring and tracking of the spread of the virus, but also in gaining a more comprehensive understanding of its characteristics, such as the symptoms, the demographics of those most-at risk, the pre-existing medical conditions that magnify the negative health impacts from those infected, etc. Importantly, it has also led to additional efforts to allocate, coordinate, and align research funding at the global level towards research for a vaccine and relevant medicines. The same holds true in the fight against climate change (e.g. Mission Innovation), and in finding ways to tackle rising inequalities worldwide, together. This hints at the **importance of research data sharing, and open access to research outputs to speed up the process of scientific discovery** as well as improve research quality, productivity and reproducibility while taking ethics and privacy into account.

Expected implications under a new ERA

Action under a new ERA

The Commission will:

- Launch, via the Horizon Europe Programme, a platform of peer-reviewed open access publishing; analyse authors' rights to enable sharing of publicly funded peer-reviewed articles without restriction; ensure a European Open Science Cloud that is offering findable, accessible, interoperable and reusable research data and services (Web of FAIR); and incentivise open science practices by improving the research assessment system. (Action 9)

Expected implications:

- **Increased excellence and social relevance of research:** encompassing the dimensions of openness, ethics, education and training can elevate both the quality of research activities and their purposefulness.

- **More efficient process and faster scientific results and advances:** sharing data in a privacy-friendly manner (as open as possible, as closed as necessary) and providing open access to research outputs will allow for faster and higher quality scientific breakthroughs, which are essential especially in the current times of a global pandemic.

- **High-quality, reusable and reproducible research:** sharing data, publications and other research contributions and outputs will ultimately make research more robust and reliable, as it can be also checked or built upon by others.

2.4.3 Research and technology infrastructures

Indicator	2018	Trend	Assessment of trend
Share of developing ESFRI Projects and operational ESFRI Landmarks in which a Member State/Associate Country is a partner[157]	35%	+15% since 2016	↗

Progress so far

Research infrastructures (RI)[158] are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. "They include: major scientific equipment (or sets of

[157] EU28. Source : ESFRI.
[158] https://www.esfri.eu/

instruments), knowledge-based resources such as collections, archives and scientific data, e-infrastructures, such as data and computing systems and communication networks and any other tools that are essential to achieve excellence in research and innovation."[159] Research infrastructures contribute to key scientific and technology discoveries and can often have a considerable impact in the broader economic and societal context, including, for example, industrial development, environmental protection, improved health and preservation of our cultural heritage. They are a key element providing a framework in which scientists and engineers can carry out their work in the facilities which best meet their needs, irrespective of where they are in Europe. Understanding these impacts, and the capability of research infrastructures to achieve them, is necessary for the public authorities to make informed investment decisions aligned with broader political goals.

To support their use, the Framework Programme contributes to funding the transnational access of researchers to national facilities. Up to now, the EU research infrastructure action covered under Horizon 2020 the costs of transnational access of nearly 15.000 researchers visiting a research infrastructure not located in their country. In the move towards developing a clear ERA policy for access to research infrastructures, the European Commission developed, in close cooperation with a broad range of stakeholders, a European Charter for Access to Research Infrastructures[160].

The **European Strategy Forum on Research Infrastructures**, ESFRI, has a key role in policy-making on research infrastructures in Europe. It contributes to the development of a strategic roadmap that identifies vital new European RIs for the next 10-20 years. So far, there are five editions of the ESFRI Roadmaps (2006, 2008, 2010, 2016 and 2018). They resulted in the development of 55 European Research Infrastructures, of which 37 have already been implemented, across all fields of science, mobilising close to €20 billion in investments[161]. Moreover, ESFRI has had an important impact on fostering a strategic approach to Research Infrastructures at national level[162], as 22 Member States have prepared national roadmaps in recent years, many of them following the ESFRI methodology and in increasing alignment with European priorities.

Technology Infrastructures (TI) are facilities, equipment, capabilities and support services required to develop, test and upscale technology to advance from validation in a laboratory up to higher Technology Readiness Levels prior to competitive market entry. They can have public, semi-public or private status. Their users are mainly industrial players, including SMEs, which seek support to develop and integrate innovative technologies towards commercialisation

[159] Article 2 (6) of the Regulation (EU) No 1291/2013 of 11 December 2013: `Establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014- 2020)`

[160] European Commission, Directorate-General for Research and Innovation, Unit B4-Research Infrastructures, European Charter for Access to Research Infrastructures, 2016.

[161] See http://roadmap2018.esfri.eu/.

[162] See ERA Progress Report 2018, p. 7.

of new products, processes and services, whilst ensuring feasibility and regulatory compliance. TIs can be understood as a broad concept currently encountered under many activities in various sectors across different EU programmes, e.g. pilot lines, testing facilities, digital innovation hubs, open innovation testbeds, KETs centres, demonstration sites or living labs. Some Research Infrastructures also provide services similar to certain technology infrastructures.

Outstanding challenges

Regarding Research infrastructures, the European Strategy Forum on Research Infrastructures, in its White Paper 'Making Science Happen',[163] called for a fully consolidated European ecosystem of Research Infrastructures enabling Europe to pursue the greatest of scientific challenges and generating the new knowledge necessary to address the most pressing of global societal challenges and improving the everyday life of European citizens. Achieving this vision requires a strengthened interplay between research, innovation and education, underpinned by greater coherence between European, national and regional priorities and policies for Research Infrastructure development and funding, and effective synergies with other European policies and funding instruments.

In particular, there is a need to closely link and coordinate the research and technology infrastructures with Cohesion policy support. Some less developed Member States in terms of GDP have significant resources allocated from Cohesion policy to this end but their capacity to manage complex R&I projects, particularly with private sector, needs to be reinforced.

There is an urgent need for aligning the European investment priorities in R&I infrastructures with key international partners to support cutting edge science and address global challenges. Cutting-edge science in many fields requires increasingly complex instrumentation in order to push beyond the boundaries of current knowledge. This is particularly true in the fields of particle physics and astrophysics, where the development of future instrumentation is likely to be beyond the financial and human resources available to single countries or regions. Equally, cooperation between existing infrastructures across the world, particularly concerning health and environmental science, is necessary to combat global phenomena such as climate change and pandemic health risks, which will only increase in future. Progress in this direction requires coordination among governments and funders, strengthening the capacity of existing bodies at European (ESFRI) and international (The Group of Senior Officials of G7) level.

There is also a need to build upon the European Charter for Access to Research Infrastructures, to ensure harmonised transnational access conditions across ERA and policy for the use of R&I infrastructures across regions

163 'Making Science Happen – a New Ambition for Research Infrastructures in the European Research Area', European Strategy Forum on Research Infrastructures, April 2020, see www.esfri.eu

and countries. However, the access of scientists from and in different parts of Europe to high quality resources is not always homogenous, as highlighted in the ERA Progress Report 2018, with different rules between countries and between infrastructures themselves. This continues to hamper access to resources, limiting Europe's capacity to respond quickly to emerging scientific needs and to develop the skills of researchers, limiting the translation of discoveries into innovative solutions and in general limits Europe's capacity to respond quickly to emerging scientific needs.

At present, the **methodologies for monitoring the performance and impact used by research infrastructures** and their funders are still fragmented and underdeveloped, with ad hoc assessments, based on limited data. They are also usually analysed separately, while they are closely interlinked and there are significant overlaps between the indicators used. It is important that performance assessment and impact assessment are brought together under a single framework, for which implementation modalities have to be agreed with public authorities and the research infrastructures which will use it.

The Commission Staff Working Document on **Technology Infrastructures** (SWD (2019) 158) has identified four main challenges for technology infrastructures and their role in the creation of agile innovation ecosystems. These challenges are priority setting mechanisms needed to help aligning public and private investments in the creation and connection of technology infrastructures, networking of existing and new technology infrastructures, their visibility to potential users, and the transparency of access conditions.

Expected implications under a new ERA

Action under a new ERA

The Commission will, together with the Member States:

- Support ESFRI to work towards a world-class research infrastructures ecosystem focusing on the broader range of the EU's policy priorities and improve its governance to address the broadened focus of its activity by the end of 2021, and establish a new governance structure for Technology Infrastructures. (Action 10)

Expected implications:

- **Quicker development and testing opportunities for new innovations:** Improvements in the governance structure of research and technology infrastructures will make it ultimately easier for new solutions to be tested and ready to enter the market.

- **Greater alignment of the infrastructures to support EU´s policy priorities:** This will support cutting-edge science to tackle social, environmental and health challenges with a global dimension.

2.4.4 Strengthening the public science system through synergies with the European Education Area

Indicator	Latest value	Trend	Assessment of trend
Research excellence, EU[164]	38.1 (2018)	+2.3% over 2013-2018 +1.5% over 2016-2018	but SLOWDOWN

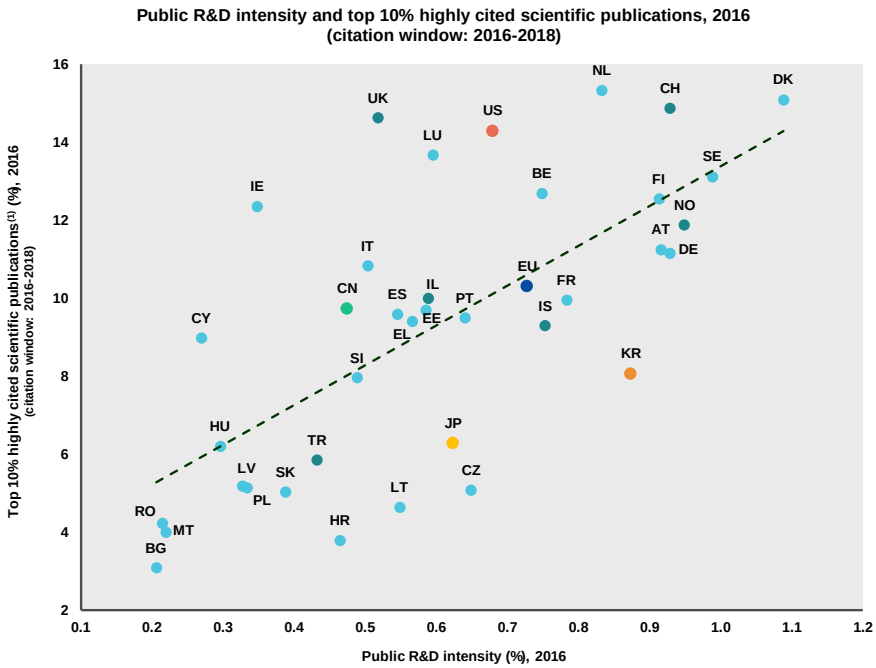
Progress so far

The EU and China are global leaders in terms of scientific output, while the United States retains the lead in scientific quality. With less than 7% of the world population, the EU is responsible for 20% of global R&D expenditure and 21% of scientific publications worldwide. The United States maintains its global leadership in terms of highly-cited scientific publications. Europe remains in second place, while China continues its sharp rise**.** Although Europe has made **some progress in raising the quality of its science, differences across European countries persist**. Research excellence in the ERA has improved over 2010-2016, even though it has slowdown more recently. Switzerland leads, followed by western European countries, which have been improving their scientific performance since 2000. A decline in scientific output has been noted for Iceland, Israel, Malta and Turkey since 2007.

Moreover, a **positive correlation between R&D intensity and scientific quality** is evident in most countries. The Netherlands, Switzerland, Denmark, Sweden, Belgium, Finland, Austria, Norway and Germany enjoy higher levels of public investment in R&D than the EU average, as well as better scientific results. All Mediterranean (except Italy), Central and Eastern European countries show below-EU-average R&D investment levels matched with below EU-average levels of scientific excellence. In the European Semester cycle of 2019, a number of countries received a country-specific recommendation (CSR) to promote the quality and efficiency of their national R&I systems.

[164] EU27. Source: European Commission, DG Joint Research Centre.

Figure 24. Scientific quality and R&D investments



Source: Eurostat (online data code: rd_e_gerdtot), OECD and Science-Metrix using data from the Scopus database

Europe has a strong knowledge community composed of highly competitive, entrepreneurial universities and other higher education institutions, increasingly networked with businesses and society. Universities exist to serve society and are integrators of society: they create as well as transmit talents and knowledge (educate and innovate). Delivering flexible, critical-thinking, decision-making, concerned and engaged citizens is a crucial task of universities; talented people are essential for the future economy and society.

Universities are key actors (and increasingly so) well-integrated in local ecosystems serving economy and society, co-creating knowledge and uptake of new knowledge and know-how in cooperation with research organisations, business, citizens and government, fostering collaboration with a wide range of actors starting from scientific expertise. This community of universities has the potential to become even more structured around Sustainable Development Goals (SDGs) and Missions, across languages, borders, disciplines and sectors. It would be pushing the barriers of curiosity-driven as well as utility-driven research, mobilising innovation ecosystems surrounding universities (including cultural, social, technological, and economical innovations), supporting the emergence of innovative initiatives and enterprises, and empowering engaged and active citizens to transform the way we live and work.

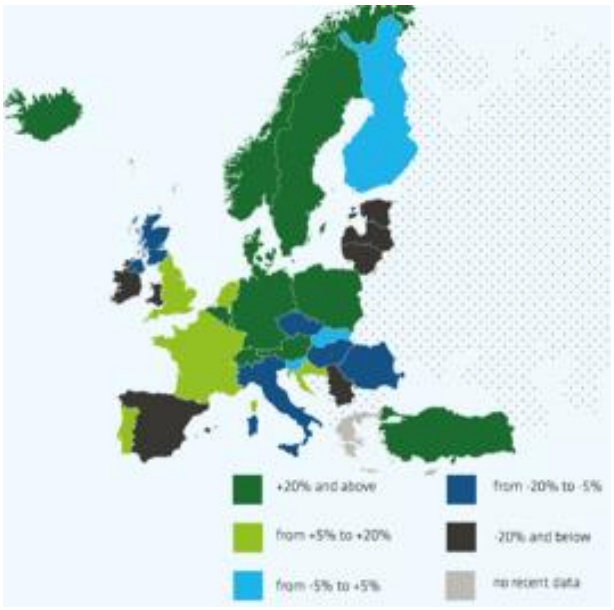
The EU has around 5000 higher education institutions[165], of which an estimated 800-1000 are **operating (or aim to operate) in the middle of the knowledge triangle:** education – research – service to society, incl. innovation. This part of university sector currently is amongst the most dynamic sectors in society, and likely entails EU's most important target enabling effective realisation of ERA. The question is how to step up the game, including introducing more systematic support for universities. At the same time, it should be acknowledged that the autonomy of universities is an essential feature for ERA and for Europe's society; similarly, the diversity of the university landscape in Europe likely remains one of ERA's strengths.

The rapidly changing environment – including decreasing trust in science and scientists – questions what kind of university EU needs, and for what kind of society. The idea of a university remains strongly value-driven, though: social engagement, the role of universities in beating inequalities, in fighting climate change, in diseases, in democratic and anti-populism are crucial.

Several systems visibly consolidated their investment effort in the long run in terms of public funding to universities. Iceland now reached the top category (over 20% investment). Others recorded further consolidation (Belgium-Flanders, Luxembourg, Poland and Sweden) or made significant improvements (Croatia, Slovenia). Several systems reduced the funding gap accumulated since 2008 (Czechia, Hungary, Ireland, Lithuania and Romania). The average annual funding change in real terms significantly differed across 33 systems in 2008-2018. Luxembourg is on top of the sample with a nearly 10% average annual increase, whereas Wales is subject to a negative trend of the same magnitude. In total, 14 systems have negative average annual values and 19 systems have positive values. In 10 systems, the average annual funding change remained flat (between -1% and +1%).

[165] Source: EACEA, https://ec.europa.eu/programmes/erasmus-plus/resources/documents/applicants/higher-education-charter_en

Figure 25. Evolution of public funding to universities, 2008-2018



Source: EUA Public Funding Observatory, February 2020, https://eua.eu/101-projects/586-public-funding-observatory.html
Note: Map in the study does not show the border with Kosovo.

Norway and Sweden have been following a positive funding trajectory that helped this group of countries preserve their student/staff ratios. Portugal has gradually re-invested in the higher education sector since 2013, although the additional funds were largely used to cover for rising staff costs including social contributions. The second group of systems are subject to higher pressure due to rising student numbers. Italy and Spain, as well as several Central and Eastern European countries, experience negative patterns both in terms of student enrolment and public funding. Poland is an exception to this trend, as it continues to invest in public universities to respond to brain drain and reducing student cohorts. Slovenia has been reinvesting for three years against a negative demographic background. Ireland, Romania and Serbia have cut funds over the monitored period, while facing growing student populations.

Figure 26. Long-term financial and demographic pressures

Category	Description	Systems
Funding ↑ > Students ↑	Funding increase higher than student numbers growth	IS, NO, PT, SE
Funding ↑ < Students ↑	Funding increase lower than student numbers growth	AT, BE-nl, DE, DK, FR, HR, NL, TR, UK-en
Funding ↑ / Students ↓	Funding increase despite student decline	PL, SI
Funding ↓ / Students ↑	Disinvestment despite student growth	IE, RO, RS
Funding ↓ < Students ↓	Funding decline lower than student numbers decline	HU, LT, SK
Funding ↓ > Students ↓	Funding decline higher than student numbers decline	CZ, ES, IT

How to read this graph:
This table captures different trends in public funding and student enrolment for 24 systems with complete datasets for the period 2008-2018. The following systems are not included in the analysis because of the incomplete datasets: BE-fr, CH, EE, FI, LU, LV, UK-ni, UK-sc, UK-wa.

Source: EUA Public Funding Observatory, February 2020, https://eua.eu/101-projects/586-public-funding-observatory.html

Outstanding challenges

To capitalise on the potential of the rich and diverse higher education institutions landscape in Europe, universities will need **support for the various institutional changes and transformations** they are deploying. The aim of a comprehensive institutional transformation narrative in a revitalised European Research Area would be to strengthen universities in the entire European Union by: leveraging research excellence in universities in less competitive research systems; supporting transformation of universities and surrounding ecosystems; raising the international profile of European universities.

The relationship between research and education, including at EU level, is probably the most complex nexus when aiming at modernising the university sector, also because of the different competencies of the political actors involved. **ERA is expected to underpin the R&I dimension of universities through a transformation agenda together with the European Education Area**, enabling shared objectives between the EU and Member States initiatives to transform higher education institutions on their education, research, innovation and service to society missions. This transformation is currently piloted under the Erasmus+ European Universities initiative, complemented by Horizon 2020 with a view to deploying a large-scale testbed to deepen the research and innovation dimension.

Whilst there is a consensus that pursuing research excellence is a continuing priority, the degree to which competition, as opposed to cooperation, should be pursued, is a topic of debate among universities across Europe and university umbrella organisations. Among universities in many European countries, there is less stress on competition and more on pursuing cooperation, which is valued highly, with strong opportunities for cooperation throughout the EU programmes and the common structures of the European Higher Education Area (EHEA). In a recent consultation, the university sector advocates creating an enabling legal framework for (trans)national cooperation between universities in Europe.

For the R&I dimension, ERA has an important strategic role to play as an enabler in allowing Europe's universities to flourish[166], solving various **outstanding challenges** such as: removing national and regional regulatory barriers to the circulation of talents and knowledge; defending academic freedom and the freedom of the individual researcher within the EU and internationally; creating the legal mechanisms for universities to cooperate on research agendas on a cross-border and intersectoral basis; promoting the sharing of access to universities' research infrastructures; promoting greater uptake of digitalisation by universities, empowering the further transition to knowledge- and digitally-driven universities embracing open science; strengthening attractiveness of researchers' careers, towards a pipeline of talents crucial for an effective ERA; facilitating co-operation with surrounding ecosystem actors for the transmission of knowledge and talents; foster efforts in creating proximity to citizens for societal challenges, such as the SDGs; and providing support to universities to enable them to strengthen digital and entrepreneurial skills among academics and researchers.

Expected implications under a new ERA

Action under a new ERA

The Commission will, together with the Member States through the EEA and ERAC steering bodies:

- Develop a roadmap of actions for creating synergies between higher education and research, notably building on the dual role of universities. (Action 11)

Expected implications:

- **Greater support for the transformation efforts of the university sector:** the development of a transformation agenda, empowering universities towards for instance developing shared R&I strategies to create directional and interdisciplinary critical mass to more effectively create

166 Consultation "Towards a 2030 Vision on the Future of Universities in Europe" (report of the analysis by CSES, forthcoming)

impact for society, facilitate sharing capacity and resources, strengthening researchers' careers and developing an effective talent pipeline, and a revamped transition to knowledge- and digitally-driven universities embracing open science, also with closer proximity to citizens.

- **More facilitated cooperation between universities and with other socio-economic actors**: universities will benefit from the further strengthening of core ERA values and principles such as academic freedom and free circulation of researchers. A longer-term cooperation framework for transnational cooperation between universities and their surrounding innovation ecosystems in Europe covering all their missions will also prove beneficial.

- **Enhanced ambition featured in the investment agenda for universities**: a clear roadmap on EU actions with strategic public and private partners and key actors together with a set of recommendations will tackle short, medium, and long-term needs through targeted spending.

2.4.5 Gender equality to strengthen the European R&I potential

Indicator	Latest value	Trend	Assessment of trend
Share of women as heads of institutions in the Higher Education Sector[167]	21.5% (2017)	+2.1% per year (2014-2017)	↗
Share of female PhD graduates[168]	48% (2017)	+0.2% per year (2013-2017)	=
Gender dimension in research content[169]	1.05 (2017)	+0.3% (2007-2010 to 2014-2017) +2.5% (2011-2014 to 2014-2017)	↗

Progress so far

The European Union has been slowly progressing towards gender equality and has still room for improvement as shown by the Gender Equality Index score reaching 67 out of 100 points in 2019 (EIGE, 2020). This applies to European research, but also to an increasingly digitally-driven economy or the emerging sectors of economic activity. Gender mainstreaming has the potential to build more equal and value-based environment, where adolescents' career plans and choice of field of study as well as parental employment or appointments to managerial positions would mirror gender equality. Besides taking into account potential sex or

[167] EU. Source: Women in Science database, DG Research and Innovation.
[168] EU28. Source: Eurostat.
[169] EU28. Source: Science-Metrix based on Web of Science.

gender differences, gender equality in R&I enhances the quality and the societal relevance of the developed knowledge and contributes to technologies together with products better suited to potential markets. The integration of the gender dimension into scientific publications has slightly progressed, making the EU perform better than the rest of the world, but remains still very limited[170].

The adoption of Gender Equality Plans and related policies as a pathway to institutional change has been increasingly embraced by many research organisations. However, the ERA Progress Report 2018 has shown the significant heterogeneity across Member States. The report points to a need for higher multiplier effect and for broader concepts taking into account gender equality, openness to intersectionality (with other social categories e.g. ethnicity, sexual orientation, disability as well as with other sectors e.g. business and innovation) and geographical inclusiveness.

Although women represent 48 % of EU graduates at the doctoral level, they only account for about a third of all EU researchers and only a fifth of those in the business sector. The share of female researchers is still not balanced, depending to a large extent on the sector of activity, with relatively higher shares of female researchers in higher education and government sector (41 % in 2017)[171] but only about a fifth of researchers in the business enterprise sector and less than 10 % among patent holders. Similar and rather persistent trends apply to the broader group of STEM higher education graduates, where women in 2017 represented only about 33 %,

Women remain in a minority in the top academic positions with only slight recent improvements. Across the EU, the proportion of women among heads of higher education institutions rose from 20.2 % in 2014 to 21.7 % in 2017, though some countries actually registered a decline, and women represent only 24% of full professors or equivalent. The under-representation of women in leadership positions has wide implications for both scientific advancement and for industries with a strong need for a technologically educated workforce (European Commission, 2018). In recent years, more scientific institutions have adopted a variety of measures to make improvements, such as leadership training, implicit bias training, and broader gender equality plans (Cameron et al., 2015). The progress in the ratios of women to men in senior academic and decision-making positions has fallen below expectations given the growing number of women among higher education graduates. For example, in life sciences, women make up the majority of graduates up to doctoral level but are less successful than men in securing research grants (ERC, 2018), and their numbers progressively decline at higher career steps (Helmer, 2017).

[170] 1.79% of total publications in the EU vs. 1.66% at global level (European Commission, She Figures 2018)

[171] Share of full-time equivalent (FTE) female researchers in the EU (without BE, GR and FI).

Box 15. National policy example

Slovenia

The resolution on the **National Programme for Equal Opportunities for Women and Men 2005-2013** foresees certain measures to improve the position of women in science. These include e.g. Support to and implementation of programmes and projects for increasing participation of women; support to researches and cooperation in the area of gender studies and integration of the principle of gender equality; creation and monitoring of EU indicators on assuring equal opportunities; elimination of obstacles for promotion encountered by female scientists.

The area of research and innovation is regulated by the **National Research and Development Strategy 2011-2020**, which foresees an action plan for researchers' better opportunities throughout the whole career and protects the gender equality principle. The ministry of education, science and sport is also involved in GENDER-NET project, which encourages the creation of a gender action plan. Specific measures support gender balance in decision-making and the enhancement of women's participation in research organisations but also tackle individual career. If the researcher is absent due to parental leave in the duration of at least six months, it is duly considered at project applications and eventually it prolongs the period until PhD defence. All permanent and temporary bodies of the Slovenian Research Agency should guarantee that at least one third of each gender is represented in science and more specifically at least one fifth of each gender in technical disciplines.

Despite some progress, a pronounced gender gap remains in the creation of innovative startups. Overall, women founders remain under-represented in the creation of startups despite having doubled their representation from 8 % in 2000 to 16 % in 2016 in OECD countries (Lassébie et al, 2019). Taking into account the countries with available data, the share of innovative startups with at least one woman founder is the highest in the United States, Italy, Spain and the United Kingdom (15% or slightly above), and the lowest in Ireland, France, Germany, Sweden, the Netherlands and Denmark. Only 1 manager out of 3 in the EU is a woman, even less so in senior management positions of the top publicly-listed companies in the EU (Eurostat/EGE): in 2019, women accounted for 28% of board members of the largest publicly listed companies (up from only 15% in 2012), and 18% of senior executives (up from 10% in 2012). Female-founded unicorns are only 2% of EU unicorns[172].

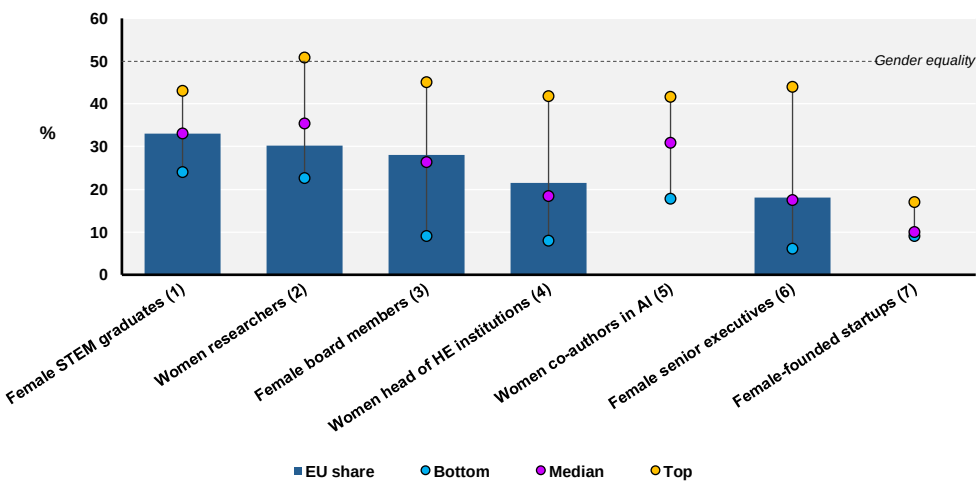
STEM-related, tech, industries are dominated by men-founded companies. Women-led start-ups tend to be in areas generally perceived as less high-tech – such as consumer goods, lifestyle, education, and fashion- rather than hardware, software, information technologies (Lassebie et al., 2019). A substantial part of the gender gap can be attributed to the origins of the gender gap in tertiary education

[172] According to H2020-funded KNOWINN Project, based on CRUNCHBASE

and later career paths (e.g. gap in STEM education). Policies to close the participation gap of women would need to address upstream factors related to education and training, as well as structural barriers. These include fostering institutional changes through the implementation of gender quality plans, as well as targeted support to women's participation in STEM education and entrepreneurship, various accompanying business supporting schemes, and promoting female role models at an early age that can contribute to close the gender gap in top leadership positions.

The scant research available on gender and platform work suggests that women work longer hours and their hourly rates are on average two-thirds of those of their male counterparts (Renan Barzilay and Ben-David, 2017). Studies have also found a systematic bias in customer ratings against women and ethnic minorities (Mitchell and Martin, 2018; Rosenblat et al. 2016). In the digital sphere, the 2018 OECD International Survey of Scientific Authors also found a **'marked digital divide by gender and age'**. In particular, female authors were found less involved than their male counterparts in the use of advanced tools and in data/code sharing practices, even though women were more likely to report 'engagement in activities contributing to their digital online identity and communication'. **A gender gap in AI research** also remains in Europe, though less pronounced than in other major economies such as South Korea and Japan. The share of AI papers with at least a female co-author is the highest in the Netherlands, Denmark, and Portugal, and the lowest in Finland, Czechia and Greece (NESTA, 2019).

Figure 27. Gender gaps in R&I in the EU, including dispersion between lowest, median and top EU Member State



Source: DG Research and Innovation- R&I Strategy and Foresight Unit, based on Eurostat, EIGE, NESTA (2019), Lassebie et al. (2019), Crunchbase.
Notes: [(1)]2017.Tertiary graduates in Natural sciences, mathematics and statistics, Information and Communication Technologies, and Engineering, manufacturing and construction. [(2)]2017. EU aggregate estimated and does not include BE and FI. BE, EL, FI - head counts (HD) for share of females. [(3)]2019. Share of female board members in the largest publicly listed companies. Board members cover all members of the highest decision-making body in each company (i.e.

chairperson, non-executive directors, senior executives and employee representatives, where present). [4]2017. Data are in headcounts (HC). BE (French speaking community universities). CZ, PT, RO, SI: 2016. CY: Academic Year 2015-2016. ES: 2015. LU excluded due to lack of data. BG: Data about heads of scientific organisations are not available. IE: Private colleges and other smaller institutions are not included. [5]2018. Graph ranks countries based on the share of female co-authors in AI papers; NESTA (2019) uses author affiliations at the date of publication as a proxy of their location and focus on countries with at least 5 000 publications and more than 50% of the authors gender-labelled with a high degree of confidence. [6]2019. Executives refer to senior executives in the two highest decision-making bodies of the largest (max. 50) nationally registered companies listed on the national stock exchange. [7]The EU sample is restricted to companies located in IT, ES, IE, FR, DE, SE, NL, DK, founded between 2000 and 2017, and for which the gender of at least one founder can be identified. It refers to innovative startups with at least one female founder identified in the CRUNCHBASE database.

Outstanding challenges

Looking at the underlying causes of gender inequalities and discrimination can assist in setting relevant and targeted objectives and measures to eliminate gender inequalities (EIGE, 2019). **The European level has a key role to play in shifting biased practices, funding experimentation, promoting monitoring, encouraging workplace flexibility and in general establishing a supportive policy context**. Furthermore, the European Commission could lead dialogue with Member States, social partners and other relevant actors about complementary actions implemented at the level of governments or institutions. This could emphasise the role of institutional change, challenging ideal worker assumptions, redesigning jobs descriptions and harnessing the creativity of work teams in a manner that meets the needs of workers and employers across sectors and organisations. The picture at the Member State level is still a fragmented one, where some EU Member States seem to have made significant progress, but others not so much. One aspect with insufficient attention from Member States is the integration of sex and gender-based analysis into research and innovation content. However, a few national research funding organisations are at the forefront on this key question, and their networking and joint advancement on the integration of the gender dimension into their funding programmes could be further stimulated.

Despite the robust policy framework, there is an imbalance in the EU in the uptake of the structural change approach. Majority of countries with better innovation performance made institutional change a key element of their national R&I policy framework for gender equality unlike many less performing countries (SWG GRI 2018). Furthermore, the structural change approach has so far focused on gender equality without attending explicitly to other axes of inequality. This approach developed mainly in the public research, higher education sector and public research funding organisations but not sufficiently in the private sector.

The issue of gender-based violence, including sexual harassment, in academia and R&I organisations is also increasingly being recognised as an issue needing to be tackled, but remains under-addressed by the EC and Member

States[173]. Research shows that gender-based violence is prevalent at all levels of higher education and research across all disciplines (Henning et al., 2017; Benya et al., 2018; Bondestam and Lundqvist, 2020). It is particularly critical in the context of the trans-national mobility of researcher staff, and for early career researchers often in precarious working conditions and facing asymmetric power relations with supervisors. International studies show that at least 25% of female students have experienced gender-based violence during their time in the higher education sector (Voth Schrag, 2017). While broader data collection among research and academic staff across the EU is still lacking, a large survey conducted by the EU Agency for Fundamental Rights (FRA) estimates that 45 to 55% of women in the EU have experienced sexual harassment since the age of 15. Among these women, 32% indicated someone from their employment context – such as a colleague, a boss, or a customer – was the perpetrator (FRA, 2015).

Achieving an inclusive institutional change requires a comprehensive set of actions addressing the three main ERA gender equality objectives simultaneously to support a gender-equal culture within organisations. **Gender equality strategies could profit from being developed and supported in an intersectional way**, through an analytical framework that examines interlocking and intersecting systems of power between gender and other social categories and identities, such as ethnicity, migration, gender identity, sexual orientation, socio-economic status or disability.

Expected implications under a new ERA

Action under a new ERA

The Commission will:

- Propose, as of 2021, in line with the Horizon Europe programme objectives, the development of inclusive gender equality plans with member states and stakeholders in order to promote EU gender equality in R&I. (Action 12)

Expected implications:

- **Increased success of organisations thanks to greater diversity:** there is a positive correlation between the share of RPOs with gender equality plans (GEPs) and the innovation and excellence indicators (Wroblewski, 2019). Research shows that diverse teams perform better and make better decisions. Individuals from different genders, ethnicities, social backgrounds and experiences bring different perspectives that can lead to innovative solutions that are more representative of society. Faculty members found guilty of sexual harassment and other forms of gender-based violence could

[173] ERAC Standing Working Group on Gender in Research and Innovation, Report on "Sexual Harassment in the Higher Education Sector National Policies and Measures in EU Member States and Associated Countries" (June 2020)

be denied research funds and career advances, just as when they are found guilty of plagiarism. Within academia, as elsewhere, the harasser often enjoys large powers, but academic power is strongly tied to research assessment. This is why treating harassment as research misconduct promises to be effective both at the symbolic level and on a practical level.

- **Greater understanding of sex and gender specificities:** Better understanding of stereotypical alignment between gender and specific occupational activities would help to remove constraints in career choices among youth. Studying gender and sex-specificities in health research, social sciences, and other fields will allow for the fine-tuning of responses and policies. Thus, integrating the gender dimension in R&I content is vital for increasing research quality and societal relevance, and for societal acceptance and trust towards R&I solutions.

- **Improved work-life balance, equal access to opportunities and wellbeing**: It will allow for improved balance between professional life and personal life for researchers, and as a result, provide greater wellbeing throughout the career development. It is expected that this will contribute to an increase in the number of women in leadership positions, in both research organizations and companies. **Better innovation performance of businesses:** Diversity in R&I leads to superior results and thus improves innovation potential (Luqun et al., 2020). The evidence points at better performance of startups founded and cofounded by women, although they have to face initial obstacles. Women owners who pitch their ideas to investors for early-stage capital receive significantly less than men – a disparity that averages more than EUR 1 million. (Abouzahr et al., 2018). Women-led startups are not funded on an equivalent basis due to structural inequalities in the population of entrepreneurs and persistent biases (Fackelmann and De Concini, 2020). Yet these businesses deliver higher revenues suggesting that women-owned companies offer better investment opportunities for financial backers**.**

3 THE GEOPOLITICAL DIMENSION OF ERA

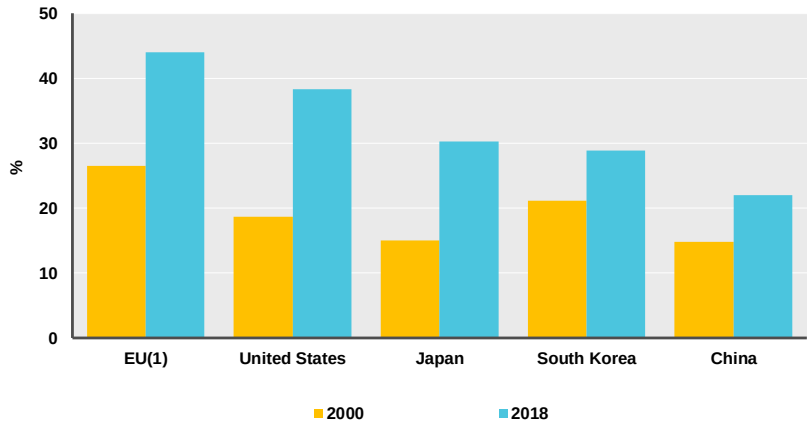
3.1 Progress so far

Indicator	Latest value	Trend	Assessment of trend
Co-publications with non-ERA partners per 1 000 researchers in the public sector[174]	261 (2018)	+5.2% per year since 2007 +4.1% since 2015	↗
Non-EU doctorate students as a share of all doctorate students[175]	16% (2017)	-0.5% per year (2013-2017)	=

In recent years the global R&I landscape has shifted towards a more globalised, multipolar and diversified network of actors, while an increasing proportion of R&I activities is performed outside of Europe. The EU's share of the world's gross expenditures in R&D has dropped from one fourth in 2000 to one fifth in 2017. China now ranks similarly to the EU in terms of R&D intensity, while the R&D intensity of South Korea is now more than double that of the EU[176]. 33 out of the top-50 R&D investor companies are situated outside the EU[177]. **The EU shows high rates of international scientific collaboration, which has seen sharp increases both in the EU and in the United States and Japan.** The share of international scientific co-publications in the EU28 almost doubled between 2000 and 2018 (from 24.6 % to 43.7 %, including intra-EU collaborations), with an even more significant rate of growth observed in the United States (from 18.7 % to 38.3 %) and Japan (from 15 % to 30.3 %).. This trend leads to improved scientific quality since scientists achieve greater impact from their international collaborations. International scientific collaboration is actively supported at the European level through the international reach of Horizon 2020, including its targeted actions for international cooperation, the dedicated mobility and training instruments of the Marie Skłodowska-Curie Actions and the international collaborations funded by ERC grants. However, granular data on EU Member State collaboration shows that several eastern European countries (Romania, Bulgaria, Poland) still report lower levels of international exposure and collaboration.

[174] EU28. Source : Science-Metrix based on Eurostat.
[175] EU28 (without Germany). Source : Eurostat.
[176] Eurostat
[177] EU Industrial R&D Investment Scoreboard 2019

Figure 28. International scientific co-publications as % of total scientific publications, 2000 and 2018



Source: European Commission, DG Research and Innovation, Chief Economist - R&I Strategy & Foresight Unit based on Science-Metrix using data form the Scopus database
Note: (1)EU average includes intra-EU collaborations.

The United States and the EU are leading in international technological cooperation, while China and Japan have taken a step back. In some EU countries, as well as in globally catching-up economies, knowledge diffusion and technological transformation continues to be stimulated through foreign direct investment and foreign business research investment[178]. International technological cooperation data points to an active policy in China, which is trying to reduce its need for foreign-based technology through domestic competitiveness and to further facilitate Chinese companies' access to international markets. This places **international technological cooperation policies in a wider perspective of changing global approaches to trade, technological sovereignty and geopolitical competition.**

The EU approach to R&I has long been one of openness to the world to facilitate brain and knowledge circulation, combined with strategically targeted actions with key partner countries. This **multilateral approach** is at the heart of the EU efforts for international coordination towards achieving the SDGs and it has served EU interests by establishing mutually beneficial cooperation with international partner countries. Moreover, in the current R&D and geopolitical landscape, setting up a level playing field for fair competition and cooperation with third countries is in some cases lagging behind, calling for the EU to redouble negotiating efforts while anticipating any risks to EU interests. What is at stake is not only Europe's prosperity and economic competitiveness, but also its ability to autonomously source and provide crucial technologies, raw materials and services that are safe and secure for

[178] Foreign businesses investing in the EU are indeed sensitive to policy instruments, such as the European Research Area (ERA), aimed at creating an integrated research and innovation area in Europe (Vertesy and Damioli, 2019).

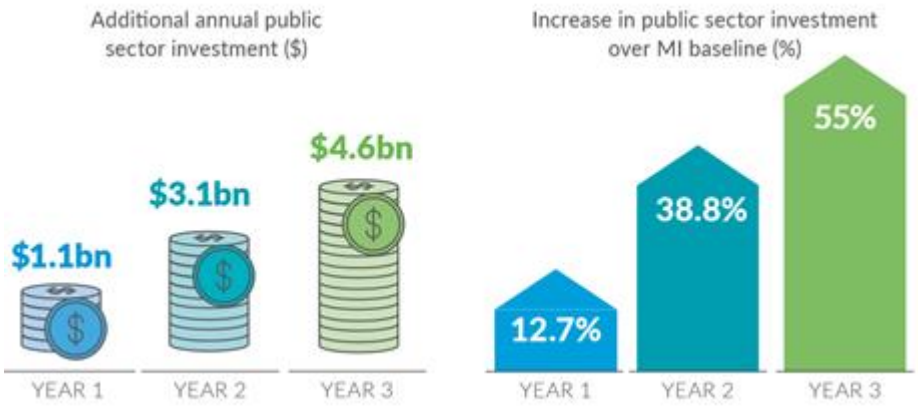
industry and people. The EU has actively supported international cooperation mainly through the R&I Framework Programmes by means of the association of third countries to the Programme as well as collaborative projects and programmatic cooperation with partner countries and the Marie Skłodowska-Curie Actions, for the mobility, training of researchers, and development of excellent doctoral programme.

Geographical and cultural proximities among participants seem to play an important role in shaping the structure of collaboration networks, at least in the case of the EU Framework Programme (Balland et al., 2019). The work programme 2018-2020 includes more than 30 'international cooperation flagships' with key third countries on strategically targeted topics. Notable examples include cooperation on global health, food and nutrition security with Africa, food production, biotech, energy and natural resources with China, cooperation with the United States, Canada, Japan and other third countries on clean energy, multilateral cooperation on research related to the seas and oceans, and automated driving with United States, Japan, South Korea and others.

During the last decade, a series of multilateral initiatives such as the Global Alliance for Chronic Diseases, Mission Innovation, the Atlantic Ocean Research Alliance and others, have contributed to coordinating research efforts and shaping the global policy agenda. More recently, international coordination of R&I efforts through multilateral set ups such as the Coalition for Epidemic Preparedness Innovations (CEPI) and the Global Research Collaboration for Infectious Disease Preparedness (GloPID-R) has proven essential for tackling the current pandemic more effectively. Reinforced support and closer cooperation with developing countries on R&I is a key element in tackling these challenges. A good example of EU multilateral approach and its commitment to global outreach in the context of European Green Deal is **Mission Innovation** (MI)[179], a multi-country alliance to accelerate clean energy innovation. MI partners committed to double their clean energy financing in five years. In year three, members reported a total annual increase of $4.6 billion against their baselines.

179 Mission-innovation.org

Figure 29. Mission Innovation



Source: Mission Innovation Impact report 2019

Science, research and innovation have an important role to play in integrating the Western Balkan region and in implementing the renewed strategy 'A credible enlargement perspective for an enhanced EU engagement with the Western Balkans'. Research and innovation are the front-runners in accession negotiations and have delivered tangible results. Participation in Horizon 2020 is a Western Balkans success story: participants from the Western Balkans (all countries but Kosovo are fully associated to Horizon 2020) are receiving more than €20 million per year (far higher than the figures from the 7th framework programme) in a competitive manner.

3.2 Outstanding challenges

Although the Framework Programmes have strongly supported international cooperation in R&I, the vast majority of Europe's R&I cooperation takes place at national level. There is a need for a closer and more integrated coordination to increase coherence, efficiency and effectiveness of **EU action in international R&I cooperation**. Furthermore, the international reach at EU level could be strengthened though **ambitious targeted initiatives**, broadening and integrating cooperation on key priorities with targeted partner countries and regions. **The increasing scope and interconnectivity of global challenges calls more than ever for international R&I collaboration across disciplines and sectors and for more systemic and structural cooperation around common agendas**.

Europe's position/excellence in key technologies is subject to challenges the rise of new global economic players and by the growing importance and

diffusion of ICT[180] in almost all economic sectors, where Europe largely lags behind other major economies[181]. ICT-enabled economies show higher productivity and R&D intensity as compared to non-ICT-enabled economies. Global innovation is often hampered by policies in certain third countries that prevent a global level playing field, e.g. forced technology transfer, local content requirements, state aid rules that distort competition or ineffective IPR protection and enforcement frameworks that allow for illegal appropriation of foreign IPs[182]. These challenges require a greater focus by the EU in its international research and innovation cooperation in order to ensure reciprocity and a level playing field.

Getting the Western Balkan countries ready for EU membership and fully integrating them into the European Research Area is the main challenge. This will include national capacity building, modernising the national science landscape, and completing the development of Smart Specialisation Strategies focusing national R&I efforts. Widening/Sharing Excellence under Horizon Europe will provide extra support to the Western Balkans (for example the large Teaming grant ANTARES to Serbia in Horizon 2020).

The strategy 'A credible enlargement perspective for and enhanced EU engagement with the Western Balkans[183] adopted in February 2018, recognised the European future of the region and called for significant enhancement of the EU's political, technical and financial support, to boost the economic growth and support the reforms required to move forward on the EU path. The **European perspective of the entire region** was confirmed again in March 2020, when Member States endorsed the Commission's proposals for a strengthened methodology[184] for the accession process and decided to open accession negotiations with Albania and North Macedonia. Fostering the stability and prosperity of this region remains a key priority for the EU.

The green transition and **digital transformation** are crucial for relaunching and modernising the economies of the Western Balkans, helping to create jobs and growth. Similarly, for an economy that works for people, addressing the long-standing challenges faced by young people in the region, including limited job prospects, inequality and brain drain, education, culture, research and innovation are essential drivers.

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[180] "An Analysis of the International Positioning of the EU Using Revealed Comparative Advantages and the Control of Key Technologies", EC

[181] See e.g. OECD STI Scoreboard 2017, http://dx.doi.org/10.1787/888933616940: Out of the 20 emerging ICT technologies identified in the report, none is led by EU27. See also EU Industrial Scoreboard 2019.

[182] See e.g. SWD(2018) 47

183 COM(2018) 65 final

[184] Commission Communication "Enhancing the accession process - A credible EU perspective for the Western Balkans", COM(2020) 57 final

4 GOVERNANCE OF THE NEW ERA

4.1 Current situation

The governance of the European Research Area (ERA) is implemented through a **systemic collaboration between Member States, Council and the Commission**. The European Research Area and Innovation Committee (ERAC, see Box 16) acts as a strategic policy advisory committee that advises the Council, the Commission and member states on the full spectrum of research and innovation issues in the framework of the governance of the European Research Area.

Box 16. The European Research and Innovation Advisory Committee (ERAC)

Members of ERAC and its different configurations include:

- All the Member States and
- The Commission

A number of other non-EU countries, which are associated to EU research and innovation programmes may participate as observers in its activities.

ERAC is co-chaired by the Commission and an elected representative from a Member State. The Council of the EU provides for the ERAC secretariat.

ERAC also meets in **two dedicated configurations**, which were established by the Council and are chaired by an elected representative of an EU country:

- The **High Level Group on Joint Programming (GPC**), which contributes to the preparation of the debates and decisions of the Competitiveness Council on joint programming
- The **Strategic Forum for international S&T Cooperation (SFIC),** which advices the Council and the Commission on the implementation of a European Partnership in the field of international scientific and technological cooperation (S&T cooperation)

ERAC currently has **three Standing Working Groups** on Open Science and Innovation, Human Resources and Mobility and Gender in Research and Innovation as well as ESFRI, the European Strategy Forum on Research Infrastructures. The context and rationale for setting up these groups and their composition is optimize the input from ERAC and enable progress on the specific era priorities.

ERAC opinions are discussed in the **Research Working Party** as a preparatory body to the **Competitive Council** and might lead to Council Conclusions if appropriate.

Its mandate (last revised in October 2015[1]) is focused on providing strategic advice that usually takes the form of ERAC opinions addressed to the Commission and to the Council, which can be furthered by Council Conclusions calling for the Commission and the Member States to take action.

Every three years, the **ERA advisory system needs to be evaluated and adjusted**. In 2018, ERAC conducted a first review of the advisory system which was welcomed by Council conclusions on the governance of ERA[185] in November 2018. The next review is foreseen for 2021, to which the forthcoming Communication on ERA will be a key input.

In 2014 the Competitiveness Council Conclusions[186] called for *an **ERA Roadmap** at European level which should serve the purpose of facilitating and reinforcing the efforts undertaken by the Member States"*. The ERA Roadmap developed in consultation with the ERAC, the ERA Related Groups and most of the organisations, which make up the ERA Stakeholder Platform[187], responds to this request. It is a living document to guide Member States in structuring their implementation of ERA at national level.

The **Roadmap** was drawn up in full recognition that national research and innovation systems across Europe have different characteristics and that this variety is an asset which Europe needs to exploit to the full. It does not propose actions which must be implemented Member States, but rather to draw attention to key areas where action is likely to pay most dividends for the majority of national research and innovation systems by spreading excellence and strengthening their ability to operate at a high level of effectiveness. The Roadmap identifies actions at national and European level. This recognises both the leading role of Member States in ERA implementation and the value of Horizon 2020 and other European co-operation in supporting this.

In response to the ERA Roadmap Member States and Associated Countries were invited to develop **ERA National Action Plans** (NAPs), in which they presented their national measures to implement ERA. Member States have full autonomy in identifying the approaches most suited to the structures and dynamics of their national research and innovation systems when it comes to implementing these actions (or other relevant priority actions at national level).

The NAPs are reported to the Commission and provide official information on ERA strategies and corresponding policy measures in Member States and Associated Countries. They constitute an important source for charting the progress of ERA implementation. The majority of NAPs are structured according to the six ERA priorities — further evidence of systematic and shared efforts to plan national reforms in order to implement ERA – its common priorities coupled with country-specific challenges. The Commission on its side produces a European Research Area Progress Report, which assesses the current state of ERA and the progress made.

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[185] https://data.consilium.europa.eu/doc/document/ST-14989-2018-INIT/en/pdf

[186] https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/146063.pdf

[187] European Association of Research and Technology Organsiations (EARTO); European University Association (EUA); League of European Research Universities (LERU); NordForsk; Science Europe; CESAER; EU-Life; European Infustrial Research Management Association (EIRMA); European Regions Research and Innovation Network (ERRIN); Association of European-level Research Infrastructure Facilities (ERF-AISBL); European Network of Innovation Agencies (TAFTI)

Mutual learning and policy learning in the context of ERA has been a success (see e.g. the increasing demand for support through the Horizon 2020 Policy Support Facility since 2015). ERA has also provided the space to raise awareness concerning the divergent research and innovation performances in Europe. This has led to the widening measures under Horizon 2020 and complemented capacity-building measures under the European Structural and Investment Funds in support of R&I. However, these actions remain essentially a mechanism for introducing soft measures on a voluntary basis, which is currently the only type of ERA governance measures to be carried out.

4.2 Trends and challenges

The current global landscape calls for a new ERA that goes beyond its traditional 'single market' remit and towards a more ambitious and encompassing approach, aiming at engaging with Member States towards a world-class, high-performing, modern European R&I system fit for tackling today's challenges. Despite the many evident achievements of ERA, the European dimension is absent in various national R&I policies, obstructing joint multi-level action, which is an essential element of a fully functioning ERA. The ERA roadmap contributed to ownership and responsibility of the Member States over ERA at the national level, but on the other hand, it reduced, to a certain extent, the progress of ERA implementation at the EU level. The ERA progress report 2018 highlights that the 'speed' of policy reforms has faltered somewhat since 2015, which can be viewed as decreasing political commitment at all levels. According to the ERA progress report 2018, progress on ERA implementation has been slowing and major disparities still exist between countries, or are even growing in part.

Another important development throughout the years was the **accession of new Member States** in 2004, 2007 and 2013, which has made the R&I landscape more diversified and resulted in more attention for concepts such as sharing excellence, widening participation and inclusiveness.

In 2020 "The ERAC Opinion on the future of the ERA[188]" recognizes that the *"slowing down of the implementation of the ERA at national level manifests itself in the continued fragmentation of the European R&I landscape. Mostly owed to the still major disparities among countries and regions in Europe. The ERA policy framework did not succeed in driving sectoral ministries towards a transdisciplinary R&I-driven 'directed' policy change on global challenges at EU and national level, such as climate, energy or agriculture, nor did it allow individual R&I actors to experience the benefits stemming from it".*

The lost momentum for realising ERA and the absence of concrete deliverables can be attributed to the low efficiency of the ERA governance structure, coupled with a low level of recognition of political ownership. This leads to additional bureaucratic

[188] https://data.consilium.europa.eu/doc/document/ST-1201-2020-INIT/en/pdf

obstacles on national level and limits the progress of developing a European dimension within national policies.

The Commission has considered these developments and has identified some **key characteristics for a new and improved ERA governance model**:

- A stronger political commitment and ownership by Member States to deliver on the key principles and values of ERA, which can be achieved through more binding obligations in reporting, monitoring and assessment of systematic and shared efforts in national reforms in order to implement ERA.
- Reinforced role of the Commission, shifting from a mainly supporting and monitoring role to a more active and steering one, allowing the Commission to supervise and direct Member States in delivering on their obligations for achieving ERA
- Strengthen and enhance the process of co-creation between the Commission, Member States and other stakeholders in further policy development on ERA
- Ensure that ERA actions and initiatives achieve better coherence between European and national (regional) R&I policies

Outlining these new governance characteristics requires a new model of monitoring and assessing of ERA. The Commission has in this regard reviewed a number of **alternative and similar governance models**:

- **The European Semester** - The Semester is the EU's annual cycle of surveillance and coordination of national economic and employment policies. It is structured around four key milestones: i) in November, the Commission sets out general priorities within its Annual Sustainable Growth Strategy; ii) in February, the Commission publishes its analyses in the Country Reports; iii) in April, Member States present their National Reform Programmes and Stability/Convergence Programmes; iv) in May, the Commission issues its proposals for Country Specific Recommendations. The Council adopts these recommendations during the summer;

- **Energy Union and Climate Action** - Member States develop integrated national energy and climate plans. The plans cover the five dimensions of the Energy Union as Member States report on the progress made in implementing the plans. The Commission monitors the progress on the EU as a whole. Member States submit their final plans for 2021-2030 to the Commission and by 2023 the Member States provide updates of the plans, in line with the 5-yearly ambition cycle of the Paris climate agreement.

Action under a new ERA

- Building on the lessons learned from the Horizon Europe Strategic Planning process, develop with member states an approach to set and implement strategic priorities that deliver on the ERA agenda through the European Forum of Transition and by means of a pact for R&I in Europe. (Action 14)

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This publication presents the Staff Working Document accompanying the Communication "A new ERA for Research and Innovation". In order to address today's multiple challenges, the European Research Area (ERA) needs to accelerate the transitions and strengthen resilience to future crises, while sustaining competitiveness. ERA needs to adapt continuously to changing social, ecological, and economic circumstances as it otherwise loses attention, commitment, and purpose, and, most importantly, it also needs to deal with priority setting in R&I policies. In order to prioritise investments and reforms in research and innovation, improve access to excellence for researchers across the EU and enable research results to reach the market and the real economy, the Commission set out new strategic objectives and actions for the ERA in its Communication "A new ERA for Research and Innovation".

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