



European
Commission



A NEW **HORIZON** FOR **EUROPE**

Impact Assessment of the
9th EU Framework Programme
for Research and Innovation

*Research and
Innovation*

A New Horizon for Europe

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EUROPEAN COMMISSION

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GLOSSARY

Term or acronym	Meaning or definition
ALLIANCE	Research platform to coordinate and promote European research on radioecology (http://www.er-alliance.org/)
Applicant	Legal entity submitting an application for a call for proposals
Application	The act of a legal entity becoming involved in a proposal. A single applicant may submit applications for one or more proposals
Associated country	Non-EU country that is party to an association agreement with the Horizon 2020 programme or the Euratom programme. It participates in the programme under the same conditions as EU Member States. Since 1 January 2017, 16 countries are associated to Horizon 2020 and two countries are associated to Euratom)
CBRN	Chemical, biological, radiological and nuclear
COSME	EU programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (2014-2020)
CSA	Coordination and Support Action
DEMO	Demonstration power plant that will generate fusion electricity
DEMO CDA	Conceptual design activity for DEMO
DEMO EDA	Engineering design activity for DEMO
Deuterium, tritium	In nature, hydrogen comes in three forms, called isotopes. Deuterium (heavy hydrogen) is twice and tritium (super heavy hydrogen) is three times heavier than common hydrogen. First-generation fusion power plants burn the hydrogen isotopes deuterium and tritium as fuel
DG RTD	European Commission's Directorate-General for Research and Innovation
Divertor	Part of a tokamak where the power exhaust takes place
DONES	DEMO-oriented neutron source
EAV	European added value

Term or acronym	Meaning or definition
ECVET	The European Credit system for Vocational Education and Training
EESC	European Economic and Social Committee
EFDA	European Fusion Development Agreement
EFSI	European Fund for Strategic Investments
EIC	European Innovation Council
EIT	European Institute for Innovation and Technology
EJP	European Joint Programme
ENEN	European Nuclear Education Network
ENSREG	European Nuclear Safety Regulators Group
ERAC	European Research Area and Innovation Committee
ERC	European Research Council
ERCEA	European Research Council Executive Agency
ERDF	European Regional Development Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESIF	European Structural Investment Funds
ESNII	European Sustainable Nuclear Industrial Initiative
EU	European Union
EUROfusion	The EUROfusion consortium, launched in 2014, carries out research funded jointly by Euratom and the Member States. EUROfusion implements fusion research in line with the European roadmap to fusion electricity
F4E	Joint undertaking for the ITER research facility and the development of fusion energy in Barcelona, Spain
FET	Future and Emerging Technologies

Term or acronym	Meaning or definition
FIIF	Fusion Industry Innovation Forum
FLCM	Full lifecycle cost management
FP	Horizon Europe Framework Programme for Research and Innovation (2021-2027)
FP7	Seventh Framework Programme for Research and Technological Development (2014-2020).
Fusion energy	Energy released by the fusion process, a process that merges together or 'fuses' the cores of atoms and that powers the sun and stars in our solar system
GDP	Gross Domestic Product
Generation- II/-III	Current generations of nuclear power plants
High-power deuterium-tritium (D-T) campaign	A type of fusion experiment in which the highest amount of fusion energy is released and the best fusion performance obtained
High-quality Proposal	A proposal that scores above set evaluation threshold, making it eligible for funding
HLW	High-level (radioactive) waste
IA	Impact assessment; innovation action
JRC	Joint Research Centre, a Directorate-General of the European Commission
KICs	Knowledge and Innovation Communities
KPI	Key performance indicator for measuring the performance and impacts of the Horizon 2020 and Euratom programmes
Magnetic confinement fusion	A fusion technology in which an extremely hot hydrogen gas, a plasma, is held together or 'confined' with strong magnets
MELODI	Multidisciplinary European Low Dose Initiative (http://www.melodi-online.eu/)
MFF	Multiannual Financial Framework

Term or acronym	Meaning or definition
MSCA	Marie Skłodowska-Curie Actions
NDAP	Nuclear decommissioning assistance programme
Newcomer	A participant in the Horizon 2020 or Euratom programmes (2014-2020) who was not involved in the FP7 programme or the previous Euratom programme (2007-2013)
NMS	New EU Member States (since 2004)
NPP	Nuclear power plant
Participant	Any legal entity carrying out an action activity or part of an action under the 2014-2020 Horizon 2020 programme or the 2014-2018 Euratom programme
Participation	A legal entity's involvement in a project. A single participant may be involved in multiple projects
Plasma	Plasma is a state of matter alongside solid, liquid and gas. Our sun and stars are made of plasma. Plasma is produced in fusion experiments
Power (energy) exhaust	A technology to control the power (energy) outflow of a fusion plasma
Project	Successful proposals for which a grant agreement is concluded
R&I	Research and Innovation
REA	Research Executive Agency
RIA	Research and Innovation Action
SME	Small or medium-sized enterprise
SRA	Strategic research agenda
STC	Scientific and Technical Committee
Success rate	The number of proposals that are retained for funding over the number of eligible proposals
TFEU	Treaty on the Functioning of the European Union

Term or acronym	Meaning or definition
Third country	A country that is not a Member State of the EU. For the purposes of this document, the term 'third country' does not include associated countries (see above)
Time to grant	The time that elapses between the closing date for the call and the signing of the grant agreement, which marks the official start of the project
Tokamak	A torus-shaped device which uses a strong magnetic field to confine a plasm. The main device used by fusion researchers for fusion experiments
TRL	Technology Readiness Level. These levels measure the maturity level of particular technologies. The measurement system provides a common understanding of technology status and covers the entire innovation chain: TRL 1 – basic principles observed; TRL 2 – technology concept formulated; TRL 3 – experimental proof of concept provided; TRL 4 – technology validated in lab; TRL 5 – technology validated in relevant environment; TRL 6 – technology demonstrated in relevant environment; TRL 7 – system prototype demonstrated in operational environment; TRL 8 – system complete and qualified; TRL 9 – actual system proven in operational environment

FOREWORD



We live in an era when the most pressing challenges we face are truly global in nature. That is why research and innovation are more important than ever before: they provide the foundations for sustainable growth and high-quality jobs for Europe, and bring about the social, economic and environmental improvements our citizens need.

The current EU research and innovation programme, Horizon 2020, is making great contributions to tackle these challenges. Significant advances in digital technologies, our ability to fight climate change, the reduction of food waste and the development of low-carbon transport are made possible through the added scale, speed and scope of EU-level investments. Its core focus on excellence, transnational competition and collaboration delivers added value that is beyond the reach of national and regional programmes.

The Interim Evaluation of Horizon 2020 and the recommendations of the Lamy High Level Group have laid the foundations for the design of Horizon Europe, the future programme for 2021-2027. Both called for strong continuity and a greater focus on impact and openness. The revamped three-pillar structure of Horizon Europe reflects this evolution: Open Science, Global Challenges and Industrial Competitiveness, and Open Innovation, underpinned by activities designed to reinforce the European Research Area.

This impact assessment provides a clear, evidence-based blueprint for how Horizon Europe will help consolidate our leadership in research and innovation. It describes what the programme strives to deliver and why. For example, a new mission-oriented approach will prioritise investments where there are tangible benefits and high impacts for society. The European Innovation Council will provide tailor-made support for innovators, laying the foundations for breakthrough innovation. International cooperation activities will be intensified, while Open Science will be the leitmotif of the future programme. A strategic approach to partnerships with the private and public sector, or with foundations, will improve their leverage and alignment with Member State and industry investments. This will also help to rationalise the EU research and innovation support landscape. Simplification of rules and procedures for beneficiaries, building on the great successes of Horizon 2020, will remain an overriding priority.

Horizon Europe, thanks to these design improvements and new features, could return up to 11 euros in GDP gains for every euro invested. Therefore, we will also monitor more closely what we invest in, and better communicate to citizens what we deliver. The future programme will implement a more sophisticated approach to impact, tracking progress in the short, medium and long-term, and will exploit and disseminate results more effectively.

Research and innovation are the most important investments for the future we all want for Europe!

A handwritten signature in blue ink, appearing to read 'Carlos Moedas'.

Carlos Moedas,
European Commissioner
for Research, Science and Innovation

PART 1

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION



IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

This impact assessment accompanies the Commission proposal for Horizon Europe, the 2021-2027 EU Framework Programme for Research and Innovation, which will succeed the current Programme, Horizon 2020 (active between 2014-2020), and the proposal for the 2021-2025 Research and Training Programme of the European Atomic Energy Community (Euratom Programme).

Research and innovation help Europe deliver on citizens' priorities, as embodied in the Sustainable Development Goals and in the Paris Agreement on fighting climate change, to bring about sustainable growth and high-quality jobs, and to solve present and unforeseen global challenges. However, Europe overall currently underinvests in research and innovation compared to its main trading partners, and so risks being irreversibly outpaced.

EU-level investment, through successive Framework Programmes, has supported the provision of public goods with a high European added value. This added value comes from the Programmes' focus on excellence through EU-wide competition and cooperation. Framework Programmes support training and mobility for scientists, create transnational, cross-sectoral and multidisciplinary collaborations, leverage additional public and private investment, build the scientific evidence necessary for EU policies, and have structuring effects on national research and innovation systems. The significant and long-lasting impact of the Framework Programmes, in particular the current Programme, is acknowledged by the EU institutions, Member States and stakeholders alike.

Horizon Europe is built on the evidence and lessons learnt from the Horizon 2020 interim evaluation, and the recommendations of the independent High-Level Group

on maximising the impact of EU research and innovation. The new Programme will be an evolution, not a revolution, focusing on a few design improvements to further increase openness and impact.

Horizon Europe's general objectives stem from the Treaty on the Functioning of the European Union. These will be: to strengthen the scientific and technological bases of the Union and foster its competitiveness, including for its industry; to deliver on the EU's strategic policy priorities and contribute to tackling global challenges, including the Sustainable Development Goals. To address particular research and innovation challenges faced by the EU, Horizon Europe also has specific objectives. All objectives apply across the Programme, and all individual Programme parts will contribute to their achievement.

The evolution from Horizon 2020 is reflected in the revamped structure. The three-pillar structure will be continued, but redesigned for more coherence, both between and within pillars, in support of the Programme objectives.

Pillar 1 - Open Science will continue to focus on excellent science and high-quality knowledge to strengthen EU's science base through the European Research Council, Marie-Skłodowska Curie Actions and Research Infrastructures. As a "bottom-up", investigator-driven pillar, it will continue to give the scientific community a strong role.

Pillar 2 - Global Challenges and Industrial Competitiveness will better address EU policy priorities and support industrial competitiveness by integrating the Horizon 2020 *Societal Challenges and Leadership in Enabling Industrial Technologies* into five clusters (i.e. Health; Resilience and Security; Digital and Industry;

Climate, Energy and Mobility; and Food and natural resources). The clusters will better support the full spectrum of the Sustainable Development Goals, and increase collaborative research and innovation across sectors, disciplines and policy fields – boosting flexibility, focus, and impact. Due to its policy focus, the pillar will be implemented “top-down”, through a strategic planning process ensuring the involvement of stakeholders and society, and alignment with Member States’ activities. The pillar will give appropriate visibility to industry’s essential role in achieving all the Programme’s objectives, not least in tackling global challenges, including by developing key enabling technologies for the future.

Pillar 3 – Open Innovation will offer a one-stop shop for high-potential innovators with the European Innovation Council and increase cooperation with innovation ecosystems and actors. This pillar will integrate and reorganise Horizon 2020 activities, such as Innovation in SMEs (notably the SME instrument), Fast Track to Innovation, as well as Future and Emerging Technologies. Innovation will continue to be supported throughout the whole Programme, not just in this innovation-focussed pillar.

Horizon Europe will reinforce the European Research Area through: Sharing excellence (extending the Horizon 2020 actions that help tackle low research and innovation performance i.e. Teaming, Twinning, ERA chairs, and COST); research and innovation reforms and policy, covering the Policy Support Facility; foresight activities; and Framework Programme monitoring, evaluation, dissemination and exploitation of results

The new Programme will also have some new features and enhancements of existing elements. With Horizon 2020 well on track to deliver excellence, impact and openness, these changes will make the successor Pro-

gramme achieve even more impact (through the European Innovation Council and mission-orientation) and more openness (through strengthened international cooperation, a reinforced Open Science policy, and a new policy approach to European Partnerships).

The European Innovation Council will help place the EU in the lead for breakthrough market-creating innovation. It will support high-risk, market-creating innovation projects that do not (yet) generate revenues, to bridge the “valley of death” between research and commercialisation and help companies scale up. The tailor-made support to innovators will be channelled through two main funding instruments. The Pathfinder for Advanced Research will provide grants from the early technology stage (proof of concept, technology validation) to the early commercial stage (early demonstration, development of business case and development of strategy). The Accelerator will support the further development and market deployment of breakthrough and market-creating innovations, to a stage where they can be financed on usual commercial terms by investors (from demonstration, user testing, pre-commercial production and beyond, including scale-up). It will place a particular emphasis on innovation generated within the Pathfinder, although it will also fund projects from other parts of the Programme, such as the European Research Council or the Knowledge and Innovation Communities. The expected implications of the role played by the European Innovation Council include more innovation that creates the new markets of the future, more companies that scale up in Europe, higher growth among SMEs, and more entrepreneurship and risk-taking.

Horizon Europe will see the introduction of a limited set of highly visible research and innovation ‘missions’ under Pillar 2 (but potentially also providing direction to the other pillars). Mis-

sions will prioritise investment and set directions to achieve objectives with societal relevance, thereby creating more impact and outreach, encouraging a systemic approach (moving from a view of narrow sectors to entire systems), and aligning instruments and agendas for research and innovation across Europe. Missions will either accelerate progress towards a set scientific, technical or societal solution, by focusing large investment on a specific target; or transform an entire social or industrial system within an established timeframe. They will be selected after the Programme launch, according to strict selection criteria, and co-designed with Member States, stakeholders and citizens. The expected implications of this new mission approach include more cross-sectoral and cross-disciplinary cooperation, higher impact on global challenges and EU priorities, and a reduced gap between science and innovation, and society.

Strengthened international cooperation is vital for ensuring access to talent, knowledge, facilities and markets worldwide, for effectively tackling global challenges and for implementing global commitments. The Framework Programme will intensify cooperation and extend openness for association to all countries with proven science, technology and innovation capacities, to make cooperation and funding of joint projects as smooth as possible. The programme will continue to fund entities from low/middle income countries. Entities from industrialised and emerging economies will be funded only if they possess essential competences or facilities. The expected implications include higher excellence in the Programme, more influence for the EU in shaping global research and innovation systems, and higher impact.

Open Science will become the modus operandi of the new Programme, going beyond Horizon 2020's open access policy to require immediate open access for publications and

data (with opt-out possibilities for the latter), and research data management plans. The Programme will encourage the proliferation of FAIR data (findable, accessible, interoperable, and re-usable) and support a sustainable and innovative scholarly communications ecosystem. It will foster activities to improve researcher skills in Open Science and the reward systems that promote this. Research integrity and citizen science will play a central role, as will the development of a new generation of research assessment indicators.

The new approach to European Partnerships will be more impact-focussed. The need to establish future European Partnerships or renew existing ones will be identified as part of the strategic programming process for the Framework Programme. European Partnerships will be open to all types of stakeholders (e.g. industry, Member States and philanthropic foundations) and will be limited in time, with clear conditions for the phasing out of the Framework Programme funding. They will be based on the principles of Union added value, transparency, openness, impact, leverage effect, long-term financial commitment from all parties, flexibility, coherence and complementarity with Union, local, regional national and international initiatives. The future partnership landscape will ensure optimal coherence between Framework Programme activities and partnerships. There will be only three types: i) co-programmed European Partnerships, based on memoranda of understanding or contractual arrangements; ii) co-funded European Partnerships, based on a single, flexible co-fund action; iii) institutionalised European Partnerships (based on Article 185 or 187 of the Treaty on the Functioning of the European Union). Following a life-cycle approach, the Framework Programme will set out the criteria for selecting, implementing, monitoring, evaluation and phasing out all European Partnerships.

The changes to the Programme's structure and the improvements to it will facilitate the achievement of the Programme's objectives, making it more effective and helping it generate even more economic benefits and value for money. These effects will be amplified by strengthened synergies and complementarities with other EU programmes, for example through the Seal of Excellence.

Efficient delivery is essential for meeting all the objectives. It is also key to achieving higher impact and further simplification. Building on the achievements of Horizon 2020, simplification remains a continuing endeavour also in the new Programme. Several improvements have been made to streamline delivery for impact. The Programme will aim at further simplification within the present real cost reimbursement system with its simplified funding model. Increased use will be made of project funding against fulfilment of activities (i.e. lump sum) and other simplified forms of funding allowed by the new Financial Regulation. Cross-reliance on audits across EU programmes and acceptance of usual cost accounting practices will be developed. To increase flexibility, the Programme will support the intersection of disciplines and sectors and allow allocation of funds between and within pillars to react swiftly to emerging issues or challenges. Further improvements to the proposal submission and evaluation process will be envisaged by continuously trying to reduce the 'time to grant' and by improving feedback to applicants. The evaluation criteria, process and involvement of independent experts will underscore the Programme's excellence and impact. Innovation support schemes will be streamlined under the European Innovation Council, while the complementarity between grants and financial instruments could be reinforced through blended finance.

Impact depends ultimately on the dissemination and exploitation of research and innovation data and results, and it needs to be effectively captured and communicated. An ambitious and comprehensive strategy will increase the availability of such data and results and accelerate their uptake to boost the overall impact of the Programme. Portfolios of mature results will be exploited in synergy with other EU programmes to ensure their uptake at national and regional level, maximising European innovation potential. This will be complemented by effective communication and outreach campaigns that build trust and engage citizens.

Progress towards the Programme's objectives will be tracked along 'impact pathways' (on scientific, societal, and economic impact). The impact pathways will be time-sensitive, distinguishing between the short, medium and long term. The impact pathway indicators will contain both qualitative and quantitative information, the availability of which will depend on the Programme's stage of implementation. Individual programme parts will contribute to these indicators to varying degrees and through various mechanisms. The data behind the key impact pathway indicators will be collected in a centrally managed and harmonised way that imposes minimum reporting burden on beneficiaries, including using unique identifiers for applicants and sourcing data automatically from existing external public and private databases. Baselines, targets and benchmarks will be established before the Programme's launch. Management and implementation data from the Programme will continue to be collected in near real-time. An analysis of progress on key dimensions of management and implementation will be carried out every year. Interim and ex-post evaluations will ensure that methodologies are consistent and coverage is comprehensive.

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT



1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT

1.1 SCOPE

This impact assessment accompanies the Commission proposals for Horizon Europe, the 2021-2027 Framework Programme for EU Research and Innovation (R&I), which will succeed Horizon 2020 (2014-2020): proposals for the Framework Programme and Rules for Participation¹, the Specific Programme², as well as the 2021-2025 Research and Training Programme of the European Atomic Energy Community (Euratom Programme)³. An impact assessment for defence research has been carried out separately and is accompanying the proposal for the European Defence Fund Regulation.

R&I are crucial for providing solutions to the challenges of our time. They deliver on citizens' priorities, as embodied in the Sustainable Development Goals and in the Paris Agreement on fighting climate change⁴, on growth and jobs, and to solve the global challenges we face today and will face tomorrow⁵. In areas like health, digital technologies, industrial transformation, resilient societies, natural resources, energy, mobility, environment, food, low-carbon economy and security, R&I are critical to the success of EU priorities, in particular jobs and growth, Digital Single Market, Energy Union and climate action. R&I are at the core of the productivity and competitiveness of our economy. About two-thirds of Europe's economic growth over the last decades has been driven by R&I. R&I support the creation of new and better jobs and the development of knowledge-intensive activities, which account for more than 33% of

total employment in Europe. Moreover, to ensure sustainable growth and the capacity to address the societal challenges ahead, Europe must reinforce and maintain its technology and industrial capacities in the key areas that underpin the transformation of our economy and society.



"Fostering R&I across the EU" is the most important policy challenge for 97% of respondents to the cluster-based public consultation on EU funds in the area of investment, research & innovation, SMEs and single market⁶.

R&I determine the productivity and competitiveness of our economy: about two-thirds of Europe's economic growth over the last decades was driven by innovation. They support the creation of new and better jobs, and the development of knowledge-intensive activities, which account for more than 33% of total employment in Europe⁶.

Europe must maintain and even reinforce its technological, industrial and innovation capacities in a sustainable way, in the strategic areas that underpin our society, economy and international commitments.

Currently, Europe underinvests in R&I compared to its main trading partners. If this con-

tinues, Europe risks being outpaced irreversibly. The EU's overall R&I intensity is just above 2% of GDP (failing to meet the 3% target⁷). In particular, private investment in research and development in the EU has remained low in comparison to other advanced economies, and the gap has grown again since 2013. This poor EU performance signals a weak capacity to translate knowledge into market-creating innovations⁸. Europe has to anticipate and ride the new global wave of breakthrough innovation that is coming up, one that will be more “deep-tech”⁹ and will affect sectors such as manufacturing, financial services, transport or energy.

EU-level R&I investments support public goods¹⁰ with a high European added value¹¹: through EU-wide competition for excellence, EU investments support the training and mobility of scientists, create transnational and multidisciplinary collaboration, leverage additional investment from the public and private sectors, build the scientific evidence necessary for effective EU policies, and structure national R&I systems¹².

To stimulate innovation in Europe, more is needed. EU investments in R&I must be enhanced and re-designed to better serve strategic areas for Europe and cover the full value chain development from early and advanced research to innovation and market deployment. They must be matched by national investments in R&I, and the market

and regulatory framework must create the right conditions for innovation to flourish¹³. However, these issues are outside the scope of this impact assessment.

1.1.1 Political context

The common view of the EU Institutions is that the Framework Programmes for R&I have a high EU added value and that the implementation of the current Programme is largely a success. In addition to the Communication on the Interim Evaluation of Horizon 2020¹⁴, the Commission's reflection paper on the future of EU finances highlights R&I as a key European priority¹⁵, citing it as an example of a public good with clear EU added value. Opinions and reports from the European Parliament¹⁶, the European Economic and Social Committee¹⁷, the Committee of Regions¹⁸, the European Research Area and Innovation Committee (ERAC, where Member States' public administrations are represented)¹⁹, and more recently, the Competitiveness Council (through Council Conclusions²⁰) support the findings of the Interim Evaluation, in particular stressing that EU added value must be the major driver for the design and implementation of the next Framework Programme.

In response to the Horizon 2020 interim evaluation, the European Parliament, supported by the Committee of Regions, similarly calls,

Box 1: Overall budget envelope

On 2 May 2018, the European Commission adopted its proposals for a new Multiannual Financial Framework (MFF) for 2021-2027²¹. **Under these proposals, the Horizon Europe and the Euratom programmes will have a combined budget of EUR 100 billion** over this period. This impact assessment report reflects the decisions of the MFF proposals and focuses on the changes and policy choices which are specific to these instruments.

among others, on the EU to avoid budget cuts to Horizon 2020 and to endow the successor programme with at least EUR 120 billion²². The ERAC calls for proportionality between budget and ambitions. Similarly, Council Conclusions emphasise the need to prioritise R&I across all relevant EU policies, and provide significant funds for the future programme.

1.1.2 Legal context

The Framework Programme for R&I is based on Articles 173, 182, 183 and 188 of the Treaty on the Functioning of the European Union²³. This initiative is in an area of (shared) parallel competence and the subsidiarity and proportionality principles apply. This impact assessment satisfies the requirements of the

Financial Regulation in respect of preparing an ex-ante evaluation.

The EU Framework Programme for R&I respects the subsidiarity and proportionality principles. Action at EU level is necessary: the underlying findings of a recent external study are that more than four out of five Horizon 2020 projects would not have gone ahead without Horizon 2020 funding²⁴. They produce **undeniable added value** in terms of scale, speed and scope compared to national and regional-level support to R&I (without replacing it²⁵) by boosting excellence through transnational competition, strengthening impact via collaborative R&I, and providing critical mass to tackle global challenges (see Annex 2). Moreover, it is **proportionate**, not going beyond what is required for Union objectives.



1.2 LESSONS LEARNT FROM PREVIOUS PROGRAMMES

EU Framework Programmes have generated significant and long-lasting impacts²⁶, as shown by successive evaluations since the EU started investing in R&I in 1984. More details on the lessons learnt from evaluations of previous Programmes are in Annex 1.

The Communication on the interim evaluation of Horizon 2020²⁸ identified several areas for improvement. In addition to in-depth analysis, this was based on extensive stakeholder feedback²⁹ and the strategic recommendations of the independent High Level Group on

Box 2: Recommendations from the ex-post evaluation of the Seventh Framework Programme

The Ex Post Evaluation of the Seventh Framework Programme (FP7) made the following recommendations²⁷, which are also relevant for this impact assessment:

- a. Ensure focus on critical challenges and opportunities in the global context.
- b. Align research and innovation instruments and agendas in Europe.
- c. Integrate the key components of the Framework Programmes more effectively.
- d. Bring science closer to the citizens.
- e. Establish strategic programme monitoring and evaluation.

maximising the impact of EU R&I Programmes (Lamy High Level Group):

- **Continue simplification.** Horizon 2020 has made great progress in terms of simplification compared to FP7, but simplification is an ever continuing undertaking, requiring constant improvements. Further simplification should be pursued to support faster innovation cycles and lower administrative burden.
 - **Support breakthrough innovation.** While some potential for supporting breakthrough, market-creating innovation was identified in Horizon 2020, such support should be considerably strengthened in order to identify, develop and deploy breakthrough and market-creating innovations and support the scale-up of young and quickly growing innovative companies to international and European levels.
 - **Create more impact through mission-orientation and citizen involvement.** The Framework Programme needs greater impact and more outreach to citizens. A mission-oriented approach would increase the focus on impact, while involving citizens, customers and end-users in agenda-setting (co-design) and implementation (co-creation) leads to more innovation by stimulating user-driven innovation and the demand for innovative solutions.
 - **Increase synergies with other EU funding programmes and EU Policies.** While synergies already exist between Horizon 2020 and other EU programmes, they should be further strengthened. In particular, building on synergies with the European Structural and Investment Funds (ESIF) and smart specialisation strategies,
- R&I capacities built over the past decade in lower performing regions could be better used for Framework Programme-supported projects.
 - **Strengthen international cooperation.** While Horizon 2020 has a broad international outreach and openness to the world, third-country participations declined when compared to FP7³⁰. International cooperation in R&I is vital for ensuring access to talent, knowledge, know-how, facilities and markets worldwide, for effectively tackling global challenges, and for implementing global commitments. It needs to be further intensified in order to strengthen Europe's R&I excellence and competitiveness.
 - **Reinforce openness.** There is a need to build on the great progress made in terms of making the scientific publications and data generated by Horizon 2020 openly accessible to the wider scientific community and public. The next Framework Programme should fully embrace Open Science policy as a way of strengthening scientific excellence, benefiting from citizen participation, achieving better reproducibility of results, and increasing the re-use of research data.
 - **Rationalise the funding landscape.** A key area for improvement is the rationalisation of the funding landscape, in particular with respect to partnership instruments and initiatives. Reforming the current policy approach to European Partnerships should make it possible to use the full potential of the new or renewed European Partnerships in achieving ambitious policy objectives that cannot be achieved by the Union or national action alone.

Following the Interim Evaluation of Horizon 2020, the Lamy High Level Group report (presented at the conference “Research & innovation – shaping our future” on 3 July 2017)³¹ and the open public stakeholder consultations for the preparation of the sectorial legislation accompanying the proposal for

the post-2020 MFF, more than 300 position papers were received. Fostering R&I across the EU resulted as the most important policy challenge according to the respondents to the public stakeholder consultation.

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- 1 The Treaty requires that rules for participation and dissemination are adopted by the European Parliament and the Council in accordance with the ordinary legislative procedure.
 - 2 The Treaty on the Functioning of the European Union (TFEU) requires that a multiannual Framework Programme is adopted by the European Parliament and Council in accordance with the ordinary legislative procedure, and implemented through Specific Programmes adopted in accordance with the special legislative procedure.
 - 3 The Euratom Treaty provides the legal basis for promoting and facilitating nuclear research.
 - 4 European Commission (2017), 2017 Special Eurobarometer on Climate change. According to the 2017 Special Eurobarometer on Climate change, 92% of EU citizens see climate change as a serious problem, and 79 % of Europeans believe fighting climate change can boost the economy and create jobs.
 - 5 This initiative contributes in particular to the following Commission priorities: Jobs, Growth and Investment; Digital Single Market; Energy Union; Deeper and Fairer Internal Market; An Area of Justice and Fundamental Rights; Towards a New Policy on Migration; EU as Stronger Global Actor; and EU of Democratic Change. It contributes as well to the implementation of the 2030 Agenda on sustainable development, the EU Global Strategy, and new EU priorities, notably security, defence and migration, in line with the Rome declaration.
 - 6 European Commission (2017), The economic rationale for public R&I funding and its impact, Policy Brief Series, p. 23.
 - 7 In contrast, China's intensity is now higher, and South Korea's is more than double. The EU will need to train and employ at least one million new researchers, but the share of R&I personnel in the labour force increased marginally 2002-2015.
 - 8 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 11.
 - 9 “Deep tech” refers to companies founded around scientific discoveries or meaningful engineering innovations.
 - 10 European Commission (2017), Reflection paper on the future of EU finances.
 - 11 More evidence can be found in the Annex 2 on the EU added value of R&I.
 - 12 The EU has been investing in R&I since 1984. Over time, the share of the EU budget dedicated to R&I has increased.
 - 13 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 11.
 - 14 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final.
 - 15 European Commission (2017), Reflection paper on the future of EU finances.
 - 16 European Parliament (2017), REPORT on the assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal, EP T8-0253/2017.
 - 17 European Economic and Social Committee (2016), EESC information report INT/807, Horizon 2020 (evaluation).
 - 18 Committee of the Regions (2017), CoR Opinion SEDEC-VI/026, Local and Regional Dimension of the Horizon 2020 Programme and the New Framework Programme for Research and Innovation.
 - 19 European Research Area and Innovation Committee (2017), ERAC Opinion on the Interim Evaluation of Horizon 2020 and preparations for the next Framework Programme, ERAC 1207/17.
 - 20 Council of the European Union (2017), From the Interim Evaluation of Horizon 2020 towards the ninth Framework Programme - Council conclusions.
 - 21 European Commission (2018), A Modern Budget for a Union that Protects, Empowers and Defends, The Multiannual Financial Framework for 2021-2027, COM(2018) 321 final.
 - 22 European Parliament (2017), REPORT on the assess-

- ment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal, EP T8-0253/2017.
- 23 The Euratom proposal is based on Article 7 of the Treaty establishing the European Atomic and Energy Community.
- 24 PPMI (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020).
- 25 Lab – Fab – App, Investing in the European future we want, Lamy High Level Group report, Annex 5, p. 32. Indeed, the Lamy High Level Group report identified no direct evidence of overall crowding-out effect of national funding. While some countries present simultaneously a decrease in national budget for R&D and an increase in EU contribution from the Framework Programme, this result is not systematic for all countries.
- 26 European Commission (2018), A new, modern Multiannual Financial Framework for a European Union that delivers efficiently on its priorities post-2020, COM(2018)98 final.
- 27 European Commission (2016) Response to the Report of the High Level Expert Group on the Ex Post Evaluation of the Seventh Framework Programme, COM(2016) 5 final.
- 28 European Commission (2018), Horizon 2020 interim evaluation: maximising the impact of EU research and innovation, COM(2018)2.
- 29 The open public stakeholder consultation on the Interim Evaluation received 3500 replies and 300 position papers.
- 30 The discontinuation in Horizon 2020 of the automatic funding to organisations from Brazil, Russia, India, China and Mexico caused an important decrease of their participation.
- 31 Conference proceedings available at <https://publications.europa.eu/s/fc5N>

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

2 CHALLENGES AND OBJECTIVES



2 CHALLENGES AND OBJECTIVES



2.1 KEY FEATURES OF HORIZON 2020 AND EXPECTED IMPACTS OF ITS CONTINUATION

Having excellence as the core underlying principle, Horizon 2020 attracts participants from the best institutions and companies in and outside Europe, covering a wide range of disciplines. Stakeholders express strong satisfaction with the programme, as shown by the sustained interest in its highly competitive calls and high oversubscription rates (which is commonly quoted by stakeholders as being the biggest problem). The programme offers unique collaboration and networking opportunities. Scientific publications of Horizon 2020 are cited already at twice the world average rate. Patents produced through the programme are of higher quality and likely commercial value than similar patents produced

elsewhere. Horizon 2020 has shown flexibility in responding to evolving political priorities, such as migration, and emergencies such as the Ebola and Zika outbreaks. Horizon 2020 is on track to contribute significantly to the creation of jobs and growth. Moreover, it supports EU policy objectives through its focus on excellent science, industrial leadership and societal challenges.

The continuation of the ongoing Programme is expected to generate even more:

- > **new knowledge and technologies, promoting scientific excellence and significant scientific impact.** The Programme

Key features of Horizon 2020:

- > significant budget (close to EUR 77 billion) for 7 years (2014-2020), with a target of 35% related to climate action and 60% related to Sustainable Development;
- > seamless integration of R&I into a single framework, from 'blue-sky', frontier research to close-to-market innovation activities;
- > direct R&I investments through an EU-wide competition based on excellence as guiding principle (and main evaluation and selection criterion);
- > central management by the European Commission, its executive agencies or other implementing bodies;
- > a three-pillar structure focusing on excellent science, industrial leadership and societal challenges.
- > major simplification measures implemented through the Common Support Centre, such as a single set of rules, an easy to use cost reimbursement model, a single point of access for participants, fewer audits.

will continue to facilitate cross-border collaboration between top scientists and innovators, allowing for trans-national and cross-sector coordination between public and private R&I investment. Horizon 2020 has already attracted the world's best research institutions and researchers, supported ~340,000 researchers, and developed Europe's human capital. The first scientific publications from Horizon 2020 are world-class (cited more than twice the world average) and contributed to major discoveries like exoplanets, the Higgs boson, and gravitational waves¹.

- > **positive effects on growth, trade and investment flows²**, quality jobs and international mobility for researchers in the European Research Area. The continuation scenario is expected to bring an estimated average GDP increase of 0.08% to 0.19% over 25 years, which means that each euro invested can potentially generate a return up to 11 euros of GDP gains over the same period^{3,4} (see Annex 3). EU investments in R&I are expected to directly generate an

estimated gain⁵ of up to 100,000 jobs in R&I activities in the “Investment phase” (2021-2027) and to foster an indirect gain of up to 200,000 jobs over 2027-2036, of which 40% are high-skilled jobs, through the economic activity generated by the Programme.

- > **significant social and environmental impact.** This will happen directly through the dissemination, exploitation and uptake of scientific results translated into new products, services and processes, which in turn contribute indirectly to the successful delivery on political priorities.

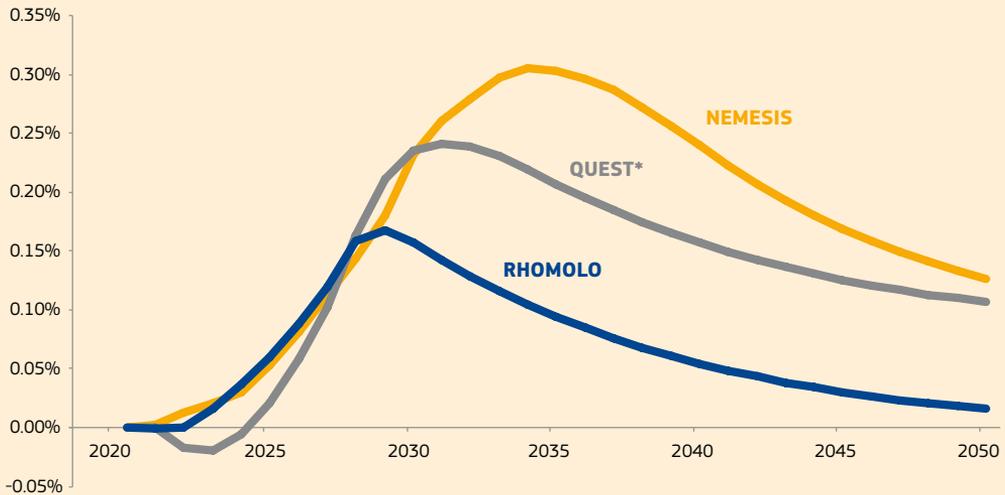
These impacts mean that the potential cost of discontinuing the EU R&I Programme (i.e. cost of non-Europe) is substantial. Discontinuation would result in a decline of competitiveness and growth (up to EUR 720 billion of GDP loss over 25 years⁶), sharp reductions in the private and national investments that are currently leveraged by EU-level co-investments, creating significant losses of social, environmental and economic impacts.

Box 3: Three phases of the economic impact of the Framework Programme

The expected economic impact of continuation is decomposed in three phases in the NEMESIS model⁷:

- **The investment phase.** From the beginning to the end of the Programme (2021-2027). Assuming a “maturation” lag of innovation between 3 and 5 years, economic impact is driven by the spending, with comparatively moderate impact from the production of innovations at this stage.
- **The innovation phase.** During and after the investment phase, R&I investments produce economic effects through the creation of new process and product innovations. Process innovation increases efficiency, which leads to lower cost. Product innovation increases the quality of, and raises the demand for, products. The lower cost and enhanced quality increase competitiveness.
- **The obsolescence phase.** After the innovation phase, knowledge depreciation decreases gains.

Figure 1: GDP gains from the continuation of Horizon 2020 (percentage change compared to a situation without the Framework Programme)



*Note: Figures calculated for EU-27; different sets of results from QUEST are presented in Annex 3 based on different funding assumptions. This graph presents the scenario with higher benefits.



2.2 MAIN R&I CHALLENGES AND PROBLEMS TO BE ADDRESSED

Based on the key findings and lessons learnt from the Horizon 2020 Interim Evaluation (see section 1.2), the following key challenges in the area of R&I to be addressed by the future Programme have been identified:

1. **The creation and diffusion of high-quality new knowledge and innovation in Europe should be improved.** Europe is overall a global scientific powerhouse, but it is essentially a “*mass producer [of knowledge] with, relative to its size, comparatively few centres of excellence that stand out at the world level and with large differences between European countries*”⁸. Moreover, the gap between high productivity firms and the rest has grown, illustrating a serious issue in the circulation of knowledge and technologies. This corresponds to the following findings of the Horizon 2020 Interim Evaluation:
 - Sub-optimal creation⁹ of high-quality knowledge and lack of diffusion¹⁰ of knowledge across borders, sectors, disciplines¹¹ and along the value chain;
 - Insufficient open science¹²;
 - Scattered pockets of scientific excellence and R&I infrastructures¹³;
 - Rapid increase of global competition for talent¹⁴;
 - Hampered global R&I cooperation¹⁵.
2. **There is a need to reinforce the impact of R&I in policy-making.** R&I have to take a more prominent place in shaping EU policy priorities and for delivering on policy commitments and priorities of the Union. R&I are expected to make a crucial contribution to achieving EU policy priorities, including the Sustainable Development Goals. The impact is stronger when investments are prioritised in areas where the EU added value is greatest¹⁶ and aligned with policy needs; when support provides incentives in a highly performing and dynamic system with supportive framework conditions; and where R&I results have a strong potential to feedback into the policy-making cycle. Investments in R&I have to better fit into the full innovation cycle, from societal needs to market deployment, supporting the implementation of EU, national and regional strategic policy priorities. Uptake of innovative solutions has been low so far, and more needs to be done to increase end-user involvement, for demonstrating and scaling up promising solutions and create favourable market and framework conditions for innovation, including social innovation, while ensuring that competition in the internal market which drives the innovative efforts of companies and unlocks their innovative potential is not distorted. This corresponds to the following findings of the Horizon 2020 Interim Evaluation:
 - Variable focus on EU strategic challenges¹⁷;
 - Sub-optimal link between R&I and EU policy-making¹⁸;

- Low awareness of innovative solutions and insufficient end-user/citizen involvement in the R&I process¹⁹.
3. **EU is lacking rapid uptake of innovative solutions.** Around two thirds of EU manufacturing companies have not recently used any advanced technologies²⁰, and competition from the USA and Asia has intensified. The EU's substantial knowledge assets, notably in the field of key enabling technologies, need to be more effectively and quickly turned into innovations, particularly as innovative solutions for global challenges are increasingly research-intensive. Apart from aiming at high industrial participation in the programme, a stronger focus is needed on innovators working on breakthrough market-creating innovations - these are rare in Europe (fast-growing start-ups, so-called *unicorns*, are five times fewer than in the USA²¹). This corresponds to the following findings of the Horizon 2020 Interim Evaluation:
- Slow industrial transformation²²;
 - Limited scale-up of innovative SMEs at EU level and lack of venture capital²³;
 - Lack of entrepreneurial skills to translate ideas into innovations²⁴.
4. **There is a need to strengthen the European Research Area (ERA).** While strong progress was made over the last years²⁵, knowledge flows, good working conditions, effective career development of researchers and other ERA priorities, need to be more widely spread. Within the EU, scientific excellence is rather concentrated, and EU funding from Horizon 2020 to low performing R&I countries remains low²⁶. The delivery of the Programme can only be optimised by unlocking the potential of all partners - this means there is a need for strengthening the EU scientific and technological base and spreading the benefits of excellence²⁷.



2.3 OBJECTIVES OF THE FUTURE PROGRAMME

The Framework Programme's general objective is based on Article 179.1 TFEU:

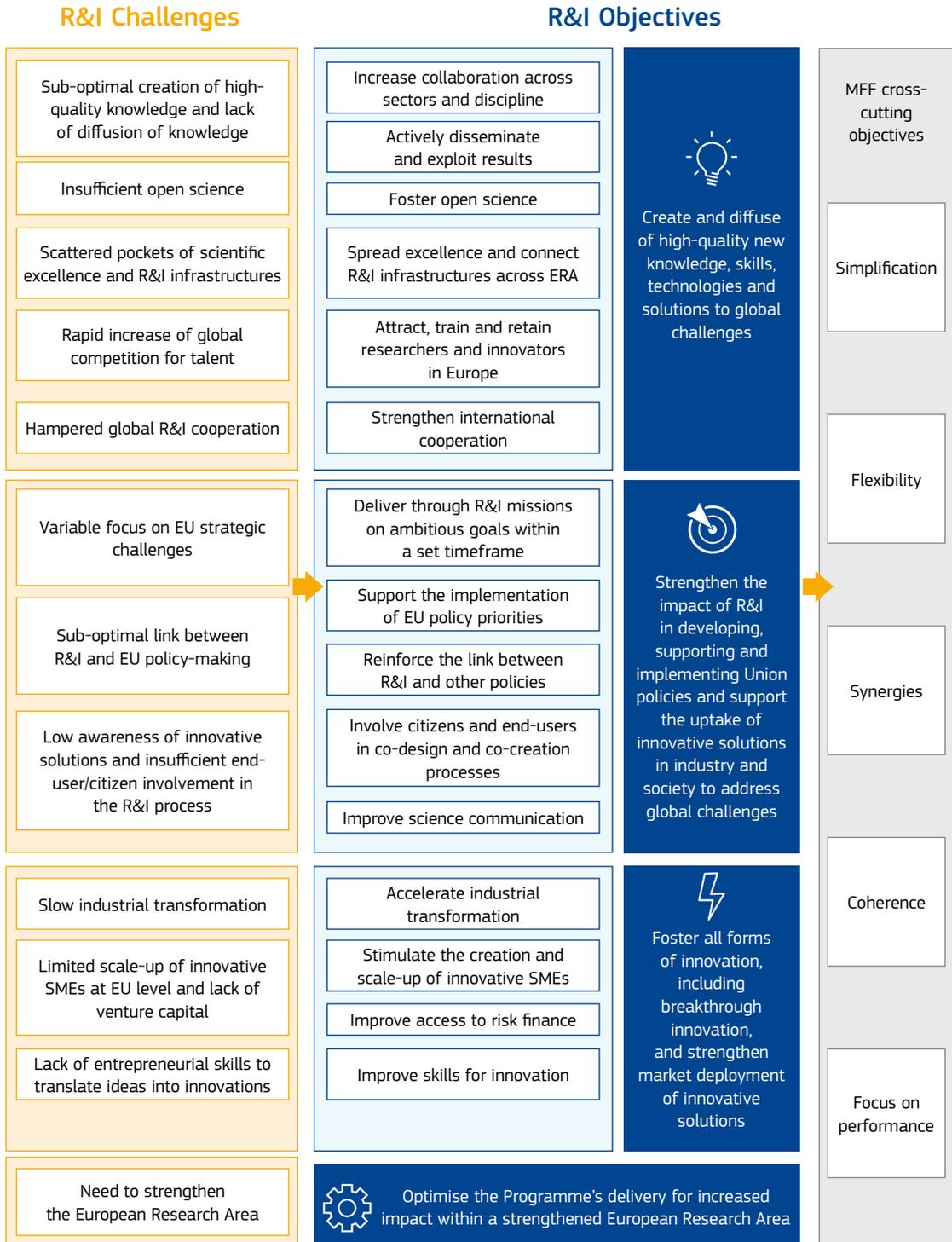
- > to strengthen the scientific and technological bases of the Union and foster its competitiveness, including for its industry, deliver on the EU's strategic policy priorities and contribute to tackling global challenges, including the Sustainable Development Goals.

As a lesson learnt from the Interim Evaluation of Horizon 2020 supported by strong stakeholder feedback, specific objectives are identified for the Programme as a whole (i.e. not per part or instrument) to improve coherence and linkages among Programme parts. Based on the challenges identified in section 2.1, the specific objectives are:

1. to support the creation and diffusion of high-quality new knowledge, skills, technologies and solutions to global challenges;
2. to strengthen the impact of research and innovation in developing, supporting and implementing Union policies, and support the uptake of innovative solutions in industry and society to address global challenges;
3. to foster all forms of innovation, including breakthrough innovation, and strengthen market deployment of innovative solutions;
4. to optimise the Programme's delivery for increased impact within a strengthened European Research Area.

General and specific objectives will be pursued through an improved Programme structure (Section 3). The implementation of the Programme will be optimised in terms of delivery (Section 4) in line with the cross-cutting objectives of the MFF, notably simplification, flexibility, coherence, synergies and focus on performance. The specific objectives are operationalised in the Specific Programme implementing the Framework Programme. All objectives articulate with each other coherently, so that all actions in each pillar can deliver on the objectives without risking any inconsistencies or exclusions.

Figure 2: Link between the Framework Programme’s challenges and objectives.



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- 1 European Commission (2017), Key findings of the Interim Evaluation.
 - 2 The economic impact of the Programme comes from the transformation of scientific excellence into innovations that generate economic outcomes: employment, exports, competitiveness, value-added and higher GDP.
 - 3 This multiplier is based on simulations done using the NEMESIS model and is consistent with figures provided in the Interim evaluation of Horizon 2020 (calculated over a period of 17 years) and in the ex-post evaluation of the 7th Framework Programme.
 - 4 The average GDP gain in RHOMOLO is 0.08%, the average gain in QUEST is up to 0.14% and the average gain in NEMESIS is 0.19%. NEMESIS results are based on Seureco (forthcoming), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme. QUEST and RHOMOLO results were produced, respectively, by DG ECFIN and DG JRC.
 - 5 *ibid.*
 - 6 This figure is calculated for the EU-27 only and it is based on the NEMESIS model.
 - 7 Seureco (forthcoming), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programmes.
 - 8 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 46.
 - 9 More than 14% of publications from the United States are in the top 10% most cited publications compared to 11% for EU publications (see Research and Innovation Observatory). When looking at the top 1% most cited publications, the difference is even larger (50% more in the US than in the EU) (see S. Thomson, V. Kanesarajah (2017), The European Research Council – The first 10 years, Clarivate Analytics).
 - 10 Knowledge diffusion between business and academia remains lower in the EU than in the US (public-private co-publications per million-population stand at 50, over 35 points lower than in the US (see European Commission (2016), Science, Research and Innovation Performance of the EU).
 - 11 J. Allmendinger (2015), Quests for interdisciplinarity: a challenge for the ERA and Horizon 2020, RISE policy brief.
 - 12 RISE Group (2017), Europe's future: Open innovation, open science, open to the world; reflections of the Research, Innovation and Science Policy Experts (RISE) High Level Group, p. 65.
 - 13 Scientific quality is concentrated in a group of leading countries, predominantly in North-West Europe, but there are a number of small universities with a small number of excellent fields in less developed regions (source: Interim Evaluation of Horizon 2020).
 - 14 Increasingly, expertise and resources are abroad: 75% of knowledge (see European Commission (2016), Science, Research and Innovation performance of the EU) and 90% of market growth (see European Commission (2015), Trade for all, Towards a more responsible trade and investment policy) will be outside the EU over the next decade (see also European Commission (2017), Strengthening European Identity through Education and Culture, The European Commission's contribution to the Leaders' meeting in Gothenburg, p. 4).
 - 15 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 100.
 - 16 Lab – Fab – App, Investing in the European future we want, Lamy High Level Group report, p. 8.
 - 17 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 59.
 - 18 *Ibid.*
 - 19 Social awareness is a constraining factor for the full-scale deployment of R&I-driven solutions required for societal transformation, but new and rapidly evolving technologies like robots and artificial intelligence raise concerns amongst citizens. In Europe, absence or uncertainty of demand for innovative goods and services are among the most cited obstacles to innovation, see also JRC Science for Policy Report (2016), Modes of Innovation.
 - 20 Flash Eurobarometer 433, Innobarometer 2016 – EU business innovation trends. This figure has increased by 14 percentage points between the last two releases of the Innobarometer (i.e. 2015 and 2016).
 - 21 Lab – Fab – App, Investing in the European future we want, Lamy High Level Group report, p. 7.
 - 22 High-Level Strategy Group on Industrial Technologies (2018), Conference Document.
 - 23 Very few European start-ups survive beyond the critical phase of 2-3 years, and even fewer grow into larger mermaids. Less than 5% of European SMEs grow internationally. Venture capital in the EU is one-fifth the level of the USA.
 - 24 Less than half Europeans believe they have the skills to pursue entrepreneurial opportunities World Economic Forum, Enhancing Europe's Competitiveness Fostering Innovation-driven Entrepreneurship in Europe, p. 16.
 - 25 European Commission (2017), ERA Progress Report 2016, Report from the Commission to the Council and the European Parliament, COM(2017) 35.
 - 26 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 119.
 - 27 *Ibidem*, p. 46.

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

3 PROGRAMME STRUCTURE AND PRIORITIES



3 PROGRAMME STRUCTURE AND PRIORITIES



3.1 SCOPE AND STRUCTURE OF THE NEW FRAMEWORK PROGRAMME

“An evolution, not a revolution”¹ - building on the positive findings of the Horizon 2020 Interim Evaluation, stakeholder feedback² and the Lamy High Level Group report, only a further refinement of the current Programme is necessary³. Therefore, the vast majority of the parts and features of Horizon 2020 will be continued, albeit with several optimisations and minor redesigns. As all components of the Framework Programme are necessary to achieve its objectives, a different level of ambition (including budgetary) would result in an adjusted level of support across all areas. Moreover, compared to Horizon 2020, Horizon Europe will invest less in sector-specific projects and partnerships, and focus instead on systemic transformations.

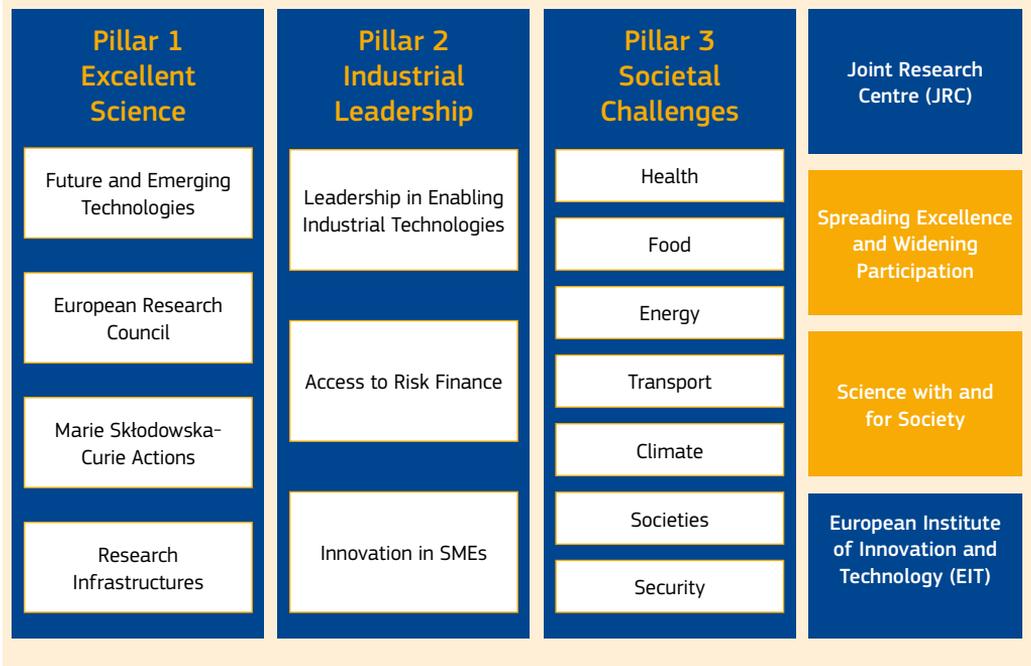
The Programme’s scope will continue to cover research⁴ and innovation⁵ in an integrated manner. Scientific knowledge, societal challenges and industrial technologies should complement each other and be mutually reinforcing, bringing industry, academia, public stakeholders, and citizens closer together, and thereby aligning the processes and the outcomes of R&I with societal needs, expectations and values, including gender balance. In close synergies with other EU Programmes, the Framework Programme will continue to support the whole innovation ecosystem with seamless support from the lab to the market uptake for high-risk activities that would not be performed without public support.

Box 4: The three-pillar structure of Horizon 2020

Pillar 1 - Excellent Science aims to raise the level of excellence in Europe’s science base and ensure a steady stream of world-class research to secure Europe’s long-term competitiveness. **Pillar 2 - Industrial Leadership** aims to speed up the development of the technologies and innovations that will underpin tomorrow’s business and help innovative European SMEs to grow into world-leading companies. **Pillar 3 - Societal Challenges** responds directly to the policy priorities of the Europe 2020 strategy and aims to and addresses major concerns shared by citizens in Europe and elsewhere.

In addition to the three pillars, Horizon 2020 has two specific objectives: (i) “**Spreading Excellence and Widening Participation**” and (ii) “**Science With and for Society**”. It also includes support for the **European Institute of Innovation and Technology (EIT)** – with the objective of promoting the knowledge triangle – and for the **Joint Research Centre (JRC)** – with the objective of providing robust evidence for EU policy making. Furthermore, a number of **cross-cutting issues** are promoted, e.g. the realisation of the European Research Area (ERA), Responsible Research and Innovation, SMEs and private sector participation, Social Sciences and Humanities, gender, international cooperation, sustainable development and climate-related expenditure.

Figure 3: The three-pillar structure of Horizon 2020



The three-pillar structure will be continued and optimised. It will be redesigned to better address the challenges described in Section 2.2. With clearly defined and complementary rationales for intervention, each part will contribute to all the specific objectives. The design of the three pillars will ensure interconnections leading to mutual reinforcement of activities, helping meet the Programme’s objectives and ultimately boosting the overall impact (see Figure 4). Support to basic research will remain a cornerstone of the Programme, pursued primarily under the first pillar (but also in the other two pillars); applied research and incremental innovation will be the centre of gravity in the second pillar, addressing both industrial and societal needs (Global Challenges and Industrial Competitiveness); innovation is the focus of the third pillar (Open Innovation). The largest share of resources is needed for the Global Challenges and Industrial Competitiveness pillar, followed by Open Science and Open Innovation, whereas

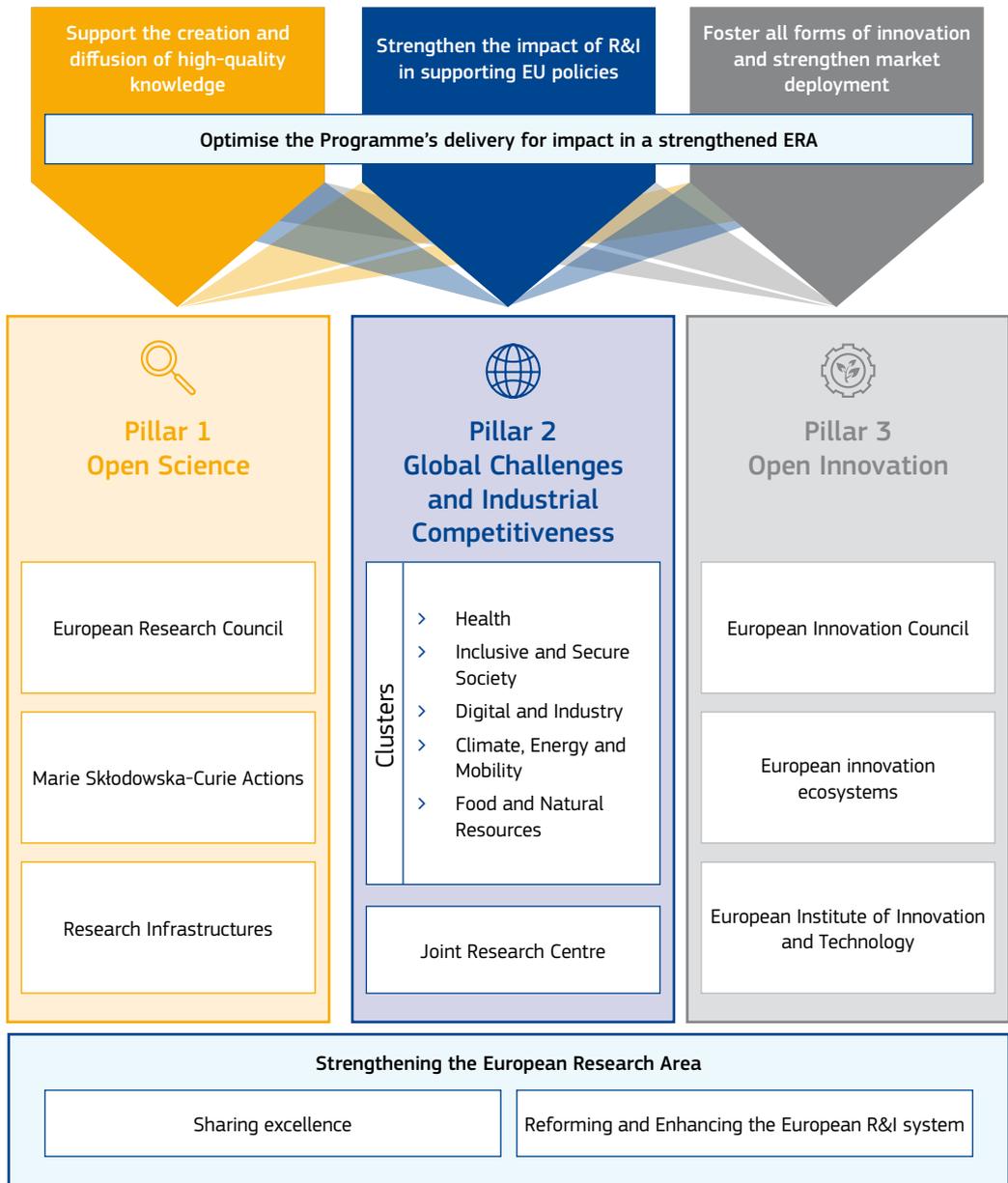
Strengthening the European Research Area entails only a limited budget.



The majority of stakeholders commenting on the pillar structure are satisfied with the current three-pillar structure of Horizon 2020 and wish to see either a complete replication or some modifications to the existing architecture. The main suggestions for improvements over the Horizon 2020 structure relate to increasing the links between pillars to improve the coverage of the entire knowledge and innovation chain. Several position papers outline the increasing importance of the ‘Societal Challenges’ and call for a more prominent pillar that takes into account the current socio-economic issues⁶.

Figure 4: Main structure of the new Framework Programme: “evolution, not revolution”

Specific objectives of the Programme



The revised pillar structure reflects the nature of the R&I challenges, which has evolved compared to Horizon 2020. As highlighted in previous sections, the Programme needs to be equipped with an innovation-focused pillar to support breakthrough market-creating innovations that bring transformational changes. In addition, given the crucial role of Key Enabling Technologies in the economy and society⁷, the R&I agenda-setting has to integrate industry's contribution to societal needs with efforts to tackle global challenges and other EU political priorities in order to improve the coherence and impact of the Programme.

The overarching mission-orientated approach will provide a sense of direction to all activities supported by the Programme. For instance, future missions under pillar 2 (see section 3.2.2) will be planned in the context of ongoing frontier research under the ERC. While fully respecting the bottom-up nature of those programme parts, relevant ERC and MSCA projects might be linked to ongoing missions. The scale and scope of missions can also inspire new research and innovation proposals elsewhere in the Programme. Promising projects from either of the first two pillars might produce spin-offs and be scaled-up with support under the EIC Accelerator under pillar 3 (see section 3.2.1). Similarly, activities supported through the EIT KICs may be picked up under the EIC Accelerator, or feed into ongoing missions (see Annex 6.1).

➤ **Pillar 1 - Open Science:** Building on its current successes, the first pillar will continue to focus on excellent science and high-quality knowledge to strengthen EU's science base through the European Research Council (ERC), Marie-Sklodowska Curie Actions (MSCA) and Research Infra-

structures. A greater emphasis will be placed on Open Science policy (open access to publications, accessibility and reuse of scientific data), including in the Research Infrastructures part in support for the European Open Science Cloud. In view of the largely “bottom-up”, investigator-driven nature of this pillar, the European scientific community will continue to play a strong role. The Future and Emerging Technologies (FET) part (Pro-active, Open and Flagships) has, and continues to have, a relevant impact on knowledge production, the economy and society⁸. The lessons learnt⁹ from these essential instruments will be taken forward and streamlined with other instruments in the Framework Programme (see section 3.2.1). However, the “FET” label will be discontinued for increased coherence and user-friendliness, in the interest of rationalising the support landscape.

➤ **Pillar 2 - Global Challenges and Industrial Competitiveness:** The second pillar will integrate the Horizon 2020 parts *Societal Challenges and Leadership in Enabling Industrial Technologies* to better address EU policy priorities and support industrial competitiveness. Due to its policy focus, the pillar will be implemented “top-down” through a strategic planning process ensuring societal and stakeholder involvement, and alignment with Member States' R&I activities. The pillar will provide robust, evidence-based support to Union policies, in particular through the Joint Research Centre (JRC). While maintaining a strong degree of continuity with Horizon 2020, the main changes will be:

- Societal Challenges and Leadership in Enabling Industrial Technologies of

Horizon 2020 integrated in five clusters to enable more flexibility and interdisciplinarity, with a specific digital and industry cluster (see Box 5);

- reinforced mission-orientation, with a limited set of highly visible R&I missions that engage citizens and civil society organisations to help reach ambitious goals¹⁰ (see Annex 6.2 on missions);
 - higher visibility for industry's role in solving global challenges (see Box 6), including through Key Enabling Technologies.
 - simplified forms of partnership initiatives that are open to all (e.g. private sector, Member States, philanthropic foundations; see Annex 6.5).
- > **Pillar 3 – Open Innovation:** Whilst innovation will be supported throughout the whole Programme, an innovation-focused pillar will offer a one-stop shop for high potential innovators with the European Innovation Council (EIC). The EIC will offer a coherent, streamlined and simple set of support actions dedicated to the emergence of breakthrough ideas, the development and deployment of market-creating innovations and scaling-up of innovative enterprises. These activities will be largely defined “bottom-up”, being open to innovations from all fields of science, technology and applications in any sector, while also enabling focused approaches on emerging breakthrough or disruptive technologies of potential strategic significance. Additional measures under this Pillar will boost support to the European innovation ecosystem, notably through co-funding various joint national

initiatives that boost innovation (e.g. joint programme between agencies implementing national/local innovation policies, joint public procurement actions). In addition to the EIC, financial instruments implemented under the InvestEU programme will help bridge the “valley of death” between research and commercialisation, and will support the scaling-up of companies. The European Institute for Innovation and Technology (EIT) and its Knowledge and Innovation Communities (KICs) will have an important role in the Open Innovation pillar, supporting the development of the European innovation ecosystem through the integration of education, research and entrepreneurship. Through their focus on key strategic priorities in line with the strategic programming of the Framework Programme (see section 4.1), KICs will also contribute to the wider programme objectives, including to deliver on global challenges and missions.

In addition to the three main pillars, the Horizon Europe will strengthen the European Research Area through successful elements of Horizon 2020 that will be integrated: (i) **Sharing excellence** (extending the Horizon 2020 Spreading Excellence and Widening Participation actions Teaming, Twinning, ERA chairs, and COST) to continue supporting low performing R&I Member States to increase their excellence; (ii) **Reforming and enhancing the European Research Area**, covering the Policy Support Facility; foresight activities; Framework Programme's monitoring, evaluation, dissemination and exploitation of results; the modernisation of European universities; and Science, society and citizens (building on the Horizon 2020 Science with and for Society).

Box 5: Clusters in the Global Challenges and Industrial Competitiveness pillar

The Global Challenges and Industrial Competitiveness pillar has five clusters that cover the activities of the LEIT part of pillar 2 and the seven societal challenges of pillar 3 of Horizon 2020. The clusters are Health; Inclusive and Secure Society; Digital and Industry; Climate, Energy and Mobility; and Food and Natural resources. The clusters are derived from specifically commissioned foresight input, including from stakeholders, and have the Sustainable Development Goals as the main reference point. The clusters and their intervention areas are expected to have more impact since they cut across classical boundaries between disciplines and address different types of challenge. The integrated clusters of activities will form the basis for support to collaborative research and innovation projects under the Global Challenges and Industrial Competitiveness pillar in the implementation of the Framework Programme.

Table 1: Clusters and intervention areas

Health	Inclusive and Secure Society	Digital and Industry	Climate, Energy and Mobility	Food and Natural Resources
<ul style="list-style-type: none"> > Health throughout the life course > Environmental and social health determinants > Non-communicable and rare diseases > Infectious diseases > Tools, technologies and digital solutions for health > Health care systems 	<ul style="list-style-type: none"> > Democracy > Cultural heritage > Social and economic transformations > Disaster-resilient societies > Protection and Security > Cybersecurity 	<ul style="list-style-type: none"> > Manufacturing technologies > Key digital technologies > Advanced materials > Artificial intelligence and robotics > Next generation internet > Advanced computing and Big Data > Circular industries > Low-carbon and clean industries 	<ul style="list-style-type: none"> > Climate science and solutions > Space > Energy supply > Energy systems and grids > Buildings and industrial facilities in energy transition > Communities and cities > Industrial competitiveness in transport > Clean transport and mobility > Smart mobility > Energy storage 	<ul style="list-style-type: none"> > Environmental observation > Biodiversity and natural capital > Agriculture, forestry and rural areas > Sea and oceans > Food systems > Bio-based innovation systems > Circular systems

stakeholders, citizens and their associations (CSOs) are brought closer together; and which seamlessly supports the whole innovation ecosystem from research to innovation and market deployment.

- **Industry is a core enabler to solve Global Challenges.** Integration of the Leadership in Enabling Industrial Technologies programme parts, previously under the second pillar in Horizon 2020 ('Industrial Leadership'), within the Global Challenges and Industrial Competitiveness pillar would provide a higher visibility to the role of industry in solving Europe's major societal challenges, for instance through Key Enabling Technologies.
- **The “Digital and industry” cluster** will be dedicated to support innovative, sustainable and digital industries, including through Key Enabling Technologies for the future. This cluster is expected to address directly the issue of slow industrial transformation and promote adjustment of industry to structural changes. **Partnerships with industry will continue.** EU policy-driven R&I partnerships with industry are important for pooling resources in order to tackle big policy and societal challenges, to support competitiveness and jobs and to encourage greater private investment in research and innovation, amongst other things. Public-private collaboration with industry will continue as part of a simplified and more impact-focussed approach to European Partnerships (see section 3.2.5).

As a result, the expected implications for industry are:

- Europe's global leadership in various industries, especially in high value added and technology-intensive products and services, will hinge on its capacity to master the Key Enabling Technologies, in which the Framework Programme will continue to invest.
- Investing in new technologies through the Programme will enhance EU's industrial competitiveness in the global transition to circular and low-carbon economy, create new business opportunities including in export markets, and protect businesses against scarcity of resources or volatile prices.
- A broader perspective involving users and society at large (and more generally the demand side) in the design and development of innovative solutions to address global challenges will ensure ownership and commitment from industry and other stakeholders, as well as the buy-in from civil society.
- Bringing together activities on digital, key enabling, clean and space technologies, the Programme will allow for a more systemic approach, and a faster and more profound digital and industrial transformation.

In terms of design structure, some stakeholders have identified the risk that merging the stand-alone “industrial leadership” pillar would discourage industry participation. On the other hand, a higher participation of industry in the Global Challenges and Industrial Competitiveness pillar could be seen as giving the private sector a disproportionate role in setting the R&I agenda at the expense of other stakeholder groups. As a mitigation measure, the strategic planning process (see section 4.1),

building on the lessons learnt from the inclusive programming process of Horizon 2020, will ensure a balanced approach by involving all stakeholders, including citizens, customers and end-users in agenda-setting. The Programme will also gain flexibility by a less prescriptive approach to defining R&I activities. This brings about a higher capacity to adapt to evolving political priorities and to respond to emerging, unforeseen challenges.

Box 7: Climate mainstreaming

The Horizon 2020 legal basis provides a target of investing at least 35% of its budget for climate-related activities. The European Parliament has asked for a thorough climate mainstreaming and underlined that the EU should not finance projects and investments that are contrary to the achievement of EU climate goals¹³. The European Court of Auditors recommends aligning EU spending and investment more closely with the Union’s strategic priorities¹⁴. 14 Member States have signed a joint letter to the Commission on 5 March 2018 asking for a climate-friendly EU-budget¹⁵.

Horizon 2020 is a major contributor to the EU’s target to mainstream climate action and sustainable development. While the expenditure target for climate action has not been met, the overall success of the mainstreaming approach has been confirmed by the Commission in the MFF Mid-Term Review¹⁶, in the European Court of Auditors Special report 31/2016¹⁷, in the related council conclusions¹⁸, and by a targeted external report¹⁹.

The EU has signed up to the Paris Agreement on fighting climate change, and has already set itself a target to reduce greenhouse gas emissions by at least 40% by 2030. It also made wider energy transition commitments as captured in the Energy Union and its implementation packages, such as the the European Strategy for Low-Emission Mobility²⁰ and the Clean Energy For All Europeans package²¹.

In continuation with the provision set out in Horizon 2020 and line with the EU’s international commitments, an ambitious goal for climate mainstreaming across all EU programmes has been set, with a target of 25% of EU expenditure contributing to climate objectives. To ensure its essential contribution to these objectives, Horizon Europe will continue contributing to climate action, including to clean energy transition in the EU. The programme is expected to contribute with 35% of its budget spent to climate objectives.



3.2 IMPROVEMENTS AND THEIR EXPECTED IMPLICATIONS

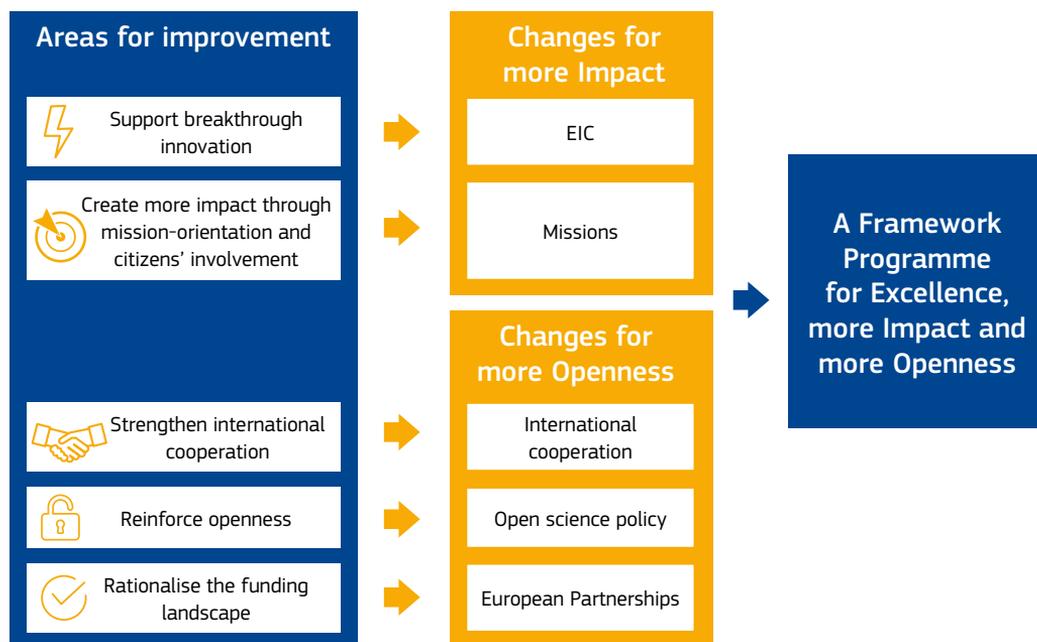
In addition to the structure optimisations described in section 3.1, the key areas for improvement identified by the Horizon 2020 Interim Evaluation (see section 1.2) have been translated into novel features and enhancements of existing features. These improvements build on the foundations of the interim evaluations²², findings of High Level Groups²³ and the work of scientific experts²⁴. They were developed on the basis of analysis detailed in the Annex 6, from among identified alternative ways to address the key challenges identified in section 2.2.

even more impact (EIC and missions) and more openness (through strengthened international cooperation, reinforced Open Science policy, and a new policy approach to European Partnerships). Neither of these changes goes beyond what is necessary at EU level (proportionality test), and each one aims to increase the overall effectiveness, efficiency and coherence of the Programme (see Section 3.3 for an overview of how this is achieved). More details can be found in Annex 6, which also covers more gradual changes, e.g. linked to Sharing excellence.

The significant improvements linked to the design of the programme (see Figure 5) will be covered in this section, along with their expected implications. While Horizon 2020 is already excellent, impactful and open, these changes will make the Framework Programme achieve

Moreover, the lessons learnt linked to simplification have been taken up in the section on delivery for impact (Section 4 and Annex 7), while those related to synergies with other EU programmes were included in the upstream design of those programmes (see Annex 5).

Figure 5: Design improvements and novelties in the new Framework Programme



3.2.1 The European Innovation Council (EIC)

Why do we need it? There is a growing lack of equity funding for risky companies dealing especially with deep-tech products, in particular young, innovative firms and scale-ups in Europe. According to a recent study²⁵, the total equity funding gap in Europe is estimated at EUR 70 billion, of which 85% is represented by the so-called “first valley of death”²⁶. The European Investment Bank estimates²⁷ that it would require around EUR 35 billion a year in additional venture capital for financing start-ups and growth-stage firms in the EU to match comparable US levels. Private investors are deterred by the lack of certainty, no cash flow generation, and unproven ability to scale-up rapidly. Such ventures need a sophisticated support ancillary to a grant, such as equity, guarantee, or other type of financing (tailor made blended finance, see section 4.5) to better de-risk them and bring them to a stage where they can be financed on usual commercial terms by investors.

What do we have now? Horizon 2020 provides some measures of targeted support to disruptive technologies and to innovative companies for bringing discoveries close to the market, with a quarter of Innovation Actions having breakthrough potential²⁸. On the one hand, the FET instrument supports high-risk cutting-edge research projects aiming to bring about transformational change by opposition to incremental innovation. However it lacks an instrument to bring these disruptive innovations to the market. On the other hand, the SME Instrument focusses especially on product, performance, business model innovations and market uptake, but much less on service, network, and customer engagement innovations and does not provide for market deployment and scale-up. In Horizon

2020, the SME Instrument has provided EUR 1,332 million in grants to 3,239 SMEs supporting the technical and commercial feasibility of a business idea and the development of innovation with demonstration and scale-up purposes. Majority of the projects emerging from receiving SME Instrument grants are however still exposed to the “first valley of death” for their subsequent development, which is not covered by the SME Instrument. These projects still have investment requirements to fully develop and commercialise their products²⁹. Overall, Horizon 2020 does not provide enough support to innovators, and in particular SMEs, to develop breakthrough technologies cutting across sectors to access market and scale up rapidly at EU level.

What did the other EU institutions say?

The European Parliament stresses the importance of innovation support in general, and of disruptive innovation and scaling up in particular. Council Conclusions emphasise the importance of supporting the whole innovation value chain, including high-risk disruptive technologies, while the possible future EIC should support breakthrough innovations and the scaling up of innovative companies³⁰.



The majority of stakeholders commenting on the EIC are supportive and provide suggestions on its possible role, objectives and implementation. In general stakeholders expect the EIC to simplify the current support to innovation and act as an European accelerator. They note that the support to innovative SMEs and start-ups is essential to maximise Europe's potential for growth and socioeconomic transformation³¹.

What changes? The Framework Programme will introduce the EIC under the Open Innovation Pillar to place the EU in the lead for breakthrough market-creating innovation³². The EIC 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 aversion³³. The EIC will integrate, reorganise and expand activities previously carried out in Horizon 2020, such as in Access to Risk Finance (in synergy with the InvestEU programme), Innovation in SMEs (notably the SME instrument), Fast-track to Innovation as well as Future and Emerging Technologies (FET-Open).

The EIC will mainly implement two complementary instruments, offering a seamless support from research and innovation activities to market deployment and scaling-up of innovative companies. The Pathfinder for advanced research will be a grant-based instrument for early stage research on technological ideas that can bring about transformational change, to nurture spin-offs and potential market creating innovations. The Accelerator will be a financial instrument operating through tailor made blended finance (advances, reimbursable or not, equity, guarantees; see also section 4.5) in support of the development and the deployment of market-creating innovation and the scale-up of innovative companies, until they can obtain support from the InvestEU programme or be financed on usual commercial terms by private/commercial investors. The Accelerator will place a particular emphasis on innovations / spin-offs / start-ups generated within the Pathfinder, as well as from any other parts of the Programme such as the ERC, the EIT KICs and R&I missions. In de-risking the operations it supports,

the Accelerator will also stimulate private investments in R&I while preserving competition in the internal market.

EIC business advisory services will complement these instruments in order to connect innovators with industrial partners and investors and provide them with other support services. A High-Level Advisory Board composed of entrepreneurs, corporate leaders, investors and researchers, will assist the Commission in the governance and have an outreach function with an ambassadorial role. For its launch, the EIC could be implemented with the support of an executive agency for some tasks. Subsequent development may however lead to establishment of a fully externalised solution, as one of the possible implementation scenarios (see Annex 6.1).

What is the EU added value? As for the Horizon 2020 Future Emerging Technologies and the SME Instrument, the continent-wide competition for ideas will ensure excellence and EU-gains. Moreover, only EU-level action has the capacity to tackle the persistent lack of large-scale venture capital. EU support will be more effective and more comprehensive (e.g. common regulation, fostering synergies with other EU programmes) compared to national or regional support. The EIC will focus on breakthrough innovations at European level, pooling resources and unleashing the potential of European and global markets for EU innovators³⁴. The EIC will not replace national and private initiatives fostering breakthrough innovation, but instead it will increase the coherence of the overall innovation ecosystem by establishing a one-stop shop for high potential innovators and partnerships with national, regional and local innovation actors.

Figure 6: EU support to innovation (bottom-up and top-down)

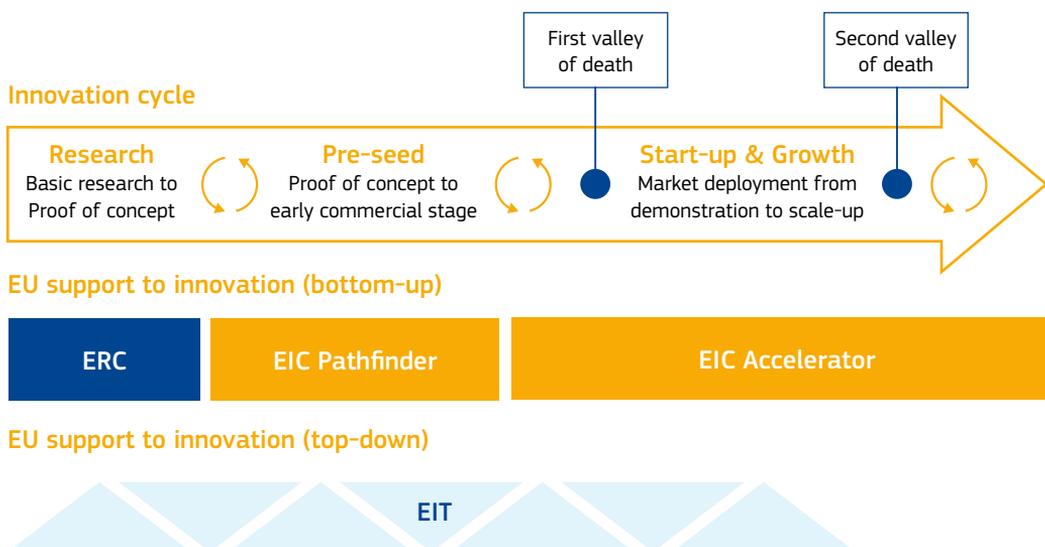


Table 2 Comparing the EIC with the ERC, EIT, and InvestEU

	European Innovation Council (EIC)	European Research Council (ERC)	European Institute for Innovation and Technology (EIT)	InvestEU
Key principles	Focus on excellence (attract best innovators) based largely on bottom-up approach, but also high-risk, breakthrough R&I activities that create markets and provide solutions to global challenges	Focus on excellence (attract best researchers), based on bottom-up approach	Focus on knowledge triangle integration (education, research and innovation) that empowers innovators and entrepreneurs to solve global challenges through KICs	Focus on bankable projects, and expected return on investment. Implemented, through financial intermediaries (Banks, Venture Capital Funds, and other private investors)

	European Innovation Council (EIC)	European Research Council (ERC)	European Institute for Innovation and Technology (EIT)	InvestEU
Target group	Focus on the individual (the innovator), with high-growth potential (researchers, entrepreneurs, start-ups, SMEs and mid-caps), from single beneficiaries to multi-disciplinary consortia, but promote their incorporation and growth under late stage activities	Focus on the individual (the researcher)	Focus both on individual entities and on cooperation of businesses, education institutions & research organisations within KICs	Focus on entities that can borrow money or can sell shares
Rationale	Remove constraints (field of innovation) for growth and scale-up	Remove constraints (field of science, collaboration partners)	Reinforce R&I ecosystems in specific areas (knowledge exchange and networks, entrepreneurship, skills); support innovators to start and accelerate new businesses; provide talent through entrepreneurial education	Leveraging private sources of finance Address market gaps and sub-optimal investment situations
Evaluation and Selection	Selection by peers (scientists and innovators) and investors based on excellence, the impact (marketability), and the level of risk	Selection by scientific peer review	Selection of KICs by EIT Governing Board; KICs business plans (i.e., innovation and education activities, projects) assessed by panel of experts appointed by EIT	Selection by financial intermediaries through due-diligence process

	European Innovation Council (EIC)	European Research Council (ERC)	European Institute for Innovation and Technology (EIT)	InvestEU
Types of Action	Grants (Pathfinder) and combination of grant-type advances and equity or financial guarantees (Accelerator) Projects may be amended or terminated if milestones are not met, seeking alignment with private investors	Long-term grants with guaranteed funding	Grants to KICs partnerships + complementary activities (incl. education & entrepreneurial programmes)	Equity finance, mainly focusing on risk-capital funds and debt finance in the form of loans and guarantees

What are the risks? Firstly, in giving priority to potential impact rather than return on investment, the EIC will promote long-term operations too risky to attract private investors. In recent years, these risks have increased due to the more multi-disciplinary nature of R&I and the intrinsic complexity and systems nature of many emerging technologies. If the risk of failure of projects under the EIC is more pronounced, even higher is the potential benefit of generating new markets that are essential for the future of the Union and its citizens, e.g. deep-tech based areas of future growth and jobs such as clean and efficient new energy sources, block-chain, artificial intelligence, genomics and robotics. Secondly, there is a potential risk of conflict of interest linked to the involvement of experts, which will also be innovators and/or investors themselves. Safeguards will be put in place, for example by preventing them to invest into EIC supported companies, or similar provisions.

Box 8: EU added value of mono-beneficiary instruments

The Horizon 2020 interim evaluation showed that the quality of R&I improves through EU-wide competition. This is an important element of EU added value, notably in areas where mono-beneficiaries are the norm, like the SME Instrument and the ERC. The EU added value of the ERC from its exclusive focus on excellence through competition helped it become a global beacon of excellence. Similarly, an in-depth evaluation study of the SME Instrument³⁵ positively assessed its EU added value: it is unique compared to similar support schemes at national/regional level (which are only focusing on certain priority domains; do not have rolling submissions; have significantly smaller project volumes; require project collaboration with other SMEs or universities).

What are the expected implications?



More innovations that create the new markets of the future. Giving more prominence and visibility to breakthrough innovation, the EIC will attract the Europe's best innovators. The selection process by peer-scientists and innovators and investors will enable risk-taking, hence providing support to radically new initiatives in uncharted territories. The EU could become the home of up to a third of leading innovators in major areas for breakthrough deep tech innovation³⁶ such as Artificial Intelligence, biotech, and augmented/virtual reality and to leading innovators addressing global challenges.



Scaled up companies and higher SME growth. The EIC will support late stage innovation activities and market deployment for the most promising ideas, resulting in an increase in the number of growing EU start-ups and SMEs. The EIC will also target innovative companies with a great potential for scaling up, offering them co-investment to become larger and increase their markets. The support to innovative companies and in particular SMEs will

increase their market valuation, employment, and turnover.



Increased complementarities between grant-type funding, financial instruments, and leverage from private investment. Under the Accelerator, blended finance will allow the Union to bear the initial risk of deploying market breakthrough innovations, with the aim of de-risking these operations as they unfold, down to a stage where they can be financed through private capital, hence incentivize private investors. Combined with activities undertaken by the (InvestEU Programme) this alignment of interests with private investors will provide improved access to venture capital and risk finance, hence leveraging the overall volume of finance available for innovation.



More entrepreneurship and risk-taking. The EIC will provide business acceleration services to innovators and will award EIC Fellowships to the outstanding ones. The EIC will highlight innovators who can inspire others to set up and grow their own enterprises.



More accessible and user friendly support to innovation. The EIC support and services will be provided through a one-stop shop enabling easy and quick access for innovators to EU support.

3.2.2 Research and Innovation Missions

Why do we need it? As underlined by the Interim Evaluation of Horizon 2020³⁷, the current EU research and innovation programme does not fully prioritise investments with the highest overall impact and added value for Europe, as expected impact is defined only at the level of individual call topics. This leads to fragmentation and a dilution of impact. The consequent lack of focus on societal impact also results in a low level of public awareness and engagement in EU-funded R&I. This implies that current EU investments in R&I are not sufficiently responsive to, or connected with, the needs of citizens.

What do we have now? Horizon 2020 featured over 20 Focus Areas in key domains, where priorities cut across different parts of the programme (e.g. blue growth, circular economy, digital security), to concentrate resources and efforts. While focus areas reinforced the programme's coherence and its capacity to provide interdisciplinary solutions to multiple societal challenges, their multiplication also resulted in some confusion. Moreover, citizens were not involved in the process, and limited coordination of the focus areas undermined their impact. Nor did they set achievable and time-bound goals.

What did the other EU institutions say? All EU Institutions stress the importance of involving citizens more profoundly in the co-design and co-creation of R&I contents to

maximise the impact generated by the Framework Programme³⁸. The European Parliament recognises the importance of society playing a more active part in defining and addressing the problems, and in jointly putting forward the solutions. The Committee of the Regions is calling for the adoption of a new, complementary approach based on missions and for greater importance of science-society actions. The European Economic and Social Committee calls for increased involvement of Civil Society Organisations in the Framework Programme. The Council Conclusions and the European Research Area and Innovation Committee (ERAC) point to the need to deliver better and continued outreach to society, and call for exploring a mission-oriented approach³⁹.



Almost all stakeholders referencing R&I missions clearly supported mission-orientation of Horizon Europe or acknowledged it as a possible future scenario. In general, stakeholders consider that tangible missions that underpin the overall political objectives could enhance visibility and create a more engaging narrative of the Framework Programme. There is also a widespread acknowledgement on the need to engage wider society in identifying the most relevant missions within broader societal challenges⁴⁰.

What changes? Horizon Europe will introduce a limited number of highly visible R&I missions. Missions will replace and build on the Horizon 2020 Focus Areas. They will be well-defined⁴¹ and self-standing programme parts, as opposed to the Focus Areas. This will more clearly and directly incentivise cross-sectoral and cross-disciplinary cooperation. Clear objectives and rationale will

be established at the mission's inception (addressing a specific weakness identified in the focus areas approach) in order to define targets, clear time-bound goals and expected impact. Finally, missions will be more closely co-designed with end-users and citizens, thus prioritising public engagement and involvement and “building upon existing work and prior commitments to bring societal actors together to prioritise R&I activity”⁴².

Different types of missions can be envisaged, for example missions to accelerate progress towards a set technical or societal solution, focusing large investments on a specific target (e.g. accelerate market uptake of post Li-ion energy storage solutions) or missions for transforming an entire social or industrial system within an established timeframe (e.g. transformation of the entire energy system or mobility system in cities). Evidence indicates that a combination of approaches would be most suited to the scale of EU-level missions and the complex challenges which they will address⁴³.

Missions will be selected (after the launch of Horizon Europe) according to the following selection criteria⁴⁴:

- Bold, inspirational, with wide societal relevance;
- A clear direction: targeted, measurable and time-bound;
- Ambitious but realistic research and innovation actions;
- Cross-disciplinary, cross-sectoral, and cross-actor innovation;
- Multiple bottom-up solutions;
- Strong EU added value.

At the implementation stage, Mission Boards for each mission will ensure proper involvement of stakeholders and end-users. Mission Boards will be involved in co-designing the missions involving stakeholders and the wider public, providing input to the content of the call for proposals and the evaluation of project proposals and in monitoring missions. A mission manager will be appointed for each mission with the task of ensuring that the mission objectives are reached through a portfolio approach. By involving citizens and stakeholders in the definition, selection and monitoring of missions, a sense of urgency and collective commitment will be created⁴⁵ while also ensuring societal ownership of the missions⁴⁶.

What is the EU added value? Setting R&I missions at EU level gives them the critical mass necessary to address global challenges. They will help the EU to better deliver on Sustainable Development Goals and its strategic policy priorities. Setting R&I missions at EU level would also facilitate ensuring that the EU regulatory framework fully supports the achievement of such an EU mission, for instance through applying the innovation principle, setting standards at EU level, or through joint public procurement at EU level. Missions can involve end-users and citizens much more closely in EU R&I activities.

What are the risks? The success of missions hinges on the timely and due dialogue with stakeholders, to avoid disengagement or weak interest. Moreover, in the implementation phase, the evaluation and monitoring mechanisms will need to be sophisticated enough to capture the long-term impacts of missions. Finally, the ultimate uptake and roll-out of innovative solutions arising from missions will depend on wider framework conditions – this kind of wider support to uptake

can be supported through policy actions in the spirit of the Innovation Principle, or through Innovation Deals⁴⁷.

What are the expected implications?



Improved cross-sectoral and cross-disciplinary cooperation.

Missions will require expertise from different sectors and disciplines to come together. 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. The mission-oriented approach will work across clusters to promote system-wide transformation.



Increased impact on global challenges and EU policy priorities.

Missions will increase effectiveness in delivering societal impact for end-users and citizens, by prioritising investments and set directions to achieve objectives with societal relevance. Missions will set the direction for the EU regulatory framework, and leverage further public and private sector R&I investments in Europe.



Reduced gap between science/innovation and society.

R&I missions will be easy to communicate, in order to mobilise citizens and end-users in their co-design and co-creation (e.g. through citizen science and user-led innovation). In turn, this increases the relevance of science and innovation for the society and it would stimulate the societal uptake of innovative solutions and leverage business investment.

3.2.3 International cooperation

Why do we need it? International cooperation in R&I is vital for ensuring access to talent, knowledge, know-how, facilities and markets worldwide, for effectively tackling global challenges and for implementing global commitments⁴⁸.

What do we have now? Association to the programme is limited to countries geographically close to Europe. Organisations from non-associated third countries can participate in projects in all parts of the programme, except for mono-beneficiary grants, specific close-to-market innovation activities and actions for access to risk finance. Except for a few cases, only participants from low- and middle-income countries are automatically eligible to receive EU funding. EU funding can be exceptionally granted to third-country entities whose participation is deemed essential for carrying out an action.

What did the other EU institutions say?

The Council and the European Parliament have called for strengthening international R&I cooperation in the Framework Programme, including with associated countries and emerging countries, as soon as possible through concrete actions. The Parliament, in addition, has highlighted the value of science diplomacy. Council Conclusions have also reaffirmed the importance of reciprocity.

What changes? The Framework Programme will intensify cooperation in line with the strategy for EU international R&I cooperation and the “Open to the World” R&I priority. The programme will extend openness for association, beyond EU enlargement, EEA countries and ENP countries, to include all countries with proven science, technology and innovation capacities to make cooperation and

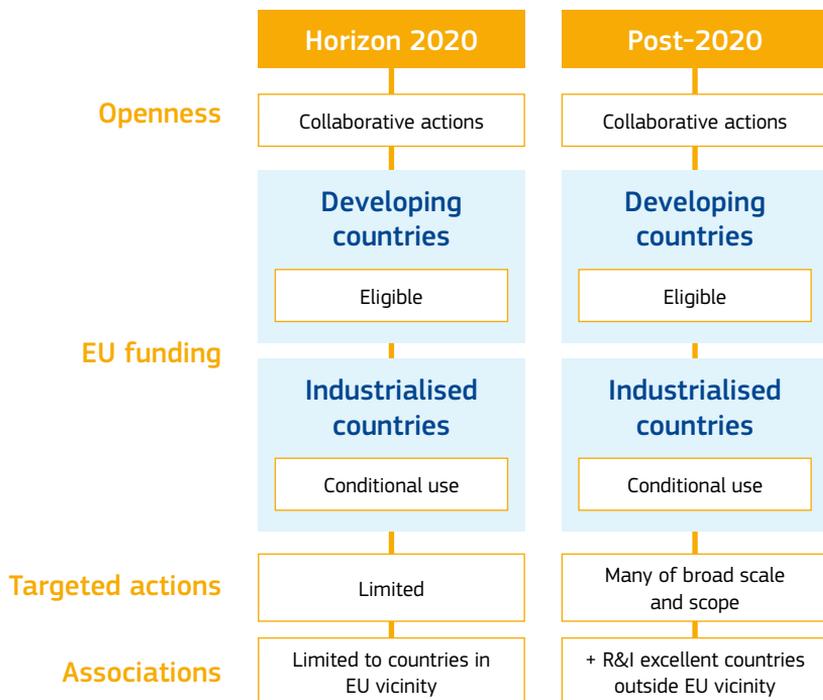
funding of joint projects as smooth as possible. The programme should increasingly invite partners from the rest of the world to join EU efforts as an integral part of initia-

tives in support of EU actions for sustainable development; it should provide more support for activities that facilitate the collaboration of European researchers with their counterparts worldwide, enable international mobility of researchers and ensure access to research infrastructures globally; and it should extend support to joint and coordinated funding of global industrial research and innovation cooperation. The programme should continue to fund entities from low-mid income countries, and to fund entities from industrialised and emerging economies only if they possess essential competences or facilities. The programme will intensify support to international flagships, partnerships, bilateral and multilateral initiatives and joint programmes and calls, to increase access to researchers, knowledge and resources worldwide and optimise benefits from cooperation.



A predominant view among stakeholders is that cooperation should be strengthened to counter the drop in internationalisation activities and participation rates from third countries that was experienced in Horizon 2020. Some stakeholders also advocate science as a platform for international diplomacy. A few stakeholders noted that EU could adopt legislation to encourage exploitation of research and innovation results in Europe first⁴⁹.

Figure 7: Approach to international cooperation in Horizon 2020 vs the new Framework Programme



Box 9: Third Countries associated to the Framework Programme

- The Framework Programme will define which countries will be able to apply for association, what criteria should be used to assess their applications, and what principles should apply for the terms and conditions regarding their participation.
- Each Association Agreement to the Framework Programme should define the scope, specific terms and conditions of participation, as well as the rules governing the financial contribution of the associated country. These rules should ensure a close approximation between payments and returns.

What is the EU added value? Openness of the Framework Programme to third countries enhances the EU added value of the Programme itself, allowing EU participants to collaborate with the best minds in the world. The EU can more effectively shape policy agendas when represented as a single voice in multilateral fora and international organisations. The EU has a comparative advantage as compared to single Member States when negotiating bilateral agreements with third countries regarding framework conditions such as mutual openness of funding programmes or issues related to Intellectual Property Rights (IPR) protection. Thanks to the Framework Programme, Member States are enabled to cooperate with several third countries, including countries with which they do not have bilateral agreements. Increasing international cooperation does not go beyond what is necessary to achieve the objectives of the programme.

What are the risks? The main risk is that the proposed specific objective, priorities for actions and instruments to be used will not be sufficient for strengthening international cooperation in the Programme compared to the current situation. Regarding the process, there is also the risk that European objectives both in terms of global challenges and competitiveness take less of a driving role in priority-setting when more international part-

ners are involved. International S&T cooperation policy dialogues and broad consultations should ensure that international joint actions are strategically designed in line with EU interests and agreed with international partners based on mutual interest and common benefit.

What are the expected implications?



Improved excellence of the Programme. Attracting and collaborating with the world's top researchers, innovators and knowledge-intensive companies reinforces the EU's science and technology base. Evidence shows that international collaboration increases the impact of scientific publications⁵⁰.



Higher influence of the EU in shaping global R&I systems. This approach will enhance the EU leading role in setting the policy agenda, in particular for addressing common challenges and for achieving the Sustainable Development Goals. The mutual benefits of international cooperation strengthen EU leadership in the knowledge-intensive economy. The Programme will be an effective instrument in Europe's efforts to harness globalisation by removing barriers to innovation and by establishing fairer framework conditions with international partners.



More impact from the Programme. Increased international cooperation will reinforce EU R&I excellence and the creation and diffusion of high-quality knowledge in the EU. Cooperating internationally is indispensable as the scope and interconnectivity of global societal challenges increase and require more international joint action and coordination of agendas. International openness of the innovation eco-systems will strengthen EU competitiveness by promoting a level playing field and enhancing supply and demand of innovative solutions. The association agreements with countries having proven R&I capacities will facilitate mutual access to European and third-country know-how and markets, as cooperation with top third country innovators facilitates access to expertise that is increasingly developed outside the EU.

3.2.4 Open Science policy

Why do we need it? The next Framework Programme should fully embrace Open Science as a way of strengthening scientific excellence, benefiting from citizen participation, achieving better reproducibility of results and increasing knowledge circulation and the re-use of research data⁵¹, hence accelerating the take-up of R&I knowledge and solutions and increasing the EU policy and societal impact of the Framework Programme.

What do we have now? There is a shift towards a more open, collaborative, data-intensive and networked way of doing research and sharing research results, enabled by developments in ICT and related infrastructures and the increasing proliferation of data. Open access to publications is mandatory, while open access publishing is encouraged, and relevant costs eligible. Beneficiaries are encouraged by guidelines to

keep enough (copy)right to self-archive, but are not legally empowered to do so. Participation in the Open Research Data Pilot is the default for Horizon 2020 projects, and it requires a Data Management Plan and open access to research data, but there are solid conditions to opt-out from the Pilot at any stage.

What did the other EU institutions say? The European Parliament opinion is in favour of the general principle of Open Access, while the European Research Area and Innovation Committee (ERAC) regards the 100% Open Access policy of Horizon 2020 as a clear measure in favour of knowledge circulation. Importantly, the Council Conclusions on the transition towards an Open Science System give valuable guidance for the future, while the Council Conclusions on the Interim Evaluation of Horizon 2020 highlight the role of Open Science in boosting impact and transparency⁵².



The majority of stakeholders who referred to Open Science note that data and knowledge produced from EU-funded projects should be shared openly. However, some business representatives underlined the need for the opt-out option to be maintained to secure confidentiality of market-oriented innovation outputs. Stakeholders also highlight that open science, open data and open access calls for new principles in citation and academic reward system and requires attention to the development of skills in research data management⁵³.

What changes? The Framework Programme will fully embrace and support Open Science policy as the new research *modus operandi*

through various requirements in the Work Programmes. It will go beyond the open access policy of Horizon 2020, requiring immediate open access for publications and data (with robust opt-outs for the latter), and research data management plans to support sound data management; it will foster the proliferation of FAIR data (findable, accessible, interoperable and re-usable). It will support activities that promote a sustainable and innovative scholarly communications ecosystem; It will foster activities for the enhancement of researcher skills in open science and support reward systems that promote open science; it will integrate research integrity in the open science activities and support citizen science. Lastly, it will also support the introduction of next generation indicators for the assessment of research.

What is the EU added value? Even while Member States are developing their own policies for Open Science, the positive effect of EU action is substantial⁵⁴. Horizon Europe will contribute towards policy alignment across the Member States and thus towards the development of a better and more unified environment for research collaboration in ERA and beyond it. Requirements of the Programme have structuring effects that accelerate the propagation of Open Science policy via collaborative projects in the research community. Horizon Europe will accelerate the transition towards Open Science by building a European Open Science Cloud supported by world-class infrastructure that will gradually also benefit industry and the public sector.

What are the risks? The main concern on Open Science in Horizon Europe relates primarily to the requirement for open access to data from research projects. Without clearly explained safeguards, this policy could be

perceived as deterrent for industry and businesses to participate. This is why, while open access to research data will be the standard, Horizon Europe will be fortified with robust exceptions to this rule, where access to data needs to be protected and Intellectual Property Rights protected. The principle that research data has to be ‘as open as possible, as closed as necessary’ will be emphasised every time it is necessary. A concern shared also at the time of Horizon 2020 is that the development of open access in Europe may offer content paid by European taxpayers for exploitation to the entire world, and therefore advantages other countries for more severe competition in research and innovation. The Commission is not the only funder with such open access and open science policy requirements. Funders across the globe are aligned in mandating open access to publications and data and relevant open science policies. It is not expected that Europe will set itself into a comparative disadvantage in this way, *vis-à-vis* other countries across the world.

What are the expected implications?



Increased availability of scientific output in open access. A higher percentage of projects will make their outputs (publications, data, algorithms etc.) available in open access because of the simplification of provisions, the stricter formulation of exceptions, and financial support provided through the Programme.



Higher levels of excellent research and innovation. Placing high quality content in the open, and stimulating knowledge circulation and the reuse of results, improves science communication and enables interdisciplinary research.



Increased accessibility to high quality digital content. Data are increasingly becoming the starting point for innovation, with high returns⁵⁵. With digitisation, it can be expected that SMEs and other companies will base new business models on digital content, hence will reap the benefits of a strengthened Open data environment in Europe and maximise the exploitation of digital resources through reusability.



Higher societal and policy impact. Open science policy allows citizens to be part of the research process (for example through citizen science), helping lifelong learning and developing an informed society for the 21st century challenges. Accessible R&I data and results can be used for evidence-based policy-making, therefore they contribute to strengthening the policy role of R&I.

3.2.5 European Partnerships

Why do we need it? The European R&I partnership landscape grew significantly in size and complexity over the last decade with an increasing risk of overlap and non-coherence with the EU framework programme and between the partnerships themselves. In particular, there is a large number of Public-Public Partnership initiatives (currently close to 100). Still, Partnerships are key to achieving policy objectives that the Framework Programme alone cannot achieve. Reforming the current partnership landscape and improving the design and implementation of future European Partnerships, renewed or newly set-up, should make it possible to use their full potential in achieving ambitious policy objectives.⁵⁶

What do we have now? Horizon 2020 supports two broad categories of partnerships: those mainly involving industry, i.e. Article 187 initiatives or Public-Private-Partnerships (PPPs) and contractual PPPs (cPPPs); and those involving mainly Member States, i.e. Article 185 initiatives or Public-Public-Partnerships (P2Ps), ERA-NET Cofund, European Joint Programming-Cofund and Joint Programming Initiatives. Moreover, there are other types of mixed partnerships such as the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT) (integrating the knowledge triangle) and the Future and Emerging Technologies Flagships.

What did the other EU institutions say?

The Competitiveness Council Conclusions stressed that the current R&I ecosystem has become too complex, and that all partnership initiatives should have an exit strategy from EU funding. The European Research Area and Innovation Committee (ERAC) considers it particularly urgent to rationalise the funding schemes, while considering public-to-public partnerships essential for more coordinated implementation of national and EU R&I. The European Parliament advocates ‘decomplexifying’ the EU funding landscape⁵⁷.



A large share of stakeholders submitting position papers is concerned by the complexity of the EU R&I funding landscape. A dozen stakeholders explicitly emphasise the fact that existing support schemes should be carefully evaluated, and the discontinuation of funding should be an option (i.e. sunset clauses)⁵⁸.

What changes? An overall European Partnerships strategy based on an objective- and impact-driven intervention logic will be developed and implemented in order to ensure that partnerships are established or renewed⁵⁹ only in cases where impacts need to be created that cannot be achieved by other Framework Programme's actions or national action alone. All future European Partnerships will be designed based on the principles of Union added value, transparency, openness, impact, leverage effect, long-term financial commitment of all the involved parties, flexibility, coherence and complementarity with Union, local, regional national and international initiatives.

The strategic planning process of the Framework Programme (see section 4.1) will frame the establishment of European Partnerships. This will ensure that the next generation of partnerships will support agreed EU priorities and will lead to a rationalised R&I landscape, with fewer, but more targeted initiatives receiving co-funding/investment from the Framework Programme.

The design and implementation of future European Partnerships will include an improved coherence between Framework Programme's actions and R&I partnerships, as well as among initiatives. In addition, communication and outreach will be strengthened by a clear, easy-to-communicate architecture under the umbrella term "European Partnerships". This encompasses all Partnerships with Member States, Associated or Third Countries and/or other stakeholders such as civil society/foundations and/or with industry (including small and medium sized enterprises), with greater openness to international cooperation. European Partnerships will only be developed

on agreed EU policy priorities in the context of the Framework Programme, and subject to the criteria set out in the Framework Programme. They will be limited in time with clear conditions for phasing out from the Framework Programme funding. There will be only three types of intervention modes (i.e. several Horizon 2020 labels like P2P, PPP, ERA-NET, FET Flagship and cPPP will be discontinued): i) co-programmed European Partnerships between the EU, Member States, and/or other stakeholders, based on Memoranda of Understanding or contractual arrangements with partners; ii) co-funded European Partnerships, based on a single, flexible programme co-fund action for R&I activities; iii) institutionalised European Partnerships (based on Art. 185 or 187 TFEU, and EIT regulation for KICs). Following a life-cycle approach⁶⁰ the legal act will set out the criteria for the selection, implementation, monitoring, evaluation and phasing out of all European Partnerships.

What is the EU added value? The main added value derives from the additional private and public R&I investments on EU priorities (additionality and leverage), the alignment of these investments towards common objectives (directionality) and the achievement of impacts that cannot be created by other Framework Programme actions or national action alone. In addition, the revised policy approach will substantially improve the coherence between European Partnerships and the Framework Programme in general, based on clear criteria identified together with Member States and other stakeholders. EU investments in R&I will be simpler to communicate and understand for stakeholders. The approach will build on, and bring together, all the on-going and future partnerships.

What are the risks? The major risk for the new policy approach is considered to be the expectations from the current partnerships to continue on a business as usual approach and expect more or less automatic renewal without being in line with the criteria set. It is crucial to ensure early involvement of Member States and stakeholders, including currently active initiatives, in the strategic programming process to build trust and ownership on the agreed future priorities.



More openness and flexibility. Partnerships will be open to all types of stakeholders (Member States, civil society/foundations, industry, including small and medium sized enterprises) with no entrance barriers for newcomers and smaller R&I players. Flexibility will be encouraged with a simplified toolbox, and a lifecycle-based planning and implementation approach.

What are the expected implications?



Improved coherence and simplification. The clear rationale for the use of R&I partnerships, the elaboration of distinct and clear intervention logics based on policy objectives and the application of an impact-based criteria framework along the life cycle of R&I partnerships, including their phasing-out will guide the establishment of the next generation of partnerships. This will lead to a smaller number of more coherent partnerships and improve the overall coherence of the European R&I ecosystem.



Enhanced impact of EU R&I funding. The new approach to partnerships will ensure that partnerships will only be established in cases where desired impacts cannot be created by other Framework Programme's actions. As EU co-funding will be limited to agreed EU strategic priorities, including EU R&I missions, the overall impact of EU R&I funding will be increased by leveraging additional investments on EU policy priorities, by providing 'directionality' to these investments, and by reaching out to a broader set of stakeholders.



3.3 OVERALL IMPACT OF THE CHANGES ON THE NEW FRAMEWORK PROGRAMME

Impact is expected to be even higher than for the current Programme, because of improved programme-design novelties, increased internal coherence between Programme pillars, with more focus on cross-disciplinary, cross-sectoral and cross-policy activities, increased synergies with the MFF programmes, rationalisation, more user-friendly modalities, increased openness to all stakeholders, more flexibility

and efficient delivery mechanisms, including a more effective dissemination and exploitation of R&I results.

The EIC which aims to capitalize on EU science strengths and improve transition from science to breakthrough innovation, (i.e. innovation with highest impact) is expected to be particularly effective in assisting companies along

Table 3: Effectiveness of the changes to the Programme

Changes	Objectives of the Framework Programme				MFF cross-cutting objectives				
	Support the creation and diffusion of high-quality knowledge	Strengthen the impact of R&I in developing, supporting and implementation EU policies	Foster innovation	Optimise the Programme's delivery for impact within a strengthened ERA	Simplification	Flexibility	Coherence	Synergies	Focus on performance
Structure	0	0	0	+	+	+	+	0	0
EIC	+	+	+++	++	+	++	+	+	++
Missions	+	+++	+	++	+/-	+	++	++	++
International cooperation	++	+	+	+	0	0	0	0	+
Open Science policy	++	+	+	+	0	0	+	0	0
Partnerships	+	++	+	++	++	+	+	+	+

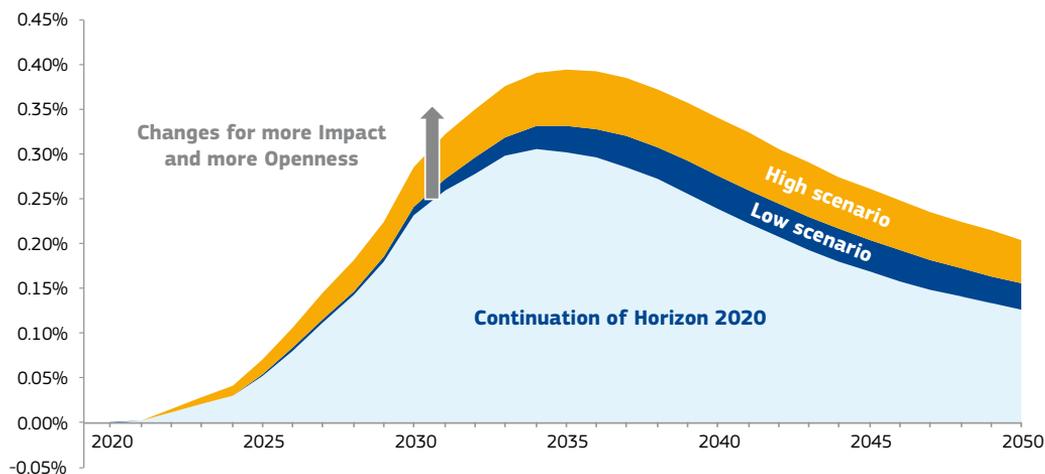
Note: +, ++, +++ correspond respectively to slight, moderate and significant improvement compared to a no-policy change scenario. +/- correspond to a coexistence of positive and negative impacts. 0 means no significant change.

their innovation journey by offering innovators seamless support (from grants to blended finance, from early stage research to market uptake). Missions which aim to set ambitious goals and channel EU R&I investment to areas with highest added value (i.e. highest impact) would allow the Programme to deliver better on EU strategic challenges; support the implementation of EU policy priorities; improve the contribution to EU policy-making; increase cross-sector and cross-disciplinary cooperation; and improve the societal uptake of innovative solutions based on better communication with, and involvement of, citizens. Strengthening international cooperation would foster R&I by attracting even more of the world’s top innovators, knowledge-intensive companies, scientific organisations and researchers. Strengthening open science policy should create and diffuse better high-quality knowledge, while better involv-

ing and informing citizens. The integrated approach for partnerships would improve leverage of, and alignment to, Member State and private investments.

Horizon Europe is expected to generate more substantial economic benefits. Compared to the baseline (Section 2.1), the improvements will increase the overall impact, with different possible scenarios depending on how R&I leverage, diffusion and economic performance will react to these changes. Illustrative results from the NEMESIS model⁶¹ (see Annex 3) show that the estimated GDP gains for the EU compared to the baseline can range from +0.04% in a low scenario to +0.1% in a more optimistic scenario (direct and indirect effect). The total impact of the Programme on EU GDP could range from EUR 30 billion to EUR 40 billion per year over 25 years (EUR 800 billion to EUR 975 billion in total)⁶².

Figure 8: Impact of the changes compared to the baseline (GDP gain, compared to a situation without the Framework Programme)



Source: Seureco, Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme.

Table 4: Economic costs and benefits of Horizon Europe

Economic Benefits ⁶³		Costs ⁶⁴	
Leverage of R&I investment	EUR 6-7 billion over 2021-2027	Submitting proposals	Cost for beneficiaries: About EUR 650 million per year ⁶⁵
GDP gain	720 to 975 billion over 25 years	Administrative burden (reporting obligations)	Cost for beneficiaries: EUR 0.9-2.3 million per year ⁶⁶
Employment	Direct benefit: Over 100 thousand jobs in R&I activities around 2027 Indirect benefit: Over 200 thousand jobs around 2035	Management of projects and proposal evaluation	Cost for administrations: EUR 500-600 million per year ⁶⁷

Horizon Europe will deliver more value for money. Figure 8 shows that the future Programme is expected to generate even more economic benefits due to the improvements in the programme structure and design, which together with more delivery for impact (see section 4) will ensure that the Programme will be cost-effective.

Lastly, these effects will be amplified by strengthened synergies and complementarities with other EU Programmes (see Annex 5). This will entail for example stronger alignment of priorities; clearer complementarities; more flexible co-funding schemes to pool resources at EU level; common strategic planning processes to allocate funding; greater alignment

between applicable rules; and eligibility of R&I high-quality proposals for funding by other EU programmes (e.g. Seal of Excellence, co-funded European Partnerships), stronger involvement of existing networks at EU level (e.g., the Enterprise Europe Network). Portfolios of R&I results will be made available for EU regions for potential uptake based on their specific needs, thus maximising the benefits coming from synergies with EU initiatives, for increasing regional competitiveness and innovation. This will maximise the impact of investments, speed up market uptake and the development of a comprehensive R&I ecosystem. Moreover, the Framework Programme will deepen links with EU policy priorities by bringing R&I results into policy-making, with full involvement of sectoral policy-makers.

Box 10: Market uptake

Improving market uptake of innovative solutions is a broad concept encompassing various activities, which help R&I-driven innovation to succeed on the market and create new value for market players and consumers/citizens alike. However, market uptake goes beyond R&I. Therefore, activities under the Framework Programme alone cannot suffice to incentivise broad market uptake and dissemination of innovative solutions. Other EU programmes need to also play a key role (see Annex 5 on Synergies).

What does Horizon 2020 currently do for market uptake?

- › Supports the development of innovative solutions until demonstrators and pilots (introduction of a first-of-its-kind innovation in the EU).
- › Speeds up the introduction of innovations on the market and supports coaching and mentoring of companies.
- › Provides support to closer-to-market activities, including the launch and scale-up of innovative companies, without distorting competition within the EU.
- › Supports public demand for innovative solutions, through Public Procurement for Innovation and Pre-Commercial Procurement. This support is limited to the coordination costs between procurers.
- › Develop standards for innovative products and services, but with limited progress so far.

How can the new Framework programme do more for market uptake?

- › Ensure market uptake is considered at the phase of proposal development, fostering applicants to co-create/experiment their research and solutions with users from the outset, to ensure improved fit to the final needs, including within the KICs co-location centres;
- › Support innovation actions and the demonstration of technological and non-technological innovative solutions of a first-of-a-kind nature in Europe with potential for replication;
- › Establish pipelines of innovative solutions (originated from R&I projects) targeted to public and private investors, including the EIC's Accelerator and other EU programmes;
- › Support to roll out and replication of innovative solutions with cross-border and transnational dimension;
- › Support to pre-commercial procurement and public procurement of innovation is maintained;
- › Support with the EIC the deployment of market-creating innovations and the scale-up of start-ups, innovative SMEs and mid-capital firms with breakthrough potential to create new markets by blended finance of grants and financial instruments under the EIC;
- › Improved monitoring and dissemination of R&I results including through initiatives such as the Dissemination and Exploitation Boosters and the Innovation Radar – also directed to other EU programmes for further implementation.
- › Support non-technological innovations (social innovation, business model innovation, public sector innovation etc.) including innovative delivery mechanisms.
- › Put in place a comprehensive go-to-market package to incentivise the exploitation of Framework Programme's results by helping beneficiaries to find the most appropriate instruments and channels for the market uptake of their innovations.
- › Provide holistic support throughout the dissemination and exploitation lifecycle to ensure a constant stream of innovations stemming from the Framework Programme.
- › Put in place an ambitious and comprehensive dissemination and exploitation strategy for increasing the availability of R&I results and accelerating their uptake to boost the overall impact of the Framework Programme and the European innovation potential.

3.4 CRITICAL MASS

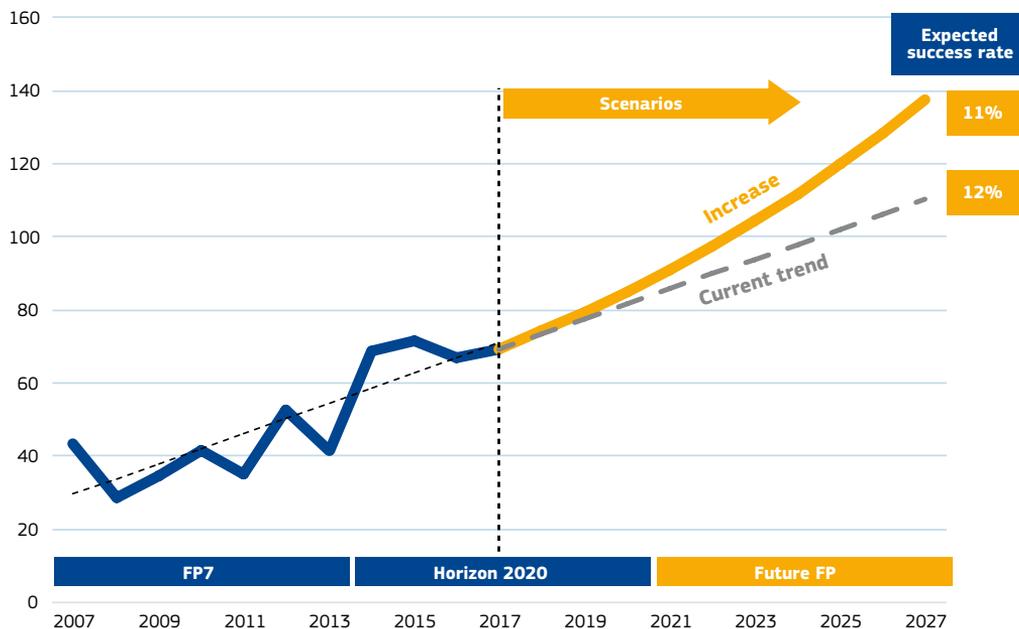
Achieving critical mass is key for the efficiency and effectiveness of the Programme⁶⁸. Horizon Europe cannot work effectively if it is not able to fund a sufficiently broad portfolio of relevant technologies and a sufficiently large range of complementary R&I projects that can build on each other and contribute to the objectives of the Programme. Reaching critical mass means that the Programme should be able to fund projects large enough to bring together across countries, sectors and disciplines, all partners and resources required to achieve the targeted objectives. Critical mass is also needed to support large-scale initiatives, preparing full market deployment of solutions in areas like batteries, infectious diseases, smart and clean buildings and vehicles, low-emission technologies, circular economy, solutions for plastic waste, and connected/automated cars. Ambitions will have to be scaled back equally across the Programme if critical mass would not be available.

Over the first three years of Horizon 2020, only 11.6% of the proposals could be funded. This low success rate can be explained by the high attractiveness of the Programme, which has led to a sharp increase in the number of eligible proposals compared to FP7⁶⁹. Moreover, in the first years of Horizon, only 1 in 4 high quality proposals could be funded - an additional EUR 62 billion would have been needed to fund all proposals independently evaluated above the stringent quality threshold⁷⁰. This underfunding represents an opportunity cost for Europe's promising R&I potential, since it undermines the critical mass needed to tackle global challenge; constitutes a waste of resources for the applicants (who spent an estimated EUR 636 million a year

preparing proposals⁷¹), deters excellent R&I players from applying, and deprives the EU of the full potential of the Programme. Based on the steady trend observed over the last decade, the number of proposals should be larger than in Horizon 2020. If the resources allocated to the Programme would remain similar to those of Horizon 2020 (in constant prices), the success rate would likely decline, or at best be maintained at ~12%, with only 20% -25% of high-quality proposals funded. This success rate is too low for the Programme to be efficient - a success rate of 15-20% (comparable to FP7), and funding for at least 30% of high quality proposals would be ideal⁷².

Alternative measures to increase the success rate are not expected to be fully effective. Using financial instruments through the InvestEU programme and enhancing complementarities with other MFF programmes, including the European Regional Development Fund, would allow funding more R&I projects. More use of two-stage calls would filter proposals at an early stage⁷³. However, financial instruments are not appropriate for all projects⁷⁴, and two-stage calls will not solve the problem for unfunded high quality proposals. Likewise, decreasing the size of projects would imply abandoning larger scale projects, mainly affecting collaborative projects, which are an intrinsic part of the EU added value of the Programme. More strict eligibility criteria can improve overall success rate⁷⁵, however will not address the issue of low success rate for high-quality proposals. Lastly, decreasing the funding rate would lower effectiveness because applicants, including those with high-quality proposals, would need to find complementary funding, and could be discouraged from applying or taking risks.

Figure 9: EC contribution requested in proposals (EUR billion)



Source: DG Research and Innovation. NB: the “increase” scenario assumes an increase in proposals’ requested contribution from Horizon 2020 to the new Framework Programme that is similar to the increase experienced from FP7 to Horizon 2020.

- 1 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 14.
- 2 80-90% of stakeholders’ position papers echo the Lamy High Level Group, recognise that Horizon 2020 is a success and do not call for changes to the basic structure of the programme.
- 3 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 11.
- 4 Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. The activity must be: novel, creative, uncertain, systematic, transferable and/or reproducible. (Frascati Manual, <http://www.oecd.org/innovation/inno/frascati-manual.htm>)
- 5 Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation. (Oslo manual, <http://www.oecd.org/science/inno/2367580.pdf>)
- 6 Griniece, E. (forthcoming) Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 7 Rüttgers J., and al. (2018), Re-defining industry, Defining innovation, Report of the independent High Level Group on industrial technologies. On industry’s contribution and value to society, see also <https://industry-changemakers.ert.eu/>

- 8 Beckett B., et al. (2018), Visionary and Collaborative Research in Europe, Pathways to impact of use-inspired basic research, Fraunhofer Institute for Systems and Innovation Research, Austrian Institute of Technology.
- 9 European Commission (2017), Annex 2 of the Interim Evaluation of Horizon 2020, SWD(2017) 221 final.
- 10 Three examples of missions for pedagogical use are described in Mazzucato M. (2018), Mission-Oriented Research & Innovation in the European Union.
- 11 Key Enabling Technologies and digital technologies are instrumental in modernising Europe's industrial base, to ensure that industry reduces its carbon footprint and embrace a circular economy approach. Moreover, industry could mobilise important industrial players and ensure participation of SMEs on social and political priorities.
- 12 European Commission (2018), Annual Report on Research and Technological Development Activities of the European Union and Monitoring of Horizon 2020 in 2017.
- 13 European Parliament (2017), Resolution of 14 March 2018 on the next MFF: Preparing the Parliament's position on the MFF post-2020, ref. 2017/2052(INI).
- 14 European Court of Auditors (2018), Future of EU finances: reforming how the EU budget operates, Briefing Paper.
- 15 <http://www.bmub.bund.de/en/service/details-europe-and-environment/artikel/statement-of-green-growth-group-2/>
- 16 http://ec.europa.eu/budget/mff/lib/COM-2016-603SWD-2016-299_en.pdf
- 17 <https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=39853>
- 18 Council conclusions 7495/17, adopted by ECOFIN on 21 March 2017, <http://data.consilium.europa.eu/doc/document/ST-7495-2017-INIT/en/pdf>
- 19 <https://publications.europa.eu/en/publication-detail/-/publication/1df19257-aef9-11e7-837e-01aa75ed71a1>
- 20 European Commission (2016), A European strategy for low-emission mobility, COM(2016)0501 final.
- 21 European Commission (2016), Clean Energy for all Europeans, COM(2016)0860 final.
- 22 Among others, the Interim Evaluation of the Joint Undertakings, Interim evaluation of the European Institute of Innovation and Technology, FET Flagships – Interim evaluation.
- 23 In particular, the High Level Group on maximising the impact of EU R&I programmes and the Research, Innovation and Science Policy Experts (RISE) group.
- 24 For the evidence used in this impact assessment, please refer also to Annex 1.
- 25 Deloitte (2016) Equity funding in the EU.
- 26 The "Valley of Death" is commonly known as a market failure. "First valley of death" is associated to pre-commercial development of a product, with still high technical risks and unproven ability to generate revenue. Companies facing the "second valley of death" are in a more advanced stage of their lifecycle, and they are mainly looking for growth finance. However, private investors are deterred by unproven ability to scale-up rapidly and generate cash flow. In both cases technologies are seen too risky by private investors, and are, therefore, often not funded.
- 27 European Investment Bank (2016) Restoring EU competitiveness, p. 36.
- 28 European Commission (2017). Interim Evaluation of Horizon 2020, SWD(2017) 220, p. 34.
- 29 European Investment Bank (2018) Improving Access to Finance for Beneficiaries of the SME Instrument.
- 30 Ibid.
- 31 Griniece, E. (forthcoming) Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 32 Breakthrough market-creating innovations are defined in Horizon 2020 as radically new, breakthrough products, services, processes or business models that open up new markets with the potential for rapid growth at European (and global) levels, in contrast to incremental innovation (improvements to existing products for existing markets).
- 33 Additional evidence provided in Annex 6.1 on the European Innovation Council.
- 34 To this end, a level playing field among competitors is key to unleashing the innovative potential of companies (especially SMEs) for breakthrough or disruptive innovation to happen.
- 35 Technopolis (2017), Evaluation of the SME instrument and the activities under Horizon 2020 Work Programme "Innovation in SMEs".
- 36 Ibid.
- 37 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 7. See also the specific recommendation in the Lamy High Level Group report on "adopting an impact-focused, mission-oriented approach" in future EU research and innovation programmes (LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 15-16.
- 38 Democratic Society (2018), "Citizen Participation in

- FP9: A model for mission and work programme engagement”. See p. 18-19 for a more detailed overview.
- 39 Ibid.
- 40 Griniece, E. (2018), Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 41 Over 20 Focus Areas were introduced in Horizon 2020, and the interim evaluation found that “their multiplication resulted in some confusion” (p. 149, In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final).
- 42 Democratic Society (2018), p. 18.
- 43 “There is much evidence that EU scale R&I missions would be best served in a hybrid model (including or combining accelerator and transformer elements), that is flexible in addressing different types of challenges and different levels of complexity, while at the same coordinating and concentrating the effort and resources towards the commonly agreed objectives”. Joint Institute for Innovation Policy (2018), Mission-Oriented Research and Innovation: assessing the impact of a mission-oriented research and innovation approach.
- 44 Mazzucato M. (2018), Mission-Oriented Research and Innovation in the European Union: A problem-solving approach to fuel innovation-led growth.
- 45 This is identified as a key characteristic of the most successful mission-like initiatives across the world. See: Joint Institute for Innovation Policy study.
- 46 “Missions require to set up specific governance structures with full-time professionals and to keep close contacts with all stakeholders. A balanced system of separation of powers between steering, strategic and financial decision-making and the day-to-day management is a must to establish from the outset”. Joint Institute for Innovation Policy study.
- 47 <https://ec.europa.eu/research/innovation-deals/index.cfm>
- 48 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 8.
- 49 Griniece, E. (forthcoming) Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 50 Within the Programme, peer-reviewed publications with at least one associated or third country have a higher impact than other ones: European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 115.
- 51 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 9.
- 52 Ibid.
- 53 Griniece, E. (forthcoming) Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 54 The effect of emulating or aligning Member States funding policies to match these of Horizon 2020 with respect to open access is clearly reported by Member States in the National Point of Reference (NPR) report of 2015) and can be seen in many instances, for example in aligning embargo periods (p. 16). Similar trends can be observed in the 2017 NPR report, where 2/3 of Member States report that the 2012 Recommendation for Open Access to and Preservation of Scientific Information has had significant impact on national policies.
- 55 <https://ufm.dk/en/publications/2018/preliminary-analysis-introduction-of-fair-data-in-denmark>
- 56 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 9.
- 57 Ibid.
- 58 Griniece, E. (forthcoming) Synthesis of stakeholder input for Horizon Europe and European Commission analysis.
- 59 Specific partnerships, whether new or renewed, are not included in the legal proposal of the Framework Programme.
- 60 As proposed by the ERAC ad-hoc working group on partnerships (2018).
- 61 The impacts of the changes were quantified based on the NEMESIS model only. As shown in Annex 3, the QUEST and RHOMOLO models provide lower results in terms of GDP gain for the baseline scenario.
- 62 Seureco (forthcoming) Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme.
- 63 These benefits are estimated after 2021 based on the NEMESIS model. Source: Seureco (forthcoming) Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme.
- 64 Costs are based on Horizon 2020 figures.
- 65 The Interim Evaluation of Horizon 2020 shows that the estimated cost for applicants to write proposals is EUR 1908.9 million or EUR 636 million annually. Of these costs, it is estimated that EUR 1.7 billion would be spent on writing proposals that do not get funded, including EUR 643.0 million for non-funded high quality proposals alone.
- 66 The administrative burden of reporting obligations were estimated based on the standard cost model. The total burden is obtained by multiplying: (1)

- Average personnel cost per hour: based on data from the R&D surveys (Eurostat), the average cost of R&D personnel per FTE R&D staff is EUR 4927 per month in the EU. Based on this, a gross salary range of EUR 4000-6000 per month is assumed for the calculations (20% around the EU average). This corresponds to an hourly wage of EUR 25 to 37.5 per hour. In line with the better regulation guidelines, the hourly pay to be used in the standard cost model corresponds to this gross salary plus overhead costs (25%). This gives a range of EUR 31.25 to 46.88 per hour. (2) Time required per reporting obligation: the duration of the tasks required to fulfil a reporting obligation is estimated to range between 4 and 8 hours. (3) Number of projects: about 11,100 projects were launched during the first three years of Horizon 2020. This corresponds to 25,900 over 7 years. (4) Number of reporting obligations: based on data from Horizon 2020 projects, an average of two reporting obligations per project is assumed.
- 67 The administrative expenditure related to the evaluation of proposals and the management of projects is below 5% of the budget. More extensive use of executive agencies since 2014 (REA, ERCEA, INEA and EASME) promoted economies of scale and increased synergies. As a result, administrative expenditure was drastically reduced (compared to 6% in FP7). At the same time, the level of client satisfaction is very high. Therefore, a rate of 5% is a reasonable assumption for the next Framework Programme. This corresponds to an estimated cost of EUR 500 to 600 million per year.
- 68 European Commission (2017), The Grand Challenge. The design and societal impact of Horizon 2020.
- 69 The success rate in Horizon 2020 is 11.6%, compared to 18.5% under the previous framework programme (FP7).
- 70 Proposals that passed all thresholds in the independent evaluation process (from Horizon 2020 Interim Evaluation).
- 71 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 83.
- 72 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 10.
- 73 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 87-88.
- 74 European Commission (2017), Reflection paper on the future of finance, p. 26.
- 75 In calls under the Horizon 2020 Societal Challenge 7 "Secure Societies", the success rate reached 20% by imposing strict eligibility criteria.

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

4 DELIVERY FOR IMPACT



4 DELIVERY FOR IMPACT

Efficient delivery is essential for reaching all the Programme's objectives. This section will describe the improvements made in order to better reach the cross-cutting objectives of the MFF: simplification, flexibility, coherence, synergies and focus on performance. These improvements are based on recommendations for optimising delivery from the Horizon 2020 Interim Evaluation¹ and the Lamy High Level Group report². The changes are presented in a structured way along the typical lifecycle of EU R&I support. When changes represent a significant departure from Horizon 2020 (see Table 6 for lessons learnt from Horizon 2020), they will be assessed qualitatively and, where possible, quantitatively. More details can be found in the Annex 7 on the Rules for Participation.

Optimising delivery is also key to achieve higher impact and further simplification.

When properly designed, the Rules for Participation ensure legal certainty for participants and contribute to overall coherence in terms of implementation. Simplification remains a continuing endeavour in Horizon Europe, building on the achievements of Horizon 2020, which reduced the administrative burden and costs for applicants, and made it more attractive for newcomers and SMEs through new elements like its funding model (single reimbursement rate and a flat rate for indirect costs), the Participant Portal, and e-signatures. Beneficiaries and stakeholders have reacted very positively³.

Impact depends ultimately on the dissemination and exploitation of R&I data and results, and it needs to be effectively captured and communicated⁴. An ambitious and comprehensive dissemination and exploitation strategy will increase the availability of R&I data and results and accelerate their uptake to boost the overall impact of the Programme. The strategy will move from a focus on individual projects to analyses of portfolio of R&I results in key policy areas and will further endorse Open Access policy to incentivise the exploitation of R&I results. In particular, clusters of mature R&I results will be exploited in synergy with other EU programmes to foster their uptake at national and regional level, maximising the European innovation potential. This will be complemented by effective R&I communication and outreach campaigns that build trust and engage citizens.

Table 5: Mapping of continued, discontinued and new features in Horizon Europe

Continued without changes	Continued with changes	Discontinued	New
Design – Priorities			
	<ul style="list-style-type: none"> > Excellent Science: <i>becomes</i> Open Science pillar and does not include the FET specific objective > Societal Challenges: <i>becomes</i> Global Challenges and Industrial Competitiveness pillar and covers the LEITs specific objective of the Industrial Leadership pillar and the EIT, which was a separate specific objective 	<ul style="list-style-type: none"> > Industrial Leadership as a separate pillar 	<ul style="list-style-type: none"> > Open Innovation pillar > Strengthening the European Research Area: covers Science With and for Society, and Spreading Excellence and Widening Participation, which are Horizon 2020 specific objectives

Design - Specific objectives			
<ul style="list-style-type: none"> > European Research Council > Marie Skłodowska Curie Actions > Research Infrastructures > Direct Actions (Joint Research Centre) > Support to the European Institute of Innovation and Technology 	<ul style="list-style-type: none"> > Leadership in enabling and industrial technologies (<i>becomes</i> cross-cluster, though in particular in Digital and Industry cluster) > Innovation in SMEs, (<i>included</i> in European Innovation Council) > Societal Challenges 1-7 (<i>becomes</i> Clusters in the Global Challenges pillar) > Science with and for Society (<i>becomes</i> intervention areas within ERA foundation) > Spreading Excellence and Widening Participation (<i>becomes</i> Sharing Excellence, within ERA foundation) 	<ul style="list-style-type: none"> > Future and Emerging Technologies as separate label, but activities included in other parts > Fast Track to Innovation > Access to Risk Finance (covered under InvestEU programme) 	<ul style="list-style-type: none"> > European Innovation Council (building on EIC pilot)

Continued without changes	Continued with changes	Discontinued	New
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Implementation - instruments

<ul style="list-style-type: none"> > Research and Innovation Actions > Innovation Actions > ERC frontier research > Training and mobility actions > Programme co-fund actions > coordination and support actions > inducement prizes > recognition prizes > public procurements > ERA Chairs > Twinning > Teaming > Policy Support Facility 	<ul style="list-style-type: none"> > Pre-commercial procurements (PCP) and Public procurement of innovative solutions (PPI) (becomes Coordinated innovation procurement) > SME Instrument (integrated into EIC Accelerator and transition activities) > Future and Emerging Technologies (FET)Open (becomes EIC Pathfinder) > Future and Emerging Technologies (FET)Flagships (incorporated within mission concept) > Support to Joint Programming Initiative, ERA-NET, Contractual Public Private Partnerships, Institutionalised public-private partnerships (Art. 187) and Institutionalised public-public partnerships (Art. 185): incorporated within European Partnerships, with strong criteria 	<ul style="list-style-type: none"> > Missions > EIC pathfinder > EIC accelerator
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Implementation – concepts

<ul style="list-style-type: none"> > Key Enabling Technologies > Gender Equality > Ethics standards 	<ul style="list-style-type: none"> > International cooperation (new criteria) > Strategic planning – widened to include R&I activities from other funding programmes > Governance
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Table 6: Lessons learnt from the Interim Evaluation of Horizon 2020 and from the Stakeholder Consultation

	What do we have now?	What did we learn?
Strategic planning	<p>The priority-setting process is defined in multiannual Work Programmes⁵ (WP). The WPs identify the priorities in calls for proposals. They allow some flexibility to respond to new developments⁶. The strategic planning process builds on: Scoping Papers developed by the Commission; foresight; targeted consultations of industry, academia and civil society; and input from experts (Advisory Groups). The WPs are adopted by Commission Decision, in consultation with Member State representatives in the 14 configurations of the Programme Committee.</p>	<p>The strategic planning process improved the intelligence base underpinning priority-setting, and made the focus of the programme more in line with stakeholders needs. Nonetheless, the translation of high-level challenges and objectives into specific calls and topics is not always clear, while the transparency in the WP formulation process and the participation of stakeholders/and citizens/CSOs in agenda-setting were identified as areas for improvement.</p>
The single set of rules	<p>The single set of rules (i.e. the Rules for Participation and dissemination of results) implies that the same rules are applied in all parts of the programme, regardless of the implementing body (Commission, Executive Agencies, Joint Undertakings). Only a very limited number of derogations from the Rules for Participation exist, when duly justified, e.g. for specific operating needs of public-to-public partnerships (Art. 185 TFEU) and public-private partnerships (Art. 187 TFEU)⁷. The Common Support Centre (CSC) harmonises implementation of the rules across all implementing actors.</p>	<p>The single set of rules and its harmonised implementation via the CSC are widely seen by beneficiaries as advantageous, contributing to increased legal certainty, coherence and simplification of the rules, though some partners perceived it as a loss of flexibility compared to FP7⁸. Moreover, Member States have repeatedly expressed their wish to include Art. 185 TFEU initiatives under the the Participant Guarantee Fund⁹, which does not currently cover them.</p>
The funding model	<p>The rules concerning the contribution of the EU to eligible costs do not differentiate between organisation categories or types of activities (in contrast to the FP7 funding model, which used a complex matrix of organisation categories and activity types). Its main features are a single reimbursement rate for direct costs (up to 100% of eligible costs for Research and Innovation Actions, and up to 70% for Innovation Actions¹⁰) and a single flat rate for indirect costs (25% is applied to the direct eligible costs¹¹).</p>	<p>The funding model has not led to a significant change in funding intensity¹². The funding model is a simplification measure that allows for flexibility and that has mobilised and largely satisfied stakeholders¹³. The overall funding rate is on average 70% of total project eligible costs (both direct and indirect). In a simplification survey¹⁴, 78% of respondents appreciated the single reimbursement rate.</p>

	What do we have now?	What did we learn?
Simplified forms of grants	<p>Horizon 2020 features a simplified cost reimbursement system with enhanced use of unit costs¹⁵, flat-rates and lump sums, while actual cost reimbursement (i.e. costs actually incurred by beneficiaries) is used still for the majority of the budget. Unit costs are used for specific types of personnel costs (i.e. for average personnel costs and SME owners without a salary) and other direct costs (i.e. internal invoices), while indirect costs are covered by a single flat-rate. Lump sums, at the start of Horizon 2020, were used for small-sized projects (e.g. Phase 1 of the SME Instrument). In the 2018-20 Work Programme, pilot actions were launched for testing lump sum project funding for "mainstream" collaborative R&I projects.</p>	<p>While beneficiaries express preference for actually incurred costs, a number of financial complexities are inherent to this model (e.g. calculation of the monthly hourly rate, additional remuneration). Moreover, reimbursement of actual costs focuses attention on justification of costs, and not on the expected impact as in the case of lump-sum funding. Further simplification of the actual cost reimbursement system is necessary, in particular for personnel costs. The European Court of Auditors¹⁶ also proposed that the post 2020 Framework Programme assesses the need for further use of simplified cost options such as lump sum project funding and prizes.</p>
Grants and financial instruments	<p>More than 90% of the Horizon 2020 support is grant based, while the rest is provided with financial instruments (i.e. debt or equity) through the European Investment Bank (InnovFin)¹⁷. Pre-commercial public procurement (PCP), public procurement for innovation (PPI) and inducement prizes represent only a limited share of the Horizon 2020 budget.</p>	<p>Only a small number of firms receiving Horizon 2020 grants benefitted from Horizon 2020 financial instruments. Extremely few companies taking part in Horizon 2020 obtained investments for scaling up from InnovFin. This points to a potential lack of integration between the grant and non-grant based instruments at different stages of the innovation cycle but also to limitations of intermediated risk-sharing mechanism where the initial risk is to be fully borne by the Union due to market risk-aversion¹⁸.</p>
Proposal evaluation and selection	<p>Major investment decisions are taken at the stage of evaluation and selection of proposals. The system, based on independent expert judgement ensures that the selected projects are the best. The approach ensures maximum coherence across the different implementing bodies, based on three award criteria against which proposals are evaluated: Excellence; Impact; and Quality and efficiency of the implementation¹⁹.</p>	<p>The Horizon 2020 proposal evaluation and selection process is generally highly regarded. Still, some stakeholders asked for more transparency, found the quality of evaluation feedback received uneven, and considered that the evaluation experts sometimes appeared to lack the appropriate expertise²⁰. To increase efficiency in relation to over-subscription, two-stage calls for proposals were identified as good practice.</p>

	What do we have now?	What did we learn?
Ex-ante and ex-post audits	The general rules related to the management and implementation of projects are detailed in the Model Grant Agreement. Beneficiaries are bound by the grant agreement they sign with the Commission. The audit and control system seeks an appropriate balance between trust and control, taking into account administrative burden for participants. The Horizon 2020 audit strategy is based on the financial audit of a representative sample of expenditure, and is complemented by a selection based on risk assessment	The Common Support Centre strengthened the corporate approach in implementing the programme and in auditing projects. However, some Joint Undertakings expressed the need of additional direct audit coverage and considered the common representative sample as not sufficient enough for their needs, leading to a potential increase of audit burden towards the Horizon 2020 beneficiaries.
Dissemination and exploitation	Throughout Horizon 2020, specific calls for proposals, coordination and support actions and public procurement provide targeted assistance to projects in order to optimise the dissemination and exploitation of their research results. To further assist project consortia, the Commission provides tailor-made support services, e.g. the Common Exploitation Booster, the Common Dissemination Booster and the Innovation Radar.	Beneficiaries develop activities for better dissemination and exploitation but results are still not fully accessible to all relevant stakeholders and this represents a barrier to knowledge circulation and to innovation uptake. The uneven exploitation capacity among beneficiaries hinders market uptake. Moreover, feedback from R&I projects into policy-making must be strengthened ²¹ .
Delegation	To ensure a more modern, effective and dynamic implementation, while reducing staffing by 5% over 5 years ²² , 75% of Horizon 2020 budget is delegated to other EU bodies: Executive Agencies (55%), Public Private Partnerships (Art. 187 TFEU initiatives, 10%), the European Investment Bank (4%), the European Institute of Technology (EIT, 4%) and Public-Public Partnerships (Art. 185 TFEU initiatives, 2%). The remaining 25% is managed "in house" by the Commission.	The delegation to implementing bodies allows Commission services to focus on policy-making and strategic planning, while maximizing the effective and efficient use of EU funding. Executive Agency evaluations confirmed their effectiveness and high value for money, with administrative costs well below 5% ²³ .



4.1 THE STRATEGIC PLANNING PROCESS

Towards a strategic, impact-oriented and collegial planning process. The strategic planning process will provide multi-annual strategic orientations for the Framework Programme. It will be co-created in synergy with other EU programmes and policies, with the intention of giving coherence to the entire portfolio of actions supported by the EU under the MFF. The process will be streamlined into a single Commission document²⁴, applying to all Programme components²⁵, including missions²⁶, European Partnerships, and the EIT Strategic Innovation Agenda²⁷. This draft Strategic R&I Plan will be open for public consultation, providing more involvement of EU Institutions and citizens than previously. The Work Programmes will then be developed on the basis of the finalised Strategic Plan.

In addition, a simpler governance structure with ad-hoc and flexible advisory mechanisms and Programme Committee configurations will improve the rationalisation and simplification of the planning process, hence delivering results more efficiently and transparently.

What are the expected implications?



Increased co-creation with other EU Institutions and citizens. While in Horizon 2020 the priority setting was defined mostly with targeted consultations, the new Strategic R&I Plan will be more open for general public consultation, involving citizens, customers and end-users in agenda-setting (co-design) for the Programme. In particular, the public will have a say in the definition of R&I missions.



Higher coherence within the Programme and enhanced synergies with other EU Programmes. By bringing together all Commission services and implementing bodies, the Strategic R&I Plan will ensure a stronger and more inclusive agenda-setting process, whereby the linkages between EU Programmes would be strengthened, promoting faster dissemination and uptake of R&I results.



Better alignment of national and EU policies. Involvement of Member States at early stage in the discussion on the strategic planning and in consequences in the work programme preparation will help to build better alignment between national and EU R&I activities.



4.2 THE SINGLE SET OF RULES

The principle of a single set of rules will continue with further improvements. In line with the corporate approach towards a *single-rule book* and the preparation of the MFF, the new EU Financial Regulation²⁸ will be used as a common reference under which the rules applicable to all EU funding programmes will be aligned. Derogations to the Financial Regulation are kept to the minimum, but maintained in order to strike the right balance between full harmonisation and specific needs of individual initiatives. The new Rules for Participation allow other funding bodies, in particular bodies implementing Article 185 or 187 TFEU initiatives, to establish limited derogations in their basic acts in cases duly justified by their specific needs. Furthermore, the Participant Guarantee Fund (renamed Mutual Insurance Mechanism) will be extended to article 185 TFEU institutionalised European Partnerships.

What alternatives were considered? Keeping Horizon 2020 status quo was considered for predictability, but this would have been a missed opportunity to streamline the approach taken on derogations (e.g. by maintaining the scope of the derogations for Art. 187 TFEU initiatives separate from other institutionalised European Partnership Initiatives) and for further simplification. Returning to FP7 Rules would provide more flexibility (e.g. by allowing different funding bodies to adopt rules as they see fit), but this would result in diverging rules, undermining simplification, legal certainty and hampering participation.

What are the expected implications?



More simplification and reduced costs. The single set of rules contributes to the rationalisation of the new Framework Programme. It further harmonises and streamlines implementation methods, hence simplifying the burden e.g. for preparing and submitting proposals. It increases the accessibility and attractiveness of the programme, in particular for applicants with limited resources, such as SMEs.



Improved synergies with other EU programmes. As the number of derogations to the Financial Regulation is reduced, EU programmes are more likely to share common rules. This increases the possibility for more targeted multi-faceted EU support, for instance through missions.



Increased flexibility while maintaining legal certainty. The Framework Programme will further improve the balance between flexibility and legal certainty e.g. by allowing funding bodies to establish rules that depart from those laid down in the Financial Regulation or in the Rules for Participation, in order to accommodate their specific operating needs of individual initiatives in duly justified cases.



4.3 THE FUNDING MODEL

Rules on funding rates will be maintained.

Given the largely positive assessment of the Horizon 2020 funding model, Horizon Europe will maintain the single reimbursement rate for direct costs (up to 100% of the total eligible costs for Research and Innovation Actions and up to 70% for Innovation Actions) and the single flat rate for indirect costs (25% is applied to the total direct eligible costs)²⁹. Similarly, the funding rate will be a maximum – this ceiling can be reduced for implementing specific actions, where duly justified (e.g. for Euratom, or specific close-to-market calls).

What alternatives were considered? Alternatives to the continuation were considered, mainly to reduce oversubscription³⁰, but maintaining attractiveness (i.e. broad involvement from all sectors and disciplines) is more important. A lower funding rate for all projects (e.g. 75%) would allow a larger number of beneficiaries to benefit from EU support. However, such an approach would decrease the overall attractiveness of the programme, especially for non-profit entities and SMEs, hence affecting the principle of excellence. Different levels of funding for industry compared to other types of beneficiaries were also considered, but this approach would have a negative impact on industry participation, on simplification and on time-to-grant. Alternative ways to address oversubscription are also identified in section 3.4 on critical mass.

What are the expected implications?



Maintained programme attractiveness. Continuity in the funding model enhances predictability, legal certainty, attractiveness and ease of access to the Programme. Administrative burden would not increase. On the contrary, a significant departure from the Horizon 2020 model would force beneficiaries to adapt once again to a new system.



Further simplification and more flexibility. The benefits of the current funding model have already largely materialised³¹: simple financial management of projects; reduced complexity of the financial rules; reduced financial error rate; acceleration of the granting processes.



Reduced oversubscription. Extending the use of flexibility to establish lower funding rates in the Work Programme can contribute to reducing oversubscription for targeted calls or topics. The level of co-investment will increase or at least remain the same as in Horizon 2020.



4.4 FORMS OF FUNDING, INCLUDING SIMPLIFIED COST OPTIONS

The cost reimbursement scheme will be further simplified. The two current unit costs (average personnel costs and internally invoiced goods and services) calculated in accordance with the beneficiary's practices³² will be maintained. In addition, in view of simplification, the unit cost for internally invoiced goods and services will allow for a higher acceptance of the usual cost accounting practices. Beneficiaries will be able, under certain conditions³³, to calculate such unit cost based on 'actual direct and indirect costs', provided those costs are recorded in their accounts. The need to further align programme provisions with beneficiaries' accounting practices was also a recommendation from the European Court of Auditors³⁴. In order to lower administrative burden, an increased use will be made of lump-sum project funding against fulfilment of activities – building on the experience from the lump-sum pilot in Horizon 2020 – as well as other simplified forms of funding provided by the new Financial Regulation, including other incentives based on contributions not linked to costs, where appropriate.

As regards actual costs, the calculation of personnel costs will be further simplified and aligned to the Financial Regulation. The distinction between basic and additional remuneration will be removed and the Horizon

2020 capping on the additional remuneration abolished. For beneficiaries with project-based remuneration³⁵, costs of personnel will be eligible up to the remuneration that the person would be paid for the time worked in projects funded by national schemes.

The system of in-kind contributions provided by third parties to beneficiaries will be further aligned to the Financial Regulation: in-kind contributions against payment will be treated and reimbursed under other budget categories according to the eligibility criteria for actual costs. In addition, the calculation of in-kind contribution free-of-charge will be further simplified: no distinction will be made if these resources are used on the premises of beneficiaries or third parties and beneficiaries will no longer need to declare them, under specific conditions, as receipts.

What alternatives were considered? Alternative simplified costs options were assessed regarding rules for personnel costs, such as optional unit cost (hourly rate) or contributions not linked to costs but were not found feasible. Fully relying on the Financial Regulation was also considered, but such an approach would imply a significant departure from current practices (lack of continuity) and would be negatively perceived by beneficiaries.

What are the expected implications?



Lower administrative burden. The broader acceptance of beneficiaries' usual cost accounting practices, the abolition of the additional remuneration scheme, and the extended use of lump sum and output-based funding significantly contributes to simplification, as they improve and simplify reimbursement of actual costs, while providing flexibility. In particular, the use of lump sums reduces substantially the reporting requirements from beneficiaries during the lifetime of the project, shifting the focus of project monitoring from financial checks to performance and content.



Lower error rate. The further acceptance of the beneficiaries' usual cost accounting practices will reduce the error rate on issues that have generated recurrent and repetitive errors under FP7 and Horizon 2020. For example, the abolition of the additional remuneration scheme will allow the beneficiaries to report their personnel cost with respect to their usual accounting practices, whilst the current experience on auditing lump sums has confirmed the low error rate on such transactions.



More coherence with the Financial Regulation. An alignment of the rules with other EU funding programmes will also allow the beneficiaries to apply even more widely their usual accounting practices, as this reduces the need to amend reporting models to the various (and sometimes diverging) needs of each EU programme. This harmonisation and further acceptance of the beneficiaries' usual accounting practices will reduce the administrative burden of the beneficiaries.



4.5 GRANTS, FINANCIAL INSTRUMENTS AND BLENDED FINANCE

Blended finance will help companies to scale up. The supply of flexible and agile funding schemes is essential for innovators. Grants will continue for projects that are far from the market, for example for basic research³⁶. Yet, projects that are closer to market may still present a too high-risk profile, preventing them access to risk finance. Through the European Innovation Council (EIC), the new Framework Programme will offer large-scale blended funding (grants or reimbursable advance with equity or guarantees) to companies undertaking such projects, for late stage innovation activities, but also for market deployment activities such as pilot manufacturing, large trials or ensuring regulatory compliance³⁷, tailored to their risk level and technological maturity. The overall purpose of blended finance shall be to support high-risk innovations beyond the usual limits of grant-based research, where the risks – whether technological, market or regulatory – cannot be borne by the market alone. By combining grant-type funding with equity or guarantees under the EIC, the Programme will hence bridge the financing gap between late stages of R&I and market uptake and deployment, and will encourage investors and lenders to support innovative high-risk projects, with a greater propensity to co-invest or to offer lower interest-rates and less onerous requirements for collateral.

What alternatives were considered? While innovation at large will be reinforced by the InvestEU single fund - providing indirect financial instruments carried out through the European Investment Bank Group or other implementing partners, with a dedicated window for R&I investments and specific products for innovative companies - financial intermediaries (banks and investors) may remain averse to the residual risk they bear when investing in high-risk innovative projects. To date, available private and corporate financing remains small³⁸ for late stage of innovation activities and market take-up for high-risk breakthrough innovations, as financial institutions must limit their risks to maintain their market rating. There is hence a necessity for direct Union intervention. Providing only for grant allows to start de-risk operations and attract private or corporate finance, but partially, as some activities too close to market, including deployment and scale-up, may not be covered by grants. Furthermore, the classical alternative of awarding blended finance to a project by allocating grant-type funding (through the Framework Programme) and financial instruments (through InvestEU) might not be fully adapted to the needs of risky breakthrough innovators, who need to proceed to the market quickly.

Box 11: Examples of blended finance

National innovation agencies such as Vinnova, BPI France, Innovate UK and CDTI operate blended finance in the form of grants in combination with soft loans and venture investments:

- > A loan combined with a grant: the proportion of grant to loan depends on an assessment of the riskiness of the innovation whose development the funding will support: the higher the risk, the greater the grant component. This approach can be combined with the whole or partial write-off of the loan if the development of the innovation fails for technical or commercial reasons; or the reimbursement of part of the grant if the innovation succeeds.
- > A conditional grant combined with a loan or equity: the payment of all or part of the grant is conditional on the grantee obtaining at least a matching amount as a loan or an equity investment (such as venture capital) from a lender or investor.

What are the expected implications?



Raise availability of large-scale risk finance in Europe by providing large tailor-made investments that combine EU support through grants and blended finance, in addition to investment through support to equity or guarantees.



Increase risk taking for breakthrough innovation by de-risking technical or financial failure.



Increase leverage through active measures put in place for EU R&I funding to stimulate private finance. For instance, proposals may also be submitted by investors including public innovation agencies looking for co-investment. A set of actions to improve 'investment-readiness' and 'bankability' will continue from the Horizon 2020 EIC Pilot in term of coaching (InvestHorizon), and the EIC events aimed at matching investor/investee and awareness raising.



4.6 PROPOSAL EVALUATION AND SELECTION

The key elements of the proposal evaluation and selection system will be maintained, including the use of independent experts, and the use of three award criteria (based on excellence, impact and quality and efficiency of the implementation) across the board, with differentiation for the proposals for ERC frontier research actions, which will continue to apply only the excellence criterion and for the EIC's Accelerator whose evaluation will include valuation of risk. Small improvements in order to address lessons learnt from the Horizon 2020 Interim Evaluation (e.g. to improve quality of feedback to applicants, differentiated expert panels, and multi-stage and multi-step procedures, gender balance in evaluation panels and the integration of the gender dimension in R&I content) can be ensured throughout the implementation of the Work Programmes. To increase the societal relevance and applicability of proposals, greater use of civil society expertise should be encouraged in appropriate evaluation panels³⁹. In particular for missions and the EIC, the Commission may select proposals based not only on the merit of individual proposals,

but also in relation to the overall coherence of the portfolio of projects and other Union policy objectives. While the main principles would be spelled out in advance in the Rules, the Work Programmes will provide further details on the application of the award criteria depending on the objectives of the calls and instruments (e.g. the aspects to be taken into account under the evaluation procedures).

What alternatives were considered? A possible alternative was the exclusion from the Rules for Participation of these provisions, relying instead on the full flexibility offered by the Financial Regulation (leaving the criteria and other provisions for the Work Programmes). Although this would maximise flexibility, it risks a divergence of rules in practice, jeopardise smooth business processes, and lead to unpredictability for applicants. Specifying in full detail the criteria for evaluation and selection of proposals in the Rules would ensure a high degree of coherence across the programme and a measure of stability for applicants but would represent a significant loss of flexibility.

Box 12: Access conditions to the Framework Programme

For collaborative projects, the consortium must include at least three independent legal entities established in a different Member State or associated country, and with at least one of them established in a Member State, unless otherwise provided for in the work programme. For other specific activities (i.e. EIC, ERC, co-fund, or MSCA training and mobility actions), different minimum conditions apply. Additional eligibility criteria may be laid down in the work programme. In case of actions carried out outside the Union using and/or generating classified information, a security agreement have to be concluded between the Union and the third country in which the activity is conducted.

What are the expected implications?



Achieve a balance between flexibility and coherence.

The current system has been shown to work well, and there is no evidence for the need for a fundamental change. However, missions and the EIC require a proactive portfolio management to reach their objectives, calling for flexibility to ensure overall consistency. Providing the main ground rules in the legislation, while permitting adaptability via the Work Programme, has proven in the current and previous programmes to ensure coherence across the board, predictability for applicants, and smooth business processes, while maintaining a strong degree of flexibility and the possibility for experimentation.



Maintain a strong focus on excellence and performance.

Streamlined but adaptable rules will help applicants design well-focussed proposals, and will lead to processes in which the best proposals are identified and selected as quickly as possible.



4.7 EX-ANTE AND EX-POST AUDITS

A wider cross-reliance on audits and assessments – including with other EU programmes – is envisaged. The increased alignment to the Financial Regulation provide an opportunity for audit synergies via Systems and Processes Audit. Indeed Systems and Processes Audit avoid duplication of audits, since there will be a common audit approach on common financial rules and hence a more harmonised and simple audit approach. By cross relying on audits of beneficiaries among the various EU programmes, the need for additional auditing will gradually be reduced. In addition, cross-reliance has been explicitly considered in other elements of assurance (e.g. Systems and Processes audits and audit on transactions) resulting into a reduced need for financial audits on beneficiaries with positive results in their Systems audits. Moreover, cross-reliance could be part of the conditions under which the obligation for the beneficiary to submit a certificate on the financial statement can be waived.

Further efforts in the area of ex-ante controls through implementing additional automated checks and tools for simpler entry of the data, will have a positive impact where beneficiaries need to submit information to Commission. Integration of ex-post audit support into the Participant Portal will enable better view on the progress of the audits to the beneficiaries, allow completely electronic exchange of documents and notifications, all that can anticipate additional reduction of burden and costs to beneficiaries.

What alternatives were considered? The concept of cross-reliance on other audits or assessments with other EU programmes was considered, however its effectiveness depend on the homogeneity of the rules between programmes. Identifying possible common benchmarks / principles or best practises for a broader accep-

tance of usual cost accounting practices of beneficiaries from different sectors and different countries can be further explored as a second alternative in view of moving a step forward from a 'rule-based' approach towards a 'principle-based' one. However, it should be noted that such a challenging alternative would be possible only once having taken into account the eligibility criteria of the different programmes, in the particular context of the absence of any international standard in that matter.

What are the expected implications?



Reduce administrative burden. Compared to Horizon 2020, the Systems and Processes Audit (SPA) will lead to a reduction of the audit burden of the beneficiary that has been positively assessed. A beneficiary which is positively assessed via a Systems and Processes Audit, receives a long term assurance that their usual accounting practices are compatible with the Horizon Europe's eligibility requirements, whilst the need for further auditing ceases to exist. The introduction of Systems and Processes Audit is a holistic audit approach, resulting into an overall assurance which when achieved, results into a significant reduction of the audit burden.



Increase simplification for beneficiaries of EU funds. The Systems and Processes Audit (SPA) allows for more synergies with the Audits carried out under the shared management mode (e.g. especially those performed under the European Regional Development Fund). With this cross-reliance between audits, the Commission increases efficiency and effectiveness, avoids duplication of audit efforts and initiates a process where auditors within the Commission can exchange data and reviews.



4.8 POLICY AND RULES REGARDING DISSEMINATION AND EXPLOITATION

Horizon Europe will provide dedicated support to dissemination (including through open access to scientific publications), exploitation and knowledge diffusion actions. Strong emphasis will be placed on portfolios of research results for targeted diffusion to end-users, citizens, public administrations, academia, civil society organisations, industry and policy-makers, including through the use of data intelligence tools for harvesting knowledge and providing innovative data uses and visualisation.

More emphasis is put on to promoting the exploitation of R&I results, in particular in the EU. Horizon 2020 provides for a “best effort” to exploit results and, if indicated in the Work Programme, for additional exploitation obligations. In Horizon Europe, the “best effort” approach to exploit must have a particular focus on the EU. As in Horizon 2020, the Work Programme can specify additional obligations if justified. The beneficiaries must include in their proposals a dissemination and exploitation plan that must be updated during and after the end of the project, to ensure a continued focus on the exploitation of results.

What alternatives were considered? Alternatives for better exploitation of R&I results that were considered range from not having specific rules at all, to having more stringent rules across the board. Having a more stringent general rule was considered unjustified, as there may be valid reasons why exploitation occurs elsewhere (the EU often still benefits from such exploitation). Moreover, such a broad approach would deter industrial and international participants. Having no rules at all, and leaving the full choice of exploitation location to market forces was considered insufficient to safeguard the appropriate exploitation of results for the benefit of the Union.

What are the expected implications?



More economic and societal impact. By fostering better exploitation of R&I results, a more EU-focussed exploitation increases the accessibility of high quality content, while ensuring that the benefits serve the EU. They aim at better ensuring the right balance between the pursuit of EU strategic interests in terms of competitiveness and job creation on one hand, and attractiveness for industry and openness to international participation on the other. This will assist market uptake, boost impact, and increase the innovation potential of results supported by EU funding.



Some additional reporting requirements. The possibility of additional reporting specifically on exploitation or impact demonstration and related administrative burden will be weighed against the need to have accurate information regarding the exploitation of results beyond the lifetime of the projects.



Higher market uptake, impact and innovation potential. Union support will ensure a constant stream of knowledge and innovations towards the scientific community, industry, policy-makers, and the public. Dedicated support services developed by the Commission, combined with the strengthened exploitation plans of the beneficiaries, will satisfy both the legitimate interest of beneficiaries and the interest of the public.



4.9 DELEGATION TO EXECUTIVE AGENCIES

The Commission will increase the share of the budget delegated to Executive Agencies, subject to positive outcome of the mandatory Cost Benefit Analysis. Given the new elements in the scope of the new Framework Programme (e.g. missions and the EIC) and the increased budget to be delegated, the reshaping of the portfolios of the existing Executive Agencies will be needed along with exploring the possibility of establishing additional ones. Activities with substantial policy content will be excluded from delegation to Executive Agencies while, in parallel, the effective feedback of R&I data and results from Executive Agencies to the Commission will be reinforced, in line with the dissemination and exploitation strategy, to strengthen the inputs for policy-making.

What alternatives were considered? For the implementation of the new Framework Programme, the following alternative options were considered: an ‘in-house’ scenario (reintegration of part of the programme management in the Commission); maintaining the current status as in Horizon 2020; and full delegation of all programme’s activities. The in-house scenario would imply returning to previous management modes that entailed comparably higher administrative costs⁴⁰. Specific scenarios for the implementation of the EIC activities through a dedicated Executive Agency are described in the Annex 6.1 on the EIC.

What are the expected implications?



Reduce administrative costs. Independent evaluations⁴¹ show that delegation to Executive Agencies brings substantial savings in administrative expenditure. The administrative costs of the programme implementation by Executive Agencies in Horizon 2020 are around 2-3% of the operational budget, which is well below the target of 5%.



Improve synergies with other programmes. Executive agencies manage parts of different programmes that complement each other⁴²: rationalising their portfolio can help aligning and integrating objectives of different programmes, for instance better linking R&I results to market deployment.



Enhance focus on performance. Executive Agencies have reached and maintained very high levels of satisfaction among their beneficiaries⁴³, while at the same time successfully managing a larger number of projects than in FP7. This consistent high performance allows the Commission to focus on strategic priorities.



4.10 OVERALL IMPACT OF THE CHANGES ON THE OBJECTIVES OF THE MFF

The delivery tools of the Framework Programme will contribute to the cross-cutting objectives of the Multiannual Financial Framework (MFF), notably simplification, flexibility, coherence, synergies and focus on performance. Overall, the Framework Programme is expected to deliver large benefits that outweigh costs, in particular for the Programme’s focus on performance, its flexibility, as well as its internal coherence and its synergy with other programmes (see Table 8).

Other MFF Programmes are closely linked to the new EU R&I Programme: synergies and complementarities between them should be enhanced (see Table 7 and Annex 5). Current Horizon 2020 beneficiaries also benefited from other EU programmes, e.g. the European Structural and Investment funds, EU Health Programme, and COSME⁴⁴.

Table 7: Synergies and complementarities with other MFF proposals

MFF Programmes	Links to new Framework Programme
<p>Common Agricultural Policy (CAP)</p>	<p>A key priority for the ‘second pillar’ of the post-2020 CAP⁴⁵ is an increased focus on fostering innovation, in particular through wider diffusion of innovation, better access to new technologies and investment support. This will involve strengthening the links between agricultural and rural development policies and R&I in support to the development of knowledge and innovation systems. The development of an ambitious, integrated Strategic Research and Innovation Plan will define priorities of the Framework Programme in the area of food, nutrition security and sustainable management of natural resources with a view to develop synergies between the Framework Programme and the CAP. The latter will promote the use, implementation and deployment of innovative solutions, including those stemming from R&I projects funded by Horizon Europe.</p>
<p>European Maritime and Fisheries Fund</p>	<p>The post-2020 European Maritime and Fisheries Fund will provide important support to the implementation of the Common Fisheries Policy and the Maritime Policy. This programme will focus on creating the conditions for boosting competitiveness in the blue economy, especially through close-to-market innovation, access to marine knowledge and by ensuring a safe and secure maritime space. Strong and sustainable blue growth requires enhanced synergies with wider EU intervention. The Framework Programme is of particular relevance in this respect as it strengthens the knowledge base from which new, innovative products, processes and services can emerge in the maritime economy. The EMFF will support the rolling out of novel technologies and innovative products, processes and services, in particular those resulting from Horizon Europe in the fields of marine and maritime policy.</p>

MFF Programmes	Links to new Framework Programme
Connecting Europe Facility (CEF)	<p>The post-2020 CEF will prioritise the large-scale roll-out and deployment of innovative new technologies and solutions which result from projects in transport, energy and telecommunications funded by the Framework Programmes. Horizon Europe will support all stages in the R&I chain, including non-technological and social innovation, and closer-to-market activities with innovative financial instruments. Through the Strategic Research and Innovation Plan, Horizon Europe will support R&I on transport, energy and mobility, in particular through the Climate, Energy and Mobility cluster, as well as digital technologies. The exchange of information and data between Horizon Europe and CEF projects will be facilitated, for example by highlighting technologies from the Framework Programme with a high market readiness that could be further deployed through CEF.</p>
Digital Europe Programme (DEP)	<p>DEP focuses on large-scale digital capacity and infrastructure building in High Performance Computing, Artificial Intelligence, Cybersecurity and advanced digital skills aiming at wide uptake and deployment across Europe of critical existing or tested innovative digital solutions. While several thematic areas addressed by both programmes converge, DEP will mainly focus on roll-out and deployment activities outside research and innovation, whereas the Framework Programme will focus on investing in the entire spectrum from research to market. R&I needs related to digital aspects are identified and established in Horizon Europe strategic R&I plan, while DEP capacities and infrastructures are made available to the research and innovation community, including for activities supported through Horizon Europe such as testing, experimentation and demonstration across all sectors and disciplines.</p>
Erasmus	<p>The post-2020 Erasmus will continue to support mobility, cooperation and policy initiatives in the field of higher education. This includes support for integration of education, research and innovation, development of competences and inter-disciplinary, transferable, digital and entrepreneurial skills in forward-looking fields or disciplines and support to higher education institutions, research centres, businesses and civil society to contribute to innovation. The Framework Programme will continue to invest in the people behind research and innovation, strengthening their skills, training and career development and fostering the transfer of knowledge and cooperation between research-performing organisations and providing incentives for universities embracing open science policy. Horizon Europe will complement the Erasmus programme's support for the European Universities initiative, in particular its research dimension, as part of developing new, joint and integrated long-term and sustainable strategies on education, research and innovation based on trans-disciplinary and cross-sectoral approaches to make the knowledge triangle a reality.</p>

MFF Programmes**Links to new Framework Programme**

European Defence Fund

Complementarity and synergies with the European Defence Fund will be ensured, so that results under civil R&I also benefit defence R&I and vice-versa.

European Regional Development Fund (ERDF)

The post-2020 European Regional Development Fund (ERDF) will provide an important part of EU funds for R&I. The post-2020 ERDF may feature increased funds dedicated to the take-up of results and the rolling out of novel technologies and innovative solutions from past Framework Programme and Horizon Europe. It will continue to invest in actions that build R&I capacities of actors aimed at participating in the Framework Programme or other internationally competitive R&I programmes. Holders of Seal of Excellence⁴⁶ labels from the Framework Programme may be funded by Member States and regions, where relevant to the local context and smart specialisation strategies, including with resources from any Union shared-management programme. The same applies for national funding of joint programmes co-funded under the Framework Programme. In addition, budget from share management could be voluntary transferred for implementation to central managed programmes. Part of the Framework Programme will continue to support low-performing countries in R&I, in the context of strengthening the European Research Area. Smart specialisation strategies will continue to promote innovation based on the strengths of each region and be a basis for ESI Funds investments in R&I and the innovation eco-systems.

European Social Fund+ (ESF)

The post-2020 European Social Fund will continue to invest in human capital and skills development, as well as in social innovation. The ESF+ can mainstream and scale up new and innovative curricula for education and training programmes developed in R&I projects under the Framework Programme. Holders of the Seal of Excellence may be funded by the ESF+ to support activities promoting human capital development in research and innovation with the aim of strengthening the European Research Area. The Health strand of the ESF+ will mainstream innovative technologies and new business models and solutions, in particular those resulting from the Framework Programmes.

MFF Programmes	Links to new Framework Programme
Neighbourhood, Development and International Cooperation Instrument	<p>The future Neighbourhood, Development and International Cooperation Instrument will merge several EU external instruments existing in the 2014-2020 period⁴⁷. The broad instrument will include a prominent neighbourhood window, strong focus on migration including a 20% unallocated envelope and provisioning for Macro-Financial Assistance.</p> <p>There are inherent complementarities between Horizon Europe and the future Instrument, for example in so far as they both contribute towards the EU's international commitments such as the 2030 Agenda for Sustainable Development⁴⁸, the Paris Agreement on Climate Change, or the renewed EU-Africa Partnership among others. The Neighbourhood, Development and International Cooperation Instrument will continue to complement the Framework Programme by building research and innovation capacity (at individual, organisational or institutional levels) including through research infrastructures in third countries and regions. It will support the diffusion and uptake of innovations, the development of human capital and market access for technological solutions developed through collaborative research and innovation.</p>
Innovation Fund under the EU Emissions Trading System	<p>The Innovation Fund under the EU ETS will support low-carbon technology demonstration projects in the EU. It has been established by the revised EU ETS Directive and it will use the proceeds from the auctioning of at least 450 million allowances under the EU ETS, as well as leftovers from the current NER 300 programme. It will specifically target innovative low-carbon technology demonstration projects in industry, renewable energy, energy storage, carbon capture and storage (CCS) or industrial carbon capture and use (CCU) to be developed via the R&I window of the (InvestEU Programme) in addition to resources deployed therein. Horizon Europe will fund the development and demonstration of technologies that can deliver on the EU decarbonisation, energy and industrial transformation objectives.</p>
Internal Security Fund and Integrated Border Management Fund	<p>The future Security and Border programmes will contribute to ensuring a high level of security in the Union, inter alia by tackling terrorism and radicalisation, organised crime and cybercrime, and by supporting the effective implementation of the European Integrated Border Management system. The programmes will support Member States' efforts in these areas, including by incentivising Member States to take up and apply R&I results from the Framework Programme. The Framework Programme will support R&I in the area of security, including border management, in particular through the cluster on Resilience and Security. Potential complementary actions can also be considered under Horizon Europe regarding research and innovation for customs control equipment in view of the Union instrument for financial support for customs control equipment (CCE).</p>

InvestEU Fund

The InvestEU Fund will include financial instruments in four separate policy windows. An R&I thematic window will bundle financing activities that are closely linked to the objectives of the R&I Framework Programme, and dedicated products for innovative SMEs and mid-caps will be deployed through SME window. Blended finance in the Framework Programme will be provided by the EIC to high-risk market-creating innovations. Appropriate synergies with the new InvestEU programme shall be established, in particular regarding budgetary guarantees and leveraging Venture Capital funds supported by InvestEU.

Programme for Environment and Climate Action (LIFE)

The post-2020 LIFE programme will continue to act as a catalyst for implementing EU environment and climate policy and legislation, including by taking up and applying R&I results from the Framework Programmes and help deploying them at national and (inter-) regional scale. LIFE will continue to incentivise synergies with Horizon Europe through the award of a bonus point during evaluation for proposals which feature the uptake of Framework Programmes' results. Horizon Europe will contribute to tackling environmental challenges in particular through the clusters on Health, Climate, Energy and Mobility and Food and Natural Resources by defining relevant R&I activities in the Strategic Research and Innovation Plan.

Single Market Programme, including the Competitiveness of Enterprises and SMEs Programme (COSME)

The post-2020 COSME will address market failures that affect all SMEs and will promote entrepreneurship and the creation of growth of companies. Under the Framework Programme, the European Innovation Council (EIC) will directly support the activities and scale-up of high-risk profile innovative start-ups, SMEs and mid-cap firms, while the InvestEU programme will more broadly focus on R&I-driven innovative companies. The Enterprise Europe Network as a corporate tool with its Key Account Managers will continue to play a role in Business accelerator services of the EIC aiming at providing beneficiaries with access to partners, investors, and assistance (coaching, training, technical support).

Continued simplification will enhance user-friendliness.

User-friendliness will mainly be enhanced by maintaining the single set of rules, continuity of funding rates and new simplifications such as the new simplified cost options, and the increased cross-reliance on certified accounting systems. Moreover, the European Innovation Council will also act as a one-stop-shop for innovators looking for funding, while also rationalising existing fund-

ing schemes for innovation, and will be clearly and visibly branded as such. European Partnerships will be opened up for all interested stakeholders. The Research Participant Portal is already highly appreciated by stakeholders (as well as other Commission services,) and we will further improve its design for the new Programme. Finally, a "toolbox" will be created to provide a comprehensive overview of all available funding tools in the legal proposal.

Synergies will be enhanced through the revamped strategic planning process, which will allow for identifying common objectives and common areas for activities (such as partnership areas or mission areas) across different Multi-Annual Financial Framework programmes. It will be open for public consultation, involving EU Institutions and citizens and end-users in agenda-setting (co-design) for the Work Programme.

Internal coherence will be strengthened through a redesigned pillar structure. The Framework Programme will not set objectives per pillar but at Programme-level. Each pillar and programme part is expected to contribute

to those objectives albeit to different degrees. This will in turn ensure that each euro invested in one area will generate multiple impacts.

The Programme has the flexibility to easily adapt to emergencies or new priorities. The strategic flexibility in the programming process will allow the Commission to react to urgent needs and new priorities well beyond its start date in 2021. The Programme will be able to shift budget allocations within and between pillars. Similarly, the strong cross-disciplinary, cross-sector and cross-border nature of the Programme allow it to produce R&I results relevant to changing circumstances.

Table 8: Contribution of Horizon Europe to the MFF cross-cutting objectives (compared to Horizon 2020)

Delivery for impact	MFF cross-cutting objectives				
	Simplification	Flexibility	Coherence	Synergies	Focus on performance
Strategic planning	0	0	++	+	+
Single set of rules	0	+	+	+	0
Funding model	0	0	0	0	0
Forms of funding	++	+	0	0	0
Blended finance	-	++	0	+	+
Proposal evaluation	-	+	+	0	+
Ex-ante and ex-post audits	+	0	+	+	0
Dissemination & exploitation	-	0	0	+	++
Delegation	0	0	0	+	+

Note: +, ++, +++ correspond respectively to slight, moderate and significant improvement compared to a no-policy change scenario. +/- correspond to a coexistence of positive and negative impacts. – indicates a slight negative impact. 0 means no significant change.

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- 1 European Commission (2018), Communication on the Horizon 2020 Interim Evaluation, COM(2018)2 final, p. 5.
 - 2 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 18.
 - 3 European Commission (2016), Report on the Horizon 2020 Simplification Survey.
 - 4 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017), p. 22.
 - 5 This is complemented by separate Work Programmes for the European Research Council, the Euratom, the Joint Research Centre, and the Strategic Innovation Agenda for the European Institute of Innovation and Technology (EIT).
 - 6 For instance, an emergency procedure to swiftly allocate funds to a particular purpose can be activated through WP updates, as happened in Horizon 2020 to tackle the outbreaks of Ebola and Zika.
 - 7 At the request of the European Parliament during inter-institutional negotiations, the scope of derogations were set out in the RfP for Art. 187 TFEU initiatives while for Art. 185 TFEU initiatives, these are laid down in the respective basic acts.
 - 8 Interim Evaluation of the SESAR Joint Undertaking (2014-2016) operating under Horizon 2020, p. 53.
 - 9 Since 2007, two Participant Guarantee Funds were created (EU and Euratom) to protect from non-recovery of sums due to the Union and to allow ongoing projects to continue in case of default of one of the beneficiaries.
 - 10 Non-profit organisations are reimbursed 100% also in Innovation Actions.
 - 11 Except subcontracting financial support to third parties, and in-kind contributions not used on the beneficiary's premises.
 - 12 The following types of actual costs can be declared as eligible: personnel costs, sub-contracting, purchase of goods, services or works (incl. travel costs), financial support to third parties and costs incurred by third parties.
 - 13 European Commission (2017), Interim Evaluation of Horizon 2020, SWD (2017).
 - 14 European Commission (2016), Report on Horizon 2020 simplification survey.
 - 15 The Marie Skłodowska Curie Actions are fully funded by a set of unit costs.
 - 16 The European Court of Auditors (2018) "A contribution to simplification of EU research programme beyond Horizon 2020".
 - 17 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 140.
 - 18 Ibid. p. 84.
 - 19 For the ERC, only the Excellence criterion applies. Under Innovation Actions in Horizon 2020, Impact has a higher weight.
 - 20 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 236.
 - 21 Ibid., p. 200.
 - 22 Commission's proposals for the 2014-2020 Multiannual Financial Framework (MFF).
 - 23 PPMI (2016), Evaluation of the operation of ERCEA (2012-2015), final report; and PPMI (2016), Evaluation of the operation of REA (2012-2015), final report.
 - 24 This could also become a formal Commission document such as a Communication or Staff Working Document.
 - 25 While the focus would be on the programmable Global Challenges and Industrial Competitiveness pillar, the relationship between this and the bottom-up parts such as the EIC, including the results from these, would feed into the planning process.
 - 26 This will reflect the expected impact of missions of up to 15 years, as appropriate.
 - 27 In the case of the ERC, the Scientific Council will continue to establish the overall strategy, the Work Programme and the proposal evaluation and selection. The JRC will also continue to establish its own Work Programme and strategy and receive opinions from Member States through its Board of Governors. The EIC will also develop its own Work Programme. As regards the EIT, the specific priority fields, financial needs, time schedule, selection process and implementation of KICs will be defined in the EIT Strategic Innovation Agenda (SIA) as a separate legal base arising from the EIT founding regulation. Proposals for future EIT KICs indicated in the EIT Strategic Innovation Agenda (SIA) should take into account the outcomes of the strategic planning process.
 - 28 European Commission (2017), Financial Regulation applicable to the general budget of the Union and its rules of application, available at: http://ec.europa.eu/budget/library/biblio/documents/regulations/financial_regulation_2017_en.pdf
 - 29 Except for subcontracting, financial support to third parties and unit costs for internally invoiced goods and service are calculated in accordance with the usual cost accounting practices of the beneficiaries. Such unit costs shall be determined on the basis of actual eligible direct and indirect costs.
 - 30 As shown in the Interim Evaluation of Horizon 2020, too much oversubscription could cause disillusionment and dissatisfaction, leaving good proposals unfunded and to be resubmitted.

- 31 European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 79.
- 32 The acceptance of other cost items will be further defined in the model grant agreement, as in the current system.
- 33 These conditions (e.g. beneficiaries must be able to identify their actual eligible indirect costs) will be further developed in the model grant agreement.
- 34 The European Court of Auditors (2018) “A contribution to simplification of EU research programme beyond Horizon 2020”.
- 35 Project-based remuneration means remuneration that is linked to the participation of a person in projects, is part of the beneficiary’s usual remuneration practices and is paid in a consistent manner.
- 36 European Commission (2017), Reflection paper on the future of EU finances, p. 26.
- 37 High-Level Group of Innovators (2018), Europe is back: accelerating breakthrough innovation.
- 38 Europe’s innovators struggle to access risk finance above the €10 million range. PwC/CB Insights, Money Tree Report Q4 2017, p. 93. Funding rounds of companies above \$100 million are five times higher in the US and Asia than Europe (p. 92).
- 39 Martinuzzi, A. et al. (2016), Network Analysis of Civil Society Organisations’ participation in the EU Framework Programmes, Vienna and Leicester.
- 40 The administrative expenditure in FP7 represented 5.16% of the total budget of the programme (indirect actions). The Interim Evaluation of Horizon 2020 shows that, over the first three years, its administrative expenditure is below the 5% target and is particularly low for the executive agencies.
- 41 PPMI (2016), Evaluation of the operation of ERCEA (2012-2015), final report; and PPMI (2016), Evaluation of the operation of REA (2012-2015), final report.
- 42 For example, INEA implements the Connecting Europe Facility Programme (large energy, transport, digital infrastructures projects) as well as Horizon 2020 Societal Challenges.
- 43 Up to 82% for REA and up to 93% for ERCEA of the beneficiaries are satisfied with the performance of the agencies. See PPMI (2016), Evaluation of the operation of ERCEA (2012-2015), final report; and PPMI (2016), Evaluation of the operation of REA (2012-2015), final report.
- 44 A total of 86% respondents to the cluster-based public consultation on EU funds in the area of investment, research & innovation, SMEs and single market reported having experience with the Horizon 2020 program. From this sample, the respondents reported having experience also with European Structural and Investment funds (22%), EU Health Programme (9%), COSME (8%).
- 45 The ‘second pillar’ of the CAP focuses on rural development and complements the system of direct payments to farmers and measures to manage agricultural markets (the so-called ‘first pillar’)
- 46 The Seal of Excellence scheme, launched in 2015, is a quality label recognising proposals submitted to Horizon 2020 calls which were evaluated as high-quality but were not funded due to lack of available budget. The holder of a Seal of Excellence can approach other sources of funding (regional, national, private, public) with this quality label.
- 47 The future External Instrument will merge the following instruments: European Development Fund, Development Cooperation Instrument; European Neighbourhood Instrument; Partnership Instrument for Cooperation with Third Countries; European Instrument for Democracy and Human Rights; Instrument contributing to Stability and Peace; Instrument for Nuclear Safety Cooperation, and the Common Implementing Rules post-2020.
- 48 See <https://sustainabledevelopment.un.org/post2015/transformingourworld>.

IMPACT ASSESSMENT OF THE 9TH EU FRAMEWORK
PROGRAMME FOR RESEARCH AND INNOVATION

5 HOW WILL PERFORMANCE BE MONITORED AND EVALUATED?



5 HOW WILL PERFORMANCE BE MONITORED AND EVALUATED?

The monitoring and evaluation framework of the new Framework Programme¹ will have three main building blocks:

- **Annual monitoring of the programme performance:** tracking of performance indicators in the short, medium and longer-term according to key impact pathways towards Programme objectives, based on baselines and targets where possible;
- Continuous collection of programme management and implementation data;
- **Two fully-fledged (meta)-evaluations** of the programme at mid-term and ex-post (upon completion).

Impact pathways, and related key impact pathway indicators, will structure the annual monitoring of the programme performance (see Annex 4) towards its objectives. The objectives translate into three complementary impact categories (each being tracked along several pathways), which reflect the non-linear nature of R&I investments:

1. **Scientific impact:** related to supporting the creation and diffusion of high-quality new knowledge, skills, technologies and solutions to global challenges;
2. **Societal impact:** related to strengthening the impact of research and innovation in developing, supporting and implementing

Figure 10: Tracking performance along key impact pathways towards impact categories translating the Horizon Europe general objectives

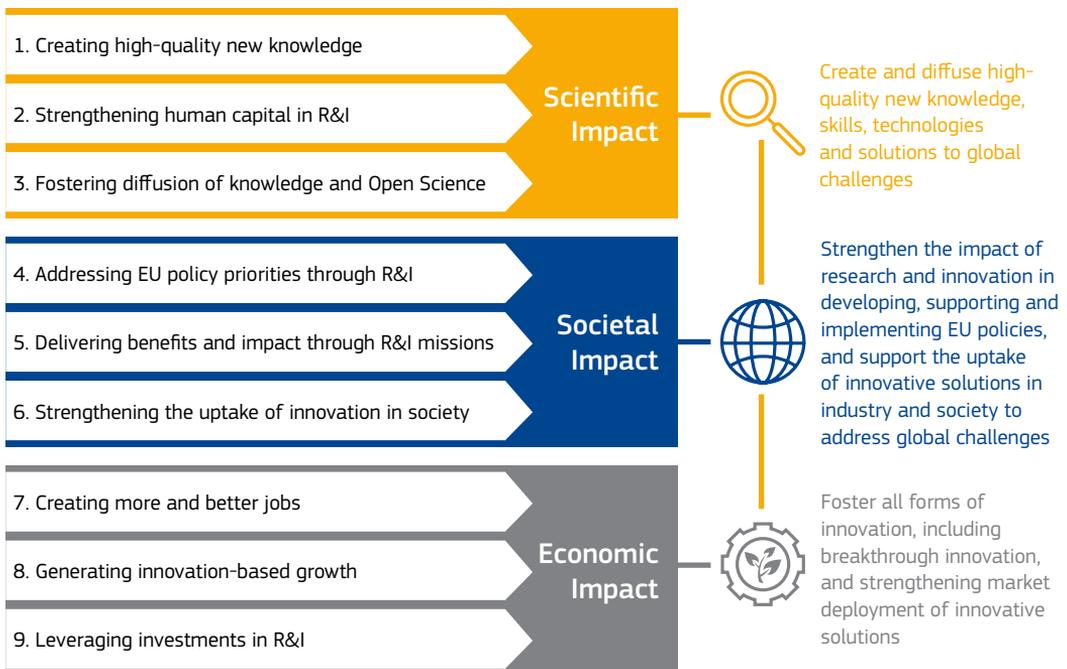


Table 9: Monitoring and Evaluation Frameworks

Horizon 2020	The new Framework Programme
<p>3 headline indicators not directly attributable to the programme²</p> <p>55 Horizon 2020 Key performance and Cross-Cutting issues indicators:</p> <ul style="list-style-type: none"> > 27 are related to management and implementation data (e.g. funding, participation) > 28 are related to outputs, results or impacts, out of which: <ul style="list-style-type: none"> • none is related to the programme as a whole (covering only programme parts) • 9 relate to publications • 7 relate to intellectual property rights and innovations • 4 relate to leveraged funding • 4 relate to researchers’ mobility and access to infrastructures 	<ul style="list-style-type: none"> > All Horizon 2020 indicators related to outputs, results and impacts are maintained but streamlined and further specified to cover the whole Programme > Management and implementation data are still collected and made available in close-to-real time through Dashboard but are not part of “performance indicators” > Key indicators are set at Programme level according to the Programme objectives and are attributable to the Programme > Key indicators are classified according to 9 key impact pathways, for tracking impact through short, medium and long term indicators – for more accurate reporting over time > Higher reliance on external data sources, qualitative data and automated data tracking to minimise burden on beneficiaries > Possibility for programme part or action specific indicators (but not in the legal base)

EU policies, and support the uptake of innovative solutions in industry and society to address global challenges;

3. **Economic impact:** related to fostering all forms of innovation, including breakthrough innovation, and strengthening market deployment of innovative solutions.

The impact pathways will be time-sensitive: they will distinguish between the short (typically as of one year, when the first projects are completed), medium (typically as of three years, and for the interim evaluation) and long term (typically as of five years, and for the ex-post evaluation). The impact pathway indicators will contain both qualitative and quantitative information, the availability of which will

depend on the state of implementation of the Programme. These indicators serve as proxies to report on the progress made towards each type of impact at Programme level. Individual programme parts will contribute to these indicators to a different degree and through different mechanisms. Additional indicators might be used to monitor individual programme parts when relevant and commensurate. These indicators proposed (see Annex 4) reflect the lessons learnt from the interim evaluation of Horizon 2020: all Horizon 2020 indicators related to outputs, results and impacts are maintained but streamlined and further specified to cover the whole programme. The management and implementation data is still collected but is separated from the key performance indicators, as illustrated in Table 9.

The micro-data behind the key impact pathway indicators will be collected in a centrally managed and harmonised way, with minimal reporting burden. This will be achieved, for example, by collecting at proposal stage the unique identifiers of applicants, by sourcing data automatically from existing external public and private databases also after project's end (e.g. data on publications, patents, employment and turnover), by adopting new ICT tools (e.g. text mining) and by using alternative primary data sources (e.g. expert reviews). Longer-term impact indicators may be estimated based on dedicated studies. The data collected will allow tracking disaggregated indicators and be analysed per type of action, type of organisation, type of collaboration, sectors, disciplines, calls, countries (including associated and third countries).

Baselines, targets, and benchmarks will be established prior to the Programme's launch. External experts will help establish accurate and timely baselines, and propose targets with appropriate benchmarks, where relevant. To the extent possible data will also be collected for control groups to allow counterfactual evaluation designs:

- > Propensity score matching- based on pairing with similar researchers/companies and the development of panel data;
- > Regression discontinuity design based on the comparison of the performance between successful and unsuccessful applicants (pending their approval on data use);
- > Difference-in difference based on the comparison of the performance of beneficiaries before/after the Programme.

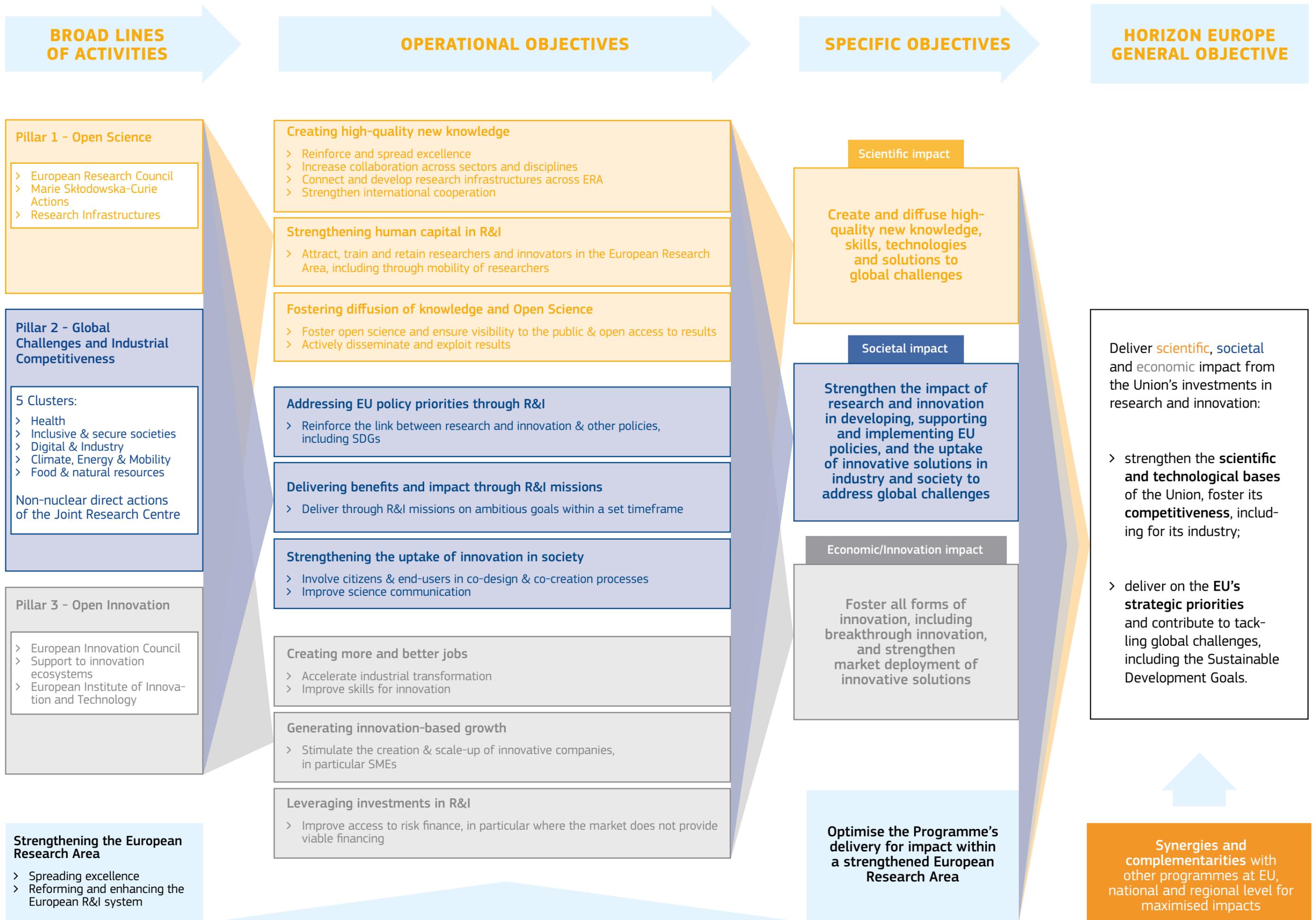
Management and implementation data for all parts of the Programme and all delivery mechanisms³ will continue to be collected in close to real-time. This data will be collected in a centrally managed and harmonised way through the Common Support Centre. It will also continue to be publicly available on a dedicated on-line portal in close to real-time allowing extraction per programme parts, types of actions and types of organisations (including specific data for SMEs). This will include inter alia proposals, applications, participations and projects (number, quality, EU contribution etc.); success rates; profiles of evaluators, applicants and participants (partly based on unique identifiers, and including country, gender, turnover, role in project etc.); implementation (including time-to-grant, error rate, satisfaction rate and the rate of risk taking etc.); and financial contribution to EU climate and environmental objectives and other mainstreaming targets. A yearly analysis of progress on key dimensions of the Framework Programme's management and implementation will be carried out.

The evaluations of the new Framework Programme will ensure coherence of methodologies and comprehensiveness of coverage (i.e covering all programme parts and all delivery mechanisms). Evaluation of individual programme parts can continue to make use of specific indicators that complement relevant the Programme-level indicators. The evaluation of the Framework Programme will build on the coordinated evaluations of each programme part, type of actions and delivery mechanism according to common evaluation criteria and standard methodologies (incl. counterfactual analysis and qualitative approaches such as case studies). The comprehensive interim evaluation of the entire

Framework Programme is foreseen by 2024, to draw the first lessons from the changes introduced in the new Framework Programme. A full-scale ex-post evaluation is planned by 2030 to provide a full assessment of the new Programme and report on the longer-term impacts of previous ones.

Lastly, evaluations will better account for the coordinated impact of R&I support at EU, national and regional level, building on existing work to better track the impact of EU R&I Programmes at national level⁴. The European RTD Evaluation Network⁵ will provide the basis for a substantially increased cooperation with Member States and Associated States.

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- 1 Including Missions and European Partnership Initiatives.
 - 2 Share of GDP invested in research and development; evolution of the Innovation Output Indicator, share of researchers as part of the active population.
 - 3 Including European Partnerships.
 - 4 European Research Area and Innovation Committee (2017), Final Report of the ERAC Ad-hoc Working Group on Measuring the Impact of EU Framework Programmes for Research and Innovation at National Level. Available at: <http://data.consilium.europa.eu/doc/document/ST-1206-2017-INIT/en/pdf>.
 - 5 More information available at: <https://ec.europa.eu/research/evaluations/index.cfm?pg=network>.



PART 2

ANNEXES



ANNEXES

ANNEX 1: EVALUATION RESULTS



ANNEX 1: EVALUATION RESULTS

1 LESSONS FROM THE EVALUATIONS OF PREVIOUS FRAMEWORK PROGRAMMES

European R&I programmes are widely considered to have been successful. However, there are important lessons to be learned from the past, from stakeholder feedback and from analytical studies. Firstly, research, innovation and education should be addressed in a more coordinated manner and coherent with other policies, while research results should be better disseminated and turned more swiftly into new products, processes and services. Secondly, the intervention logic of EU programmes should be developed in a more focused, concrete, detailed, inclusive and transparent manner. Thirdly, access to the programme should be made easier for start-ups, SMEs and other industrial players, organisations from lower-performing countries in R&I and in countries outside the EU. Finally, monitoring and evaluation needs to be strengthened.

1.1 Improved policy coordination

A number of ex-post evaluations of the Framework Programmes have noted that the coordination between the Framework Programme and other EU policies, and with Member States' research activities, could be improved. The FP7 interim evaluation¹ noted that a strategic shift is needed to establish stronger and better connections between research, innovation and education. More broadly, the FP6 ex-post evaluation² called for a clearer division of labour between the

FP and the EU Structural Funds. It also stated that other EU policies such as transport and energy should be more closely connected with the research activities under the Framework Programme.

This is confirmed by the conclusions of the OECD's work on appropriate systems of innovation governance³. This mentions the need to develop "a strategic, horizontal approach" which "should include and develop the innovation policy potential in other ministerial domains and ensure a co-ordinated division of labour between them". A central conclusion⁴ is that "given the increasingly central role of innovation in delivering a wide range of economic and social objectives, a whole-of-government approach to policies for innovation is needed".

The FP6 ex-post evaluation also noted that, given its small size compared to national spending, the Framework Programme should not try to act as a substitute for Member State R&D policies. Instead, it should deploy its added value in a more strategic way and set an attractive and accepted European agenda. In the same vein, another evaluation⁵ concluded that the division of labour between the EU and national level should be further refined, in particular with the introduction of new EU-level initiatives. On this issue, the OECD⁶ calls for "coherence and complementarities between the local, regional, national and international levels".

1.2 Focus and a more robust intervention logic

A number of ex-post evaluations⁷ of the Framework Programmes have noted that the programme's design could be improved. Some pointed that the Programme lacks a clear and robust intervention logic, that it has too many objectives and that higher-level objectives are not well-reflected in more specific objectives.

The FP6 ex-post evaluation⁸ and expert evidence⁹ stated that this programme featured too many objectives, noting that they addressed almost all S&T and socioeconomic challenges. As a result, they were too abstract and vague and thus complicated the task of evaluating the programme. A European Parliament ITRE Committee report¹⁰ noted similarly that “an ever-growing number of objectives and themes covered and diversification of instruments has widened the scope of FP7 and reduced its capacity to serve a specific European objective”. In addition, another report found that no explicit links were made between higher-level objectives and more specific technical goals¹¹. Meanwhile, instruments should be designed explicitly to achieve particular objectives: challenges should not be defined to match existing funding instruments¹². This results in ‘catch all’ instruments that try to tackle all problems and cater for all types of stakeholders. That is why the European Court of Auditors has called for addressing a single objective per instrument¹³.

The importance of focus and a proper hierarchy of objectives (combined with appropriate monitoring) are confirmed by the OECD,¹⁴ which has called for “a more strategic focus on the role of policies for innovation in delivering stronger, cleaner and fairer growth”. “Innovation policy cannot be properly imple-

mented without precise targets and intelligent follow-up. Governments should increase their capacity to develop actions plans based on horizontal, strategic approaches and translate these into concrete measures to be taken by each ministry or agency”¹⁵.

1.3 Lower barriers to participation and increase dissemination and valorisation of outputs

All ex-post evaluations of the Framework Programme (see the FP6 ex-post¹⁶ and FP7 interim evaluations¹⁷) are unanimous in their view that application, contract negotiation and project management procedures are too complex and burdensome for applicants. This results in high barriers to application and participation to the programme, in particular for first time, start-up, SMEs and applicants from low performing R&I countries.

Typically, participants' main reasons for engaging in the Framework Programme relate to networking opportunities and the creation of new knowledge¹⁸. Research under the Framework Programme is very often long-term, exploratory and technologically complex¹⁹, and so it takes time for marketable products and processes to arise from the programme.

Nevertheless, evaluations have concluded that more attention should be paid to the production of project outputs and to their dissemination and exploitation, in particular given that the programme should support Europe's competitiveness. A recurring finding points to the lack of channels enabling the exploitation of research results and deploying new knowledge from the programme to benefit society²⁰. Similarly, the FP7 interim evaluation noted a lack

of clarity on how the programme incorporates innovation (as opposed to ‘pure’ research).

In this respect, the OECD²¹ argues that “the creation, diffusion and application of knowledge are essential to the ability of firms and countries to innovate and thrive in an increasingly competitive global economy”.

1.4 Strengthen monitoring and evaluation

The main problem affecting the monitoring and evaluation of the Framework Programmes is that they do not have focused objectives or a clear logic for intervention. The evaluation process aims to link evidence emerging from funded projects with the programme’s strategic and specific objectives. As the European Court of Auditors²² has observed, if this connection is unclear then it renders a proper assessment very difficult.

The importance of a proper monitoring and evaluation system is emphasised by the OECD²³, which, recommends “improving evaluation and learning”. In general, governments should create a “solid basis for evaluation and learning and make them part of the policy-making process. This includes evaluation of broader reforms, as knowledge about their impact on innovation is useful for feedback and policy formulation. A more holistic approach to evaluation and learning can enhance feedback in the governance system and lead to more effective policy”. The OECD²⁴ also argues that “evaluation is essential to enhance the effectiveness and efficiency of policies to foster innovation and deliver social welfare. Improved means of evaluation are needed to capture the broadening of innovation, along with better feedback of evaluation into the policy-making process. This also calls for improved measurement of innovation, including its outcomes and impacts”.

2 LESSONS LEARNT FROM THE INTERIM EVALUATION OF HORIZON 2020

The Horizon 2020 Interim Evaluation identified the following strengths of the programme as well as the challenges to be addressed during its last three years and in the next Framework Programme:

2.1 Strengths

1. Overall, Horizon 2020 is an attractive and well-performing programme. It has so far attracted more than 100,000 applications, representing a huge increase in the annual number of applications compared to FP7. It involves top-level participants from higher education, research and the private sector; from a wide range of disciplines and thematic fields; and from over 130 countries. Some 52% of participants are newcomers. Industrial participation has increased compared to FP7, with 23.9% of the budget for industrial and enabling technologies and societal challenges goes to SMEs: far exceeding the target of 20%. Stakeholders are generally very satisfied with the programme.
2. Horizon 2020's objectives and rationale remain highly relevant and are fully consistent with recent EU and global priorities, such as the Sustainable Development Goals. The programme has also proven that it is flexible and can respond to emergencies (e.g. Ebola, Zika) and emerging needs.
3. Horizon 2020 is on track to be cost-efficient. It has a very low administrative overhead thanks to externalisation of programme management to executive agencies and the creation of a Common Support Centre. The large-scale simplification of the rules for participation, in particular the funding model, has also reduced time-to-grant and lowered costs for participants to the satisfaction of stakeholders and without reducing the level of co-funding by beneficiaries.
4. In terms of effectiveness, through its focus on generating scientific, economic and societal impacts, Horizon 2020 contributes to the creation of jobs and growth and helps to achieve major EU policy goals. It strengthens the science base by involving the EU's and world's best research institutions and researchers; by training large numbers of EU-based researchers; by producing large numbers of world-class open access scientific publications and data; by producing scientific breakthroughs; and by building cross-sectoral, inter-disciplinary, intra- and extra-European R&I networks.
5. The programme fosters industrial leadership by successfully involving the private sector and SMEs in R&I activities; by creating networks between businesses; universities and research institutions; by providing businesses and SMEs with risk finance to carry out their R&I projects; by

- investing in demand-driven innovation; by producing high quality, commercially valuable patents and other intellectual property rights; by supporting the deployment of innovation solutions; by producing new knowledge and strengthening capabilities, and by generating a wide range of innovation outputs including new technologies, products and services.. It addresses major societal challenges by producing publications, patents, prototypes, products, process and methods. It is successful in spreading excellence and widening participation through dedicated instruments and a cross-cutting focus. It achieves encouraging results in promoting gender equality and supporting social sciences and humanities.
6. Compared to FP7, Horizon 2020 shows better coherence between its different parts. Attention has been paid to putting in place synergies with other EU programmes.
 7. Horizon 2020 has clear European added value in terms of speed, scale and scope. This additionality is shown by the fact that 83% of funded projects would not have gone ahead without EU funding.
 3. There is a need for greater outreach to civil society to better explain results and impacts and the contribution that research and innovation can make to tackling societal challenges. Civil society and citizens should be more closely involved in agenda-setting and implementation of the programme.
 4. While great efforts have been made to increase synergies between Horizon 2020 and other EU programmes (notably European Structural and Investment Funds), these linkages can be strengthened further. This is particularly true for R&I capacity-building activities for lower performing EU regions.
 5. While Horizon 2020 has achieved a broad international outreach, international cooperation needs to be intensified and more efforts are needed to ensure that the programme fully delivers on its target for sustainable development.
 6. Great progress has been made in simplifying Horizon 2020. This is a continuing endeavour and there is scope for rationalising the range of funding schemes and initiatives under Horizon 2020.

2.2 Challenges

1. Horizon 2020 suffers from underfunding, resulting in large-scale oversubscription, much larger than in FP7. This constitutes an enormous waste of resources for applicants, and a waste of high-quality R&I proposals.
2. While Horizon 2020 shows potential for supporting breakthrough, market-creating innovation, this needs to be strengthened substantially.
7. While Horizon 2020 has made great progress on open access to scientific data and publications, more can be done in this respect.

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 - 2 Rietschel et al. (2009), Evaluation of the Sixth Framework Programme for Research and Technological Development, p. 58-59.
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 - 12 Stampfer M. (2008), European Added Value of Community Research Activities - Expert analysis in support of the ex-post evaluation of FP6, WWTF, Vienna Science and Technology Fund.
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 - 19 Polt W. et al. (2008), Innovation impact study – Final report.
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ANNEXES

ANNEX 2: ADDED VALUE OF EU-FUNDED R&I



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Without replacing national research and innovation (R&I) activities, EU funded R&I activities through the Framework Programmes produce demonstrable benefits compared to national and regional-level support to R&I in terms of scale, speed and scope. The added value comes through strengthening the EU's scientific excellence through competitive funding; the creation of cross-border, multidisciplinary networks; the pooling of resources to achieve critical mass for tackling global challenges, and developing the evidence-base to underpin policymaking.

Overall, this increases EU's global attractiveness as a place to carry out R&I. It also strengthens the EU's competitiveness, contributes to growth and jobs¹ and makes the EU a world leader in tackling global challenges. Therefore, EU R&I should be "one of the essential policy priorities in the future"².

Added Value:

- **Strengthening the EU's scientific excellence through competitive funding** – Excellence-based EU-wide competition increases the quality and visibility of R&I output beyond what is possible with national or regional-level competition. This is shown by the fact that EU-funded peer-reviewed research publications are cited more than twice the world average. Publications from EU-funded R&I activities are almost four times more represented in the world's top 1% of cited research, compared with the overall publication output of the 28 EU Member States³. Compared to 1.7% of national publications, 7% of publications arising from European Research Council-funded projects (973, since its creation in 2007) are among the top 1% highly cited in the world by field, year of publication and type of publication⁴.
- **Creating critical mass to address global challenges** – Collaborative projects funded at EU level will help to achieve the "critical mass" required for breakthroughs when research activities are of such a scale and complexity that no single Member State can provide the necessary financial or personnel resources". This occurs where a large research capacity is needed and resources must be pooled to be effective, or where there is a strong requirement for complementary knowledge and skills (i.e. in highly inter-disciplinary fields). Investing in R&I at EU level will address global challenges (i.e. migration, security, climate change, health), and this means that solutions can be found more quickly and efficiently than through national R&I activities.
- **Reinforcing the EU's human capital** – EU-funded R&I activities support human capital reinforcement through mobility and training.⁵ Some 340,000 researchers in the EU are fully or at least partly involved in EU-funded research activities⁶. In the case of Marie Skłodowska-Curie Actions (MSCA), evidence shows that the research impact of internationally mobile researchers is up to 20% higher than for those opting to stay in their home country⁷.

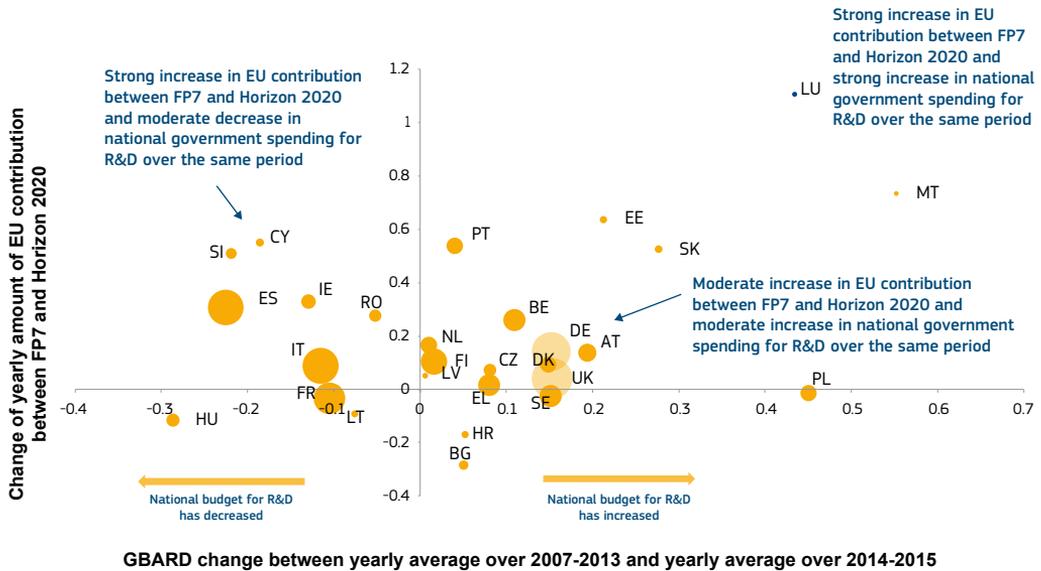
- > **Building multidisciplinary transnational networks for more impact** – EU support activities build cross-sectoral, inter-disciplinary R&I networks which reach across and outside Europe. This is crucial for bringing knowledge quickly to market and gaining industrial leadership. Based on a counterfactual analysis, EU funded R&I teams had, on average, 13.3 collaborations versus six collaborations. The beneficiary teams also built almost two times as many collaborations with partners from outside the EU (on average, 3.6 partners from third countries versus 2.1 partners)⁸. This leads to more impact: for example, Horizon 2020 publications that include authors from associated and third countries score up to more than three times as much as the world average⁹.
 - > **Increasing the EU's competitive advantage** – EU R&I activities increase the competitive advantage of participants, for example through international multi-disciplinary networks, the sharing of knowledge and technology transfer and access to new markets. Compared with non EU-funded R&I teams, EU-funded teams grow faster (11.8% more)¹⁰ and are around 40% more likely to be granted patents or produce patent applications¹¹. In addition, patents produced through the EU programmes are of higher quality and likely commercial value than similar patents produced elsewhere.
 - > **Creating new market opportunities through collaborative multi-disciplinary teams and dissemination of results** – Compared to the national level, EU R&I activities involve a wider array of key industrial players, SMEs and end-users. This reduces commercial risks, for exam-
- ple through the development of common standards and interoperable solutions and by bringing together existing markets. EU open access policies enable a quicker and wider dissemination of results to users, industries, firms (SMEs in particular) and citizens. This leads to more effective exploitation of results and larger impact than would be possible at national level.
- > **Strengthening the evidence-base for policy-making** – EU funded R&I activities are an important source of support to policy-making. This can be seen in the results of EU-funded projects on antimicrobial resistance¹², while projects on climate change played a key role in developing and aggregating climate change models that had a strong impact at the International Panel on Climate Change (IPCC).
 - > **Leveraging private investment:** EU-funded R&I activities induce the private sector to invest more of their own funds than under national funding schemes, with one analysis showing a 24.6% difference in this respect¹³. Involving key players from industry helps ensure that research results and solutions are applicable across Europe and beyond. This also enables the development of EU-wide and global standards and interoperable solutions, and their exploitation within a market of 450 million people. Based on preliminary data, public-private partnerships (PPPs) are expected to attract between EUR 0.90 and 2.17 from private actors for each EUR of EU funding invested¹⁴. Existing public-private partnerships in advanced manufacturing and processing (Factories of the Future, SPIRE and Energy-efficient Buildings) already show private investments between 1.5 and 5.4 times more than public funding¹⁵. Thanks

to its leverage effect, it is estimated that each EUR of EU investment in R&I would bring a GDP increase of between EUR 6 and 8.5 during the 2014-2030 period.

- > **High additionality** – The EU invests in distinctive R&I projects, which are unlike those funded at national or regional level.

The additionality (i.e. not displacing or replacing national funding, see Figure 3) of Horizon 2020 is very strong: on average, 83% of projects that would not have gone ahead without Horizon 2020 funding.¹⁶

Figure 3: Change in Government budget allocations for R&D and change in EU contribution between FP7 and Horizon 2020 (size of circles: number of applications in Horizon 2020)



Source: LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017)

What stakeholders say about the EU Added Value of EU programmes and funds

In their open responses to the public consultation on future EU funding programmes which was open from January to March 2018, some 2541 stakeholders provided input on the added value of EU programmes and funds. Four types of EU added value were most frequently mentioned:

- › **Collaboration:** 36% of respondents referenced collaboration and cooperation as an added value of the EU programmes and funds, especially in the way that major challenges with a cross-border character (e.g. environmental sustainability, energy, health) can be addressed. The programmes also help to access external expertise, resources and innovations that may not be available in one country, while allowing scale-up of innovative projects beyond national contexts. Multi-annual strategic plans and long-term strategies are also more helpful in aligning priorities between international partners than national programmes.

Business and industry stakeholders frequently noted that the EU programmes and funds allow access to the EU single market that boosts their global competitiveness and help achieve greater long-term impacts. Often cited here was the creation of new cross-border value chains, standards and interdisciplinary partnerships between diverse stakeholders and markets. Civil society organisations noted that improved collaboration contributes to the harmonisation of the EU market and policies, improves social cohesion among Member States and advances European integration. This allows objectives to be achieved due to critical mass and pooling of resources.

In addition, research organisations viewed international cooperation beyond the EU as a considerable added value of the programmes, as it contributes to greater impact of research projects, expands possible partnership options and introduces a European dimension beyond the EU. A positive consequence of this cooperation, according to research organisations, is the breakdown of research silos and reducing duplications.

- › **Maximising competition:** 22% of stakeholders underlined that the EU programmes and funds provide considerable improvements to the competitiveness of participants by incentivising cross-border and cross-sectoral partnerships. This contributes to pooling of resources and transfer of knowledge, along with other positive spillover effects. Stakeholders also noted that the EU programmes and funds improve Europe's competitive edge by sustained investments in innovation addressing pan-European and global societal challenges; and that they help to maintain effective innovation ecosystems throughout Europe.

National public authorities noted that, while oversubscription is one of the main obstacles that prevent the programmes from achieving its objectives, high competition for funds also strengthens the European knowledge base. It also boosts the competitiveness and visibility of successful applicants. Also, performance benchmarking of participants by all applicants improves the overall performance, leading to more ambitious and higher quality projects, breakthroughs and increased impact. Regional public authorities noted that EU R&I investments also strengthen the integration of SMEs into European value chains.

- › **Mobility:** 10% of stakeholders noted that, as quality research is not localised to a specific country, a highly useful added value of EU programmes and funds is the support for the mobility of researchers, particularly through mechanisms such as Marie Skłodowska-Curie Actions (MSCA) and Erasmus. These are considered as vital elements of programmes that support scientific exchange, foster methodological innovation, multi-centred research collaborations, and a culture of joint research.

Universities further noted that support for mobility has several amplifying effects on the added value of EU programmes and funds, particularly in the form of skills and career development. This also improves social cohesion and cooperation between European researchers, thus increasing the productivity of this community. It also provides greater freedom in choosing research topics and scope, partners, and impact areas than under national activities. International organisations noted that mobility contributes to successful cross-border collaboration, while also providing measurable benefits to research and commercial activities.

- › **Access to new markets:** 9% of stakeholders noted that the programme, along with other EU funds and programmes, stimulates access to the EU single market and new markets in a way that national funding initiatives cannot do. The support for the entire innovation chain, from the idea to the market, helps achieve these objectives. EU programmes are also considered somewhat more successful in accelerating time-to-market of innovative solutions. Business and industry stakeholders further noted that EU funds help reducing risks associated with R&D investments that on national and local levels are frequently funded through loans, thus freeing up resources. Explicit incentives for research-industry cooperation also allow for developing innovative products, thereby generating new markets and unlocking private sector investment in innovation.

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- 1 Macro-economic modelling suggests that by 2030, the extra impacts of investing EUR 70 billion in R&I at EU level is expected to generate between 0.27% and 0.35% more GDP, to increase EU net exports by between EUR 18 and 23 billion and to increase employment by between 110 000 and 179 000 units compared to the reference scenario. Source: PPMI study, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)" (2017).
 - 2 High Level Group Own Resources report, http://ec.europa.eu/budget/mff/hlgor/library/reports-communication/hlgor-report_20170104.pdf
 - 3 Elsevier, based on Field Weighted Citation Index.
 - 4 The European Research Council is recognised as a global brand synonymous with research excellence, with substantial structuring effects in the Member States. Four ERC grantees have been awarded the Fields Medal after being funded by the ERC. The ERC, MSCA and FET, together with collaborative research themes, have supported at least 17 Nobel Prize winners prior or after the award of their prize and Horizon 2020 beneficiaries have also contributed to major scientific discoveries including the Higgs Boson at CERN, the detection of gravitational waves and the discovery of a planetary system composed of seven Earth-like worlds (exo-planets) located relatively close to Earth in 2017.
 - 5 Study on assessing the contribution of the Framework Programmes to the development of human research capacity: http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/fp_hrc_study_final_report.pdf
 - 6 PPMI study (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020).
 - 7 <http://www.oecd.org/sti/Science-brief-scoreboard.pdf>, "Outflows tend to be associated with higher rated publications than their staying or returning counterparts. Assuming one could raise the performance of "stayers" to the level of their internationally mobile researchers [...] this would help countries catch up with leading research nations."
 - 8 PPMI study (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020). Based on survey data.
 - 9 Elsevier based on Field Weighted Citation Index.
 - 10 Average growth rate of 24.4% in EU-funded teams compared with 12.6% in the control group.
 - 11 PPMI study (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020). Based on survey data.
 - 12 Several of these projects have allowed collaboration with policy makers, such as the European Medicines Agency and their results have had an effect on antibiotic stewardship policies and infection control policies
 - 13 Beneficiary teams increased their R&D budgets by 22.4%. The corresponding value for the non-FP teams was -2.2%. PPMI study (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020). Based on survey data.
 - 14 Data provided by the Thematic Units responsible for the seven Joint Undertakings.
 - 15 Annual monitoring reports of Factories of the Future, SPIRE and Energy-efficient Buildings. This takes current investments into account and discounts intentions regarding future investments.
 - 16 PPMI study (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020). Based on survey data.

ANNEXES

ANNEX 3: MACROECONOMIC MODELLING



ANNEX 3: MACROECONOMIC MODELLING

Macroeconomic modelling is used to quantify the expected economic impact of Horizon Europe in terms of GDP gain and job creation in the EU. While there is a consensus¹ that R&I are an important factor in increasing productivity, quantifying the impact of R&I policies at a macroeconomic level requires modelling tools that accurately capture how R&I translate into economic gains.

There are several models available for assessing the impact of R&I, each with specific features. This impact assessment uses results produced by three macroeconomic models: NEMESIS, QUEST and RHOMOLO. Results from NEMESIS were produced by a team of external experts², while RHOMOLO and QUEST results were produced by the European Commission services (DG Joint Research Centre for RHO-

MOLO and DG Economic and Financial Affairs for QUEST).

The strengths of these models is their distinct features. Di Comite and Kanacs (2015)³ consider that NEMESIS is the richest model in covering different types of innovation. QUEST is the most appropriate for assessing the impact of R&I policies over time. By modelling regional economies, RHOMOLO is the most suitable model to address the geographical concentration of innovative activities.

The three models are used to assess the impact of continuing the current Framework Programme. Each model is then used to produce additional sets of results: NEMESIS for capturing the changes foreseen in Horizon Europe, and RHOMOLO for assessing regional impacts.

1 NEMESIS

Presentation of the model

NEMESIS was developed by a European consortium⁴ in 2000 in order to analyse the macro-sectoral impacts of European policies, based on R&D investments and related knowledge spillovers. The model became a reference tool for the assessment of European or national R&I policies. Since 2004, NEMESIS has been used by the European Commission for several analyses. These include the assessment of the Lisbon Strategy target of 3% of EU GDP to be invested in R&D⁵, the assessment of the RTD National Action Plan related to the Barcelona Objective⁶ and the

assessment of the impact of European R&I Programmes (ex-ante assessment of the 7th Framework Programme⁷ and of Horizon 2020⁸). In 2017, NEMESIS was used for the ex-post assessment of FP7 and the interim evaluation of Horizon 2020⁹.

Structure

NEMESIS is a macro-econometric model consisting of detailed sectoral models for every EU country. Measuring technical progress in NEMESIS is derived from the new growth theories where innovations result from the

investment in R&D by private firms, and from R&D undertaken by the public sector. In the new version of NEMESIS used for this impact assessment, innovations still arise from private and public investments in R&D, but also from investments in two other complemen-

tary innovation inputs: ICT and Other Intangibles (including training and software). These enable improved accuracy in assessing R&I policies by considering the most up-to-date theoretical and empirical findings of economic literature (Le Mouël, et al., 2016).

How NEMESIS models R&I

- 1 Firms determine their investments in the three innovative assets (private R&D, ICT and OI).
- 2 The investment effort feeds their own knowledge (stock variable) as well as the knowledge in other sectors and countries through knowledge matrices (knowledge transfers). For each innovative asset, these knowledge stocks are modelled as a weighted sum of the stock of assets, R&D, ICT or OI, belonging to all sectors and countries. The spread parameters used to build these stocks are calibrated using matrices based on patent citations between sectors and countries. These matrices combine the citations between patents allocated by technology classes and country with the OECD concordance table, in order to allocate these citations between sectors (Johnson, 2002).
- 3 The growth of the knowledge stock of each innovation asset, coupled with knowledge absorption capacity (measured with the investment intensity in each innovative asset), generates innovations.
- 4 These innovations take two forms: product and process. Product innovation increases the intrinsic quality of the product sold by the firms, whereas process innovation improves the production process without changing the quality of the product sold (pure TFP effect). This distinction between process and product innovations is crucial as econometric studies show that process innovations alone have a negative, or only a slight positive impact on employment, whereas the impact of product innovations is always positive (Hall, 2011).
- 5 New product innovations raise internal as well as external demands for the enhanced product. New process innovation reduces the production cost of the sector that, within a competitive market, will reduce the end-user prices of the product and then increase its demand on the internal and external markets.
- 6 All these dynamics at sectoral level are brought together by the input-output tables of the model. Then, the combination of these sectoral interdependencies (“bottom-up”) with the “top-down” macro-economic forces impulses the medium and long term dynamics of the model. These macroeconomic forces depend mainly on the labour market and wage setting that are drivers for final consumption, and also for domestic production prices and the competitiveness of the economy.

The macroeconomic dynamic in NEMESIS can be summarised in three main phases:

1. An investment phase that is a “demand phase” in which all the dynamics are induced by the change in the R&D expenditures, with or without the moderated impacts of the innovation (as they take time to appear). This phase can be viewed as a Keynesian multiplier.
2. The innovation phase: the arrival of innovation (process and product) reduces the production cost of the new products or raises their quality, which induces an increase of external and internal demands.
3. The obsolescence phase: the new knowledge progressively declines due to the knowledge obsolescence¹⁰ and, in the long-term, the macro-economic track goes back to the reference scenario.

Key assumptions for the impact assessment

Key assumptions in NEMESIS for assessing the impact of the Framework Programme are related to budget size, budget allocation and the value of key parameters such as leverage¹¹ and performance.

Table 1: Key Assumptions

Issue	Key assumptions (continuation of Horizon 2020)
Budget size	Continuation of Horizon 2020 budget in constant prices – 15%
Budget allocation across years, countries and sectors	Horizon 2020 allocation
Knowledge spillovers	Inter-sectoral and international spillovers modelled using patent citation techniques with no additional specificity for the Framework Programme
Direct leverage effect	Direct leverage: <ul style="list-style-type: none"> > Basic research: 0 > National funding of applied R&I: 0.1 > EU funding of applied R&I: 0.15 Indirect leverage: firms keep their investment effort constant in the long term
Economic performance	Higher performance of EU funding (+15%) compared to national funding
Financing	Reduction in public investment

Budget size and allocation are assumed to be the same as in Horizon 2020 in constant prices, minus the contribution from the UK (assumed to be 15% of the budget). The programme is assumed to be financed by lowering national public investment. Regarding the direct leverage effect, the assumptions used are supported by a survey¹² on research units involved in FP7 and by the empirical literature¹³.

produced for this impact assessment. Economic performance in NEMESIS is calibrated by country and sector on the basis of the available empirical literature. A higher leverage and performance parameter for EU funding compared to national funding reflects the benefits related to the EU added value of the Programme, with values supported by existing quantified evidence on publications, patents and revenues from innovations¹⁵.

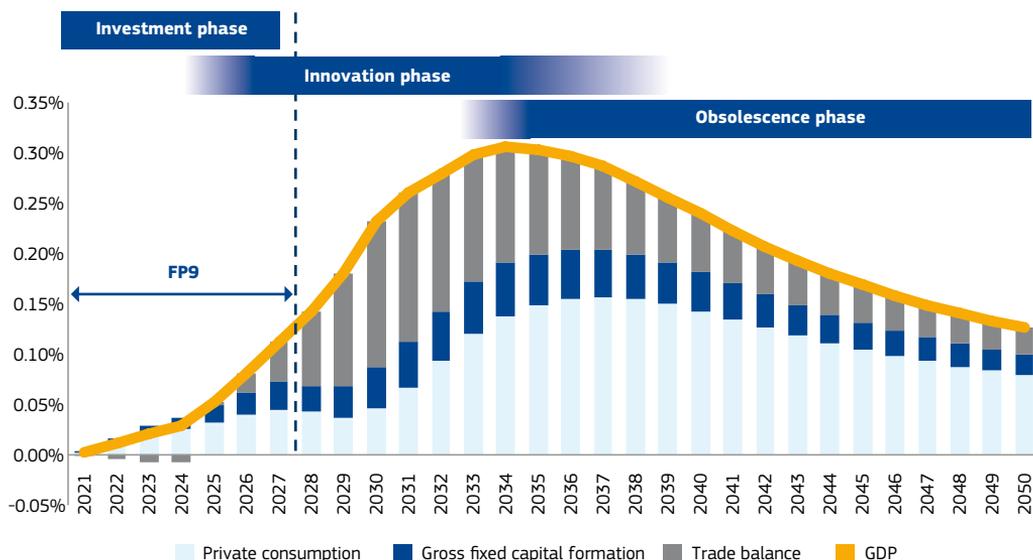
A further analysis¹⁴ shows that this parameter does not significantly drive the results

In order to assess the impact of the various changes regarding the structure and priorities

Table 2: Assumptions in NEMESIS

Changes for more impact	This assumes ...	Range
Higher economic performance	Focus on R&I with higher economic impacts and on breakthrough innovations	Higher performance of EU funding compared to national funding: +0 (baseline) to +5 percentage points
Lower knowledge obsolescence	More focus on breakthrough knowledge	14% to 13% obsolescence rate compared to 15% in the baseline
Stronger complementarities with other innovative assets	More cross-technological and cross-sectoral R&I	5% to 10% stronger than in the baseline
Higher direct leverage of private R&D	Better access to finance of innovative firms, especially for SMEs	0.1 (baseline) to 0.15
Changes for more openness	This assumes ...	Range
Higher complementarities with national support to R&D	Increased complementarities through partnerships	Increased leverage for basic research: 0.05 to 0.1 compared to 0 in the baseline
Stronger knowledge diffusion	Facilitated knowledge diffusion nationally, between the different categories of research organisations and/or internationally	5% to 10% stronger than in the baseline

Figure 4: GDP impact of the continuation of Horizon 2020 (NEMESIS, % deviation from a situation without FP)



Source: Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme

of Horizon Europe, each of the changes for more impact and more openness (section 3) was translated into variations of the parameters in NEMESIS. While the sign of these variations is straightforward, their size is uncertain. Therefore different scenarios were considered, from low to high, by using ranges in the variation of the parameters. These ranges rely on plausible values found in the literature¹⁶, with extreme values showing how impactful Horizon Europe can be in the most ambitious and optimistic conditions.

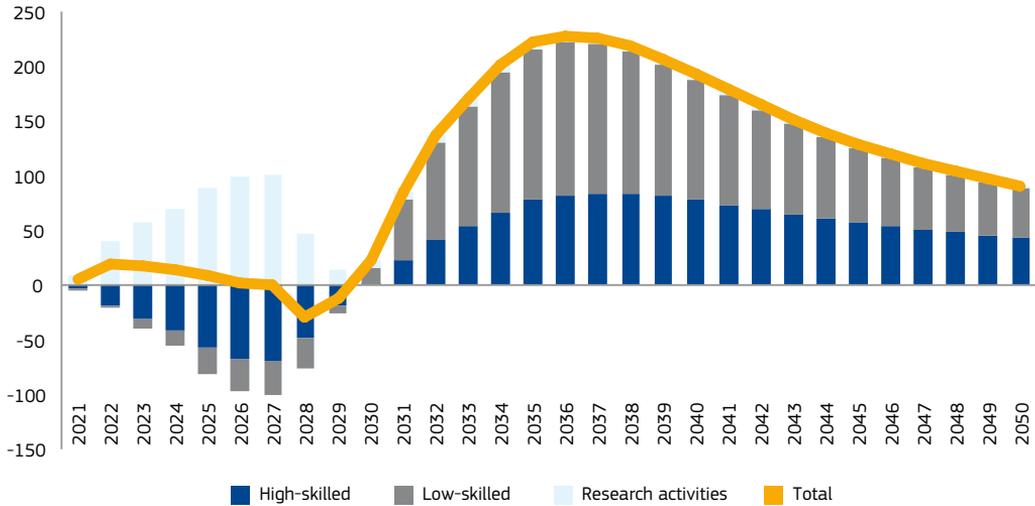
Results

Results from the NEMESIS model indicate that Horizon Europe is expected to generate large GDP gains. The continuation of the Framework Programme is expected to produce 0.08% of

additional GDP on average over 25 years, which means that each euro invested can potentially generate a return ranging from EUR 10 to 11 of GDP gains over the same period¹⁷. The highest gains (+0.31% of GDP) are expected to occur around 2034.

The impact on jobs is also substantial. Over the programme’s lifetime from 2021-2027, up to 100,000 jobs are expected to be directly created in R&I activities. During this period, while the programme has a positive effect on jobs in R&I, the decrease in national public investment assumed by the model is accompanied by a comparable decrease in non R&I-related jobs. The net indirect impact of the programme on jobs materialises as from 2030, with the creation of more than 200,000 jobs after 2035, including more than 80,000 highly-skilled jobs.

Figure 5: Employment impact of the continuation of Horizon 2020 (NEMESIS, deviation in thousand jobs from a situation without Framework Programme)

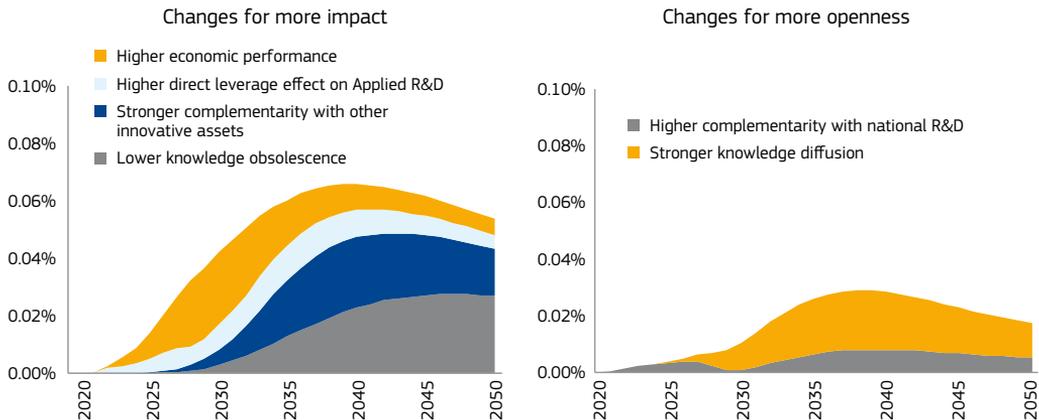


Source: Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme

Compared to the continuation of Horizon 2020, the changes in the programme’s design can potentially generate an additional GDP gain up to 0.04% in a low scenario, and up to 0.1% in a high scenario. The impact of

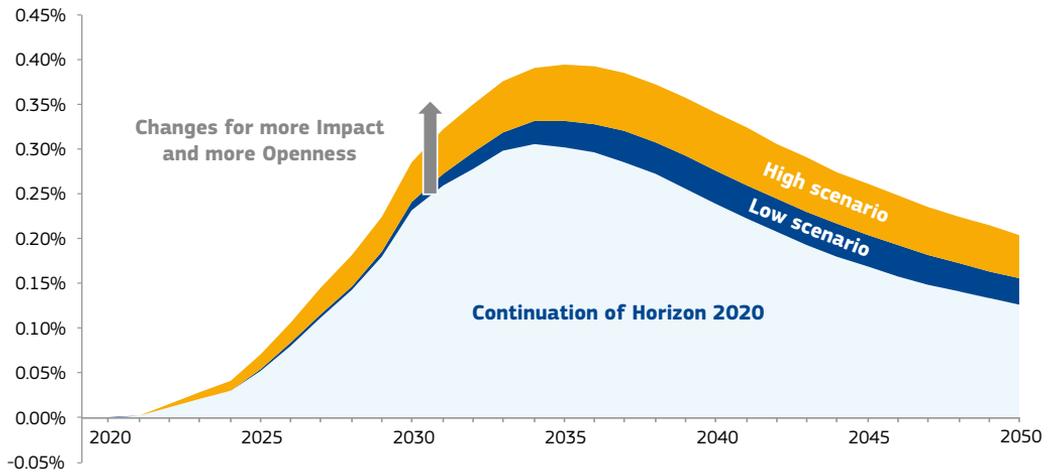
the changes is expected to be most significant after 2030. The total impact of the programme on EU GDP would be between EUR 800 billion and EUR 975 billion over 25 years.

Figure 6: Decomposition of GDP impact of changes for more impact and more openness (deviation in % from the continuation of Horizon 2020, scenarios based on highest values of the ranges)



Source: Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme

Figure 7: GDP impact of changes for more impact and more openness (deviation in % from a situation without Framework Programme)



Source: Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme

Limitations of the model

While NEMESIS' strengths justify its relevance for measuring the impact of R&I policies, the model's specific features also imply a number of limitations to be taken into account when interpreting the results. First, it relies on the empirical observation of relationships and allows

for flexibility in behavioural functions, which may generate inconsistencies among the most recent developments in macroeconomic theory. Furthermore, it does not use forward-looking expectations but adaptive ones. NEMESIS also does not link the use of human capital with investments in the educational system.

2 QUEST

Presentation of the model

The QUEST model is a global dynamic general equilibrium model developed by the Directorate-General for Economic and Financial Affairs of the European Commission¹⁸. The different model variants have been extensively used for macroeconomic policy analysis and research, e.g. analysing the impact of fiscal and structural reforms and assessing the impact of Cohesion Policy¹⁹. QUEST is a fully dynamic structural macro-model with rigorous microeconomic foundations. The model also accounts for frictions in goods, labour and financial markets.

Structure of the model

QUEST belongs to the class of micro-founded dynamic general equilibrium (DGE) models that are now widely used in economic policy institutions as the latest step in the development of macroeconomic modelling. The focus in these models is on the economy as a whole, as an integrated system of economic agents that base their decisions over a range of variables by continuously re-optimising while subject to budgetary, technological and institutional constraints. These models are forward-looking and intertemporal, i.e. current decisions account for expectations about the future.

This impact assessment uses the semi-endogenous growth version of the Commission's QUEST model with an R&D production sector (QUEST3RD). The model economy is populated by households, firms producing final and

intermediate goods, a research industry and a monetary and fiscal authority. In the final goods sector, firms produce differentiated goods which are imperfect substitutes for goods produced abroad. Final goods producers use a composite of intermediate goods and three types of labour: low-, medium-, and highly-skilled.

The model has two types of households: liquidity and non-liquidity constrained. This feature has become standard in general equilibrium modelling. Liquidity-constrained households have no access to financial markets. They simply consume their current income during each period. Non-liquidity constrained households buy the patents of designs produced by the R&D sector and license them to the intermediate goods producing firms. The intermediate sector is composed of monopolistically competitive firms, which produce intermediate products from rented capital input using the designs licensed from the household and by making an initial payment to overcome administrative entry barriers. The production of new designs takes place in research labs, employing highly-skilled labour and making use of the commonly available domestic and foreign stock of knowledge. Importantly, the model is a global multi-country model of the EU Member States and the rest of the world in which individual country blocks are interlinked with international trade and knowledge spillovers.

Assumptions used for the impact assessment

Issue	Key assumptions (continuation of Horizon 2020)
Budget size	Continuation of Horizon 2020 budget in constant prices – 15%
Budget allocation across years, regions and sectors	Horizon 2020 allocation
Spillovers	International trade and knowledge spillovers, based on trade statistics and elasticities in the relevant literature
Direct leverage effect	Identical leverage of EU funding and national funding
Economic performance	Identical performance of EU funding and national funding

For this impact assessment, results were produced based on two scenarios regarding the financing of the Framework Programme. In the first, financing relies on raising additional VAT revenues in the Member States. The second assumes that Horizon Europe is financed at the expense of lowering national public investment.

Results

The results highlight the importance of the underlying financing assumptions. As value added taxes are some of the least distorting taxes, financing productivity-enhancing R&D investments from these resources is unambiguously beneficial at the EU level in the medium and long term (see left side graph in Figure 8a).

Figure 8: GDP impact of the continuation of Horizon 2020 (QUEST, deviation in % from a situation without Framework Programme)



Source: European Commission, DG ECFIN

By changing from VAT financing to public investment cuts (e.g. roads, buildings), Member States lose the potential productivity effects of these public investments and the GDP results are lower both in the short- and long term (second panel in Figure 8b).

There is a small short-run output loss due to crowding out effects in the beginning of the intervention period. This is because R&D subsidies stimulate innovation by helping R&D intensive companies to attract more highly-skilled labour from traditional production into research (with higher wages). In the second scenario, the expected GDP effects are less beneficial at the EU level. Similarly to R&D investments public investment also boosts productivity, so this type of financing is more costly for Member States. It also takes longer to compensate the short-run output loss.

In both scenarios, the GDP gains peak around the 2030-2032 period, up to 0.14%, and gradually decrease after the programme period due to the depreciation of tangible and intangible capital. The average impact over 25 years can reach up to 0.14%. In the QUEST simulations, it is important to note that EU and nationally-funded R&I have the same leverage and performance effects.

Limitations of the model

Although the model is well-suited to simulate the effect of public financed subsidies to private R&D, it does not distinguish between research undertaken in private or public R&I entities. All R&D activities are carried out by a (virtual) R&D sector. Being an aggregate macroeconomic model, QUEST also misses the extensive regional details present in RHOMOLO.

3 RHOMOLO

Presentation of the model

RHOMOLO is the macroeconomic model of the European Commission focusing on EU regions. It has been developed and maintained by the Directorate-General Joint Research Centre, in cooperation with the Directorate-General for Regional and Urban Policy. It is used for policy impact assessment and provides sector-, region- and time-specific simulations on investments and reforms covering a wide array of policies. RHOMOLO is built on a micro-founded general equilibrium approach²⁰ and is used to provide a breakdown of results by region and sector.

Structure of the model

RHOMOLO is a spatial dynamic general equilibrium model that covers 267 regions at the NUTS2 level. Each region contains 10 economic sectors. A subset of these operates under monopolistic competition. The rest of the sectors operate under 'perfect' compe-

tion. Regional goods are produced by combining labour and capital with domestic and imported intermediates, creating vertical linkages between firms.

Final goods are consumed by households, government and investors. Each region is inhabited by a representative household that supplies labour of three skills: type, consume and save. The government levies taxes, purchases public consumption goods, makes public investments and allocates transfers to the various parts of the economy. Goods and services can be sold in the domestic economy or exported to other regions. Trade between regions is associated with a set of bilateral regional transportation costs. The RHOMOLO model incorporates imperfect competition in the labour market. The model allows a switch from a wage curve to a Phillips curve. RHOMOLO contains two types of capital: sector specific private capital and public capital available to firms in all sectors within the region.

How RHOMOLO models R&I

- R&D expenditure is modelled as private investments. Hence, R&D spending generates demand for capital goods. In addition, R&D spending leads to the accumulation of an intangible knowledge capital stock which in turn spills into an increase in total factor productivity (TFP).
- Expenditure for R&D support is introduced into the model as a reduction in user cost of capital which in turn generates an increase in R&D investments.
- The impact of R&D expenditure on total factor productivity through the accumulated knowledge capital stock is captured by a set of regional spillover elasticities which are conditional on R&D intensity within the region. Higher regional R&D intensity is associated with higher spillover from knowledge capital to TFP. The R&D spillover elasticities are based on estimates by Kancs and Siliverstovs (2016)²¹.

Assumptions used for the impact assessment²²

Issue	Key assumptions (continuation of Horizon 2020)
Budget size	Continuation of Horizon 2020 budget in constant prices – 15%
Budget allocation across years, regions and sectors	Horizon 2020 allocation
Regional spillovers	Regional spillovers are conditional on R&D intensity within the regions.
Direct leverage effect	Direct leverage: Calculated as a weighted average from NEMESIS Indirect leverage: Determined endogenously by the models investment demand specification
Economic performance	Identical performance of EU funding and national funding
Financing	Reduction in public investment

The regionalisation of funding is based on the regional distribution of existing Framework Programme spending. Hence, it is assumed that future R&I support would follow the same regional distribution as previous funding programmes. Figure 9 shows the assumed regional accumulated spending for R&D support for the period 2021-2027 as a percentage of GDP. Large regional variations in spending can be observed.

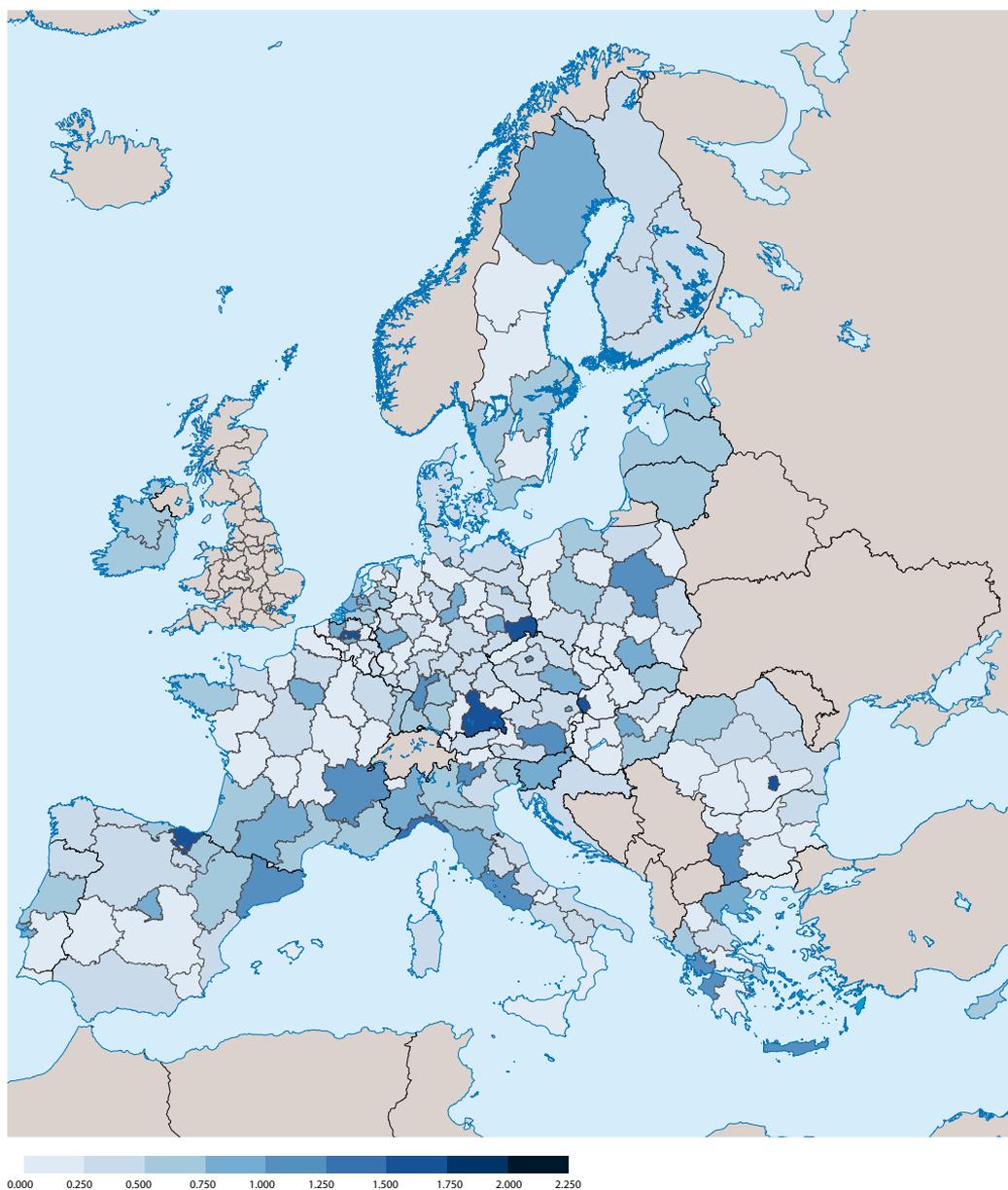
The impact of the Spreading Excellence and Widening Participation (SEWP) part of Horizon 2020 is also measured using RHOMOLO by using the regional allocation of funds for the years 2014-2015 under SEWP. Most funding was awarded to regions in Cyprus, Hungary, Slovenia, Portugal and Estonia. The funding is mainly concentrated in regions in the widening countries. However, some regions in other Member States also receive funding through

participations in projects with counterparts in the countries eligible for Widening Participation support²³.

Results

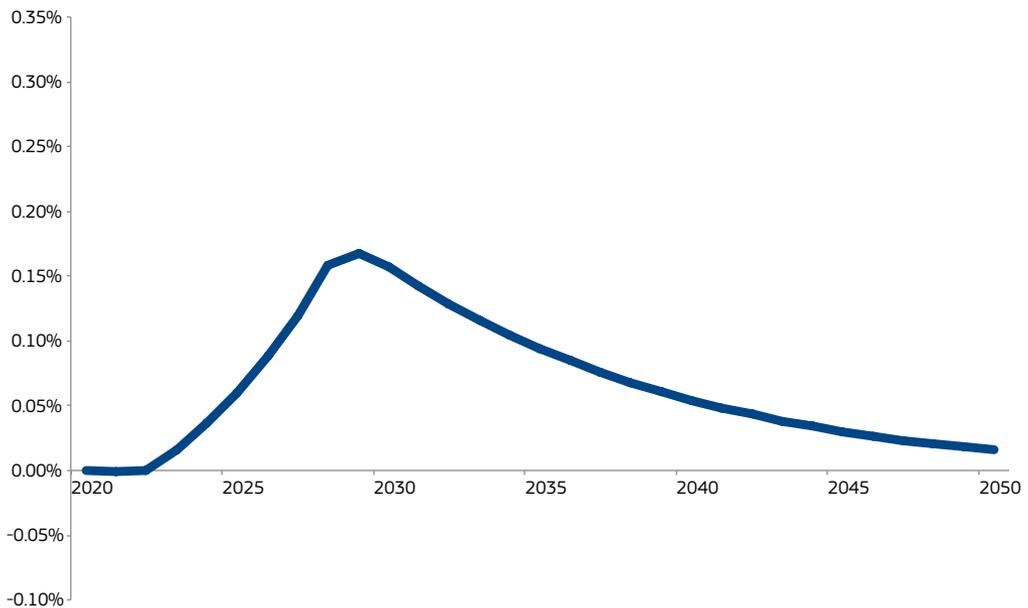
Results from RHOMOLO show significant benefits of continuing the EU R&I Programme compared to a situation in which funding is reallocated to national public investments. The Programme is expected to generate up to 0.17% (in 2020) of additional GDP compared to a situation without the EU R&I Programme, with an average impact of 0.08% of GDP over 25 years.

Figure 9: Accumulated regional spending in support of R&D in the reference scenario (percent of GDP)



Source: European Commission, DG JRC

Figure 10: GDP impact of the continuation of Horizon 2020 (RHOMOLO, deviation in % from a situation without Framework Programme)



Source: European Commission, DG JRC

Key regional results from the model are the following:

- Regions from all Member States are directly or indirectly impacted by SEWP measures, not only targeted countries.
- The regional impact of the SEWP can be as high as 0.18% of regional value added in some regions.
- Each Euro invested in the SEWP part of the Framework Programme is expected to bring similar return in terms of GDP gain compared to the rest of the programme.

Limitations of the model

While the spatial dimension of RHOMOLO is a key strength of the model, the extensive regional disaggregation of the model requires that the dynamics are kept relatively simple²⁴. This implies that the optimisation problems in RHOMOLO are inherently static and do not acknowledge the inter-temporal consequences of innovation decisions that can change not only the level but also the rate of growth of regional economies. This is solved by recursive dynamics. Furthermore, RHOMOLO does not explicitly distinguish between private and public R&D investments or between types of endogenous innovation.

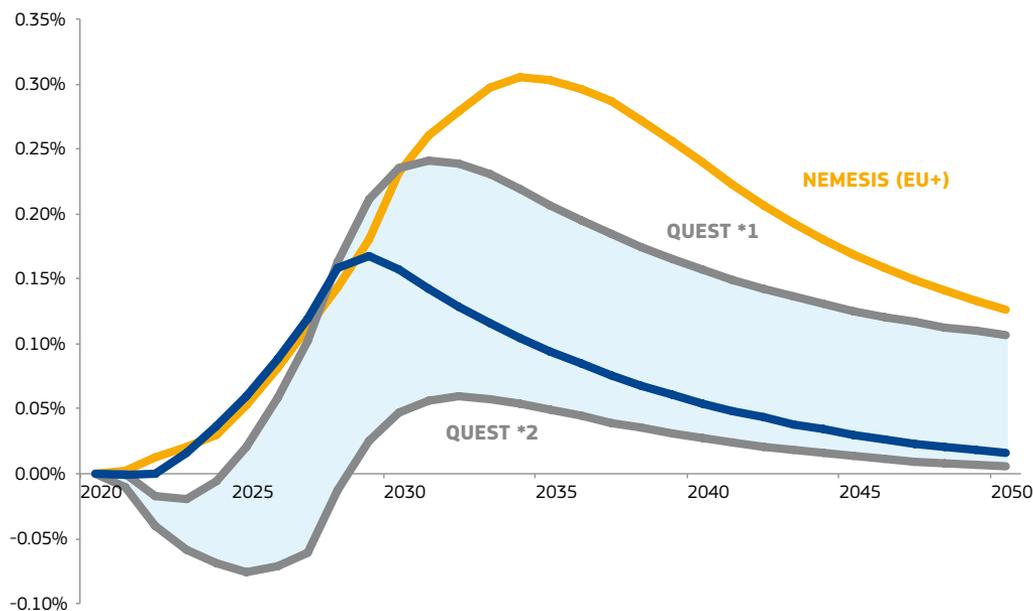
4 COMPARISON OF RESULTS

RHOMOLO, QUEST and NEMESIS are three different models corresponding to different approaches and with very different specifications and settings of parameter values. One should therefore not expect the three models to produce identical estimates of the economic impact of a given policy change. However, comparing the findings from the three models for the baseline scenario (i.e. the continuation of Horizon 2020) allows assessing the consistency of the impacts identified in each model and contributes to address to some extent the issue of model uncertainty.

Overall, NEMESIS, QUEST and RHOMOLO present consistent results in terms of sign and temporal pattern of the GDP gain from the

Framework Programme (compared to the discontinuation of the programme) over 2021-2050. The three models show a strong increase in GDP impact during or after the period covered by the programme, with the highest impacts expected between 2029 and 2034. The size of the GDP gain is the highest based on the NEMESIS results. This can be explained by the fact that the three models use different sets of innovation channels and elasticities. Furthermore, the parameters and mechanisms in QUEST and RHOMOLO do not directly take into account the higher leverage and performance expected from EU funding of R&I compared to national funding. These are acknowledged in NEMESIS as an illustration of the EU added value of the Framework Programme.

Figure 11: GDP impact of Horizon 2020 continuation (deviation in % from a situation without Horizon 2020)



Source: European Commission, DG Research and Innovation. Note: EU+ indicates that Nemesisis uses higher performance and leverage for EU funding compared to national funding as a reflection of the EU added value of the Programme. QUEST *1 assumes that financing of the Programme relies on VAT increase. QUEST *2 assumes that financing relies on lowering public investment.

- 1 Di Comite F. and Kancs D., Macro-Economic Models for R&D and Innovation Policies (2015), IPTS Working Papers on Corporate R&D and Innovation – No 03/2015.
- 2 Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme.
- 3 Ibidem.
- 4 Lab. ERASME / Ecole Centrale Paris (now SEURECO), Federal Planning Bureau of Belgium, E3M3 lab. / ICCS /NTUA and Chambre d'Industrie et de Commerce de Paris.
- 5 Brécard, D., Fougeyrollas, A., Le Mouël, P., Lemiale, L. and P. Zagamé (2006), "Macro-economic consequences of European Research Policy: Prospects of the NEMESIS model in the year 2030", Research Policy No 35(7), pp. 910-924. Doi:10.1016/j.respol.2006.03.001.
- 6 Chevallier, C., Fougeyrollas, A., Le Mouël, P., and P. Zagamé (2006), "A time to sow, a time to reap for the European Countries: A macro-econometric glance at the RTD National Action Plans", Revue de l'OFCE, 2006/5 (No 97 bis), pp. 235-257. Doi:10.3917/reof.073.0235
- 7 Delanghe, H. and U. Muldur (2007), "Ex-ante impact assessment of research programmes: The experience of the European Union's 7th Framework Programme", Science and Public Policy, No 34(3), pp. 169-183, doi:10.3152/030234207X218125.
- 8 European Commission (2012), "The Grand Challenge – The design and societal impact of Horizon 2020", Directorate-General for Research and Innovation. Doi:10.2777/85874.
- 9 PPMI (2017), "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", 2017. <https://frama.link/o6oBPRZU>.
- 10 The obsolescence of the innovation comes from the depreciation rate used in the knowledge stock formulation. These depreciation rates are of 15% for R&D, 35% for ICT and 36% for the Other Intangibles.
- 11 Amount of additional R&I expenditures leveraged by the initial R&I investment.
- 12 PPMI (2017), Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020), Final report, European Commission report.
- 13 Seureco (2018), Support for assessment of socio-economic and environmental impacts (SEEI) of European R&I programme.
- 14 Ibidem.
- 15 Ibidem.
- 16 Ibidem.
- 17 Figures in constant prices. This corresponds to about EUR 720bn over 25 years, and EUR 550bn over 20 years.
- 18 See Ratto, M., Roeger, W., & in't Veld, J. (2009). QUEST III: An estimated open-economy DSGE model of the euro area with fiscal and monetary policy. *Economic Modelling*, 26(1), 222-233.
- 19 See Varga, J., Roeger W. and in 't Veld, J. (2014), "Growth effects of structural reforms in Southern Europe: the case of Greece, Italy, Spain and Portugal" *Empirica*, vol. 41, issue 2, 323-363., Varga, J. and in 't Veld, J. (2011). "A model-based analysis of the impact of Cohesion Policy expenditure 2000-06: Simulations with the QUEST III endogenous R&D model." *Economic Modelling*, 28 (1-2), 647-663. and https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-research/macroeconomic-models_en for other publications using the QUEST model.
- 20 The micro-founded general equilibrium approach is also the basis for other macroeconomic models developed by the Commission such as the QUEST model developed by the Directorate-General for Economic and Financial Affairs (DG ECFIN).
- 21 Kancs, D. and Siliverstovs, B. (2016), R&D and non-linear productivity growth, Research Policy, 45, 634-646.
- 22 Christensen, M., Assessing the regional socio-economic impact of the European R&I programme, forthcoming.
- 23 See here for a list of these countries: <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/spreading-excellence-and-widening-participation>
- 24 Di Comite F. and Kancs D. (2015), Macro-Economic Models for R&D and Innovation Policies, IPTS Working Papers on Corporate R&D and Innovation – No 03/2015.

ANNEXES

ANNEX 4: INDICATORS



ANNEX 4: INDICATORS

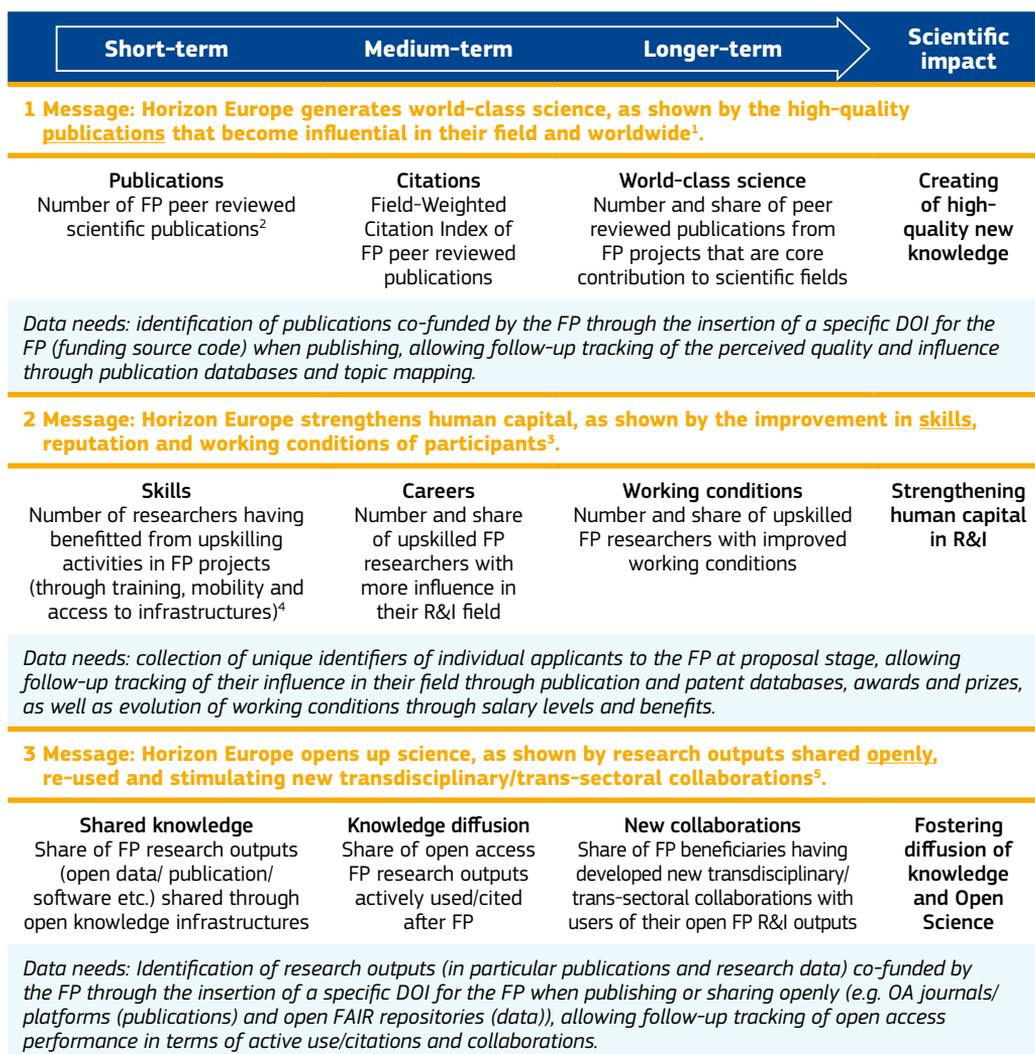
1 KEY IMPACT PATHWAYS INDICATORS

1.1 Scientific impact pathway indicators

Horizon Europe is expected to generate scientific impact by creating high-quality new knowledge and enabling its diffusion, strengthening

human capital in R&I and promoting Open Science. Progress towards achieving this impact will be monitored through the proxy indicators outlined in Figure 12, which are categorised as three key ‘impact pathways’.

Figure 12: Key scientific impact pathways indicators



1.2 Societal impact pathway indicators

Horizon Europe is expected to have societal impact by addressing EU policy priorities through R&I, delivering impact through R&I

missions and strengthening the uptake of R&I within society. Progress towards this impact will be monitored according to the proxy indicators and impact pathways set out in Figure 13 below.

Figure 13: Key societal impact pathways & progress indicators



1.3 Economic impact pathway indicators

Horizon Europe is expected to have an economic/innovation⁸ impact by stimulating the creation and growth of companies, creating

jobs both directly and indirectly and by leveraging investments for R&I. Progress towards this impact will be monitored according to the proxy indicators and impact pathways set out in Figure 14 below.

Figure 14: Key economic impact pathways indicators



2 KEY MANAGEMENT AND IMPLEMENTATION DATA

This section outlines the key data to be collected in order to assess how the programme is being implemented. The data covers the inputs and activities of Horizon Europe, including the European Partnership initiatives.

- › *Number of proposals and applications submitted, EC contribution requested and total costs of submitted proposals (by source of funds)*
- › *Number of proposals reaching the quality threshold (funded/not funded)*
- › *Number of retained proposals*
- › *Success rates of proposals*
- › *EC contribution and total costs of retained proposals (by source of funds)*
- › *Number of participations and single participants*

This information shall be collected according to:

- › *Types of action*
- › *Types of organisations, including Civil Society Organisations (with specific data for SMEs)*
- › *Countries and regions of applicants and participants (including from associated and third countries)*
- › *Sectors*
- › *Disciplines*

Data shall also be monitored on the profiles of beneficiaries and proposal evaluators, including:

- › *Gender balance (in projects, evaluators)*
- › *Role(s) in project¹⁷*
- › *Share of newcomers to the Programme*

Data shall also be monitored on project implementation issues, including:

- › *Time-to-grant*
- › *Time-to-pay*
- › *Error rate*
- › *Satisfaction rate*
- › *Rate of risk taking*

Data shall also be monitored on:

- › *The financial contribution that is climate-related*

Data shall also be collected on:

- › *Communication of R&I results*
- › *Dissemination of R&I results*
- › *Exploitation and deployment of R&I results, including through monitoring the funding allocated for uptake of R&I results through the other proposals for the long-term EU budget.*

-
- 1 Indicators on publications are collected under Horizon 2020, for instance the number of peer reviewed publications and top 1% or 10% citations but with different coverage across programme parts.
 - 2 The indicators will be tracked also for co-authored publications across types of organisations, disciplines, sectors, countries (including associated and third countries).
 - 3 Data on individual researchers and innovators is collected only under some programme parts under Horizon 2020 (ERC, MSCA). It is proposed to extend the coverage to the whole Programme and to look at the overall effects of the FP on individuals based on the collection of unique identifiers for each beneficiary at project's start. This shall allow for a more solid and automated analysis of the contribution of the Programme to the strengthening of human capital without further data requests to beneficiaries.
 - 4 By type of activities: training, mentoring/coaching, mobility, access to infrastructures.
 - 5 Two indicators were specified as a cross-cutting issue under Horizon 2020 for open access publications and open access to data.
 - 6 Missions are a new element under the Framework Programme, which did not exist under Horizon 2020 and will be not be specified at the stage of the legal proposal. The interim evaluation of Horizon 2020 pinpointed to the lack of data to track the societal impact of the Programme beyond publications and patents in fields related to societal challenges. It is proposed to assess the progress towards the achievement of the targets set in each mission.
 - 7 Data on responsible research and innovation was collected under Horizon 2020 at the level of the activities within projects. It is proposed to go beyond this indicator to assess the effects of the co-creation on the development of citizen engagement mechanisms in beneficiary entities (such as citizen fora, participatory research, co-creation facilities, etc.) to then assess the extent this affects the uptake and outreach of the scientific results (e.g. changing behaviours) and innovative solutions from the programme.
 - 8 An innovation is a new or improved product or practice (policy, process or procedure) of an institutional unit, or a combination thereof, that differs significantly from the unit's previous products and practices and has been brought into practical use by the unit or made available to others.
 - 9 Horizon 2020 includes an indicator on the growth and job creation in participating SMEs but no data is collected. It is proposed to extend this indicator to the whole programme and to collect information on the types of jobs created or maintained based on the collection of unique identifiers of companies. This shall allow for a more solid and automated analysis of the contribution of the Programme to the creation of more and better jobs without further data requests to beneficiaries.
 - 10 Types of innovation: by level of novelty of the innovation (e.g. based on the Oslo Manual definition), by objective of the innovation (incl. social innovation) and by source of innovation (i.e. technological (Key Enabling Technologies, other) /non-technological).
 - 11 Patents, trademarks, standards. The indicators will be tracked also for co-authored IPR across types of organisations, disciplines, sectors, countries (including associated and third countries).
 - 12 Data on innovative products, process or methods developed in FP projects is collected under Horizon 2020 but the effects on company creation, growth and market shares are not monitored.
 - 13 Types of jobs: by level of qualification (low, medium, high (based on ISCED 1997 levels) and contract duration (short, long term).
 - 14 Direct jobs: jobs within beneficiaries entities. Indirect jobs: Jobs in non-FP beneficiary entities (e.g. suppliers).
 - 15 Public and private funding leveraged under Horizon 2020 is computed on different ways depending on the types of action. It is proposed to use an overall indicator of the direct and indirect public and private investment leveraged including venture investment, loans and other co-financing, to be able to assess the overall contribution of the Programme to the achievement of the 3% target for R&D investments.
 - 16 Including venture investment, loans and other co-financing.
 - 17 e.g. Research performer; Technology development; Testing / validation; Demonstration (proof of viability); Scale-up; Private buyer of solutions to be developed; Public procurer of innovative solutions; Finance provider; Provision of the technology basis; Provision of the technology infrastructure; Representative of civil society interests/needs; Co-definition of a research / market need; Training, dissemination activities).

ANNEXES

**ANNEX 5:
SYNERGIES WITH
OTHER PROPOSALS
UNDER THE FUTURE
MULTIANNUAL
FINANCIAL FRAMEWORK**



ANNEX 5: SYNERGIES WITH OTHER PROPOSALS UNDER THE FUTURE MULTIANNUAL FINANCIAL FRAMEWORK

1 WHY DO WE NEED SYNERGIES BETWEEN EU PROGRAMMES?

The set of EU funding programmes under the next multiannual budget must be closely linked to each other, and they must work in synergy. This can be described as:

- > **Compatibility:** harmonised funding rules for projects; making co-funding schemes more flexible; pooling resources at EU level;
- > **Complementarity** between EU programmes: no overlap in funding;
- > **Coherence:** alignment of strategic priorities in support of a common vision.

As learned from the Horizon 2020 interim evaluation, in cases where EU programmes were not designed with a clear strategic overview on their complementary features from the start, it proved difficult to ensure full complementarity and coherence during their lifetime.

More effective synergies between programmes under the next EU Multinational Financial Framework (MFF) will make the EU's overall investments more effective, efficient and able to provide better value for citizens. It will amplify the impact of EU-level investments in R&I for creating jobs, growth and competitiveness on the ground by establishing both stronger connections and clearer

delineation between European, national and regional R&I funding. Ultimately, they should contribute in a complementary way to a common vision and shared objectives on tackling the major challenges facing Europe. This will make the EU better-equipped to face the ever-increasing competitive pressure from global markets.

At the programme design stage, creating synergies between Horizon Europe and other future EU programmes with an R&I element aims to:

- (i) ensure complementarity in designs and objectives of the different programmes to ensure the most efficient use of limited public resources and a better understanding for beneficiaries;
- (ii) capture the scope of the activities supported through the different programmes to ensure full synergies and coherent approaches on the ground; for instance through aligned strategic programming processes (e.g. on priority areas, partnerships), and common missions to guide funding priorities of different programmes;
- (iii) ensure the development of complementary and combined funding across programmes and facilitate the implementation of the Seal of Excellence.

What have we learned from the Horizon 2020 Interim Evaluation?

- “It is difficult to assess to what extent the political willingness to increase Horizon 2020’s external coherence has translated into practical implementation. Given different rules and implementation structures, and varying scale and scope of programmes, promoting synergies at project level (in terms of combining different financing sources for the same project) still appears difficult”¹.
- Differences in applicable rules lead to legal uncertainty for potential applicants; while communication, coordination and support for synergies between all institutional actors involved is not optimal.
- “Despite initiatives being taken to reinforce synergies with other EU funds, notably the ESIF, further coherence is hampered by the different intervention logics and complexity of the different funding and other rules”².
- “The main areas to be addressed to improve the generation of synergies and to boost their impacts on regional development, on growth, job creation and tackling societal challenges are: strategic framework and programming; generation of concrete guidance and implementation of best practice; monitoring. These issues should support a more specific, widespread, efficient and effective implementation of synergies between Horizon 2020 and ESIF”³.



What do stakeholders say?

The large majority of stakeholders state that increased synergies, coordination and strategic alignment with other EU programmes would help to maximise the impact of Horizon Europe.

In general, this is a consistently high priority for other EU institutions:

- [The European Parliament] “Notes that synergies between funds are crucial to make investments more effective ... regrets the presence of substantial barriers to making synergies fully operational and seek, therefore, an alignment of rules and procedures for R&D&I projects under ESIF and FP ... encourages the Commission to enhance synergies between the Framework Programme and other dedicated European funds for R&I, and to establish harmonised instruments and aligned rules for those funds”⁴.
- [The Council] “Highlights the importance of improved synergies and complementarities between the FP and other EU funding instruments. Considers therefore that regulations for the next FP and the European Structural and Investment Funds, as well as state aid rules and any other relevant EU programmes must be designed from the very beginning with synergies, coherence, compatibility and complementarity in mind

in order to provide a level playing field for similar projects under different management modes and to consider harmonization of funding rules for R&I towards those of the FP⁵.

Specific suggestions from stakeholder organisations include:

- > To include education activities in relevant parts of the EU R&I programme and secure synergies with the next EU framework programme for education.
- > To increase the impact of national and regional funding coming from ESIF allocated to R&I activities, to allocate a minimum specific percentage of the budget devoted to synergies with the R&I programme for each Member State.
- > To step up efforts for the 'Seals of Excellence' enabling excellent-but-unfunded projects submitted to the R&I programme to be funded under other schemes (including private, national, other EU funds).
- > To co-construct the future R&I and ESIF programmes by ensuring efficient support from the ESIF funds to excellent R&I projects in capacity-building (upstream) and uptake of results (downstream).
- > Request for broader acceptance of usual cost-accounting.

2 THE ROLE OF HORIZON EUROPE IN THE EU R&I SUPPORT SYSTEM

Horizon Europe will be the sole EU programme supporting mainly trans-national R&I activities and networks - including through partnerships with Member States, businesses and foundations - based on the key criterion of excellence. This includes trans-national access to and integration of national research infrastructures across Europe and the development of ESFRI⁶ pan-European research infrastructures.

Horizon Europe will cover activities that support the development, demonstration and market uptake of innovative solutions, which usually have a trans-national dimension or require more support than can be provided at national/regional level. Across its activities, the programme will support the development of the skills of researchers and innovators involved. While Horizon Europe will be open to participation from all Member States and beyond, it will continue to support building capacity in low-performing countries in R&I through dedicated collaborative schemes - including for policy reforms, in the context of strengthening the European Research Area, including outermost regions.

Other future EU programmes will provide support for R&I activities, including demonstration of solutions tailored to specific national/regional contexts/needs, as well as bilateral and interregional initiatives. In particular, the European Regional Development Fund (ERDF) will support the building of R&I ecosystems in Member States (including infrastructures, human resources, clusters). Other programmes such as the Connecting Europe Facility, the Digital Europe Programme, the

European Social Fund+ (ESF+) or LIFE make use of public procurement to deploy infrastructures, innovative technologies and solutions in specific areas. These can originate from Horizon Europe activities, but not only.

Horizon Europe will also provide support for R&I activities underpinned by these infrastructures and facilities, including testing, experimentation and demonstration across all sectors and disciplines. Actions implemented through other EU programmes will support system transitions (e.g. infrastructures for energy transition) and improve the conditions for innovation. The latter includes issues such as standards, innovation-friendly regulation, and wider diffusion and uptake of (European) innovations in the international arena.

Overall, the wider dissemination of R&I results attained through Horizon Europe towards a broader audience (Member States, stakeholders, EU institutions) will be encouraged. Through the Seal of Excellence initiative launched under Horizon 2020, proposals submitted to Horizon Europe that are evaluated as high-quality but are not funded will be eligible for support through other sources of funding, including the European Regional or ESF+ where relevant.

The further refinement of centralised IT tools and platforms will provide for a more coherent implementation of projects, thus increasing the chances to build synergies at project level. Cross-reliance on audits of other EU programmes could also be considered, depending on the similarity of the rules between programmes.

Table 3: Support to R&I projects/activities, incl. closer-to-market activities, replication & diffusion of technologies & innovative solutions – Complementarities Framework Programme/ Other EU programmes

Horizon Europe	What will the other EU programmes typically cover?
<p>R&I activities/projects:</p> <ul style="list-style-type: none"> > Programme focussed on excellent R&I from TRL 1-9 with continued strong focus on collaboration > Support to individual entities and transnational collaborations (top down and bottom-up) > Mainly grants for TRL 1-8; repayable or convertible advances, equity and/or guarantee for loans (no grants) for TRL 5/6-9 > Support technological & non-technological innovations ((citizen science, user-led innovation, social innovation, business model innovation, public sector innovation etc.) > Continuation of Coordination and Support Actions > Incentives for institutional changes towards Responsible Research and Innovation and gender equality > Continued streamlined support to European Partnerships: co-programming, co-funding (incl. through procurement), institutional funding open to all types of public, private stakeholders (incl. foundations) 	<p>R&I activities/projects</p> <ul style="list-style-type: none"> > Continue support R&I activities tailored to specific national/regional contexts/needs, as well as bilateral and interregional initiatives (e.g. ERDF, LIFE) > Build R&I capacity in countries and regions (including regional and national research infrastructures): ERDF, InvestEU (infrastructure, human capital and SME windows); Neighbourhood, Development and International Cooperation Instrument, Erasmus-supported European Universities initiative, Strategic Partnerships, Knowledge Alliances and Mobility > High-quality but unfunded proposals under Horizon Europe (Seal of Excellence) should be supported through alternative funding sources, including ERDF or ESF+ where relevant. In the case of the Seal of Excellence they should benefit from similar funding conditions elsewhere, including under national/regional funding schemes. > Pool resources for coordinated parallel actions that complement Horizon Europe (including ERDF or ESF for the support of European Partnerships) and for R&I in specific areas (i.e. with Emissions Trading Scheme Innovation Fund) > Align funding provisions/financial regulations between programmes > Provide advice on finding alternative funding sources through COSME

Horizon Europe	What will the other EU programmes typically cover?
<p>Market uptake:</p> <ul style="list-style-type: none"> › Market uptake considered as of FP proposal development, enabling applicants to co-create/experiment their research and solutions with users from the outset, including within the EIT Knowledge and Innovation Community (KIC) co-location centres › Supporting innovation actions and the demonstration of solutions of a first-of-a-kind nature in Europe with potential for replication › Establishing pipelines of innovative solutions from R&I projects (incl. from European Research Council Proof of concept) targeted to public and private investors, including European Innovation Council (EIC) Accelerator scheme and other EU programmes › Support to roll out and replication of innovative solutions with cross-border & transnational dimension › Support to pre-commercial procurement and public procurement of innovation as a stand-alone tool maintained › Support to scale-up of companies with breakthrough potential to create new markets with financial instruments under the European Innovation Council, in particular where the market does not provide viable financing › Improved monitoring and dissemination of R&I results including through initiatives such as the dissemination and exploitation Boosters and the Innovation Radar 	<p>Market uptake:</p> <ul style="list-style-type: none"> › Support user-driven activities tailored to specific national/regional contexts (e.g. living labs, testbeds under the ESI funds, Digital Europe Programme) › Support demonstration and innovation activities tailored to specific national/regional contexts including trans-regional activities (incl. LIFE, ESI funds) › Take up FP results and support further development, dissemination and deployment for the benefit of economy and society (project pipelines) (all EU programmes when relevant) › Replicate and deploy tested technologies and innovative solutions to improve the environment, energy consumption or the health of citizen or in digital technologies at local and regional level incl. trans-regional through CAP, LIFE, ERDF or ESF (e.g. for acquiring technologies, skills development) while preserving competition within the internal market › Support the take-up of innovative solutions by individuals and final users, industry and public administration (e.g. for energy consumption, health, environment) through ESI funds, LIFE, CAP › Build enabling framework conditions for the transition processes (e.g. energy transition) such as interoperability, standards, innovation-friendly regulations, but also enhanced skills and awareness of the wider population, the spreading of best practice in R&I policy implementation, but also for the wider diffusion and uptake › Support wider diffusion and uptake of (European) innovations (including through External Instrument) › Deploy physical infrastructures allowing technological system transitions (e.g. for a transition to clean energy under CEF; financial instruments under Invest EU, ERDF) › Reinforce cooperation between Commission departments for developing further the public procurement for innovative solutions in key areas of European interest, in particular for energy, transport, environment, health & ICT

Table 4: Support to entrepreneurship, start-ups, SME growth/scale up, clusters & innovation hubs

Horizon Europe	What will the other EU programmes typically cover?
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> > Support the launch and scale-up of start-ups, innovative SMEs and mid-capital firms with breakthrough potential to create new markets with financial instruments through the European Innovation Council (Pathfinder, Accelerator schemes), preserving competition within the internal market and not crowding out private investments > Dedicated R&I thematic window and SME Window (i.e. including innovative SMEs) under InvestEU that are closely linked to the objectives of Horizon Europe > Blended finance for innovators that is distinct from indirect financial instruments under InvestEU, but in synergy with funds and intermediaries supported by InvestEU > Support to companies (incl. mentoring and coaching) provided within the EIT KICs, including investments via EIC’s Accelerator <p>Support to clusters, hubs and broader innovation ecosystem:</p> <ul style="list-style-type: none"> > Joint programmes and other actions to enhance innovation ecosystems > Reinforcement of EIT KICs’ co-location centres (innovation hubs) for experimentation and testing with end-users > Support to development of standards for innovative products/services in FP projects 	<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> > Ensure full complementarity with financial instruments implemented through InvestEU windows to support scale-up of companies > Support the growth and internationalisation of mainstream individual companies (e.g. through COSME; ERDF and Neighbourhood, Development and International Cooperation Instrument) in a competitive environment > Support to business skills development (ESF+) <p>Support to clusters, hubs and broader innovation ecosystem:</p> <ul style="list-style-type: none"> > Support the construction and equipment of structures for SME support (clusters, incubators, etc., notably under ERDF) > Support to regional/national innovation ecosystem development incl. provision of advice and support services to companies (incl. through COSME, the Enterprise Europe Network, ESI funds). > Shape R&I supportive standards in the international standardisation arena (incl. through COSME)

Table 5: Support to research infrastructures, human capital development, networking & policy-making

Horizon Europe	What will the other EU programmes typically cover?
<p>Research infrastructure:</p> <ul style="list-style-type: none"> › Consolidate the landscape of European research infrastructures e.g. European Strategy Forum for Research Infrastructures: support early-phase development of pan-European research infrastructures, the European Open Science Cloud and European Data infrastructures and enable delivery of High Performance Computing/data services › Open, integrate and interconnect national research infrastructures › Support partnerships with industry for the supply of high-tech components while ensuring a level playing field between competitors › Reinforce European research infrastructure policy and international cooperation <p>Human capital development:</p> <ul style="list-style-type: none"> › Supporting individual researchers (incl. ERC, MSCA) and R&I networks for the exchange of knowledge, incl. mobility & career development › Continue supporting mobility & career development of researchers in the European Research Area (e.g. Human Resources Strategy for researchers, EURAXESS, RESAVER Pension Fund, etc.) › Continue supporting access to research infrastructures for researchers, innovators & SMEs on a transparent and non-discriminatory basis › Continue supporting responsible research and innovation and gender equality & gender dimension in R&I › Continue supporting the development of entrepreneurial skills in universities (EIT-KICs) and reinforce the role of the EIT KICs for future skills identification in areas related to global challenges 	<p>Research infrastructure:</p> <ul style="list-style-type: none"> › Support the national/regional contributions to the construction of pan European research infrastructures i.e. with ERDF and InvestEU Fund › Exploit the potential of the Connecting Europe Facility and Digital Europe Programme instruments for the large-scale coordinated procurement/deployment of digital infrastructures and infrastructures for digital technologies › Use Neighbourhood, Development and International Cooperation Instrument for developing capacity in third countries to participate in global research infrastructures of EU interest › Provide appropriate and continued financial support for long-lasting initiatives beyond FP funding lifetime <p>Human capital development:</p> <ul style="list-style-type: none"> › Support to skills development (technical, digital and transversal) to support the use of innovative solutions, while increasing employability and career prospects, but also entrepreneurial skills through the future COSME (Erasmus for Young Entrepreneurs) and ESF+ › Build/reinforce human R&I capacity in countries & regions (including through regional & national research infrastructures & fellowships): European Social Fund (incl. basic digital skills), InvestEU (research infrastructure, human capital & SME windows); Erasmus (targeting particular sectors to provide a pipeline of talented pre-graduates that can embark on a research career, European Universities initiative, Strategic Partnerships individual mobility for studies and for traineeships); Neighbourhood, Development and International Cooperation Instrument

Horizon Europe

What will the other EU programmes typically cover?

- > Increase FP role in **modernisation of universities in the European Research Area**, i.e. through embedding Open Science practices as well as entrepreneurship focus (e.g. skills, recognition and rewarding mechanisms, etc.)
- > Continue **mentoring & coaching** companies to enhance innovation & entrepreneurial skills (EIC, EIT/KICs)
- > Launch new Recognition prizes (Women Innovators, Capital of Innovation, EIT awards) and **EIC Prizes**
- > Continue reinforcing **human capacity in low R&I performing countries** (ERA Chairs)

Networking and policy-making:

- > Continuation of **coordination and support actions** incl. Sharing Excellence actions (Teaming, Twinning, ERA-Chairs), Policy Support Facility to help EU Member States reform their R&I policies and Innovation Deals to identify barriers to innovation at sectoral level
- > Rationalised support to **European Partnerships**: co-programming, co-funding, institutional funding open to all types of stakeholders
- > Improved **monitoring and dissemination of R&I results** towards policy
- > **EIC Forum** of national agencies implementing national innovation policies

- > Develop skills and capacities towards **gender equality and Responsible Research and Innovation**
- > Foster **links and synergies** between relevant policy actions linking education/research/innovation

Networking and policy-making :

- > Ensure strong **coordination** between programmes, especially in the area of research infrastructures, innovation hubs, large demonstrators etc.
- > Continue support R&I networking activities tailored to specific **national/regional** contexts and **inter-regional** cooperation
- > Build **R&I policy capacity** in countries and regions e.g. by developing networks for policy evidence
- > Support through CAP and ERDF to upgrade **national and regional ecosystems** and make them more innovation-conducive (incl. through Smart Specialisation Strategies)
- > Neighbourhood, Development and International Cooperation Instrument actions to help improve **framework conditions** for innovation and cooperation in R&I

3 SYNERGIES WITH THE EUROPEAN REGIONAL DEVELOPMENT FUND (ERDF)

Table 6: European Regional Development Fund- Research and innovation related support

<p>Sectors/Domains:</p> <ul style="list-style-type: none"> > Under development <p>Target beneficiaries:</p> <ul style="list-style-type: none"> > All of the Framework Programme's beneficiaries may also get ERDF support either for different types of projects or within a common project <p>Geographical coverage:</p> <ul style="list-style-type: none"> > Member States and regions 	<p>R&I activities/projects</p> <ul style="list-style-type: none"> > Supports R&I projects of individual enterprises, and public institutions, cooperation university-business and university researchers <p>Market uptake:</p> <ul style="list-style-type: none"> > Focuses funding for R&I on the take-up of technology and knowledge > Social innovation and co-creation, use of design-thinking and other newer forms of innovation > Supports all types of market take-up, prototyping, IPR management advice, etc. (within State-Aid limits!) > Funds replication and diffusion of innovative solutions and technology deployment, including the actual public and private procurement of innovative solutions > Open to PCP and PPI funding (both preparation of Terms of Reference and actual procurement), offers technical assistance and training for national and regional authorities; networking among different countries > Supports interregional partnerships along value chains for joint investment pipelines, with the aim for industrial transition
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> > Financial instruments under ERDF > Funds the provision of advice and support services 	<p>R&I Infrastructure:</p> <p>If in line with the relevant smart specialisation strategy, ERDF may pay for:</p> <ul style="list-style-type: none"> > The construction and upgrade of research infrastructures (this may include some training “on the job” to correctly use new infrastructures and equipment) > The construction and upgrade of innovation infrastructures (pilot lines, living labs, demonstrators, tech transfer offices)

Support to clusters, hubs and broader innovation ecosystem:

- › Funds the construction and equipment of infrastructures for SME support (clusters, incubators, etc.)
- › Funds the innovation ecosystem development

Human capital development:

- › Funds the purchase of equipment and infrastructures needed for human capital development, if relevant for the implementation of the smart specialisation priorities

Networking and policy-making:

- › Supports the development and improvement of national & regional innovation eco-systems including business-industry-citizens-public support bodies' cooperation, innovation governance, capacity-building and the cooperation with other regions & Member-States for mutual learning & joint investment pipelines
- › Invests in networking with other countries & regions bringing together the policy-makers & funding agencies/authorities/stakeholders on the ground
- › Invests in better innovation policy-making for industrial modernization (Smart Specialisation)
- › Invests in better innovation governance (entrepreneurial discovery process)

The Regional Development Funds aim to strengthen economic, social and territorial cohesion within the EU. They have a prominent role in developing, improving and connecting national and regional innovation ecosystems, and will continue to dedicate important amounts in the post-2020 period to R&I ecosystem investments (including R&I infrastructures, SME innovation capacities, networking, innovation support services and support to human capital). Support to innovation is provided through regional smart specialisation strategies, by which regions focus on their competitive strengths. This prepares stakeholders to participate in the Framework Programme, but also helps to exploit and diffuse R&I results developed under the programme.

Horizon Europe will continue to support and build capacity of low-performing countries in R&I, in the context of strengthening the European Research Area and reforming national

R&I systems. The complementarity between Horizon Europe and ERDF support to the national and regional innovation systems will be ensured. For instance, the Teaming mechanism (launched under Horizon 2020) will still require compliance with the relevant smart specialisation strategy.

The scaling-up and transferability of projects and better communication and sharing of good practices are two key areas for future improvement. Transnational cooperation activities and national innovation initiatives will be further supported with a view to promote social innovation in the implementation of the European Pillar of Social Rights.

Arrangements for synergies between Horizon Europe and ERDF, ESF+ or national contributions for similar type of projects will benefit from more conducive rules. Legal provisions allowing cumulative funding of grants from the Framework Programme and ERDF/ESF for the

same action (provided that there is no double funding) will be kept allowing a pro rata basis approach. Programme co-fund actions will be designed to bring such synergies to life. Similarly, funding of Seal of Excellence awards from national ERDF or ESF+ allocations will be simplified and facilitated. Moreover, the take-up in Horizon Europe of simplified cost options for reimbursing expenditure (lump sums, flat rates, unit costs) will further facilitate the combination of funds. To do this, all relevant rules and regulations will be revised accordingly in time for Horizon Europe, provided certain conditions are fulfilled.

High-quality-but-unfunded proposals under Horizon Europe (Seals of Excellence) will be able to benefit from the same co-funding rates elsewhere, including under regional funding schemes. For example, this means that ERDF or ESF+ allocations can be used to support Seal of Excellence projects, where relevant to the local context and smart specialisation strategies.

Portfolios of R&I results and innovations attained by projects funded under the Framework Programmes that correspond to existing national or regional needs will be made systematically available to national or regional ERDF and ESF+ managing authorities. The role of advisory services and their access to available innovations, knowledge and results stemming from the Framework Programmes will be given particular attention. More specifically, the ERDF may feature increased funds dedicated to the take-up of results and the rolling out of novel technologies and innovative solutions from past Framework Programmes and Horizon Europe.

Box 1: Concrete examples of how synergies with ERDF could look like in practice

- > Horizon Europe projects can be implemented using the equipment and research infrastructures previously funded from the ERDF.
- > SMEs which have received a Seal of Excellence can apply for alternative funding under conditions to be further defined under relevant rules and regulations, including as regards compatibility with state aid. This will allow for reducing administrative burden and costs for both the SMEs and funding bodies.

4 SYNERGIES WITH THE EUROPEAN SOCIAL FUND (ESF+)

Table 6: European Social Fund + - Research and innovation related support

<p>Sectors/Domains:</p> <ul style="list-style-type: none"> > Not sector-specific <p>Target beneficiaries:</p> <ul style="list-style-type: none"> > No groups are excluded <p>Geographic coverage:</p> <ul style="list-style-type: none"> > EU 	<p>R&I activities/projects</p> <ul style="list-style-type: none"> > ESF+ to continue promoting social innovation (i.e. policy testing and experimentation in the social & employment policy fields)
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> > ESF+ programme > access to finance (microcredit and microloans)for vulnerable groups and micro-enterprises; continued support for youth, social entrepreneurship 	<p>R&I Infrastructure:</p> <ul style="list-style-type: none"> > Complements other EU instruments for investments in R&I infrastructure <p>Human capital development:</p> <ul style="list-style-type: none"> > Aims to improve the quality, efficiency and openness of (tertiary) education e.g. developing new teaching methods, delivering high quality educational content, which is relevant to labour market needs > Stimulates partnerships between higher education, business and research organisations > Aims to strengthen human capital in R&I, e.g. through training and capacity building for researchers (e.g. complementarities and synergies with MSCA Seal of Excellence and MSCA co-funded doctoral and postdoctoral research training programmes) and for teachers; opening tertiary education access to disadvantaged groups > Can mainstream curricula oriented towards equipping students with the skills needed in the future labour market developed under the Framework Programme <p>Networking and policy making:</p> <ul style="list-style-type: none"> > ESF+ support for reforms of education systems, curricula

The European Social Fund (ESF) is instrumental in supporting continuous investments in skills, which are key for harnessing technological development. Skills are a crucial element for developing environments conducive to innovation, including in the European Research Area. The ESF post-2020 (known as the ESF+) will mainstream and scale up Framework Programme-funded innovative curricula that will equip people with the skills and competences needed for the jobs of the future (based on forecasting of future professions).

Across the EU funds, the ESF represents the major bulk of funding for social transformation. This helps to diffuse social innovation throughout the economy and reinforces human capital, including for R&I.

The deployment and support of ESF+ to Framework Programme-funded curricula promoting skills and competences can take several approaches (i.e. integration of Framework Programme-funded curricula in national or regional programmes; transnational cooperation networks on skills). This will result in practical synergies and complementarities between ESF+ and the MSCA co-funded doctoral and postdoctoral research training programmes. MSCA proposals with the Seal of Excellence may be funded by the ESF+ to support activities promoting human capital development in R&I and to attract talents, in aiming to strengthen the European Research Area.

Box 2: Concrete examples of how synergies with ESF+ could look like in practice

- › MSCA-funded researchers can use ERDF-financed equipment and infrastructures for training and the ESF+ can financially support innovative training activities as well as other capacity-building measures (e.g. networking activities, mobility allowance).
- › Researchers who received the MSCA Seal of Excellence under Horizon 2020 or Horizon Europe can be supported through alternative sources of funding at regional or national level, including through use of ESF+. This allows countries/institutions to identify and employ excellent researchers, while removing/reducing the need to carry out a new evaluation of the proposals.

5 SYNERGIES WITH THE EU PROGRAMMES FOR AGRICULTURAL AND MARITIME POLICY

Table 7: European Agricultural Guarantee Fund; European Agricultural Fund for Rural Development; European Maritime & Fisheries Fund - Research and innovation related support

Sectors/Domains:

- > Agriculture

Target beneficiaries:

- > Farmers
- > Policy makers
- > Bio-industries
- > SMEs

Geographical coverage:

- > EU

R&I activities/projects:

- > Support to R&I in Member States' CAP Strategic Plans
- > Knowledge exchange and innovation activities within Agricultural Knowledge and Innovation System (AKIS)
- > Innovation projects (operational groups) with EIP-AGRI (European Innovation Partnership)
- > Bottom-up innovation projects (operational groups)

Market uptake:

- > Investments projects
- > EIP-AGRI

Human capital development:

- > AKIS (European Agricultural Knowledge and Information Systems) /EIP-AGRI
- > Conditionality in coming CAP plans

Networking and policy making:

- > CAP network
- > European Innovation Partnership network

Research and innovation are set to play a stronger role in the future agricultural and maritime policy as part of a key priority to foster innovation. This will take place especially through the wider diffusion of innovation and better access to new technologies and investment support services.

Through Horizon Europe's strategic planning processes, coherent approaches with these policies will be ensured. In particular, they will work in tandem to promote Food and Nutrition Security and the Sustainable Management of Natural Resources as a strong component Horizon Europe and under the modernised CAP. This will result in an ambitious, integrated Strategic Research and Innovation Agenda (building on the Strategic Approach to EU Agricultural R&I and the Food 2030 initiatives, as well as the EU Bioeconomy Strategy) which will help shape Horizon Europe and help serve the evolving innovation needs of the CAP.

The development of the Strategic Research and Innovation Agenda Plan will inform Horizon Europe priorities in the area of food and natural resources, whereas the uptake of R&I results in the agricultural sector will be promoted through the modernised CAP. This will build on the achievements to date of the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI)⁷ in mobilising the agricultural sector for innovation, funding multi-actor pilot projects and making new knowledge available. The ambition is to bring about systemic knowledge generation and CAP support that is generated upstream, leading to the downstream uptake and deployment of innovations by end users within projects. This will enable the CAP to make best use of R&I results and to promote the best use of innovative solutions, including those stemming from projects funded by the Framework Programmes and those supported by the EIP-AGRI.

Box 3: Concrete example of how synergies could look like in practice

The implementation phase will ensure greater uptake of Framework Programme results in CAP programmes, e.g. by:

- Reinforcing the role of Agricultural Knowledge and Innovation systems (AKIS) in Member States and improve the connections between national AKIS at various levels (regional, national, EU levels). The role of advisory services and their access to research outcomes will be given particular attention.
- Increasing the impact of CAP instruments to foster demonstration, investments or new business models in farming and rural areas. Examples provided under CAP instruments could address innovations in digitisation, precision farming and the bioeconomy.

6 SYNERGIES WITH THE SINGLE MARKET PROGRAMME

Table 7: Single Market Programme – Research and innovation related support

Sectors/Domains:

- › SMEs across sectors
- › Focus on SME in strategic value chains

Target beneficiaries:

- › SME intermediaries
- › Cluster organisations
- › Technology clusters
- › Specialised SME support actors

Geographical coverage:

- › EU

Market uptake:

- › Support SME's uptake of innovation through Joint Cluster Initiatives & Scaling-up Instrument
- › Facilitates SME's access to markets, including through public procurement

Support to entrepreneurship & SME growth:

- › Upgraded Enterprise Europe Network: specialised business advisory services, e.g. scale-up advice for entrepreneurs with a proven business model
- › Erasmus for Young Entrepreneurs: mentoring; initial business matchmaking
- › New Scaling-up Instrument: For SMEs & strategic value chains channelled by Joint Cluster Initiatives; supports SME scale-up across regional, sectoral & technological boundaries to access global industrial value chains
- › Delimitation New Scaling-up Instrument/ EIC accelerator: focus on growth drivers beyond innovation (e.g. internationalisation, skills); specialised mainstream SMEs (#only breakthrough innovators in EIC)

Support to clusters, hubs and broader innovation ecosystem:

- › Joint Cluster Initiatives: foster strategic interregional collaboration among specialised clusters and ecosystems to strengthen EU value chains (10-20 major EU value chains)

Human capital development:

- › Integrated business support, incl. skills development and mentoring in “Erasmus for young entrepreneurs”

Networking and policy-making:

- › Strategic Cluster Initiatives: strategically connect ecosystems and clusters
- › Enterprise Europe Network (innovation ecosystem integrator & corporate tool)
- › SME Panels and SME Feedback tools for policy making through the EEN

The Single Market Programme - which integrates the COSME programme - addresses the market failures that affect mainstream SMEs. It will also promote entrepreneurship and the creation and growth of companies. As a result, it will focus on generating growth opportunities for mainstream enterprises. Under Horizon Europe, the European Innovation Council will support, in a complementary way, the scale-up of innovative start-ups, SMEs and mid-cap firms with market-creating innovation potential; in particular, where the market does not provide viable financing.

Horizon Europe will remain the one-stop-shop for EU innovation policy support. It will also stimulate the uptake of innovation, building on the dissemination and exploitation strategies of projects supported under Horizon 2020. Full complementarity will be ensured between the COSME scaling-up instrument for mainstream companies deployed through InvestEU and the actions of the future European Innovation Council for innovative companies. The same will apply for support services for SMEs, in particular where the market does not provide viable financing.

For raising awareness of Horizon Europe and the Single Market Programme, the Enterprise Europe Network (EEN) may play a complementary role to dedicated support structures put in place for Horizon Europe such as National Contact Points (NCPs). The future mandate of the Enterprise Europe Network and the Horizon Europe support structures (e.g. NCPs, Innovation Agencies) will be defined in order to avoid duplication, with the aim of maximising their usefulness to SMEs.

The skills and knowledge available in existing networks including the EEN may be used to improve existing services, such as coaching activities for recipients of European Innovation Council funds. These could include investment readiness activities and enabling connections with private investors, business partners and customers through brokerage activities and events including trade fairs. Testing of new SME support initiatives may also take place.

7 SYNERGIES WITH THE INVESTEU FUND

Table 8: InvestEU Fund - Research and innovation related support

The InvestEU Fund will integrate current EU-level financial instruments and budgetary guarantees under a single mechanism and in particular deploy indirect financial instruments provided for under Horizon Europe and other EU programmes

Sectors/Domains:

- › R&I Window
- › SME Window including innovative companies
- › Sustainable infrastructure window
- › Social, skills and human capital window

Target beneficiaries:

- › Financially viable projects or commercial entities facing market gaps or sub-optimal investment situations

Geographical coverage:

- › EU

Support to entrepreneurship & SME growth:

- › The SME window will improve access to finance by supporting SME financing, including and in particular for innovative companies. It will further support start-ups and companies commercialising R&I results.
- › The R&I window and SME Window will provide a range of financing products to support growth of companies, including and in particular innovative ones
- › The Social, skills and human capital window will promote inclusive entrepreneurship; improve access to employment (including self-employment), job creation, labour market integration, social inclusion by increasing the availability of and access to micro-finance⁸, and access to finance for social enterprises

R&I activities/projects

- › The R&I window and products for innovative companies developed under the SME Window, will provide a range of debt and equity financing products in line with the variety of potential final beneficiaries at different development stages and in different EU policy areas

Market uptake:

- › The R&I window will support high-risk investments in R&I and new technologies, including in large-scale first-of-a-kind demonstrations for which market investor interest may be low
- › The R&I window will de-risk investments in innovative technologies and, together with the SME window, transfer established solutions to new markets
- › Products for innovative companies developed under the SME Window will boost SME investment capacity

R&I Infrastructure:

- › The R&I Window will facilitate access to finance through debt and equity instruments to research infrastructures. It would support in particular those that are financially viable and investment ready

Human capital development:

- › Social and human capital window: support to investment in all levels of education and (necessary for building a knowledge-based society), support to increase vocational training and lifelong learning, including non-formal learning investment in human capital

Networking and policy making:

- › The InvestEU Fund will provide project development assistance to support the development of a robust pipeline of investment projects. It could also be used to facilitate blending opportunities with grants schemes

Financial instruments for R&I which are designed for innovative companies (including SMEs) and supported under Horizon Europe or other EU programmes will be deployed through InvestEU. This programme will feature dedicated R&I and SME windows that will target innovative companies. Investment efforts under InvestEU will complement those taking place under Horizon Europe (including by supporting high-risk investments in R&I and new technologies) in a manner that does not crowd out private investments.

Horizon Europe will also provide blended finance for innovators in a way that is distinct from the financial instruments under InvestEU, where there is a very high level of risk where no intervention from InvestEU would be possible (yet). Blended finance shall be implemented in tandem with financial intermediaries supported by InvestEU, in order to ensure continuity of investments.

Box 4: Concrete example of how synergies could look like in practice

A radically innovative SME that shows potential for scaling up and is supported under the **Accelerator scheme** of **Horizon Europe's European Innovation Council** will benefit from a mix of finance and other types of support in order to deliver on a particular innovation. This implies that the latter, being ready for the market and for investment, can be eligible to the different schemes under the **SME window of InvestEU**. This will allow the company to find additional finance – where appropriate and necessary – to support further development and scale-up. In this way, the Accelerator will reduce the risks of innovation project driven by the SME so that it becomes an attractive investment target for financial intermediaries implementing SME products under InvestEU.

8 SYNERGIES WITH THE CONNECTING EUROPE FACILITY

Table 9: Connecting Europe Facility – Research and innovation related support

<p>Sectors/Domains:</p> <ul style="list-style-type: none"> > Energy > Transport > Digital <p>Target beneficiaries:</p> <ul style="list-style-type: none"> > Public authorities > Industry: infrastructure building/ manufacturing, Infrastructure managers, transport operators > Consultants for studies <p>Geographical coverage:</p> <p>CEF-transport divided into 2 ‘envelopes’:</p> <ul style="list-style-type: none"> > General envelope: for all Member States > Cohesion Fund envelope: for Cohesion Member States 	<p>R&I related activities/projects:</p> <ul style="list-style-type: none"> > Transport, energy, telecom: Support to deployment of new technologies & innovation > Real-life pilots (studies/works) > Deployment of existing innovations <p>Market uptake:</p> <ul style="list-style-type: none"> > CEF supports pilots, prototypes for certain technologies developed under the Framework Programmes or which are relevant for transport infrastructure > CEF funds transnational infrastructures to strengthen Energy Union and accelerate energy transition: research and innovation state-of-the-art should be considered in CEF (particularly regarding digital applications, electric charging and alternative fuels) > CEF transport supports the development of solutions arising from projects funded by the Single European Sky ATM Research public-private partnership
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> > Grants and public procurement 	<p>R&I Infrastructure:</p> <ul style="list-style-type: none"> > Not R&I infrastructures but efficient and interconnected networks + main infrastructure components > Smart infrastructure for sustainable mobility (digital, alternative fuels, multimodality, innovation) > Safer, secure, resilient and accessible infrastructure (i.e. climate resilience) <p>Networking and policy making:</p> <ul style="list-style-type: none"> > Support to policy making: alternative fuels, ITS, Urban, etc. policies

The future CEF will prioritise the large-scale rollout and deployment of innovative new technologies and solutions that result from projects funded by the Framework Programmes in transport, energy and mobility, in particular through the Climate, Energy and Mobility cluster and digital technologies strands of Horizon Europe. Europe's R&I needs in the areas of transport, energy and the digital sector will be established during the Horizon Europe strategic planning process.

Strategic synergies will be pursued through making the two programmes' contributions to EU policy more explicit, while deployment of cutting-edge technology will be pushed within targeted areas – for example electro-mobility⁹. The exchange of information and data between Framework Programme and CEF projects will be facilitated by highlighting technologies arising from the former programme with a high market readiness that could be deployed through CEF.

The blending of funds and instruments for common objectives, for example public procurement, will be explored. Given the investment challenges prevalent in the three CEF focus areas, and the transformational character of many CEF projects, public procurement for innovation could be used to reduce the risks inherent in the uptake of these technologies. This could also enable system operators to invest substantially higher volumes (both through their balance sheets and their regulated asset bases) than usual.

Box 5: Concrete example of how synergies could look like in practice

Research and innovation on low-emission vehicles will be supported by Horizon Europe, while re-charging infrastructure/alternative re-fuelling stations will be deployed under CEF.

9 SYNERGIES WITH THE DIGITAL EUROPE PROGRAMME

Table 10: Digital Europe Programme - Research and innovation related support

Sectors/Domains:

Digital technologies for :

- > High Performance Computing (HPC)
- > Cybersecurity
- > Artificial Intelligence
- > Advanced digital skills
- > Areas of public interest and industry

Target beneficiaries:

- > Public authorities and administrations
- > Industry including SMEs

Geographical coverage:

- > EU wide

Market uptake:

- > Support to transformation of areas of public interest and industry
- > Wide deployment of digital technologies
- > Large-scale deployment projects making best use of digital capacities and latest technologies such as High Performance Computing and Artificial Intelligence in areas of public interest

Support to entrepreneurship & SME growth:

- > Through Digital innovation hubs and networking of competence centres

Support to clusters, hubs and broader innovation ecosystem:

- > Support to Digital Innovation Hubs and networking of digital facilities

R&I Infrastructure:

- > Co-investment in digital capacities (through joint procurement)
- > Promotion of interoperability and standardisation

Human capital development:

- > Support to advanced digital skills in HPC and Big Data, Cybersecurity and Artificial Intelligence

The Digital Europe Programme (DEP) is a new initiative designed to enlarge and maximise the benefits of digital transformation for all European citizens and businesses. Both Horizon Europe and the DEP will provide public R&I support in the field of digital technologies. Under Horizon Europe, a dedicated budget will be allocated to a “Digital and industry” cluster. In addition, due to their cross-cutting nature, digital technologies will be supported in a wide range of other (thematic) parts of Horizon Europe.

While several thematic areas addressed by Horizon Europe and Digital Europe cohere (e.g. both will cover High Performance Computing, Artificial Intelligence, Cybersecurity), the type of activities to be supported, their expected outputs and intervention logic are different and complementary. Digital Europe will focus on large-scale digital capacity and infrastructure building. This will support the uptake and deployment across Europe of critical existing or tested innovative digital solutions. This will mainly be implemented through coordinated and strategic investments with Member States, notably through joint public procurement. Investments will focus on digital capacities to be shared across Europe, and on EU-wide activities to support interoperability and standardisation for developing a Digital Single Market.

R&I needs in the digital field will be identified and established as part of the strategic planning process of Horizon Europe; including for High Performance Computing, Artificial Intelligence and Cybersecurity. This also applies to combining digital with other enabling technologies and non-technological innovations; support for the scale-up of companies introducing breakthrough innovations including based on digital technologies; the integration of digital within the Global Challenges pillar; and support to e-infrastructures.

Capacities and infrastructures developed through Digital Europe will be made available to the R&I community, including for activities supported through Horizon Europe such as testing, experimentation and demonstration across all sectors and disciplines. As the development of novel digital technologies matures through the lifetime of Horizon Europe, these technologies will progressively be taken up and deployed by Digital Europe. Horizon Europe support for skills and competences curricula, including those delivered at the co-location centres of the European Institute of Innovation and Technology’s Digital KIC (EIT Digital) will be complemented by Digital Europe-supported capacity-building in advanced digital skills.

To ensure strong coordination, the strategic programming and operating procedures for both programmes will be aligned (including by using the services provided by the Common Support Centre created under Horizon 2020).

Figure 15: Complementarities between Horizon Europe and Digital Europe at the strategic level

Horizon Europe	Digital Europe
Development of technological and non-technological solutions, including digital content	Large scale deployment of digital capacity and existing digital technologies in areas of public interest or market failure
Research, technological development, demonstration, piloting, proof-of-concept, testing and innovation including pre-commercial deployment	Capacity and infrastructure building on High Performance Computing, Artificial Intelligence, Cybersecurity and advanced digital skills
Research and innovation on digital technologies	Making the best use of digital capacities in areas such as health, public administration, justice and education
Selection through EU-level competition and support for cross-border collaboration	Large-scale deployment of digital capacities, infrastructures and solutions within Member States as part of an overall EU strategy or policy
EU-level calls for proposals: grants, public procurement, financial instruments and budgetary guarantees (*)	Strategic co-investment with Member States through public procurement. Funding also to be provided through procurement grants, financial instruments and budgetary guarantees(*)
Networking at EU level of research & innovation actors	Promotion of interoperability of digitised public services
Support to cross-border access to and integration of research infrastructures	Construction, maintenance, upgrade and use of digital capacities and infrastructures in computing, AI and cybersecurity
Development of curricula promoting skills and competences	Support for capacity building in advanced digital skills
Supporting EU-wide research databases	Building of shared digital capacities including "common data spaces" of public sector data and other publicly available data

(*) To be implemented under the InvestEU Fund.

Complementarities in thematic priorities between Digital Europe and Horizon Europe

High Performance Computing (HPC)

- > **Digital Europe** will focus on co-investment (through joint procurement with Member States) in the latest supercomputers, networking these facilities and their use for the public interest, e.g. health, public administration, climate. Supercomputing capacity will be also available to the scientific community and industry, notably SMEs. The budget will be used: (i) to procure together with Member States two exascale supercomputers by 2022-23; (ii) to provide an EU coordinated framework for Member States wanting to upgrade and share their mid-range supercomputing facilities across Europe; (iii) to facilitate the networking and use of these facilities.
- > **Horizon Europe** will support R&I underpinned by HPC infrastructures and facilities, including testing, experimentation and demonstration across all sectors and disciplines. On HPC specifically, Horizon Europe funding will cover R&I for next generation computing paradigms and new programming environments such as cognitive computing, neuromorphic systems, multi-purpose quantum computing and codes for post-exascale performance. It will explore features like extreme low power and large-scale distributed data processing.

Cybersecurity

- > The DEP will focus on:
 - Investments in **advanced cybersecurity equipment** and infrastructures essential to protect critical infrastructures and underpin the Digital Single Market. This could include investments in quantum facilities for cybersecurity and other tools to be made available to the public and private sectors across Europe;
 - **Scaling up existing technological capacities in Member States' Competence Centres and ensuring the deployment of the latest cybersecurity solutions** across the economy;
 - **Networking of the Competence Centres** in order to support the digital economy. This should also include aligning and improving cybersecurity skills.
- > **Horizon Europe** will provide support for R&I underpinned by cybersecurity infrastructures and facilities, including testing, experimentation and demonstration across sectors and disciplines. Horizon Europe will also support R&I on cyber-secure components and software relevant for the protection of infrastructure or privacy and data protection. This will enable advances in, for example, cryptography and cyberattack monitoring and rebuttal.

Artificial Intelligence (AI)

- > **Digital Europe** will focus on capacity building to ensure the wide deployment of AI in Europe including, e.g. (i) the provision of “AI on demand” based on open source software, algorithms, tools and equipment, and on an “common data space”. The platform will be made available across Europe (notably through the Digital Innovation Hubs, see below) and across sectors; (ii) the creation and reinforcement of Digital Innovation Hubs covering all regions in Europe with AI expertise and facilities. Support for the reinforcement of existing competence centres (at the core of the Digital Innovation Hubs) and for building up new centres will be provided.
- > **Horizon Europe** will support R&I underpinned by AI infrastructures and facilities, including testing, experimentation and demonstration across sectors and disciplines. Horizon Europe will also support R&I in advanced AI technologies (including unsupervised machine learning). It will also support the networking of and EU-wide access to specialised innovation hubs and innovation infrastructures.

Digitisation of areas of public interest and of industry

- > **Digital Europe** will support the Europe-wide transformation of areas of public interest and of industry. This will be done through co-investment with Member States and, where relevant, the private sector in deployment projects making the best use of digital capacities and technologies in areas of public interest or market failure. The added value of Digital Europe will be in ensuring interoperability of solutions, suitable regulatory conditions and standards across the EU. The programme will also generate higher impact through EU-wide activities designed to reduce the digital divide, and which lead to significant economies of scale. An important component of Digital Europe will be the access to and availability of advanced digital skills. This will complement the training activities undertaken in the KIC-Digital under Horizon Europe.
- > Under **Horizon Europe**, a dedicated budget will be allocated to support R&I dedicated to “digital and industry” and digital aspects will be part of many of the priority areas including health, transport, environment, energy, etc.

10 SYNERGIES WITH THE PROGRAMME FOR ENVIRONMENT & CLIMATE ACTION (LIFE)

Table 11: LIFE - Research and innovation related support

<p>Sectors/Domains:</p> <ul style="list-style-type: none"> › Better integration of environmental legislation: Natura 2000 areas › Waste, water, air pollution plans › Projects with direct environmental impact › Climate mitigation measures › Climate adaptation measures <p>Target beneficiaries:</p> <ul style="list-style-type: none"> › Cities, NGO, administrations, enterprises <p>Geographical coverage:</p> <ul style="list-style-type: none"> › EU 	<p>Market uptake:</p> <ul style="list-style-type: none"> › "Standard action projects" best-practice or demonstration projects (public, private, university) for new measures or approaches at Member State/regional level with significant environmental or climate impact › "Strategic integrated projects" mobilising and ensuring the effective contribution of other EU, national/regional/private funds to the implementation of key measures as per the environmental and climate plans (e.g. river basin management plans, clean air plans, adaptation strategies or climate and energy plans) › Not directly supporting PCP/PPI but regions could use the Strategic Integrated projects to that end › Capacity building, policy implementation and support for large-scale deployment of innovative solutions for clean energy transition (energy efficiency, renewable energy)
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> › Financial instruments as part of Invest EU 	<p>Networking and policy making:</p> <ul style="list-style-type: none"> › Not addressing R&I actors but enterprises, cities, NGO, administrations

The future LIFE programme will continue to put EU environment, climate and energy policy and legislation into practice, including by taking up and applying the results of projects funded by the Framework Programmes. The future LIFE programme will strengthen this role, for example through strategic integrated projects. Secondly, its complementary nature with other EU programmes will be reinforced where the market does not provide viable financing.

Synergies with Horizon Europe will ensure that R&I needs for tackling environmental, climate and energy challenges within the EU are identified and established during the Horizon Europe strategic planning process. LIFE will take up and apply results from Horizon Europe and help deploy them at national and (inter-) regional scale, thus helping to address environmental, climate or clean energy transition issues. Deployment could then take place at a large scale, funded by other sources including Horizon Europe.

In particular, LIFE will continue to incentivise synergies with Horizon Europe through the award of a bonus point during the evaluation for proposals that feature the uptake of results from Horizon Europe. The European Innovation Council under Horizon Europe will be able to provide support to scale up and commercialise new breakthrough ideas resulting from LIFE-funded projects. The Horizon Europe strategic programming will allow LIFE to highlight areas where it sees R&I needs.

The integration of the Clean Energy Transition sub-programme in LIFE will continue the actions funded under Intelligent Energy Europe III/ the Horizon 2020-Societal Challenge on Secure, Clean and Efficient Energy. It

will focus on capacity building and policy support activities, while Horizon Europe will focus on technology and non-technology related R&I for clean energy transition.

LIFE projects will also find further ways to gain support in helping them scale up and commercialise their ideas. This will occur via channelling successful LIFE projects into the European Innovation Council mechanism. This would concern innovators recognised by the LIFE programme as having had direct environmental impact at the regional or national scale; or showing a high growth potential and ambition to accelerate the transition to a low-carbon, energy efficient and circular economy through sustainable innovation.

11 SYNERGIES WITH ERASMUS

Table 12: Erasmus - Research and innovation related support

<p>Sectors/Domains:</p> <ul style="list-style-type: none"> › Education, Training, Youth/ Higher Education, Vocational Education and Training, Adult Learning <p>Target beneficiaries:</p> <ul style="list-style-type: none"> › Students (researchers and young entrepreneurs) › Teachers, Researchers and other Higher Education Staff › Higher Education Institutions › Policy Makers & Higher Education stakeholders <p>Geographical coverage:</p> <ul style="list-style-type: none"> › EU and international 	<p>R&I activities/projects</p> <ul style="list-style-type: none"> › European Universities initiative: <ul style="list-style-type: none"> • support the development of new, joint and integrated, long term and sustainable strategies on education, R&I based on trans-disciplinary and cross-sectoral approaches to make the knowledge triangle a reality, providing impetus to economic growth • foster the emergence of multidisciplinary and multilingual environments where students, lecturers, researchers and other public and private actors co-create and co-share knowledge and innovation, working together to address global societal challenges (for example: they could focus on SDGs or priorities of the Framework Programme) › Further roll-out of Higher Education for Smart Specialisation to advice public authorities to involve higher education institutions and to align their educational offer to the needs identified in smart specialisation strategies <p>Market uptake:</p> <ul style="list-style-type: none"> › Strategic Partnerships and Knowledge Alliances for the small-scale testing of research outcomes
<p>Support to entrepreneurship & SME growth:</p> <ul style="list-style-type: none"> › Support for Innovation Partnerships through Knowledge Alliances › Expanded use of HEInnovate tool in making innovation and entrepreneurship a core part of overall institutional strategy › Step-up support for University-Business Cooperation and Establishment of regional and national University-Business fora 	<p>R&I Infrastructure:</p> <ul style="list-style-type: none"> › Create a Europe-wide platform for digital higher education <p>Human capital development:</p> <ul style="list-style-type: none"> › European Universities initiative – educating students and researchers to be critical and reflective thinkers with solution-oriented analytical skills and ethical and intercultural awareness › Erasmus research internships and Strategic Partnerships will encourage undergraduates and Masters students to be involved in research projects and develop their research and critical thinking skills <p>Networking and policy making:</p> <ul style="list-style-type: none"> › Ensure dissemination of results from Policy Experimentation projects to common stakeholders and explore synergies between Erasmus-supported Peer Learning and Peer Counselling on funding of higher education and Research and Innovation supported Peer Review

Europe's high-level skills needs will be addressed by both Horizon Europe and the future Erasmus programme through investments in the development of competences, inter-disciplinary, transferable and entrepreneurial skills. This will take place particularly in areas that are critical for economic and social development (such as science, technology, engineering and mathematics, climate change, clean energy, artificial intelligence, robotics, data analysis, design, etc.). More specifically, Erasmus will continue to support mobility, cooperation and policy initiatives in the field of higher education. Horizon Europe will continue to support the improvement of skills within funded projects and provide incentives for universities embracing open science practices.

Both programmes foster the integration of education and research through facilitating higher education institutions to formulate and set up common education, research and innovation strategies. These strategies inform teaching with the latest findings and practices of research to offer active research experience to all students and higher education staff and in particular researchers, and to support other activities that integrate higher education, research and innovation.

Horizon Europe will complement the Erasmus programme's support for the European Universities initiative, in particular its research dimension, as part of developing new, joint and integrated long-term and sustainable strategies on education, research and innovation. This will be based on trans-disciplinary and cross-sectoral approaches, and will provide impetus to economic growth.

At the level of postgraduate training, the Marie Skłodowska-Curie Actions (MSCA) under Horizon Europe will further strengthen the provision of transferable skills for researchers, including by transferring research results into teaching. Participation in MSCA projects' activities, in particular network-wide training, of Erasmus students or staff and vice versa will bring about concrete synergies between research and education programmes.

Erasmus European Universities, Strategic Partnerships, Knowledge Alliances or Erasmus Mundus Joint Masters Degrees will support forward-looking skills and new curricula that are aligned with the objectives of the future EIT KICs and the missions supported under Horizon Europe. Encouraging undergraduate and Masters students to be involved in R&I projects and develop their research and critical thinking skills will continue as a priority to be supported through research internships and Strategic Partnerships under the future Erasmus programme.

The European Universities initiative will be a catalyst for human capital development, education, research and innovation activities and projects. The alliances will seek to address the big societal challenges and skills shortages that Europe faces, underpinned by higher education institutions that can seamlessly cooperate across borders. This will progressively increase the international competitiveness of European higher education institutions by:

- fostering development of new, joint, long term and sustainable strategies on education, research and innovation based on trans-disciplinary and cross-sectoral approaches;

- > bringing innovation into education by making use of new teaching methods and digital technologies;
- > creating new joint curricula based on new skills and multidisciplinary approaches;
- > attracting the best students, teachers and researchers across the world and acting as role models and mentors for other higher education institutions throughout Europe;
- > fostering opportunities for students, teachers, researchers and other public and private actors to co-create knowledge and innovation together (e.g. to address global societal challenges, Sustainable Development Goals or priorities identified by Horizon Europe).

Box 6: Concrete example of how synergies could look like in practice

The Erasmus students could take part in the EIT/KICs courses and vice-versa where the Erasmus activities will be easier to access for the beneficiaries of the Framework Programme.

12 SYNERGIES WITH THE NEIGHBOURHOOD, DEVELOPMENT AND INTERNATIONAL COOPERATION INSTRUMENT

Table 13: EU Neighbourhood, Development and International Cooperation Instrument - Research and innovation related support

Sectors/Domains:

- > Cross-cutting sectorial role covering all pillars of the Framework Programme (sustainable agriculture, food & nutrition security, natural resources & environment, migration, socio-economic development)
- > 2030 Agenda – Sustainable Development Goals
- > Commitments under the Paris Agreement (2015)

Target beneficiaries:

- > Public authorities
- > Civil society
- > Beneficiaries in procurement contracts

Geographic coverage:

- > Geographic pillar of the External Instrument covering the Neighbourhood, Sub-Saharan Africa, Americas, Asia and Pacific and European non-EU member states, corresponds to global reach of the Framework Programme ...

Market uptake:

- > Infrastructure projects
- > Investment projects

Support to clusters, hubs and broader innovation ecosystem:

- > Socio-economic development programmes including access to finance, capacity building and entrepreneurship programmes
- > Support to clusters, hubs and broader innovation ecosystem: Development of technology roadmaps

R&I Infrastructure:

- > Laboratory and research facility benchmarking and development

Human capital development:

- > Capacity building for researchers as well as
- > Education
- > Researcher/expert mobility

Networking and policy making:

- > EU representation in international for a and organisations including at regional level (e.g. the Union for the Mediterranean)

The Neighbourhood, Development and International Cooperation Instrument will group together several existing external funding instruments¹⁰ under the current MFF, plus the European Development Fund (which will be brought under the EU budget). This new design will address the fragmented nature of the current external instruments, and should enable synergies to be exploited during the lifetime of Horizon Europe. Synergies will ensure that Horizon Europe activities with the participation of Third Countries and targeted international cooperation actions seek alignment and coherence with parallel market uptake and capacity-building activities under the Instrument.

Horizon Europe and the Neighbourhood, Development and International Cooperation Instrument are complementary, for example, they both contribute towards the EU's international commitments such as the 2030 Agenda for

Sustainable Development¹¹, the Paris Agreement on Climate Change¹², or the renewed EU-Africa Partnership¹³.

The overall objectives of the Neighbourhood, Development and International Cooperation Instrument will focus on supporting sustainable economic, social and environmental development, reducing global poverty, maintaining a close relationship with neighbourhood countries and addressing global challenges.

Targeted international cooperation activities will be mainly implemented through the Horizon Europe call topics dedicated to international cooperation. This will build on the flagship initiatives under Horizon 2020 as a means to lever international cooperation. In addition, European Partnerships are also expected to play an important role in structuring cooperation with Third Countries. These comprise both co-programming and co-funding activities.

Box 7: Concrete example of how synergies could look like in practice

- The Neighbourhood, Development and International Cooperation Instrument will develop research capability and supports the role of academia and evidence-based policy making in third countries. Capacity building will take place at individual level, for example through brain circulation and training; at organisational level (laboratories, building research departments) and institutional (by developing good governance, regulatory environments and incentive schemes).
- The EU-African Union partnership will develop a joint research and innovation programme on renewable energy to adapt renewable energy technologies to the African environment, social and economic conditions through joint research efforts. Subsequently market take-up and scaling of technologies and solutions developed could be undertaken by the Neighbourhood, Development and International Cooperation Instrument in African markets.
- As part of the external dimension of internal EU policies, opening trade and cooperation in other policy areas including migration and visas are also key contributors for establishing framework conditions for innovation and the penetration of technologies developed in the EU in world markets.

13 SYNERGIES WITH THE EUROPEAN SPACE PROGRAMME

Space technologies, data and services can support numerous EU policies and key political priorities, including the competitiveness of our economy, migration, climate change, the Digital Single Market and sustainable management of natural resources. Space is also of strategic importance for Europe. It reinforces Europe's role as a stronger global player and is an asset for its security and defence. Space policy can help boost jobs, growth and investments in Europe. Investing in space pushes the boundaries of science and research. Europe has a world-class space sector, with a strong satellite manufacturing industry representing around 33% of the open world markets, and a dynamic services sector with a large number of SMEs. The European space economy, including manufacturing and services, employs over 230,000 professionals and its value was estimated at €46-54 billion in 2014, representing around 21% of the value of the global space sector.

The Union has made a strong political commitment with the Space Strategy for Europe, supplemented by an ambitious space agenda (welcomed by the Council of the EU and European Parliament) which provided further political orientations. The Space Strategy focuses on four strategic objectives: (1) Maximising the benefits of space for Europe's society and economy; (2) Fostering a globally competitive and innovative European space sector; (3) Reinforcing Europe's autonomy in accessing and using space in a secure and safe environment; (4) Strengthening Europe's role as a global actor and promoting international cooperation.

Europe needs to maintain and further strengthen its world-class capacity to conceive, develop, launch, operate and exploit space systems. To do this, it is necessary to support the competitiveness of the whole supply chain and actors from industry to research organisations. It is also important to stimulate the emergence of an entrepreneurial ecosystem, to open up new sources of financing, to create new business opportunities and then ensuring that this will benefit businesses in all Member States.

Coherence and synergies between the space programme and Horizon Europe will be instrumental for the delivery of solutions to these broad challenges. Space research shall be an integral part of the Global Challenges and Industrial Competitiveness pillar of Horizon Europe, with R&I needs of space sector identified and established as part of the programme's strategic planning process. Space data and services made available by the Union space programmes will be used to develop breakthrough solutions.

Horizon Europe will also be instrumental to foster the space entrepreneurial innovation ecosystem through the Open Innovation pillar and to push the frontiers of space science through the Open Science pillar. Space data and services made available through the European Space Programme can be used to develop breakthrough solutions through R&I, including in Horizon Europe, while Copernicus Data and Information Access services will contribute to the European Open Science Cloud and thus facilitate access to this data.

Box 8: Concrete example of how synergies could look like in practice

- › Space data and services made available as a public good by the Union Space Programme will be used to develop breakthrough solutions through R&I, in particular for sustainable food and natural resources, climate monitoring, smart cities, automated vehicles or disaster management.
- › The Copernicus Data and Information Access Services contribute to the European Open Science Cloud and thus facilitate access to Copernicus data for researchers and scientists.
- › Horizon Europe will underpin the evolution of the Union Space Programme systems and services as well as the competitiveness of the space sector, notably with regard to sustainability of supply chains, non-dependence and access to space.
- › Technology transfer from the space ecosystem can enable multidisciplinary innovation and entrepreneurship.
- › The space innovation ecosystem will be fostered by the Open Innovation pillar of Horizon Europe through a mechanism for pipelines of projects emerging from the implementation of the Space Programme.
- › Research infrastructures, in particular in situ observing networks constitute essential elements of the in situ observation infrastructure enabling the Copernicus services. In turn, they benefit from information produced by Copernicus services.

14 SYNERGIES WITH THE INNOVATION FUND UNDER THE EU EMISSIONS TRADING SYSTEM

Table 14: Innovation Fund under the EU Emissions Trading System - Research and innovation related support

Sectors/Domains:	R&I activities/projects:
<ul style="list-style-type: none"> > Innovative low-carbon technologies in energy intensive industries in Annex I of the ETS Directive, energy storage, CCS and innovative renewable energy technologies 	<ul style="list-style-type: none"> > Can support projects as of TRL 6-9 > Market uptake: > Demonstrations & first-of-a-kind commercial scale projects
<p>Target beneficiaries:</p> <ul style="list-style-type: none"> > Enterprises and their grouping 	
<p>Geographical coverage:</p> <ul style="list-style-type: none"> > EU 	

The Innovation Fund is established by the revised EU Emissions Trading System (ETS) Directive and supports innovation in low-carbon technologies and processes. This includes environmentally safe carbon capture and utilisation (CCU) that contributes substantially to mitigating climate change. Also covered are products substituting carbon intensive ones, which help to stimulate the construction and operation of projects that aim at the environmentally safe capture and geological storage of CO₂ (CCS), as well as innovative renewable energy and energy storage technologies.

The EU ETS Directive defines the support provided by the Innovation Fund. For example, projects should have the potential for widespread application or for significantly lowering the costs of shifting towards a low-carbon economy for the sectors concerned. In addition, technologies receiving support should not yet be com-

mercially available, but should represent breakthrough solutions or be sufficiently mature to be ready for demonstration at pre-commercial scale. Finally, projects shall be selected in geographically balanced locations within the EU.

Horizon Europe (and the R&I window of the InvestEU Fund) will support research and technology development and innovation in decarbonisation, energy and industrial transformation, especially under the Open Innovation pillar. However, the need for public financing to overcome the “valley of death” of low-carbon technologies at high TRLs is significant. The Innovation Fund may support the demonstration phase of eligible projects that may have received the support from the Horizon Europe or its predecessor programmes, subject to fulfilment of the selection and award criteria, Synergies will be sought in steering the programmes and in aligning funding rules.

Box 9: Concrete example of how synergies could look like in practice

- > Potential Innovation Fund support provided via financial instruments could be channelled via the R&I window under the InvestEU Fund, if possible and relevant, subject to meeting the provisions of the ETS Directive.
- > Further synergies will be sought in governance cooperation for the benefit of beneficiaries.

15 RELEVANT STUDIES

- > From Rivalry to Synergy: R&I Policy and Cohesion Policy. European Commission, DG Regional and Urban Policy, February 2018.
- > In-Depth Staff Working Document for Horizon 2020 Interim Evaluation, SWD(2017) 221 final, May 2017. See in particular section 9.2: “To what extent is Horizon 2020 coherent with other EU initiatives?”
- > Issue Papers for the High Level Group on maximising the impact of EU research and innovation programmes. European Commission, DG Research and Innovation, February 2017¹⁴.
- > Synergies between Framework Programmes for Research and Innovation and European Structural and Investment Funds – Contributing to the Interim Evaluation of Horizon 2020 Final Report.
- > DG Research and Innovation and Joint Institute for Innovation Policy, 2017.
- > EU Funds Working Together for Jobs and Growth: Synergies between the R&I Framework Programmes and the European Structural and Investment Funds. European Commission, DG Research and Innovation, 2016.
- > Enabling Synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes – Guidance for policymakers and implementing bodies. European Commission, DG Regional and Urban Policy, 2014.
- > Maximisation of Synergies between European Structural and Investment Funds and Other EU Instruments to Attain Europe 2020 Goals. European Parliament, REGI Committee, 2016.
- > European Parliament Resolution of 6 July 2016 “Synergies for innovation: the European Structural and Investment Funds, Horizon 2020 and other European innovation funds and EU programmes”.
- > Synergies between EU R&I Funding Programmes: Policy Suggestions from the Launching of the Stairway to Excellence. Joint Research Centre Technical Report, 2014.

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- 1 In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 221 final, p. 171.
 - 2 'LAB-FAB-APP: Investing in the European future we want' - Report of the High Level Group on Maximising the Impact of EU R&I Programmes, July 2017, p. 26.
 - 3 Synergies between Framework Programmes for Research and Innovation and European Structural and Investment Funds – Contributing to the Interim Evaluation of Horizon 2020, September 2017, p. 6.
 - 4 European Parliament Report on the assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal June 2017, p. 15.
 - 5 Council Conclusions "From the Interim Evaluation of Horizon 2020 towards the Ninth Framework Programme", December 2017, p. 11.
 - 6 European Strategic Forum on Research Infrastructures.
 - 7 For example through a dedicated budget under CAP, programmed to be implemented under the Framework Programme.
 - 8 With specific regard to vulnerable groups including refugees micro-enterprises and young adults.
 - 9 See p. 43-44 of the Connecting Europe Facility Mid-Term Evaluation Staff Working Document (SWD 2018 44 final) for details on the coherence and complementarity with Horizon 2020. For example: "With its deep research and development shape, Horizon 2020 can be seen as an instrument for providing financial support to studies, assessments and preliminary tests and pilot projects, which can be then tested and deployed in the framework of CEF".
 - 10 Notably including the EDF, DCI; ENI; PI; EIDHR; IcSP; INSC and the CIR. Financial instrument include the European Fund for Sustainable Development (EFSD) and the European Investment Bank's (EIB) external lending mandate (ELM).
 - 11 See <https://sustainabledevelopment.un.org/post2015/transformingourworld>.
 - 12 See http://unfccc.int/paris_agreement/items/9485.php.
 - 13 See <https://www.africa-eu-partnership.org/en>.
 - 14 The Issue Paper on 'Widening Participation' states: "*An important example of synergies between ESIF and Horizon 2020 is the ELI - Extreme Light Infrastructure (distributed) project, located in Czech Republic, Hungary and Romania, that is supported by these countries under their ESIF resources complementing the European Strategy Forum on Research Infrastructures (ESFRI)*". Many examples of ESIF-R&I Framework synergies are also profiled in the "EU Funds Working Together for Jobs and Growth" publication listed above, while practical ways to improve Horizon 2020-ESIF synergies are outlined in the "Contributing to the Interim Evaluation Final Report" publication listed above.

ANNEXES

ANNEX 6: DETAILED INFORMATION ON KEY IMPROVEMENTS IN THE DESIGN OF HORIZON EUROPE



ANNEX 6: DETAILED INFORMATION ON KEY IMPROVEMENTS IN THE DESIGN OF HORIZON EUROPE

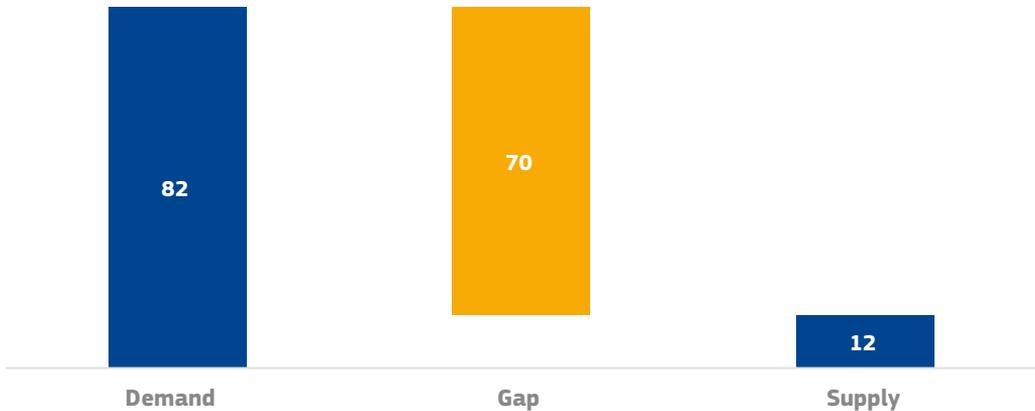
1 EUROPEAN INNOVATION COUNCIL (EIC)

1.1 Why do we need an EIC and why should this be done at EU level?

The EU innovation ecosystem generates as many start-ups as the US, but only a few of these grow rapidly¹. This is even more true for start-ups carrying out breakthrough innovation² and for science-based³ start-ups ('deep tech')⁴. The fact that the next wave of breakthrough innovation will be based on scientific insights and discoveries calls for immediate action.

Breakthrough innovation that creates new markets – therefore creating growth and jobs – is too rare in Europe. This is due to a range of factors including the lack of venture capital (VC) and a deep-rooted aversion to risk, which are reinforced by a fragmented internal market, regulatory barriers to innovation and difficulties in transferring new technologies to the market. The EIB estimates that the total equity funding gap in Europe is EUR 70 billion, of which 85% is represented by the first valley of death⁵ (the stage between basic research and commercialisation, during which many new ideas fail to progress).

Figure 16: Equity funding in the EU: gap of EUR 70 billion in the SMEs and mid-caps (up to 3000 FTEs)



Source: Deloitte, July 2016

Evidence⁶ suggests that there is a particularly acute funding gap for the ‘deep tech’ companies (in areas such as life sciences, semiconductors and photonics). These companies are characterised by high intensity of capital, high technology risk, and long development periods. This makes the investment appeal of deep tech companies less attractive from a risk/return perspective compared to companies in the ICT/digital sphere (which mainly assume own risks).

Firms with a high-growth potential, which receive public funding in the form of equity, typically contribute to job creation and growth. The employment growth rate varies from 50% to 145% and turnover from 125% to 800%⁷. Evidence shows that innovative firms grow twice as much as their non-innovative coun-

terparts in terms of employment, while “faster growing firms continue to innovate providing impulses to rejuvenate the economy”⁸. This may be due partly to their R&I activities⁹. As a result, EU support to breakthrough innovators needs to become more agile, seamless and tailor-made. Current EU support for innovators remains fragmented, complex and does not attract the most innovative companies. It is often described as complex to navigate, too prescriptive, uncoordinated and governed by many rules. This leads to inflexible projects and forms of funding and management which are designed for traditional R&D projects, not fitting with innovators’ needs. Moreover, current EU programmes do not provide tailor-made R&D support which enables breakthrough innovation and scaling up to take place.

Challenges

Europe lacks venture capital for companies to scale up fast.

The ample supply of venture investment in the USA helps to turn market-creating innovations into world-leading companies, while Europe’s innovators struggle to access risk finance above the €10 million range.¹⁰ The supply of flexible and agile funding, such as via blended finance (combining grants with loans or equity), or through crowdfunding, is insufficient. This hampers young innovative companies (*‘yollies’*) to scale up to become ‘Unicorns’¹¹. ‘Unicorns’ are young companies reaching a market valuation of \$1 billion. Europe has 26 such companies, China has 59, and the US has 109. Per capita, Europe has 7 times fewer unicorns than the US.

Lack of financial resources is the main challenge that EU companies face when commercialising their innovative goods and services¹². Two-thirds of VC investments in Europe are in the home country of the investor only¹³. Consequently many European start-ups move to the US: US companies enjoy 14 times more later-stage capital than their European counterparts do¹⁴. Stock markets in Europe provide insufficient help. Between 2012 and 2016, the average European venture capital exit via Initial Public Offering was nearly \$70 million versus \$220 million for the US¹⁵.

Challenges

Access to finance for young high growth innovative enterprises needs to be improved

Evidence shows that, of the 25 countries that provided data for 2016, growth in new SME loans was negative in 15 of them, sometimes substantially. In the Czech Republic and Denmark, SME loan growth became negative in 2016 following positive growth the previous year. Austria, Luxembourg, Portugal and Slovenia witnessed a bigger decline in 2016 than in 2015. In only a few cases, growth rates became positive or were strengthened¹⁶.

Most SMEs, including new, innovative and fast-growing firms, in fact remain heavily reliant on internal resources and traditional bank debt. The lack of appropriate forms of finance, especially of the equity-type, stands in contrast with large businesses. This limits their market entry, long-term investment, expansion and innovation¹⁷.

According to an EIB study, a significant proportion of companies in Key Enabling Technologies, including innovation leaders with a documented solid growth, find it hard to raise the capital needed to expand. Thus, while there is evidence that high-growth innovative firms can be catalysts for wider economic growth, their capacity to grow is highly dependent on access to financial resources¹⁸. Almost 30 per cent of these companies fail to obtain adequate debt financing. Thus, around half of these companies struggle to obtain the finance needed to generate further growth and innovation¹⁹.

Europe has a shortage of risk capital for small, early-stage growing businesses. This is holding back the development of high-growth sectors which are essential for economic competitiveness. While sources of capital such as crowdfunding and business angels are becoming more accessible, the EU is still at a significant disadvantage to the US²⁰.

Europe needs high growth companies to create new jobs

Among the 23 million European SMEs, only a fraction are high-growth companies are quick to grow, invest, create jobs and become leaders in their respective markets. «With more equity investment, more businesses could survive and potentially create new jobs. But start-ups, scale-ups and high growth companies respectively need seed funding, early-stage and expansion capital to reach their objectives»²¹.

Europe is associated with a deep-rooted aversion to risk

Europe is associated with 'a deep-rooted aversion to risk' and a low entrepreneurial spirit compared to the US, China and Korea²². In Europe (as in some other parts of the world) failure in business can be a stigma, inhibiting an entrepreneur's ability to secure new investors. Relatively few European start-ups (compared to Silicon Valley) set aggressive goals or start with the idea of changing an industry or the world, instead targeting niche growth in their home markets'.

European financial intermediaries (e.g. banks) are also risk-averse when confronted with high-risk projects. Banks appear to have become more risk-averse compared to the pre-crisis period, to the detriment of innovative companies, young firms and start-ups²³. For instance, under the InnovFin actions in Horizon 2020, the European Commission had to provide 100% guarantee for products such as Energy Demo Projects (EDP) and Infectious Diseases Finance Facility (IDFF) to get the intermediaries signed up to provide loans.

Challenges

Europe lacks transfer of new technologies from the research base to the market

According to the 2016 Eurobarometer²⁴, around two thirds of European manufacturing companies have not recently used any advanced technologies and this proportion has increased considerably since the 2015 survey. At the same time, significant resources have been devoted in recent years by the US and Asian economies to the development and deployment of key enabling technologies such as ICT, nanotech and biotech in such companies. The results can be seen in the ICT industry worldwide. Most of the biggest R&D-intensive ICT companies are in US or Asia and many of them are young²⁵.

European innovators cannot exploit the scale of the Union and face regulatory complexity

In Europe, innovators and companies with international growth potential have to cope with 28 national markets with their diverse currencies, languages and business cultures²⁶. Such fragmentation also applies to the innovation ecosystem. While Europe is home to a growing number of hotspots (London, Berlin, Paris, Stockholm and Amsterdam now figure in the top-20 world-wide start-up ecosystems²⁷), these are not well connected²⁸. In addition, regulations can hinder company growth²⁹, especially the 'maze of regulatory regimes' in Europe³⁰. Consequently, European start-ups tend to move to the more homogeneous US market³¹.

Current EU support is not optimal for breakthrough innovation

Horizon 2020 is the first European programme to support innovation next to research, but few of the young and quickly-growing innovative companies take part. The current range of support schemes is seen as too complex and discourages applications. EU support has tended to focus on incremental innovation and prescribed thematic topics that often do not correspond to cutting-edge innovation taking place at the intersection between different sectors and disciplines.

Tackling these challenges at the EU level allows:

- **To pool resources and unleash the potential of European and global markets for EU innovators.** Scaling up to exploit the European market is the first step towards international growth. Only the EU as a whole has the capacity to tackle the persistent lack of large-scale high-risk venture capital. EU support can be bigger in size and more comprehensive (e.g. common regulation) compared to national or regional support.
- **To encourage risk taking and increase the quality of innovations through EU-wide competition between the best.** This will provide Europe's best innovators with the resources needed to allow them to scale up and compete better at global level. Operating across Europe on a competitive basis will allow for drawing on a wider pool of talents and ideas than would be possible through national schemes. Only the most risky and breakthrough ideas will compete against each other.
- **To create synergies across Europe (and beyond) by stimulating cross-border cooperation mainly through networks³².** European support for innovation creates synergies with related regional and national programmes, agencies and financial intermediaries. For instance, tackling the problem of slow industrial transformation at the EU level provides the critical mass and the networks needed to develop and take up key enabling technologies by manufacturing companies and their supply chains³³.

What do we have now in Horizon 2020?

- **SME Instrument** provides EUR 500 million per year in grants to SMEs for investigation of technical and commercial feasibility of a business idea and development of innovation with demonstration and scale-up purposes (TRL 6).
- **Fast Track to Innovation** provides EUR 100 million in grants to consortia of partners from different countries with innovation projects addressing any technology or societal challenge field. It aims to reduce the time from idea to market and to stimulate the participation of first-time applications to EU R&I funding.
- **Future and Enabling Technologies (FET)** provides EUR 200 million per year in grants to collaborative research. It aims to stimulate bottom-up small scale explorations (FET-Open), build up a critical mass around promising directions (FET-Proactive) and fund large scale interventions that require a common European effort over a longer period to pursue grand challenges in science and technology (FET Flagships, such as Graphene and the Human Brain Project).
- **InnovFin** actions provide EUR 400 million per year in loans to single beneficiaries for investment in R&I, guarantees to financial intermediaries making loans to beneficiaries and combinations of loans and guarantees, guarantees or counter-guarantees for national, regional and local debt-financing schemes, venture and/or mezzanine capital to individual enterprises in the early stage (start-up window).

- › **EU awards** challenge prizes to innovators who develop a new solution for a highly demanding challenge, such as the battery of the future with advanced specifications. These prizes are open to any bids and can attract both incumbents and newcomers. They are top-down in defining the challenge, but encourage bottom-up new approaches.
- › **Public procurement of innovative solutions (PPI)** are grants for establishing networks of public procurers to prepare for launching PPI as well as direct financing for groups of public procurers to undertake PPI procurement.
- › **Pre-commercial procurement (PCP)** are grants to groups of public procurers to buy R&D from several competing suppliers in parallel to compare alternative solution approaches and identify the best value for money solutions that the market can deliver to address their needs.

What have we learned from the Horizon 2020 Interim Evaluation?

- › Horizon 2020's Interim Evaluation identified that the programme has potential for supporting breakthrough, market-creating innovation, but noted that **such support must be considerably strengthened in the future**.
- › In particular, the Horizon 2020 Interim Evaluation found that the programme **lacks connection between grant and loan based financing for companies**. Horizon 2020 invests EUR 400 million per year in risk financing through the European Investment Bank (the InnovFin scheme) but only a small number of firms receiving Horizon 2020 grants benefit from such financial instruments.
- › Similarly, Horizon 2020 invests EUR 500 million per year in the SME Instrument. The Interim Evaluation assessed that the scheme is on track to deliver innovations to the market by providing grant based funding and business acceleration services to SMEs. However, there is also scope for improvement such as the **need to scale up companies** and the need for **more interaction with business angels and Venture Capitalists**.
- › The Communication on the Interim Evaluation notes that the future Framework Programme should provide **support faster and more flexibly** and build on the current achievements in innovation support through the SME Instrument, collaborative projects and public-private partnerships.
- › Horizon 2020 supports scientific excellence in Europe and has contributed to high-profile scientific breakthroughs. But there is a need to **step up support for breakthrough market-creating innovations**, which is vital for future growth and jobs. This is not about switching budget from fundamental research to innovation, but about generating more impact from innovation funding. This could build on key ingredients in the success of the **European Research Council**, for example building a prestigious brand focused around excellence, with a strong bottom-up emphasis.



What do stakeholders say?

- › The **Lamy High Level Group**³⁴ called for a ‘true EU innovation policy that creates future markets’ and proposes that the impact of the EU programme is maximised by fostering ecosystems for research, innovators, industries and governments, and by investing in innovative ideas with rapid scale-up potential. The group notes that an ambitious European Innovation Council should be a central pillar in the next EU R&I programme. It also recommends (#4 Design the EU R&I programme for greater impact) that the EIC design new proposal evaluation and selection processes to better capture high-risk, high-return projects, introduces greater flexibility in grant management (stop-go decisions) and tolerates failure.
- › **The High Level Group of Innovators**, advising the Commission on innovation policy, developed a set of recommendations to support single innovators turning disruptive/breakthrough science and technology into market-creating innovations³⁵:
 - Funding: empower the innovator, simplify, incentivise private investment,
 - Awareness: champion innovators, communicate success,
 - Scale: build European ecosystems,
 - Talent: connect people, create prestige for innovators.
- › The Commission engaged in a dialogue with a **variety of other stakeholders** to gain more insight into possible options for the EIC. A consultation process was organised with national innovation agencies³⁶ as well as the wider innovation community through a ‘Call for Ideas’³⁷ and cluster consultation. In their feedback provided, stakeholders called for:
 - A European Innovation Council that increases synergies and acts as a European Accelerator. Some 51% of all stakeholders submitting a position paper expressed their views on the idea of the European Innovation Council (EIC). Around two thirds of these stakeholders favour the overall idea of the EIC, and provided detailed suggestions on its possible role, objectives and operation.
 - A recurring view is that the EIC should not add an extra layer of governance, but rather seek to identify gaps, coordinate and forge synergies with existing support instruments - thus serving as an umbrella initiative with a strong added value.
 - The idea of bringing together existing instruments (SME Instrument, Fast Track to Innovation, FET Open and inducement prizes) for a comprehensive support to all forms of innovation and technologies, including market-creating innovation is well echoed across the stakeholder input.
 - For example, Tekes considers that the role of the EIC should be to provide the best applicants with a tailor-made growth package including a combination of public and private funding fit for the needs of the company. This must be complemented by top-level expertise services like coaching, mentoring, training. In other words, “EIC should act as an European Accelerator bringing all relevant EU funding and services into a single, fit-for-purpose ‘one-stop-shop’ for the most

promising enterprises”. Some stakeholders (for example, CEASAR) view the EIC as a label for excellence and a vehicle to leverage more private investments.

- The main concerns expressed are that support to incremental innovation should not diminish due to an increased emphasis on radical and ground-breaking innovation that the EIC is envisioned to promote. Four position papers (Denmark, Flanders, Croatia and ALLEA) inexplicitly caution against the creation of a separate organisation. These stakeholders suggest evaluating more carefully the possible merging of the EIC’s mandate with that of the EIT, FET or ERC to capture the whole research-innovation spectrum.

1.2 What do we want to achieve with the EIC?

With the European Innovation Council (EIC), the objective is to identify, develop and deploy breakthrough innovations, and to support the rapid scale-up of innovative firms carrying out market-creating innovations at the European and international level.

The EIC will aim at:

- 1 Fostering breakthrough and market creating innovations within the EU and supporting the rapid scale-up of innovative firms at EU and international levels;
- 2 Sharing high risks involved in breakthrough innovations, leveraging public and private investment; rewarding the most promising ideas and impactful innovations;
- 3 Increasing the entrepreneurial and risk-taking mind-set in Europe through the structural impact of EIC-funded projects and innovators, setting a clear and inspirational targets for breakthrough innovation in Europe;
- 4 Simplifying EU support schemes for breakthrough market-creating innovations by combining existing schemes under one EIC umbrella.

The EIC will not create an additional administrative layer; on the contrary, it will provide a one-stop shop for innovation support thereby making the programme more user-friendly.

1.3 What changes will the EIC bring and what are the expected implications?

To place the EU in the lead for breakthrough market-creating innovation, the Council EIC will be set up under the Open Innovation pillar of Horizon Europe.

The EIC will combine all EU support for breakthrough and market-creating innovation in one place. It will build on the experience gained with Access to Risk Finance and the EIC Pilot launched in early 2018 under Horizon 2020, which grouped relevant existing schemes and introduced some simpler elements (e.g. simplified application forms and interviews with potential beneficiaries). However, this pilot phase is constrained by the legal framework of Horizon 2020 and much more will be possible in Horizon Europe.

The EIC will provide tailor-made support to innovators through two main funding instruments – the **Pathfinder** and the **Accelerator**. They will have the following common char-

acteristics: a focus on breakthrough innovation; a largely bottom-up approach (with top-down elements); a high-risk taking behaviour; a focus on innovator needs; and proactive management.

- The **Pathfinder** will provide grants for early technology stage (proof of concept, technology validation activities) to the early commercial stage (early demonstration, development of business case and strategy development activities). Top-down competitive calls developing key strategic objectives³⁸ calling for deep-tech and radical thinking will build critical mass and new multidisciplinary collaborations. However, the Pathfinder will also allow for the submission of proposals on a bottom-up basis in order to stimulate unexpected ideas, concepts and discover-

ies. The *Pathfinder* will be open to all, from academic researchers to start-ups, SMEs and mid-caps.

- The **Accelerator** will support the further development and market deployment of breakthrough and market-creating innovations so that they can be financed by investors (from demonstration, user testing, pre-commercial production and beyond, including scale-up). It will provide tailor-made blended finance (i.e. grant support with equity financing or financial guarantee) through a single process and according to the needs, stage of development and risk profile of the innovation. The Accelerator will be open to all innovators, start-ups, SMEs and midcaps. It will also accelerate innovations, spin-offs or start-ups generated within the Pathfinder and

What is blended finance?

‘Blended finance’ is a financial instrument that combines grant-type support with equity or access to loans and other types of finance. Finance can be blended both simultaneously — for example, as a grant-plus-loan package offered at once— and sequentially, as when a grant attracts a later investment by a VC fund, business angel or corporate VC arm, or facilitates a loan from a bank or a non-bank lender. The EIC’s Accelerator will essentially target high-risk potential market-creating innovations. It will hence provide for simultaneous blending, with the aim of de-risking the selected proposals and attracting later stage co- or alternate private investors.

Why blended finance?

Grants may be provided up to demonstration stages, but only covering part of the costs and for limited amounts. Financial instruments such as those to be deployed under InvestEU intervene when a project is “bankable”, meaning there is a return on investment, or where the level of risk can be easily mitigated and be acceptable for private investors, including VC funds. This leaves innovators facing “the valley of death” where there are high development costs (which can only be partially covered by grants) but where the level of uncertainty and risks for making returns are too high for private investors. The EIC’s Accelerator aims at bridging this valley of death and to de-risk selected operation so as to leverage these investors.

from any other parts of Horizon Europe such as the European Research Council, the European Institute of Innovation and Technology's Knowledge and Innovation Communities and R&I missions. Thus, it will finance projects with high risks concerning innovation that is close to market, or small businesses investments. The open and bottom-up calls will be complemented by focused approaches on emerging breakthrough or disruptive technologies of potential strategic significance.

Under both the Pathfinder and Accelerator, each EIC awardee would also be offered a series of support services such as coaching, peer to peer mentoring, facilitated access to services provided by others schemes (EIT, national and regional, corporates, etc.), specific support to help with regulatory barriers (similar to the Innovation Deals launched under Horizon 2020³⁹), access to world-class fairs, etc. The Commission will organise an EIC Forum of Member States' and Associated countries' public authorities responsible for innovation policies and programmes, in order to promote coordination and dialogue on European innovation ecosystem.

The EIC work programmes will be implemented by a single body managing all EIC funding (i.e. an executive agency and a specific vehicle/networks of finance partners). This will include the possibility to stop or amend the projects and to support and use technology intelligence in order to strengthen the potential of the projects. This requires programme managers (as in DARPA⁴⁰) who are able and empowered to interact with innovators/market players.

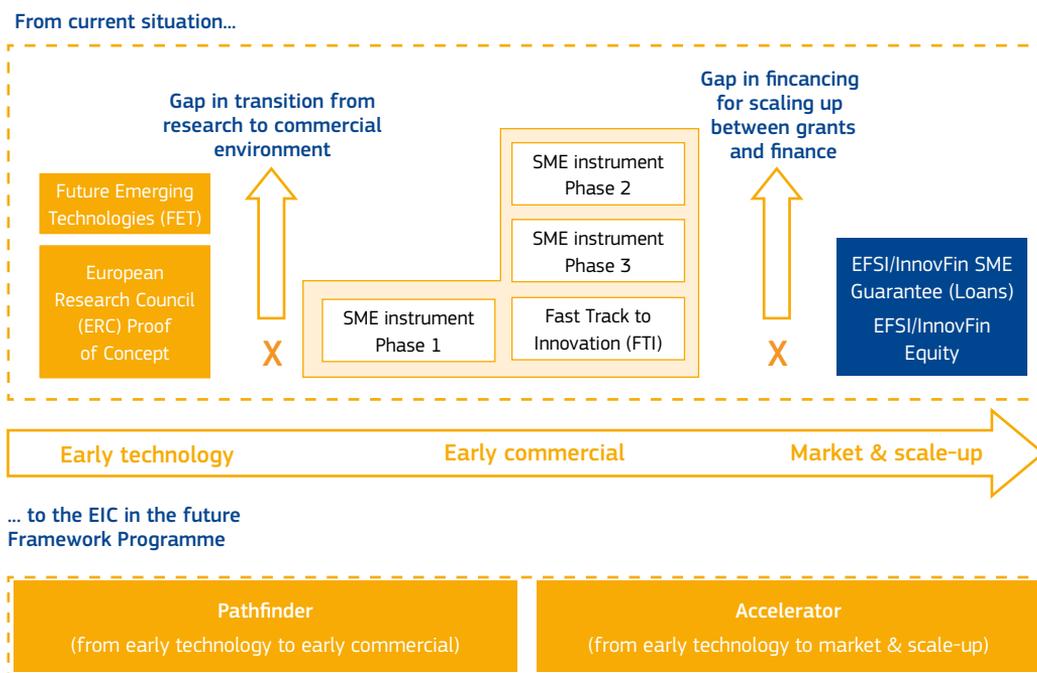
In particular, programme managers will propose the ranking of proposals based on the constitution of a strategic portfolio of projects that are expected to contribute to the emergence of potential societal or economic market creating innovations. An EIC Advisory Board (composed of high-level investors, entrepreneurs, etc.) will support and guide the programme managers. The EIC Advisory Board will also advise the Commission on implementation issues (e.g. design of calls and evaluation processes), to assess emerging technologies and trends (including by bringing in top expertise in areas identified by the programme managers).

The EIC will fund what other investors do not dare to invest in, or at least not alone (the risk aversion issue). Thus the EIC shall rely on expertise stemming also from the investment world, and will allow for investors to submit projects for which sharing the risks is key (pre-screening).

In order to mitigate risks of distortion of competition, the EIC will operate at market price and will exit from investment as soon as alternate investors are ready to substitute, hence there will be no 'crowding out' effect.

The EIC would considerably simplify the funding landscape and fill the gaps that currently exist.

Figure 17: Pathfinder and Accelerator in the EIC



Evolution not revolution: the EIC from Horizon 2020 to Horizon Europe

Horizon 2020, including the EIC pilot	EIC in Horizon Europe (experiences from the EIC pilot)
FET Open: bottom-up, early stage, future and emerging technologies FET Proactive, FET Launchpad	Yes, will be taken up in the Pathfinder and further developed through transition activities aiming at nurturing emerging innovations and spin-offs from portfolios of projects
FTI: consortia, SME-driven	Yes, will be taken up in the Accelerator
SME phase 1 feasibility study	<ul style="list-style-type: none"> > Feasibility studies can be awarded under Pathfinder's transition activities, and where needed as part of the overall support provided under the Accelerator > Member States and associated countries can set up joint programmes to support feasibility studies. EIC can co-fund these

Horizon 2020, including the EIC pilot	EIC in Horizon Europe (experiences from the EIC pilot)
SME phase 2 projects as in the EIC pilot, so bottom-up, with interviews, 4 cut-offs per year, evaluation criteria are Horizon 2020 standard (excellence, impact, organisation). Grants of up to €2.5 m (in principle, higher is possible)	<p>Yes, will be taken up in the Accelerator, with changes:</p> <ul style="list-style-type: none"> > even stronger focus on market-creating innovations > 6 cut-offs per year > non-SMEs can also apply: from non-incorporated individuals to mid-caps. Investors may also submit proposals for co-investment by the Union > larger amounts: more budget per projects > wider range of support: through blended finance: grant-type advances with, equity or loan, guarantees. Will follow the phase of the innovation > evaluation by experts on excellence, impact and (new) the risk profile > Commission will take yes/no decisions on a first come first served basis > Commission may deviate from the experts' proposal > for projects coming from other parts of the Framework Programme, award decision will rely on review of the on-going project
SME phase 3 business acceleration, e.g. linking SMEs to investors and corporates, open to all beneficiaries	Yes, similar services to be continued in pillar III Open Innovation
SME coaching, role for Enterprise Europe Network and coaches	Yes, similar services to be continued in pillar III Open Innovation
Monitoring of running projects by their self-reporting, private data on VC, experts using the Innovation Radar	Yes, to be continued in pillar III Open Innovation, more intensively. Closer Commission involvement to stop projects not reaching their milestones, or amend projects (high-level programme managers)
Waypoint SMEs to the InnovFin financial instruments by EIB/EIF and their partners	Yes, to be continued in pillar III Open Innovation. InvestEU will have a dedicated R&I window and products for innovative companies under the SME window
HLG of innovators	Advisory Board will assist in defining the EIC work programmes, objectives, actions, evaluation criteria and selection of proposals
-	EIC Fellowships
EIC inducement prizes	EIC Inducement prizes

A need for a dedicated implementing body?

Three scenarios of implementing bodies for the EIC are envisaged based on the expected difference in the programme management between Horizon 2020 actions and the EIC namely a move from generic to specialised profiles, passive to active management and from process-driven to portfolio driven management. The three scenarios are as follows:

- › Scenario 1: Business as usual - existing Executive Agency for SMEs (EASME) as implementing the EIC;
- › Scenario 2: EASME revamped as EIC exclusive implementing Executive Agency by transferring non-EIC activities from EASME to other agencies; or
- › Scenario 3: EIC implemented by a dedicated newly created Executive Agency possibly starting with the pilot under Horizon 2020 and continuing under Horizon Europe.

Further assessment of different implementation options shall be based on a dedicated cost benefit analysis.

Horizon 2020 implementation by the executive agency EASME

EIC implementation by a dedicated structure

Generic profiles: Project officers (mainly contract agent staff) with generic skills and competences in project management and project finance. No industry/sector specific knowledge required

Specialised profiles:

- › Programme managers with specialised profiles and considerable knowledge and experience in the industry/sector, in particular with start-ups/scale-ups to respond to the need for high level technical and financial expertise
- › Project officers (mainly contract agent staff), with generic skills and competences in project management and finance to help keeping projects on track

Passive management: Project officers have no power or knowledge to select, steer or terminate the project (apart from financial and legal fraud cases)

Proactive management:

- › Project officers will assist programme managers (responsible authorising officers, i.e. RAOs) in identifying research teams and projects (after independent evaluation by external experts)
- › Programme managers will support actively the management of selected portfolios of projects and propose a vision for their development (e.g. EIC transition activities). Programme managers will steer the beneficiaries by helping project innovators identify and anticipate commercialisation challenges (e.g. market shifts or manufacturing bottlenecks). They may recommend amending or terminating projects, based on pre-established milestones and external reviews

Horizon 2020 implementation by the executive agency EASME

EIC implementation by a dedicated structure

Process-driven management:

Different project officers assigned to the same project at different implementation stages. No connection between different projects overseen by one officer. Projects in the same industry/technology managed by different project officers. Project management and distribution mainly based on the principle of efficiency.

› **Portfolio driven management:** RAOs are responsible for the overall management of a portfolio of projects within the same technology domain/industry from the selection process onwards. They are assisted in this role by programme managers. Distribution of projects among RAOs will be based on the principle of effectiveness/impact (i.e. the added value to the portfolio and complementarities, cross-linkages of projects within each portfolio).

1.4 What are the expected implications?



More innovations that create the new markets of the future.

Giving more prominence and visibility to science-based breakthrough innovation, the EIC will allow Horizon Europe to increase its capability to attract Europe's best innovators. The selection process by researchers, innovators and investors will increase probability that the most promising innovators are supported. Those selected will be managed actively (by programme managers empowered as responsible authorising officers) based on a set of challenging targets, including the possibility to amend and terminate the projects when necessary. The type and volume of financing will be tailor-made to their needs. According to the High Level Group of Innovators⁴¹, a successful EIC should allow the EU to become home to leading companies in major areas for breakthrough deep tech innovation such as Artificial Intelligence, bio-tech, and augmented/virtual reality (e.g. 1/3 of the leading global companies should come from Europe).



Scaled up companies and higher SME growth.

The EIC will support late stage innovation activities and market deployment for the most promising ideas, resulting in an increase in the number of growing EU start-ups and SMEs. It will target innovative companies (up to mid-caps) with a great potential for scaling up, offering financing tailor-made to the firm's size and stage, the nature of the technology and the length of the innovation cycle/market deployment. Co-investment in equity or through guarantees for alternative types of finance (e.g. bank loans) will be awarded for scale-up. These measures are expected to help fill the gap in risk finance in Europe ("the valley of death"). Such support is expected to have a positive impact on the growth, market valuation, employment and turnover of EU companies (especially SMEs).



Increased complementarities between grant-type funding financial instruments and leverage from private investment.

Under the EIC Accelerator, blended finance would allow the EU to bear the initial risk of deploying mar-

ket-creating breakthrough innovations. This would help to de-risk these operations as they unfold, until they can be financed through private capital. The EIC support through blended finance should lead to a greater propensity to co-invest or to offer lower interest-rates loans and less onerous requirements for collateral. This means that more breakthrough market-creating innovations will be effectively deployed in the market. Financing will be targeted to involve private investors on the basis of de-risking. The alignment of interests with private investors will provide improved access to venture capital and risk finance, hence leveraging the overall volume of finance necessary to develop the innovation to a stage where it can be financed through private capital.



More entrepreneurship and risk-taking. The EIC will provide business acceleration services to innovators and will award EIC Fellowships to the outstanding ones. The EIC will highlight innovators who can inspire others (researchers, youngsters and other potential entrepreneurs) to set up and grow their own enterprises.



More accessible and user-friendly support to innovation. The EIC support and services will be provided through a one-stop shop enabling easy and quick access for innovators to EU support.

1.5 What alternatives were considered?

Four alternative policy options were considered and discarded:

- **Full centralisation:** Under this option, public support for market-creating inno-

vation at the EU level would be fully centralised. The EU would replace the existing national, regional and local level support to promote market-creating innovation.

- **Discontinuation:** This option assumes that the EU R&I Framework Programme would stop financing activities related to market-creating innovation. Public support for market-creating innovation would become fully decentralised and solely in the remit of the Member States.

- **Horizon 2020:** Under this option, the initial Horizon 2020 measures to support innovation would continue. This would include the SME Instrument, Fast Track to Innovation (FTI) and FET Open (and, by implication, other existing innovation support schemes such as InnovFin, Eurostars, Joint Technology Initiatives (JTIs) and KICs).

- **Horizon 2020 with the EIC Pilot:** This option would combine the three Horizon 2020 measures that offer most opportunities for potential market-creating innovations: the SME Instrument, Fast Track to Innovation and Future and Emerging Technologies Open under one umbrella. This would make the SME Instrument bottom-up, would integrate interviews by financiers and innovators within the proposal evaluation process and extend mentoring and coaching to support SMEs. It would also blend grants with financial instruments to assist the growth of companies. InnovFin, Eurostars, JTIs and KICs would remain the same as under Horizon 2020 option.

This is being implemented in the second half of the Horizon 2020 programme. However, as this pilot operates within the legal and budget boundaries of Horizon 2020, its effectiveness

and coherence would remain flawed. The link between direct innovation support (grants) and indirect support (loans, VC) would remain weak; while a parallel time-consuming evaluation and decision process would take place through indirect financial instruments. There would be confusion due to the different criteria and risk perception for private investment; there would

be no explicit interface between the EIC and the other parts of Horizon 2020 and the three grant schemes would remain ‘joint’ in the pilot but without optimal coherence.

1.6 How will the EIC be implemented?

	Pathfinder	Accelerator
Management	<ul style="list-style-type: none"> > European Commission assisted by EIC Advisory Board and supported by an executive agency: <ul style="list-style-type: none"> • EIC Advisory Board: Established by specific programme decision will assist the Commission in setting the overall strategy, governance of the instruments, the work programmes • A dedicated implementing body with high-level programme managers (5 years non-renewable) acting as Responsible authorising officers (RAO) managing Pathfinder’s portfolios of projects. RAOs will consult with the EIC Advisory Board. RAOs decide on Pathfinder’s transition activities and steer their beneficiaries. Pathfinder and Accelerator projects may be amended or terminated by RAO if milestones are not met 	
Aim	<ul style="list-style-type: none"> > Strengthening the emergence and development of breakthrough science/ technology leading to breakthrough innovation 	<ul style="list-style-type: none"> > Accelerating and accompanying the scale-up of enterprises carrying-out breakthrough innovation
Target group	<ul style="list-style-type: none"> > Researchers, universities, start-ups, SMEs: from single beneficiaries to multi-disciplinary consortia 	<ul style="list-style-type: none"> > Innovations / spin-offs, including those generated within the Pathfinder as well as any other part of the Framework Programme > Individual entrepreneurs, mainly start-ups and SMEs, including young and women innovators



Pathfinder

Accelerator

Toolkit

- › **Research and innovation actions (RIA):** grants to high-risk cutting-edge research projects from early technology stage (proof of concept, technology validation) to early commercial stage (early demonstration, development of business case and development strategy)
Available to all legal entities
- › **Transition activities:** Proactive management of portfolio of related RIA projects, on theme distinct from Pillar 2 missions and industrial road maps. Establish a critical mass of European researchers, building up and structuring new interdisciplinary research communities with the objective to bring market creating breakthrough ideas to genuine and mature innovations. Activities may consist in additional grants to existing actions, new **innovation actions and coordination and support actions** (e.g. feasibility studies for SMEs)
- › **Innovation and market deployment actions:** blended finance (i.e. grants with direct equity financing and access to lean financing) for further development and market deployment of breakthrough and market creating innovations, to a stage where they can be financed on usual commercial terms by investors (from demonstration, user testing, pre-commercial production and beyond, including scale-up)
- › **Business acceleration services:** access to networks of potential partners and investors
- › **Equity and bank guarantee to other types of finances:** to be managed in close relation with InvestEU and EIB Group (service level agreements). Management of equity may entail the establishment of a dedicated **Investment Fund** in close relationship with the EIB group

Calls

- › Bottom-up and top-down calls, following the ethical principles of the framework programme
- › periodical competitive closing dates
- › direct award (no call) of small CSA (50,000 euros) in the context of **transition activities**
- › Bottom-up and top-down calls, following the ethical principles of the framework programme
- › cut-offs every two months, first come first served basis
- › **Business acceleration services** may involve **coordination and support actions**, including procurements



Pathfinder

Accelerator

Selection/ Evaluation

- | | | |
|--|---|--|
| <ul style="list-style-type: none"> > Selection criteria: excellence of science and innovation, impact (market-creating nature) and excellence of delivery (quality of organisation) > evaluated by expert panels | <ul style="list-style-type: none"> > Selection criteria: excellence of science and innovation, excellence of the impact (marketability), and the level of risk > Step 1: Expert panel (e.g. researchers and scientists) > Step 2: Expert panel (e.g. innovators and investors) > Step 3: Interviews with expert panel (e.g. innovators and investors) > Projects may be amended or terminated if milestones are not met | |
|--|---|--|

Links to other programme parts

- | | | |
|--|--|--|
| <ul style="list-style-type: none"> > Selected RIA falling within the scope of Pillar 2 missions shall be managed in close relation with related mission portfolio > Close coordination with ERC and KICs | <ul style="list-style-type: none"> > Will accelerate innovations / spin-offs/ start-ups generated within Horizon Europe, in particular the ERC, EIT KICs or other parts of the Global Challenges and Industrial Competitiveness pillar following a fast-track procedure that builds on previous review | |
|--|--|--|

1.7 Complementarities with InvestEU Fund

EIC support would be clearly differentiated from InvestEU products:

- **EIC would only support start-ups or SMEs where the risk profile requires a component of grant funding and strong public support to lower risks for private investors to intervene.** Innovative SMEs that can be financed through private debt or equity would be directed to the schemes provided under the InvestEU Fund (notably under its SME Window – innovative SMEs dimension).
- **EIC would be highly selective, targeting those innovations that have a breakthrough nature** (not incremental improvements to existing products, services or business models) and essentially support start-ups/SMEs where the profile requires a component of grant funding and strong public support to lower the risks for private investors to intervene.
- **EIC funding would be based on tailored governance.** While final financing decisions would be made by the Commission, this would follow assessments by the best independent expertise from across Europe (e.g. to judge the breakthrough nature) and strategic advice from the EIC Board.

1.8 Relevant studies

- Funding - Awareness - Scale - Talent (FAST): Europe is back: Accelerating Breakthrough Innovation, January 2018.
- LAB-FAB-APP: Investing in the European future we want: Report of the High Level

Group on Maximising the Impact of EU Research and Innovation Programmes, July 2017.

- Europe's future: Open innovation, open science, open to the world: reflections of the Research, Innovation and Science Policy Experts (RISE) High Level Group, May 2017.
- European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).
- Improving Access to Finance for Beneficiaries of the SME Instrument, InnovFin Advisory (EIB), 2018.
- Improving access to finance for young innovative enterprises with growth potential: evidence of impact on firms' outputs JRC 2017.
- The Shortage of Risk Capital for Europe's High Growth Businesses AFME March 2017.
- Financing SMEs and Entrepreneurs 2018 - An OECD Scoreboard.
- Improving access to finance for young innovative enterprises with growth potential: evidence of impact on firms' outputs JRC 2017.
- Access-to-finance conditions for Key Enabling Technologies (KETs) companies EIB 2016.
- European Small Business Finance Outlook EIF, June 2017.

2 RESEARCH AND INNOVATION MISSIONS

2.1 Why do we need EU R&I missions and why should this be done at EU level?

Currently, the EU's investments in R&I could have a higher impact on the strategic challenges our society faces and in driving sustainable economic growth. A mission-oriented, impact-focussed approach would enable a sharper EU focus on global strategic challenges. This would also enable industrial transformation towards a more knowledge-intensive economy and more job creation.

Missions would be designed specifically to privilege cross-sectoral and multidisciplinary collaboration. They should capture public imagi-

nation and involvement by setting a clear and inspiring time-bound goal for Europe, which would have clear and understandable benefits on the daily lives of European citizens. A mission-oriented R&I policy can improve the flow of knowledge across disciplinary and sectoral 'silos', and it can involve end-users and citizens much more closely in EU R&I activities. Missions can also stimulate system-wide transformation across many different sectors. Developing strategic R&I missions at EU level will provide the necessary scale, scope and wide mobilisation of resources that are required to address pressing common challenges that cross national borders.

Challenges

Europe's R&I investments directed to tackling societal challenges are spread thinly

Europe invests significant resources in tackling global societal challenges through R&I activities providing solutions to those challenges. Around €30 billion from 2014 to 2020 is allocated for collaborative R&I under seven Societal Challenges within Horizon 2020, while a number of other EU-level initiatives (public-private partnerships, EIT Knowledge and Innovation Communities, Industrial Leadership pillar of Horizon 2020) address major challenges facing our society. However, a key finding of the Horizon 2020 interim evaluation is that investment is fragmented across different funds, schemes and instruments. Thus, a mission-oriented approach would create more impact by concentrating EU investments in priority areas with a transformative potential for the economy, society and/or environment.

Citizens are disengaged from EU research and innovation

The interim evaluation of Horizon 2020 emphasises the clear need for greater outreach to citizens. Involving citizens, and end-users in the Horizon Europe agenda-setting (co-design) and its implementation (co-creation) will stimulate more user-driven innovation and greater demand for innovative solutions. This is one of the major opportunities afforded by adopting a more impact-focused, mission-oriented approach under the future programme.

What do we have now in Horizon 2020?

- › Within a dedicated Societal Challenges pillar, **seven societal challenges** with a budget of around €30 billion support collaborative research and innovation tackling specific challenges facing our society and economy.
- › Within Horizon 2020, over **20 Focus Areas** were introduced in key areas in which priorities cut across different parts of the programme (i.e. blue growth, circular economy, Internet of Things, smart and sustainable cities, Digital Security). Focus Areas concentrate resources and efforts on areas of high policy, political relevance and societal concern. The interim evaluation of Horizon 2020 found that the programme's coherence was reinforced by the use of Focus Areas, even if their multiplication has also resulted in some confusion.
- › Under the Future and Emerging Technologies scheme, Horizon 2020 supports **two FET Flagship initiatives** on Graphene and the Human Brain (with a third Flagship, Quantum, planned to become fully operational under Horizon Europe). These large-scale partnerships are expected to run for about 10 years, with a total budget of around €1 billion each. A key overriding aim is to establish a close link between related activities (at European, national and regional levels) of the research activities that contribute to the Flagship.

What have we learned from the Horizon 2020 Interim Evaluation?

- › “The EU should not spread its investments in R&I too thinly. Instead, it should prioritise investing in areas where the EU added value is greatest and where the benefits of economies of speed, scale and scope can be reaped. The post-2020 EU R&I programme should thus translate global societal challenges into a limited number of large-scale R&I missions. These would define expected impacts across an entire portfolio of activities, rather than at the level of individual call topics ... Missions should be open to all actors in the research and innovation cycle, easy to communicate and capture public imagination and involvement. They should mobilise many actors and investors, including at national level, and induce action across disciplines, sectors and institutional silos”. (*‘LAB-FAB-APP: Investing in the European future we want’ - Report of the High Level Group on Maximising the Impact of EU R&I Programmes, July 2017*)

In the conception and design of future R&I missions, it is also important to take into account lessons learned from ongoing mission-like initiatives across EU countries. These include the ‘Energiewende’ plan to clean the energy system in Germany by 2050, or the ‘Fossil fuel-free vehicles by 2030’ mission in Sweden. In the USA, the ‘Cancer Moonshot’

initiative unveiled in 2016 aims to accelerate cancer research to achieve in 5 years (by 2023) research and treatment gains that otherwise might take at least a decade, while the Apollo programme in the 1960s is estimated to have generated more than 400,000 jobs and over 1,800 spin-off companies⁴².



What do stakeholders say?

A wide range of stakeholders back the idea of adopting a mission-oriented approach in the future EU R&I programme. Examples of specific feedback within stakeholder position papers include:

- > “We need to look beyond the short-termism of the current 3-year project cycle. Many of the problems to be tackled through the missions will require contributions from across research fields and involve a wide variety of stakeholders”.
- > “The concept of ‘missions’ looks attractive as it captures the objective of prioritising investments in areas with a clear EU added value and of defining expected impacts for each of them. It also has the potential to strengthen the link between research-driven and industry-driven EU level activities”.
- > “Continuing the explicit alignment of the United Nations Sustainable Development Goals with the future Framework Programme’s missions is warranted for Europe to become the global leader in research and innovation. Europe and its trading partners need a Framework Programme that is mission-oriented, addresses both current and future global challenges, and encourages bottom-up solutions”.
- > “The potential added value of missions in the Framework Programme can contribute to making the results of research and innovation more tangible for society at large. For these missions to be successful, however, it is crucial that they have well-defined thematic goals. Missions should focus on topics where a European approach has a distinct added value, and should be generated bottom-up and top-down in broader national and European policy initiatives”.

The Economic and Societal Impact of Research and Innovation (ESIR) expert group has emphasised that a future EU mission-oriented approach would substantially increase private investment in R&I and increase the economic impact of R&I. In short: an approach which more effectively supports the whole innovation cycle.

A structured consultation process to obtain stakeholder input on future EU R&I missions has taken place, including the opening of a public call for expressions of interest from February 2018 until April 2018. In addition, as part of the Joint Institute for Innovation Policy study (referenced on the final page of this section), over 1800 responses were submitted to an online survey and 40 stakeholders were interviewed. The responses, submitted by all types of stakeholders, strongly emphasise that a mission-oriented approach would increase the impact of Horizon Europe.

2.2 What do we want to achieve with missions?

The need to create more impact from, and generate more citizen involvement within, EU R&I activities through mission-orientation has been identified as one of the key improvements to be made in the design and execution of the future EU R&I programme⁴³.

A mission-oriented approach for Horizon Europe will aim at:

- Prioritising investments where the EU added value in addressing a global challenge (social, economic, environmental) is greatest;
- Focusing on areas with a transformative potential for science, technology, industry or society;
- Inducing cross-sectoral and multi-disciplinary collaboration in achieving mission goals, including the social sciences and humanities;
- Stimulating demand for innovative solutions and supporting user-driven innovation through co-design and co-creation of missions with citizens and civil society (including by taking into account the local context and smart specialisation strategy, where relevant);
- Improving communication and outreach on the contribution of R&I in providing solutions to major global challenges;
- Inspiring, enthusing and mobilising citizens (and citizen groups)⁴⁴ around clear time-bound goals;

- Set the direction for public and private sector R&I activities in Europe, thereby leveraging further investments and improving the societal uptake of innovative solutions.

This approach would put into practice a number of key recommendations of the Horizon 2020 interim evaluation and the Lamy High Level Group report, thus demonstrating that missions would be an appropriate tool of delivery for Horizon Europe.

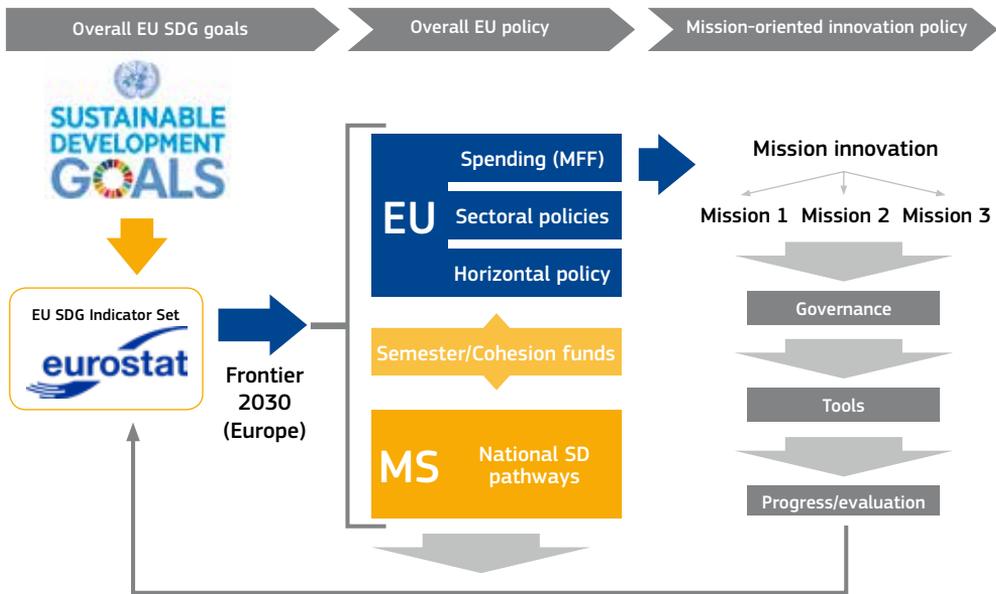
2.3 What changes and what are the expected implications?

The legal proposal for Horizon Europe will lay down the selection criteria and methodology that will frame a mission-oriented approach, while missions as such will be identified and chosen during the implementation phase. The starting point and reference framework for defining a mission-oriented approach are the UN's Sustainable Development Goals. The SDGs are a powerful point of departure for rethinking Europe's efforts, instruments and approaches to promote R&I (as illustrated by the figure below), including through a mission-oriented approach.

Based on recommendations made by Prof Mariana Mazzucato⁴⁵, the criteria proposed for selecting missions are:

- Bold, inspirational with wide societal relevance;
- A clear direction: targeted, measurable and time-bound;
- Ambitious but realistic in terms of research and innovation;

Figure 18: From SDGs to mission-oriented innovation policy



- > Cross-disciplinary, cross-sectoral, and cross-actor activities;
- > Multiple bottom-up solutions;
- > Strong EU added value.

Horizon Europe will introduce a limited number of highly visible R&I missions. Missions will replace and build on the current “focus areas” used within Horizon 2020. They will be well-defined⁴⁶ and self-standing programme parts, as opposed to the focus areas which are ‘virtually linked calls’ within the Horizon 2020 programme structure.

This will more clearly and directly incentivise cross-sectoral and cross-disciplinary cooperation. Clear objectives and a clear rationale will be established at the start (this addresses a specific weakness identified in the focus areas approach) in order to define targets, clear time-bound goals and expected impact. Non-prescriptive calls will underpin the missions, as opposed to the ‘top-down’ focus

areas. Finally, missions will be co-designed with end users and citizens, thus prioritising public engagement and involvement. Dedicated governance of the missions and their main innovation and technological outputs “is both inevitable and desirable, helping to develop shared ownership and responsibility of outcomes and risks”⁴⁷.

At the implementation stage, missions will be managed by an empowered Mission Board that is responsible and held accountable for the progress and achievements of the mission. Governance will be flexible, in order to adapt to shifting challenges and to monitor critical issues in real time in order to achieve the mission’s goals. Mission Boards will be involved in co-designing the missions involving stakeholders and the wider public. They will provide input to the content of the calls, the evaluation of proposals and in monitoring the missions. A mission manager will be appointed to ensure that objectives are reached through a portfolio of projects and activities. By involving citizens and stakehold-

ers in the definition, selection and monitoring of missions, a sense of urgency and collective commitment will be created while also ensuring societal ownership⁴⁸.

Future missions could accelerate technological, social or industrial change; or they could transform entire systems. One type of missions could aim to accelerate progress towards a set technical or societal solution, focusing large investment on a specific target. This would speed up the delivery of innovative – often disruptive – solutions (for example, efforts to accelerate market uptake of post Li-ion battery and energy storage solutions).

Another type of missions could focus on transforming an entire social or industrial system within an established timeframe, for instance transforming the energy or public transport system in cities (in line with major EU policy goals). The distinctive feature would be a clear and measurable target set from the outset for the complete transition, and linked to a specific end date. This overall EU objective would articulate new R&I solutions taking into account regulatory, infrastructure, financial or social initiatives initiated elsewhere than Horizon Europe.

Figure 19: Characteristics of missions that accelerate and missions that transform

Missions that accelerate	Missions that transform
<ul style="list-style-type: none"> › Can be scientific, technological, social or industrial › More narrowly defined missions that are linked to specific breakthroughs › Targets will aim to speed up developments already in the pipeline (e.g. lifesaving drug to market in 5 rather than 10 years) › The cross-sectoral and cross-disciplinary dimension will be important › The need to involve coordination with policy and regulation may still exist, but will be less strong than with transformer missions › Relevant targets to be defined by straightforward indicators (xKW per hour for €y by 20XX) or targets (vaccine for malaria by 20XX) 	<ul style="list-style-type: none"> › Address European societal challenges: aiming at achieving truly transformative change in how economic sectors and organisations work, and how citizens live › Will contain a number of accelerator missions aimed at achieving related scientific, technological, social or industrial aims › Aligned with wider policy and regulatory measures and demand-side stimulus (procurement) › Broad coherence with wider European and international policy agenda › Require research and innovation achievements, but also changes in regulation and user behaviour › Cover coordinated R&I activities in several sectors, across thematic policies (i.e. energy, transport etc.) and may require public sector innovation, social innovation, behavioural change › The relevant targets will concern broad societal indicators, presupposing a wide uptake of new technologies, products and processes › Strong multi-level governance and coordination is required (EU, national, regional and urban level)

The success of missions hinges on timely and thorough consultation and dialogue with stakeholders, to avoid the risk of disengagement and lack of follow-up. When implementing the mission, a challenge will be to ensure that evaluation and monitoring mechanisms can capture their long-term impacts. Finally, the uptake and roll-out of innovative solutions arising from the missions would ultimately be dependent on wider framework conditions – this can be addressed by policy actions in the spirit of the Innovation Principle (screening upcoming legislation for its potential effects on innovation) or through Innovation Deals⁴⁹. A mission-oriented approach in Horizon Europe will thus require new adaptations and learning.

ments and set directions to achieve objectives that are relevant for the society. ‘Directionality’ and ‘intentionality’ are highly distinctive features of mission-oriented R&I initiatives. Lack of strong direction can impede system transformations and lead to the failure of a mission, as shown by many examples of mission-like initiatives across the globe⁵⁶. In addition, instituting a mission-oriented approach with visible targets can provide a reliable long-term framework which will incentivise private firms and the public sector to invest in R&I. Public R&I investments will have a higher economic impact if they are directed to specific missions, with targets set by policy in close interaction with both public and private actors⁵⁷.

What are the expected implications?



Improved cross-sectoral and cross-disciplinary cooperation.

Missions will require expertise from different sectors and disciplines to come together: climate change cannot be tackled by the energy sector alone; this will also require changes in transport, agriculture and many others⁵⁰. Because global challenges are complex and “wicked”⁵¹, and their solutions imply system transformations⁵² and creating instead of fixing markets⁵³, mission-oriented R&I initiatives must ensure that technologies will be developed and deployed across sectors⁵⁴. The mission-oriented approach will work across the clusters (the major part of the Global Challenges and Industrial Competitiveness pillar of Horizon Europe) to promote system-wide transformations. This is supported by a large majority of stakeholders⁵⁵.



Increased impact on global challenges and EU policy priorities.

Missions are expected to be more effective in delivering societal impact for end-users and citizens, because they prioritise invest-



Decreased gap between science/innovation and society.

R&I missions should be easy to communicate, in order to mobilise citizens and end-users in their co-design and co-creation. In turn, this will increase the relevance of science and innovation for society, while stimulating societal uptake and deployment⁵⁸ of innovative solutions and leveraging business investment.

2.4 What alternatives were considered?

- Replacing Societal Challenges with missions:** an option would be to replace the current seven societal challenges of Horizon 2020 with a similar number of missions, for example having a mission on energy and one on health. This would require large-scale missions that are broad in scope. This alternative was discarded because it would not meet the operational objectives. Defining broad, large-scale missions entails a significant risk that they would not provide sufficient focus. And if missions become very broad, there is a risk that stakeholders will find

it more difficult to take ownership of the mission. Very broad missions would be difficult to measure, since they would need to cover many different aspects.

- > **Continue with the Horizon 2020 focus areas:** according to the interim evaluation of Horizon 2020, the focus areas have boosted the programme's internal coherence and its capacity to provide interdisciplinary solutions to multiple societal challenges. However, adopting over 20 focus areas with limited overall coordination resulted in confusion among stakeholders. Also, the current strategic programming process for choosing focus areas and priorities for Societal Challenges involves end-users and citizens only to a limited extent. This leads to low awareness and acceptance of R&I driven societal transformation. Because the focus areas are virtual and do not always have clear objectives, they do not provide the necessary impetus to set the direction for public and private investments.
- > **Accelerator-type missions only:** this alternative would imply that the 'Global Challenges and Industrial Competitiveness' pillar would allocate funding exclusively to future accelerator missions. Each call under this pillar would focus on one clear scientific, technological or industrial mission, with a clearly defined target and timeline. The lack of focus on entire systems means that the transformative potential of accelerator missions would be smaller compared to transformer missions. This would not allow EU strategic challenges to be addressed, limit the mission's contribution to EU policy-making and not enable cross-sectoral and cross-disciplinary cooperation. The accelerator missions would also be less easily understood by citizens.

- > **Transformer-type missions only:** under this scenario, the Global Challenges pillar would invest in future transformer missions with a very large funding allocation. Each call would be defined as a transformer mission, contributing to the overall EU policy agenda and sustainable development. The complexity of transforming entire systems involves a risk of not achieving the mission, and this could result in confusion over the role of stakeholders.

More widely, if the Global Challenges pillar is implemented only via missions, many of the current topics and calls that address specific policy needs could not be operated as they do not require a large-scale intervention. Many current R&I priorities would no longer be tackled, leading to a significant loss of capacity in these areas. This would make it difficult to pave the way for new missions.

2.5 How will the mission-oriented approach be implemented?

Only a part of the Global Challenges pillar would be implemented through missions, thus leaving room to operate more 'traditional' calls for collaborative R&I as in Horizon 2020. Future missions will often cut across the different programme parts for collaborative R&I, and thus they will need to be implemented in a flexible way.



- > **Co-creation** of potential missions with Member States, stakeholders, citizens and other actors will be a key part of the strategic programming process, while the choice of missions should be adaptable to future EU policy priorities and global R&I needs.

- Aligned with the guiding principles of Responsible Research and Innovation in ensuring transparent governance, **citizens will thus be involved in setting priorities for the missions.**
- **Missions will define the expected impact at call level**, meaning that the calls for proposals can be more open than under Horizon 2020 work programmes.
- If needed to achieve a particular mission, attention will be paid to measures enabling a suitable **regulatory framework** that is conducive to innovation.
- **Involvement of end-users** could be defined as an award criterion, or as an eligibility criterion, for project proposals.

Missions will be implemented using the existing Executive Agencies of the Commission, and will largely use the same evaluation criteria as the other parts of Horizon Europe. However, there will be specific features for the **evaluation of proposals**;

- Applicants to choose the most suitable instrument from a limited toolbox;
- A higher weighting for impact as an evaluation criterion could be used;
- To select proposals that are not in the ranking order as established by the evaluators, on the grounds that they are more likely to achieve the mission objectives;
- When managing a mission, there should be an option to easily amend or stop projects.

2.6 Relevant studies

- Mission-Oriented Research and Innovation: assessing the impact of a mission-oriented research and innovation approach. The Joint Institute for Innovation Policy, Joanneum Research, TecNALIA, TNO, VTT, the Danish Technological Institute, and Valdani Vicari & Associati (2018).
- Citizen Participation in FP9: A model for mission and work programme engagement. Democratic Society, February 2018.
- Mission-Oriented Research and Innovation in the European Union: A problem-solving approach to fuel innovation-led growth, by Mariana Mazzucato. February 2018.
- Mission-Oriented Research and Innovation Policy: A RISE Perspective, February 2018.
- Towards a Mission-Oriented Research and Innovation Policy in the European Union: An ESIR Memorandum, December 2017.
- LAB-FAB-APP: Investing in the European future we want: Report of the High Level Group on Maximising the Impact of EU Research and Innovation Programmes, July 2017.
- European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).

3 INTERNATIONAL R&I COOPERATION

3.1 Why do we need international R&I cooperation and why should this be done at EU level?

International cooperation in R&I is vital to ensure that researchers and innovators in the EU have access to knowledge, expertise and facilities that lie outside the Union. They need to collaborate with counterparts worldwide to tackle increasingly interlinked global societal challenges. This is also needed to ensure that companies in the EU stay competitive. EU-level action can more effectively shape multilateral R&I policy agendas, activities and mechanisms for cooperation.

The increasing scope and interlinked nature of global societal challenges require more international joint R&I action and coordination of R&I agendas. This is also seen in the increasing number of multilateral initiatives that have emerged in the last decade such as the Belmont Forum⁵⁹ and Mission Innovation⁶⁰, shaping the global R&I policy agenda and coordinating efforts.

With the growing dominance of international collaborative research in knowledge production and the emergence of new countries as major R&I players, the EU needs to intensify its access to, and reap benefits from, the world's best talents, expertise and resources. Over the last decade, the EU's share of global expenditure in R&D has dropped from one-

fourth to one-fifth. The EU's share of scientific publications has dropped from one-third to one-fourth, while the EU's share of patents has also dropped from one-third to one-fourth of the global total⁶¹.

Such cooperation is important to support to the internationalisation and scale-up of innovative EU companies, by removing barriers to entering global value chains and foreign markets. International co-invention of patents has increased significantly across almost all technologies over the last decade, and most countries have experienced significant increases in the share of foreign value added in exports and final consumption.

There are clear benefits of intensifying international R&I cooperation at EU level, compared to what can be achieved by Member States alone. Openness of the EU programme to third countries enhances the EU added value of the programme itself, enabling collaboration with the best counterparts worldwide. The EU can more effectively shape policy agendas when represented as a single voice in multilateral fora and international organisations. The EU also has a comparative advantage compared to single Member States when negotiating bilateral agreements with third countries on issues like mutual openness of funding programmes or Intellectual Property Rights (IPR) protection. Thanks to the EU programme, Member States can cooperate with third countries including those with which they do not have bilateral agreements.

What do we have now in Horizon 2020?

- › Association to the programme is limited to countries geographically close to Europe: Enlargement, EFTA and European Neighbourhood Policy countries, as well as countries already associated to FP7. Legal entities from Associated Countries can participate in actions under the same terms and conditions as entities from Member States.
- › Legal entities from non-associated third-countries can participate in projects in all parts of the programme, e.g. for mono-beneficiary grants, specific close-to-market innovation activities and access to risk finance.
- › Third-country nationals are eligible to apply for European Research Council grants when the host institution is in a Member State or Associated Country. Third-country nationals are eligible for all Marie Skłodowska-Curie Actions (except for the European Reintegration Panel under the Individual Fellowships scheme).
- › Except for a few cases, only participants from low- and middle-income countries are automatically eligible to receive EU funding. EU funding can, exceptionally, be granted to other third-country entities whose participation is deemed essential for carrying out an action.

What have we learned from Horizon 2020 Interim Evaluation?

- › **Targeted international R&I cooperation initiatives are needed to pursue strategic collaboration.**

Targeted activities are important incentives to attract international engagement. While topics that are particularly relevant for international cooperation correspond to around 25% of all call topics in Horizon 2020 work programmes, they attract around 75% of international participation. Moreover, the established co-funding mechanisms with countries that are not eligible for funding have proven more effective in increasing their participation to the programme when combined with targeted activities (for example, targeted activities with China have largely restored that country's previous levels of participation). These targeted activities hence have a strong impact.

- › **Association agreements do not necessarily lead to increased participation.**

The highly competitive, excellence-driven nature of Horizon 2020 has led to a disparity in the engagement of associated countries: participation of those with less advanced R&I systems is far more challenging than those with strong R&I systems. On the other hand, policy support, mobility and coordination activities have proven beneficial for some of the underperforming countries. For example, Switzerland, Norway, Iceland, Israel have longstanding participation in the EU Framework Programmes and a strong performance in R&I. For ENP countries, association to Horizon 2020 has contributed to the integration of their R&I systems in the ERA, despite a relative lack of capacity in R&I.

- **Secured (EU and third country) funding for R&I is an important incentive to attract international engagement.**

EU funding is an important incentive for engaging third countries in the programme. The discontinuation in Horizon 2020 of the automatic funding to organisations from Brazil, Russia, India, China and Mexico caused an important decrease in their participation. Most countries for which the rules regarding eligibility for EU funding remained the same did not experience such a significant drop. Co-funding mechanisms with third countries can lead to increased participation of the country in question, though its success is largely dependent on tailored rules and communication.

- **Investing in global multilateral R&I partnerships brings important benefits, but implementation can be improved.**

Horizon 2020 has invested more in EU participation in multilateral R&I partnerships and initiatives. This has led to better international coordination and leverage of investments from other countries. However, there is need for further rationalisation of funding schemes and to further improve the EU support to international initiatives.



What do stakeholders say?

Stakeholder provided the following recommendations for EU support to international R&I cooperation:

- Strengthen international R&I cooperation in the Framework Programme while encouraging reciprocity.
- Explore synergies between the Framework Programme and national R&I strategies, structures, instruments and networks to support strategic coordination of international cooperation in the Framework Programme.
- Use the Sustainable Development Goals to frame large-scale R&I missions and stimulate and steer international R&I cooperation on common global challenges.
- Organise the Framework Programme to facilitate access to and benefits from talent, knowledge, ideas and markets across the globe.
- Associate third countries to the Framework Programme based on their excellence in R&I, not confined to one part of the world.

3.2 What do we want to achieve with international cooperation?

International cooperation in R&I is indispensable for effectively tackling global challenges and for implementing global commitments. It will aim at:

- Attracting the participation of the world's top researchers, innovators and knowledge-intensive companies.
- Shaping the global R&I policy agenda, in particular for addressing common challenges and achieving the Sustainable Development Goals.
- Establishing stronger framework conditions with international partners, thus helping to harness the forces of globalisation.

3.3 What changes and what are the expected implications?

International cooperation will be intensified through the following measures:

- Extend association to Horizon Europe beyond EU enlargement, EEA countries and ENP countries, to include all countries with proven science, technology and innovation capacities; in order to make cooperation and funding of joint projects as smooth as possible.
- Intensify support to international large-scale flagship initiatives, partnerships, bilateral and multilateral initiatives and joint programmes and calls; in order to increase EU access to researchers, knowledge and resources worldwide and optimise benefits from cooperation.

- Horizon Europe will continue to fund entities from low-to-middle income countries, and to fund entities from industrialised and emerging economies only if they possess essential expertise.

What are the expected implications?



Improved excellence of the programme. Attracting and collaborating with the world's top researchers, innovators and knowledge-intensive companies reinforces the EU's science and technology base. Evidence shows that international collaboration increases the impact of scientific publications⁶².



Higher influence of the EU in shaping global R&I systems. This approach will enhance the EU leading role in setting the policy agenda, in particular for addressing common challenges and for achieving the Sustainable Development Goals. The mutual benefits of international cooperation strengthen EU leadership in the knowledge-intensive economy. Horizon Europe will be an effective instrument in Europe's efforts to harness globalisation by removing barriers to innovation, and by establishing fairer framework conditions with international partners.



More impact from the programme. Increased international cooperation will reinforce EU R&I excellence and the creation and diffusion of high-quality knowledge in the EU. Cooperating internationally is indispensable as the scope and interconnectivity of global societal challenges increase and require more international joint action and coordination of agendas. International openness of innovation eco-systems will strengthen EU competitiveness by promoting

a level playing field and boosting the supply and demand of innovative solutions. New association agreements with countries having excellent R&I capacities will facilitate mutual access to European and third-country expertise and markets. Finally, cooperation with top third country innovators will provide access to R&I expertise and knowledge that is increasingly developed outside the EU.

3.4 What alternatives were considered?

The international dimension of the Framework Programme depends on its openness to association, participation and funding of third countries, as well as the scale of targeted international cooperation actions.

Alternatives to a Framework Programme that would be less ‘Open to the World’ than Horizon 2020 include, for instance, a programme without targeted international cooperation activities. This would mean losing opportunities to pursue strategic international cooperation in line with EU priorities. A Framework Programme not funding entities from developing countries, meanwhile, would be damaging since many of these countries play a major role in global efforts on tackling global challenges. Finally, a Framework Programme excluding third country entities from close-to-market activities would hamper the ability of EU-based companies to exploit the growing supply of and demand for innovative solutions in new and emerging markets outside Europe.

3.5 How will international cooperation be implemented?



Horizon Europe will be **open to association** of EU enlargement, EEA countries and ENP countries, as well as other countries with proven science, technology and innovation capacities. The rules governing their financial contribution should ensure a close approximation between payments and returns.

- > Horizon Europe will **promote and integrate cooperation** with international partner countries. This will be based on common interests and mutual benefits, and will take into account the country’s science and technology capabilities, its market opportunities and impact on EU competitiveness, its contribution to international commitments and the framework conditions for cooperation.
- > Horizon Europe will intensify synergies with EU external policies, e.g. to help build R&I capacity, support diffusion and uptake of innovation, and contribute to the EU’s economic and development policy objectives.
- > **The general opening for participation of entities from all third countries** will be maintained, while encouraging comparable reciprocal access to third country programmes.
- > Horizon Europe will **continue to fund entities from low-to-middle income countries**, and to fund entities from industrial-

ised and emerging economies only if they possess essential expertise or facilities.

- > Cooperation through **strategic targeted initiatives** will be reinforced with a wider use of a range of implementation tools:
 - Programme co-funds for supporting international partnerships, multilateral initiatives and joint programmes;
 - Joint, coordinated and twinning calls for bilateral and multilateral cooperation;
 - Calls for proposals on topics of broad scale and scope mandating or strongly encouraging third-country participation.

3.6 Relevant studies

- > OECD Science Technology and Industry Scoreboard (2017).
- > Science, Research and Innovation Performance of the EU (2016).
- > “Global Catastrophic Risks“, Global Challenges Foundation (2017).
- > “Rates of return to investment in science and innovation”, prepared for the UK Dept. for Business, Innovation and Skills (2014).
- > World Intellectual Property Indicators, WIPO (2015).
- > European Commission (2016), Analysis of the International Positioning of the EU Using Revealed Comparative Advantages and the Control of Key Technologies.
- > “Global Startup Ecosystem Report”, Startup Genome LLC. (2017).
- > “EU Industrial R&D investment Scoreboard”, EC (2016).
- > “Analysis of ERA-NET Cofund actions under Horizon 2020”, Expert Group Report (2016).
- > LAB-FAB-APP: Investing in the European future we want: Report of the High Level Group on Maximising the Impact of EU Research and Innovation Programmes, July 2017.
- > European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).

4 OPEN SCIENCE

4.1 Why do we need Open Science and why should it be supported at EU level?

Open Science entails a general shift towards a more open, collaborative, data-intensive and networked way of doing research and sharing research results. It supports the early sharing of research outputs in open access arrangements, empowers the participation of non-academic scientists in the research process (e.g. citizen-scientists), and promotes active public engagement.

Among stakeholders in Europe and worldwide, there is a shared understanding of the potential benefits of Open Science and a consensus that it represents the future of research policy. EU Member States are gradually establishing strategies for open access and Open Science, and political endorsement has been given via the Competitiveness Council Conclusions of May 2016.

Open Science helps to rapidly advance research and tackle societal challenges, as well as reducing unnecessary duplication, non-reproducibility of research, fraud and scientific misconduct. Traditional, closed scientific practices, on the other hand, are obstacles to scientific progress and limit the economic and social impact of science.

Open Science is needed to improve the efficiency of EU support to R&I by facilitating the circulation and re-use of the excellent R&I funded by the Framework Programmes. EU-level support will accelerate the transition to Open Science in Europe, and its positive effects will be amplified by the wider scale at which they are implemented (e.g. more research data openly accessible leads to less duplication). Moreover, the European Commission already supports (through the Horizon 2020 Work Programmes) the development of the European Open Science Cloud as the underpinning research data infrastructure.

Challenges

Only some two thirds of scientific publications supported by the EU Framework Programme are openly accessible, locking them away from innovative SMEs, interested citizens, and fellow researchers.

There is a very large economic potential in opening up access to research outputs (including data) from publicly supported research. The estimated economic return on investment for the Human Genome project is close to 10.

What do we have now in Horizon 2020?

- **Open access to publications:** Open access to publications is mandatory, i.e. self-archiving ('Green OA') only or the combination of open access publishing with self-archiving ('Gold OA' combined with 'Green OA'). Open access publishing is encouraged and the relevant costs are eligible. Beneficiaries are encouraged by guidelines to keep enough documentation to self-archive but are not legally empowered to do so.
- **Open access to research data:** Participation in the Open Research Data Pilot is the default for Horizon 2020 projects, and it requires a Data Management Plan (DMP) to be developed. Under specific conditions, it is possible to opt out from the Pilot at any stage of the proposal/project. There is no reference to FAIR data (Findable, Accessible, Interoperable, Re-usable). Data is 'as open as possible, as closed as necessary'.

What have we learned from Horizon 2020 Interim Evaluation?

While Horizon 2020 has made great progress in terms of making the scientific publications and data it generates openly accessible to the wider scientific community and public, more can be done in this respect. In addition to **further efforts for mainstreaming open access and open data practices**, more can be done to promote broader Open Science practices.

- **Only ~61-68% of publications funded by Horizon 2020 appear to be actually available in open access.** Participation rates in the Horizon 2020 Open Research Data Pilot for the years 2014-2016 were 68% of projects in the pilot's core areas, with an additional 9% voluntarily opting in (from non-core areas). For 2017, preliminary data indicates a participation rate of 62%.



What do stakeholders say?

- In the context of the **Open Science Policy Platform** established by the European Commission in 2016, stakeholders have issued detailed advice on how to further elaborate and implement Open Science policies.
- Adopting policies towards Open Science is recommended by the **RISE high level advisory group for policy development**, which supports the Commission in R&I policymaking.
- Open Science and the significance of open data has been underlined in the **G7 Science Communiqué** published in September 2017.
- Research-performing organisations increasingly require open access to publications and data resulting from their funding, and they incentivise Open Science practices through specific programmes or awards. Increasingly, universities are considering new ways to assess researchers' careers and to harness new types of research skills from researchers.

4.2 What do we want to achieve with Open Science?

The limited progress at the EU level in shifting towards Open Science, including on open access to research outputs, has been identified as one of the key area for future improvement. Reinforced support to Open Science will contribute to the Horizon Europe objectives. More specifically, Open Science will aim at:

- Increasing the circulation of openly accessible high-quality scientific content, to stimulate its rapid creation and diffusion;
- Improving the reproducibility and re-use of research data, reducing duplication;
- Participating in the globalisation of Open Science through the G7/G20, the Global Research Council and initiatives on research data – both general (RDA), sector-specific, and as part of multilateral bilateral agreements (e.g. with CERN).
- Increasing and improving the level of openness, transparency and networked collaboration leading to increased responsiveness of the research community in tackling societal challenges;
- Stimulating greater trust in and accessibility of science for citizens and civil society organisations, by engaging with them in the programming and conduct of scientific activities.
- Fostering innovation, in particular among innovative SMEs by facilitating and speeding up access to cutting-edge discoveries.

4.3 What changes and what are the expected implications?

- The **open access mandate for publications** will be simplified through more straightforward provisions: enabling conditions will be put in place for authors/beneficiaries to be able to comply.
- Open access to research data will be decoupled from **Data Management Plans (DMPs)** and thus enable sound research data management. Open data will continue to apply by default, but with opting-out possibilities in duly justified cases under the principle ‘as open as possible, as closed as necessary’. So the development and implementation of a DMP will be an obligation for all projects which generate data.
- Further support for **Findable, Accessible, Interoperable and Re-usable (FAIR) data principles**.
- Horizon Europe will **fully embrace and support Open Science** as the new research *modus operandi*.

What are the expected implications?



Increase the availability of scientific output available in open access. A higher percentage of projects will make their outputs (publications, data, algorithms etc.) available in open access due to simpler provisions, more robust exceptions and financial support provided through Horizon Europe.



Higher levels of excellent R&I. Making high-quality content publicly available, and stimulating its diffusion, improves science communication and enables interdisciplinary research. Peer-reviewed scientific information will be made available to all.



Increased accessibility to high quality digital content. Data is increasingly becoming the starting point for innovation. By harnessing digital trends, SMEs and other companies will be able to base new business models on digital content. Thus, they will be able to reap the benefits of a strengthened open data environment in Europe, and making best use of digital resources.



Higher societal impact. Horizon Europe will improve reach-out and involvement of citizens in the research process, contributing to building a society based on knowledge and education. Open Science allows citizens to be part of the research process (for example through citizen science), helping lifelong learning and strengthening connections between science and society.

4.4 What alternatives were considered?

Alternatives consisting of a less strong policy, or no open access policy, were ruled out for a variety of reasons. Firstly and most importantly, they do not contribute towards but rather go against the objectives of Horizon Europe for the circulation of knowledge and enhancing open science. Studies show that non-binding and institutional open access policies typically lead to limited uptake of the policies⁶³. Therefore going back on the requirements of the current open access po-

licy would result to less uptake than is currently the case (roughly 61% for publications). Further, discontinuing an open access policy, or open research data policy, would work against existing national and international initiatives and would not be endorsed politically.

4.5 How will Open Science be implemented?



Open access will be adapted to the evolving scholarly communication environment. Open access to all scientific publications will continue to be mandatory, with beneficiaries and/or authors retaining sufficient intellectual property rights to ensure compliance. Early sharing of publications (pre-prints) will be encouraged. Article Processing Charges will be eligible for purely open access publishing routes (i.e. not in 'hybrid' journals).

- > **Data Management Plans** will be required for all projects which produce research data in order to make Data Management an integral part of the research process.
- > **Open access to research data** will be the general rule following the principle 'as open as possible, as closed as necessary'. Possibilities for exceptions will be available for duly justified reasons (e.g. concerns related to commercial exploitation, protection of personal data or confidentiality/security).
- > **Open access to other related research outputs** will be promoted (e.g. to software, algorithms).
- > **Mandatory technical standards** will be crafted to ensure that scientific information, publications, data and other outputs

(and corresponding metadata) available for re-use in the long term. This includes the use of persistent and unique identifiers, the use of certified repositories that are compliant to the standards of the European Open Science Cloud. It also includes complying to the FAIR principles for the management of research data produced by projects.

- Requirements for recognized good **Open Science practices** for the entire research cycle will be embedded in certain programme parts, depending on the scientific discipline.
- **Financial incentives** to encourage **Open Science practices** may be deployed in some programme parts as incentives for full compliance with good Open Science practices. This will also concern training and development for researchers seeking to improve their skills in Open Science.
- On **rewards for Open Science**, a label will be introduced to recognise universities which embody modern, collaborative practices.
- **Research integrity** will be fully incorporated in guidance documents and likewise the Commission will promote the adaptation of the European Code of Conduct for Research Integrity. Minimum scientific quality requirements (e.g. publishing research protocols) will also be foreseen.
- In order to build effective cooperation between science and society, funding will

be ensured for **Citizen Science**. Specific Key Performance and Impact Indicators linked to citizen science activities will also be set.

- **Combined with qualitative expert assessment, next generation metrics** will be used to accurately capture the uptake of Open Science.
- Open Science will be considered as part of proposal **evaluation**.

4.6 Relevant studies

- Tennant JP, Waldner F, Jacques DC et al. (2016), The academic, economic and societal impacts of Open Access: an evidence-based review. *F1000Research* 2016, 5:632 (doi:10.12688/f1000research.8460.3).
- Kittrie E, Atienza AA, Kiley R, Carr D, MacFarlane A, Pai V, et al. (2017) Developing international open science collaborations: Funder reflections on the Open Science Prize. *PLoS Biol* 15(8): e2002617. <https://doi.org/10.1371/journal.pbio.2002617>
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- European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).

5 EUROPEAN PARTNERSHIPS

5.1 Why do we need research and innovation partnerships at EU level?

Through R&I partnerships, the Framework Programmes since 2002 pool resources between the EU, the private sector and Member States to tackle big challenges, support competitiveness and jobs, develop closer synergies with national and regional programmes, and

encourage greater public and private investment in R&I. Beyond supporting the development of a true European Research Area (ERA), EU-wide partnerships provide added value by contributing to greater openness and more excellent transnational cooperation in R&I. They also provide leverage and directions for European R&I investments to address common policy objectives.

What do we have now in Horizon 2020?

Figure 20: Overview of R&I partnerships supported under Horizon 2020, including how they are implemented

Partnership approaches	Public-public partnership (P2P)	Public-private partnership (PPP)	EIT-KICs*	FET Flagships**
Implementation modes	ERA-NET-Cofund, EJP Cofund Article 185, Joint Programming Initiative (JPI)	Contractual Arrangement (cPPP) Article 187)	H2020 Grant agreements for different types of actions Framework Partnership Agreements (FPA)	
Currently active R&I Partnership (Horizon 2020)	a) ERA-NETs: ~70 b) EJP Cofund: 5 c) Article 185: 6 d) JPIs: 10	a) JUs: 7(+HPC) b) cPPP: 10	a) KICs: 6	a) FET-Flagships: 2 (+Quantum)
Financial contribution from H2020, (estimated)	2500 MC (3,1% of H2020 budget)	13 450 MC (17,5% of H2020 budget)	2400 MC (3,1% of H2020 budget)	1000 MC (1,3% of H2020 budget)

*EIT-KICs: Knowledge and innovation Communities (KICs) of the European Institute for Innovation and Technology

**FET-Flagships: Flagships of the Future and Emerging Technologies programme (FET)

Horizon 2020 supports two broad categories of partnerships:

- **Public-private partnerships (PPP)**: mainly involving industry, i.e. Article 187 initiatives and contractual PPPs (cPPPs); and
- **Public-public partnerships (P2P)**: involving mainly Member States, i.e. Article 185 initiatives, ERA-NET Cofund, European Joint Programming-Cofund (EJP-Cofund) and Joint Programming Initiatives⁶⁴.

In addition, **other types of partnerships are supported** through the Future and Emerging Technologies (FET) Flagships and the Knowledge and Innovation Communities of the European Institute of Innovation and Technology (KICs).

What are the criteria for the identification of R&I partnerships under Horizon 2020?

➤ **Public-private partnerships (Article 25 of Horizon 2020 Regulation)**

1. Horizon 2020 may be implemented through public-private partnerships where all the partners concerned commit to supporting the development and implementation of pre-competitive R&I activities of strategic importance to the Union's competitiveness and industrial leadership or to addressing specific societal challenges. Public-private partnerships shall be implemented in such a way that full participation of the best European players is not impeded.
2. The involvement of the EU in public-private partnerships shall make use of existing governance structures and may take one of the following forms:
 - (a) financial contributions from the Union to joint undertakings established pursuant to Article 187 TFEU under the Seventh Framework Programme, subject to the amendment of their basic acts; to new public-private partnerships established pursuant to Article 187 TFEU; and to other funding bodies referred to in points (iv) and (vii) of point (c) of Article 58(1) of Regulation (EU, Euratom) No 966/2012. This form of partnerships shall only be implemented where the scope of the objectives pursued and the scale of the resources required justify it taking full account of the relevant impact assessments, and where other forms of partnerships would not fulfil the objectives or would not generate the necessary leverage;
 - (b) contractual arrangements between the partners referred to in paragraph 1, which specify the objectives of the partnership, respective commitments of the partners, key performance indicators, and outputs to be delivered, including the identification of R&I activities that require support from Horizon 2020.

With a view to involving interested partners, including, as appropriate, end-users, universities, SMEs and research institutions, public-private partnerships shall make public funds accessible through transparent processes and mainly through competitive calls, governed by rules for participation in compliance with those of Horizon 2020. Exceptions to the use of competitive calls should be duly justified.

3. Public-private partnerships shall be identified and implemented in an open, transparent and efficient way. Their identification shall be based on all of the following criteria:

- (a) the demonstration of the added value of the action at Union level and of the choice of the instrument to be used;
- (b) the scale of impact on industrial competitiveness, job creation, sustainable growth and socio-economic issues, including societal challenges, assessed against clearly specified and measurable objectives;
- (c) the long-term commitment, including a balanced contribution from all partners based on a shared vision and clearly defined objectives;
- (d) the scale of the resources involved and the ability to leverage additional investments in R&I;
- (e) a clear definition of roles for each of the partners and agreed key performance indicators over the period chosen;
- (f) complementarity with other parts of Horizon 2020 and alignment with the Union R&I strategic priorities, in particular those of the Europe 2020 strategy.

Where appropriate, complementarity between priorities and activities and the involvement of Member States shall be ensured in public-private partnerships.

4. The research priorities covered by public-private partnerships may, where appropriate, be included in regular calls in Horizon 2020 work programmes, in order to develop new synergies with R&I activities of strategic importance.

› **Public-public partnerships (Article 26 of Horizon 2020 Regulation)**

Horizon 2020 shall contribute to the strengthening of public-public partnerships, as and when appropriate, where actions at regional, national or international level are jointly implemented within the Union. Particular attention shall be paid to Joint Programming Initiatives between Member States. Joint Programming Initiatives receiving support from Horizon 2020 shall remain open to the participation of any Member State or associated country.

Public-public partnerships may be supported either within, or across, the priorities set out in Article 5(2), in particular through:

- (a) an ERA-NET instrument using grants to support public- public partnerships in their preparation, establishment of networking structures, design, implementation and coordination of joint activities, as well as Union topping-up of no more than one joint call a year, and of actions of a transnational nature;
- (b) Union participation in programmes undertaken by several Member States in accordance with Article 185 TFEU where the participation is justified by the scope of the objectives pursued and the scale of the resources required.

For the purposes of point (a) of the first subparagraph, top-up funding shall be conditional on the demonstration of the added value of the action at Union level and on prior indicative financial commitments in cash or in kind of the participating entities to the joint calls and actions. One of the objectives of the ERA-NET instrument may, where possible, be to harmonise rules and implementation modalities of the joint calls and actions. It may also be used in order to prepare for an initiative pursuant to Article 185 TFEU.

For the purposes of point (b) of the first subparagraph, such initiatives shall only be proposed in cases where there is a need for a dedicated implementation structure and where there is a high level of commitment of the participating countries to integration at scientific, management and financial levels. In addition, proposals for such initiatives shall be identified on the basis of all of the following criteria:

- (a) a clear definition of the objective to be pursued and its relevance to the objectives of Horizon 2020 and broader Union policy objectives;
- (b) indicative financial commitments of the participating countries, in cash or in kind, including prior commitments to align national and/or regional investments for transnational R&I and, where appropriate, to pool resources;
- (c) the added value of the action at Union level;
- (d) the critical mass, with regard to the size and the number of programmes involved, the similarity or complementarity of activities and the share of relevant research they cover;
- (e) the appropriateness of Article 185 TFEU for achieving the objectives.

Proposals for Article 185 initiatives shall be identified on the basis of all of the following criteria:

- (a) a clear definition of the objective to be pursued and its relevance to the objectives of Horizon 2020 and broader Union policy objectives;
- (b) indicative financial commitments of the participating countries, in cash or in kind, including prior commitments to align national and/or regional investments for transnational R&I and, where appropriate, to pool resources;
- (c) the added value of the action at Union level;
- (d) the critical mass, with regard to the size and the number of programmes involved, the similarity or complementarity of activities and the share of relevant research they cover;
- (e) the appropriateness of Article 185 TFEU for achieving the objectives.

➤ **Other partnerships – EIT Knowledge and Innovation Communities (EIT Regulation and SIA)**

The European Institute of Innovation and Technology selects and designates partnerships into Knowledge and Innovation Communities according to the priority fields and time schedule defined in the EIT Strategic Innovation Agenda. This selection and priority-setting process is governed by the EIT Regulation⁶⁵.

The interim evaluations of Horizon 2020-supported partnership initiatives show how effective they are in leveraging significant additional private and public funding and in aligning R&I priorities across Europe.

Public-public partnerships under Article 185 (such as Eurostars 2, European and Developing Countries Clinical Trials Partnership 2) have created long-term R&I partnerships and networks between research funders and governments, thus contributing to the ERA. They mobilise significant investment in transnational research projects in important policy areas, with an increasingly global action remit. The key strength for all **public-private partnerships** under Article 187 (such as Bio-Based Industries, Clean Sky 2) is their ability to engage and leverage strategic industry part-

ners in priority areas for the EU, across borders and business sectors, and in their direct contribution to competitiveness and EU policy goals.

They link activities across the innovation cycle, and help overcome fragmentation in their respective sectors by creating long-lasting precompetitive collaborative networks that bring together previously unrelated stakeholders. **Contractual PPPs**, such as Factories of the Future and Energy-efficient Buildings, were found to have broadly achieved their goals. They are flexible and efficiently managed and they bring together major industrial partners in EU-driven strategies in an open and transparent way. **The KICs of the EIT succeeded** in creating a portfolio of nearly 250 supported start-ups and scale-ups and were able to raise nearly €300 million of equity investments.

Challenges

Need to rationalise the European R&I partnerships landscape

There are close to 100 different R&I partnerships, of which around 80 Public-Public Partnerships, under Horizon 2020. Multiple partnership structures and networks are established without clear exit strategies from the EU funding. This results in the risk of a static system that gives preference to the continuation of existing partnerships without self-sustainability, instead of creating opportunities for new ones of greater relevance.

Need to improve the openness and transparency to launch future European R&I partnerships

Smaller actors and R&D less-intensive countries and regions often do not have necessary (human) resources to participate on equal terms. 46 % of Horizon 2020 funding in Joint Undertakings goes to 3 Member States and 18% of PPP funding go to SMEs (23% in the case of cPPPs). This is a barrier for a more optimal and inclusive participation of all types of stakeholders, favouring rather closed incumbents networks from a limited number of countries and hampering the diffusion of knowledge across borders, sectors, disciplines and along the value chain.

Need to link European R&I partnerships to future EU R&I missions and strategic priorities

There is limited coherence between R&I partnerships within certain thematic fields (including obvious thematic overlaps) and between the R&I partnerships and priorities of the Framework Programme: This tends to favour partnerships which have a strong political support, without ensuring a selection towards partnerships with the highest impact probability in complementarity with actions of the Framework Programme.

What have we learned from evaluations on the areas for improvement for R&I partnerships?

- The **Horizon 2020 interim evaluation** concludes that the partnership landscape in Europe has become overly complex and fragmented. While the overall number of R&I partnerships in Horizon 2020 is about 100, they represent on average about 25% of the available Horizon 2020 budget with PPPs (cPPPs and JTIs) accounting for about 17.5% of the Horizon 2020 budget. The interim evaluation identifies the need for a rationalisation of the European R&I partnership landscape, to improve their openness and transparency and link them with future EU R&I missions and strategic priorities.
- The **Article 185 evaluation** finds that the EU public-to-public cooperation landscape has become crowded, with too many similar initiatives working with insufficient coherence among the P2Ps, as well as between the P2Ps and Horizon 2020.
- The **Article 187 evaluation** points out that Public-Private Partnership (PPP) activities need to be brought more in line with EU, national and regional policies, and calls for a revision of the Key Performance Indicators.
- The **contractual PPPs (cPPPs)** review identified challenges of coherence among cPPPs and the need to develop synergies with initiatives such as KICs.

The **EIT evaluation identifies the need to develop further synergies with other EU initiatives** (at programming and implementation level) such as other parts of Horizon 2020 and the thematic smart specialisation platforms (TSSPs), funded through the Structural funds.

5.2 What do we want to achieve with a new approach to European R&I partnerships?

The objective for the use of partnerships under Horizon Europe is to improve substantially the quality and impacts of R&I investments in Europe, by supporting more coherent and integrated use of public and private investments.

A more effective and smarter use of partnerships requires a more strategic and ambitious approach that is impact-oriented and ensures complementarity with Horizon Europe, with the Commission facilitating the selection and set-up of partnerships. The revised approach aims at:

- Preparing for a new generation of R&I partnerships based on common guiding principles and objective- and impact driven goals. This will help to achieve impacts from EU funding that cannot be achieved elsewhere in Horizon Europe or through national activities;
- Setting and applying clear criteria for the establishment, implementation, monitoring and phasing out of partnerships;, including clear exit strategies thus contributing to a rationalisation of partnerships;
- Catalysing a more open and integrated use of public and private R&D investments on common EU strategic priorities, in particular future R&I missions and EU strategic priorities;

- Ensuring more participation of different types of stakeholders from different countries and regions in R&I partnerships.

5.3 What changes and what are the expected implications?

An overall R&I partnership strategy based on an objective- and impact driven set of principles that will be developed and implemented to ensure that R&I partnerships are established only in cases where the desired impacts cannot be achieved by other means. The Horizon Europe strategic planning process will frame the establishment of the partnerships.

This will ensure that the next generation of partnerships will support agreed EU priorities and will lead to a rationalised R&I landscape, with fewer, but more targeted initiatives receiving co-funding/investment from Horizon Europe. All future European Partnerships will be designed on the basis of the same guiding principles of EU added value, transparency, openness, impact, leverage effect, long-term financial commitment of all the involved parties, flexibility, coherence and complementarity with EU, national, regional and international initiatives.

The design and implementation of future European Partnerships will include an improved coherence between other Horizon Europe activities and R&I partnerships. In addition, communication and outreach will be strengthened by a clear and understandable architecture under the umbrella term ‘European Partnerships’.

This encompasses all Partnerships with Member States, Associated or Third Countries and/or other stakeholders (civil society, foundations, industry including SMEs) with greater openness to international cooperation. Partnerships will only be developed on agreed EU policy priorities, and subject to the commitment of partners to align their own investments, programmes and priorities. They will be limited in time, with clear conditions for phasing out from the EU funding.

There will be only three types of intervention modes, meaning that several Horizon 2020 labels like P2P, PPP, ERA-NET, FET Flagship and cPPP will be discontinued:

- i) co-programming between the EU, Member States, and/or other stakeholders, based on Memoranda of Understanding or contractual arrangements with partners;
- ii) co-funding of R&I activities, based on a single, flexible programme co-fund mechanism;
- iii) institutionalised partnerships (based on Art. 185 or 187 TFEU, EIT regulation for KICs).

Table 15: European Partnerships – a simplified implementation for more impact

Issue	Co-programmed European Partnerships	Co-funded European Partnerships	Institutionalised European Partnerships
Objective	To encourage public and private stakeholders to co-programme, co-invest and coordinate their R&I priorities together with the Commission	To provide EU support to a joint programme of public and/or private stakeholders to tackle EU strategic priorities through R&I	To commit in the long-term for shared investments in R&I with public and private stakeholders in key strategic areas with international visibility and impact
Coverage of FP support	Parts of the FP work programme largely defined by the partners but implemented through FP rules	Co-funding and policy collaboration between the EU, Member-States/ associated countries and other private non for profit organisations such as foundations to achieve impacts that FP action alone cannot achieve	EU commitment for shared investments with public and private stakeholders based on individual legal acts
Changes compared to schemes existing under Horizon 2020	Replaces cPPPs	Replaces ERA-NETs, EJPs, FET Flagships	Art 185 of the Treaty on the Functioning of the European Union (TFEU): institutionalised public-public partnerships Art 187 TFEU: institutionalised public-private partnerships
Thematic coverage	Delivering on FP global challenges and R&I missions across the whole FP		
Target groups	Member States, industry (including small and medium sized enterprises) and civil society organisations/foundations		

Issue	Co-programmed European Partnerships	Co-funded European Partnerships	Institutionalised European Partnerships
Changes in priority setting process	Only developed on agreed EU priorities in the context of the FP, based on pre-defined criteria		
Changes in implementation mode	Memoranda of Understanding and/or contractual arrangements FP contributions for coordination costs through the Work Programme (incl. comitology), e.g. through Coordination and Support Actions	Cofund actions implemented through the Work Programme (incl. comitology) conditional to partners fulfilling their commitments and obligations. More flexibility in support for joint actions, including financial support to third parties in the form of grants, prizes and investments/loan guarantees.	Art 187: Implemented via a Council Regulation Art 185: Implemented via a Decision by European Parliament and Council
Changes in governance model	An overall 'strategic coordinating process' will advise on selection, implementation, monitoring and phasing out of future European Partnerships as part of the overall strategic programming process for the Framework Programme		

What are the expected implications?



More coherence and better impacts through a limited number of partnerships with clear guiding principles and criteria for establishment, implementation, evaluation and phasing-out.

The new generation of R&I partnerships, both renewed and new ones, will be based on a clear rationale and logic for intervention based on policy objectives and the generation of impact. This revised policy approach will lead to a smaller number of R&I partnerships and thus improve the overall coherence and readability of the European R&I ecosystem. The toolbox will be simplified with three types

of intervention under the 'European Partnerships' term: co-programming of R&I agendas; co-funding of R&I activities between the EU and public and private stakeholders to deliver on EU strategic priorities; institutionalised R&I partnerships.

By doing this, more public and private R&I investments in Europe will be directed towards commonly shared European policy objectives, thus reducing the R&I related risks for business and strengthening the societal impacts stemming from R&I investments in Europe. The strengthening of cross-border R&I cooperation within European Partnerships will have positive impacts on the excellence of

the European science system, and it will contribute to the deepening of the single market for knowledge-based activities.



More openness and flexibility through partnerships open to all types of stakeholders (Member States, civil society/foundations and industry, including small and medium sized enterprises) with no entrance barriers for newcomers, smaller R&I players. The future generation of R&I partnerships will respond better to the needs and priorities of all EU Member States and other stakeholders (notably industry and foundations). Openness will be strengthened through a more strategic and revised policy approach, closely linked to the overall strategic programming process for Horizon Europe. Flexibility will be encouraged with the simplified toolbox and a life cycle based planning and implementation approach.

In this way, more Member States and stakeholder groups will be active partners in the European Partnerships. A broader set of activities beyond joint calls between the partners will substantially increase the flexibility of the partnership initiatives according to the specific needs and objectives. Thus they will increase impacts, in particular policy and societal impacts.



Enhance impact and visibility of EU R&I funding. R&I partnerships have the potential to boost the impacts of EU R&I funding. They should leverage additional R&I investments on EU priorities, should provide ‘directionality’ to public and private R&I investments and should reach out to broader stakeholders. This will improve the uptake of innovative solutions and enhance the visibility of Horizon Europe. The future design of R&I partnerships will ensure that impacts will be exploited by encouraging

a broader scope of joint activities, by ensuring clearer intervention logics for the use of R&I partnerships and by encouraging more open participation. In addition, the uptake of innovative solutions will be facilitated both in national/regional policies and in new products and processes. Overall, EU support to partnerships will have quantitative and qualitative impacts on the ERA and thus on the quality of Europe’s R&I ecosystem. The strategic use of partnerships at EU level will be echoed at national and industry level. In turn, this will result in higher and better commitments from partners and to stronger recognition and visibility of EU’s R&I policy and support measures. Europe’s capacity for taking up innovative solutions will thus be strengthened.

5.4 What alternatives were considered?

Taking into account stakeholders’ suggestions on the improvement of the EU R&I partnership landscape, the following policy alternatives have been considered and discarded:

- **Discontinuation of EU R&I partnerships.** Support to any kind of partnerships in Horizon Europe would be discontinued.
- **Continuation of Horizon 2020 approach.** The forms and criteria for establishing EU R&I partnerships under Horizon 2020 would continue to exist. The development of a more coherent and strategic partnership approach would not be addressed, as transaction costs and potential impacts are assessed as being unbalanced. Still, a substantive part of the available budget of the Framework Programme (between 25% and 40%, based on the Horizon 2020 experience) would be devoted to existing partnerships. The scope of activities would

continue to be largely limited to joint calls and managing the selected projects. The existing partnerships would be mostly continued and their growing maturity would raise the risks of a rather closed set of beneficiaries with limited openness and transparency.

- **Simplification: limitation of EU R&I partnerships to coordination.** The EU R&I partnership landscape would be simplified by limiting the number of partnership variations. Two sub-alternatives were identified:

a) Only coordination actions: Coordination and Support Actions would be used to support the alignment of national and/or industry related R&I programmes in Europe. In contrast to the second alternative, this would be organised in a competitive way and would not be linked to the strategic priorities of Horizon Europe. This would allow new networks and topics to emerge in a coordinated way, and would have a stronger impact on the ‘openness’ of national and/or sectorial R&I systems.

b) Only joint co-funding: Horizon Europe would co-fund joint efforts by Member States and/or industry sectors in a small number of overall EU priorities, clearly linked to the programme priorities. On the other hand, Horizon Europe would no longer support coordination of national and/or sectorial R&I priorities. As a result, the number of co-funded R&I partnerships would decrease and the landscape would be simplified. The focus of co-funding based on Horizon Europe priorities would substantially improve the strategic positioning of partnerships within the programme..

The mandatory co-funding, following largely the Horizon Europe rules, might however discourage industry and other private non-for-profit stakeholders (such as foundations) to participate in the R&I partnerships, as they prefer simpler and faster mechanisms.

- **Maximising EU R&I partnerships.** Partnerships would be used as default option for implementing projects funded under Horizon Europe.

All alternatives presented are legally feasible, as they are covered by the EU Treatu and would not require new legislation (except for articles 185/187 TFEU initiatives). The technical feasibility of the alternative 4 ‘Maximising EU R&I partnerships’ is limited, as it would require a complete overhaul of procedures. There would not be political or industrial endorsement for such a move. The coherence with other EU policy objectives is for the two policy alternatives ‘discontinuation’ and ‘maximising partnerships’ limited, as the potential of R&I partnerships to address broader EU policy objectives - notably growth and competitiveness and tackling global challenges jointly - would not fully be used.

5.5 How will the revised research and innovation partnerships be implemented?



In order to implement the changes the following elements need to be developed:

- **The establishment of European Partnerships framed by the strategic planning process of Horizon Europe** to ensure focus on agreed EU strategic priorities;
- **The application of an objective- and impact-based guiding principles along the life-cycle** of European Partnerships - developed together with Member-States - for the selection, implementation, monitoring, evaluation and phasing out the partnerships ;
- **New modes of governance** for the partnerships, in order to ensure their strong value, visibility and outreach.

The revised approach to European Partnerships will be limited to three different types:

a) Co-programmed European Partnerships:

- This mode is the simplest, fastest and least bureaucratic in implementation, with the legal basis for the European Partnerships being political Memoranda of Understanding (MoU)/ contractual arrangements with public and/or private partners (extended cPPP model). This will specify the objectives of the partnership, the related commitments for financial and/or in-kind contributions of the partners, the key performance and impact indicators and the outputs to be delivered;

- The MoU specifies the partners' commitment to invest in the area and coordinate programmes and activities. They implement their programmes, activities and investments under their responsibility;
- The Commission implements its part via calls for proposals, based on indicative commitments for funding. In addition, if necessary, the coordination between partners can be supported via the standard means, i.e. the Coordination and Support Action.

b) Co-funded European Partnerships:

- This will be applied if the integration of all activities in a single programme is necessary to achieve the objectives;
- The legal basis will be provided under the respective work programme, providing Horizon Europe funding for co-funded activities which will be open to a wider array of organisations;
- It will be used to co-fund the partnerships for implementing a joint programme of activities, based on the commitment of the partners for financial and in-kind contributions and integration of their relevant activities;
- The initiatives will be implemented on the basis of Annual Work Plans, subject to approval by the Commission. The programme of activities may support networking and coordination, research, innovation, pilot and market deployment, training and mobility, awareness raising and communication, dissemination and exploitation activities. These will be directly implemented by entities or by third parties to whom they may provide financial support

in the form of grants, prizes, procurement, as well as financial instruments such as loan guarantees.

c) Institutionalised European Partnerships⁶⁶:

- This is the most complex arrangement and will be implemented in cases required by the Treaties and where a political validation via a Council Regulation (or Decision by the European Parliament and Council, for Article 185 TFEU initiatives) is necessary. This could also occur if other forms of European Partnerships would not fulfil the foreseen objectives or would not generate the expected impacts, and if justified by a long-term perspective and high degree of integration including central management of all financial contributions;
- The legal basis is the respective basic act, the delegation agreement with a dedicated implementation body or a Joint Undertaking, and annual work programmes.

➤ European Commission (2017), Interim evaluation of the European Institute of Innovation and Technology (EIT), Staff Working Document (SWD).

➤ European Commission (2017), LAB – FAB – APP: Investing in the European future we want, Report of the independent High Level Group on maximising the impact of EU Research & Innovation Programmes.

➤ European Commission (2017), FET Flagships – Interim evaluation.

➤ European Commission (2017), Mid-term review of the contractual Public Private Partnerships (cPPPs) under Horizon 2020, Report of the independent expert group.

➤ European Parliament (2017), REPORT on the assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal.

➤ European Research Area and Innovation Committee (ERAC) (2017), ERAC Opinion on the Interim Evaluation of Horizon 2020 and preparations for the next Framework Programme.

5.6 Relevant studies

➤ European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).

➤ European Commission (2017), Participation of the EU in research and development programmes undertaken by several Member States based on Article 185 of the TFEU, Staff Working Document (SWD).

➤ European Commission (2017), Interim Evaluation of the Joint Undertakings (JUs) operating under Horizon 2020, Staff Working Document (SWD).

6 STRENGTHENING THE EUROPEAN RESEARCH AREA - SHARING EXCELLENCE

6.1 Why do we need to share excellence and why should it be supported at EU level?

The Framework Programme is based on excellence and every entity, regardless of its origin, can benefit from the Programme as long as the selection criteria are met. While pockets of scientific excellence exist in all EU countries, they are scattered. Moreover, despite serious efforts at national and European level, disparities in R&I performance persist among EU Member States. This is confirmed in detail by the European Innovation Scoreboard 2017⁶⁷. The ERA Progress Report 2016⁶⁸ also concluded that large disparities, both in performance levels and growth rates between countries in the field of R&I exist. Hence, there is still much room for progress in developing the European Research Area (ERA).

Different analyses⁶⁹ agree on a number of reasons for this. These include: 1) low national and regional R&I investments; 2) insufficient creation and diffusion of high-quality knowledge and innovation; 3) insufficient connectivity and visibility and international cooperation; 4) inadequate R&I framework conditions; 5) sub-optimal functioning of R&I systems; 6) low involvement and information of beneficiaries and lack of skills for participation in the Framework Programmes.

Additional obstacles⁷⁰ often highlighted are: information and language barriers; lack of research networks; lack of leading universities and research organisation leaders in proposals; weak training in preparing successful proposals and in project management; little experience in trans-national cooperation; generally low focus on R&I in policy and in business; and limited options for exploitation of research results at the national level.

In addition, there is a gap⁷¹ between the scientific and technological portfolio of prospective participants from countries which joined the EU after 2004 (EU13), and that of the more successful EU15 countries. Both the Horizon 2020 interim evaluation and other studies highlight that, while EU13 have lower rate of participation and success compare to EU15, the dichotomy is not so clear. In addition, the problems are not specific to all the EU13, nor absent from the EU15 countries.

What do we have now in Horizon 2020?

- Horizon 2020 introduced three specific measures addressed to low R&I performing Member States: teaming (institution-building), twinning (networking institutions), ERA Chairs (bringing excellence to institutions).
- Additionally Horizon 2020 provides funding for the Policy Support Facility (PSF) – tailor-made services to reform national R&I systems and COST (Cooperation in Science and Technology) – European framework to promote networking of researchers.
- The Widening National Contact Points network also receives Horizon 2020 support to promote spreading excellence and widening calls and build the skills by organising brokerage events, workshops and conferences.

What have we learned from Horizon 2020 Interim Evaluation?

- The interim evaluation of Horizon 2020 provides evidence that participation of low R&I performing countries remains low in absolute terms. However, taking into account the size of the population, the number of researchers and national investments in R&D the performance differences are more nuanced and the targeted countries are affected by these problems in various intensity. Moreover, there are clear performance differences among the EU13 countries and across Horizon 2020.
- Current activities supported under Horizon 2020 have demonstrated a positive impact: ERA Chairs and Twinning projects already resulted in substantially increasing the attractiveness of the participating institution for international excellent researchers, and boosting the capability of the institution to compete for international funding. Teaming, whose second phase involves the creation of centres of excellence, has already leveraged significant amounts of Structural Funds. COST actions are effective in supporting excellent researchers from low R&I performing countries with a steadily increasing participation rate. Recurrent feedback on the Policy Support Facility suggests that the operational recommendations from leading experts and policy practitioners prove valuable as catalysers of national R&I reforms.



What do stakeholders say?

Stakeholder provided the following recommendations for EU support to sharing excellence:

- synergies with ESI funds and ring-fenced budget dedicated to “spreading excellence” objective,
- continued support to teaming, twinning, ERA-Chairs, COST, NCP networks, EIT Regional Innovation scheme (EIT RIS),
- targeted measures to promote pockets of excellence in low R&I performing countries .

Stakeholder input was used to improve activities addressed to low R&I performing countries under Horizon 2020.

6.2 What do we want to achieve with the Sharing Excellence strand?

The overriding goals of consolidating the Spreading Excellence and Widening Participation activities under Horizon 2020 is to reinforce EU R&I capabilities through the creation and diffusion of high-quality knowledge, by sharing and connecting excellence across Europe and increasing cross-sectoral, cross-disciplinary and cross-border cooperation.

The new 'Sharing Excellence' strand of Horizon Europe will aim at:

- Helping in creating new or upgrading existing centres of R&I excellence;
- Strengthening a defined research field by linking entities with different experience in the area with internationally-leading research institutions;
- Helping in attracting and maintaining excellence in the institution;
- Stimulating networking and cooperation between researchers from targeted countries and from countries performing strongly in R&I.

6.3 What changes and what are the expected implications?

Following the results of the interim evaluation of Horizon 2020 and feedback from stakeholders, the main set of activities launched in Horizon 2020 under "Spreading Excellence

and Widening Participation" will be maintained with a few changes. These changes reflect the refined structure of Horizon Europe and changes in the European R&I landscape in the targeted countries. The title of these activities becomes Sharing Excellence.

In **Horizon Europe**, the Sharing Excellence strand, with four key activities (Teaming, Twinning, ERA Chairs, COST), will be included in the "Strengthening the European Research Area" programme part. The Sharing Excellence activities are focused on addressing disparities in R&I performance in targeted countries. The second strand (Reforming and Enhancing the European R&I System) is open to all the EU Member States and will focus on reforms and improvements to the European R&I system and institutional changes in research funding and performing organisations including universities, citizen science and gender policies.

For Teaming, Twinning and ERA Chairs under Sharing Excellence a dedicated indicator will be used to **identify low R&I performing countries**. Only participants from these countries and from Outermost Regions would be eligible as coordinators⁷².

Taking into account the importance of sharing excellence across Europe, as well as the existing support under Horizon 2020, the budget of this strand will be **ring-fenced and increased** in comparison to Horizon 2020.

Following the Horizon 2020 interim evaluation, feedback from stakeholders and from coordinators and evaluators of current Teaming, Twinning and ERA Chairs projects, there are several areas for future improvement:

- **Sustainability:** Specific arrangements could be considered (e.g. a co-funding mechanism) to allow better combination and exploitation of synergies between Horizon Europe and Structural Funds. To address concerns around ensuring continuity after the project funding is finished; proposals submitted to this part of Horizon Europe could require a sustainability plan.
- **Preparatory scientific activities:** The usefulness of networking, staff exchanges and expert visits can only reach a certain level, which is why stakeholders recommend supporting preparatory scientific work (i.e. a starter kit) under these funding schemes.
- **Strengthen research management:** One of the issues coming from the different analyses is the lack of experience with regard to research management and administration in certain countries. There is a need to reinforce institution-building as part of these funding schemes by emphasising, amongst other things, training on proposal preparation and project management.
- For ERA Chairs, following some feedback on this initiative within Horizon 2020, it is under consideration to include an Advanced Partner, as is currently the case for the other ‘Spreading Excellence and Widening Participation activities.

COST, under Sharing Excellence, will continue (open to all the countries) while expanding the focus on targeted low R&I performing countries (80% of the budget will be devoted to countries identified as low R&I performing countries). COST will provide opportunities for participation and thus give organisations

from these countries the opportunity to build experience, accumulate a reputation, and strengthen their network position. Continuing the COST actions with a higher budget devoted to the targeted countries will address this need and will strengthen collaboration across Europe.

The implications of these changes are the following:



Better R&I performance. Increasing the excellence of the science base, strengthening knowledge transfer, the innovation creation and diffusion, building knowledge, skills, and cooperation. Tapping into the unexploited R&I potential of Member States with a lower R&I performance, increasing their ability to participate in the Framework Programme and integrate into the European Research Area will maximise the quantity, quality and impact of R&I investment. This will benefit each Member State concerned and Europe as a whole.



More cooperation. Forging cooperation and links across national borders and across sectors, while fostering open science and open innovation practices which help the diffusion of excellence and expertise across the Europe.



Better impacts of R&I investments. Improved quality and impact of R&I systems on productivity, economic growth, job creation and well-being. Although the impact of measures addressed to targeted countries varies across regions, positive impacts are recorded within regions across all the Member States (in some cases with up to 0.18% of GDP)⁷³.

6.4 What alternatives were considered?

The following options were considered and discarded, following consideration of stakeholder views and taking into account the findings of the Horizon 2020 interim evaluation.

- > **Discontinuation** of core ‘Spreading Excellence and Widening Participation’ measures under a ring-fenced budget and alternative financing for similar actions would be established mainly under the Structural Funds. With this approach, opportunities for overcoming the participation gap and innovation divide by improving connectivity and networking would be missed. The partnering dimension by knowledge circulation between a lower-performing and advanced partner would be constrained due to the financial support having to abide by Structural Funds rules. The Structural Funds also do not fully align with the political objectives of the current Teaming instrument. To operate Twinning with more complex consortia would be even more difficult to implement under this constraint, and the continuation of COST networks with on average 27 participants would be unworkable.

6.5 How will this be implemented?



Sharing Excellence will be implemented, as in Horizon 2020, via calls for proposals. The list of eligible countries will be included in the work programmes.

7 SUPPORT TO POLICY-MAKING: ACTIVITIES OF THE JOINT RESEARCH CENTRE (JRC) IN HORIZON EUROPE

7.1 Why do we need support to policy-making and what is the role of the JRC?

People rightly expect political leaders to be honest with facts when making decisions that impact on their everyday life or their future, especially in an era when the role of scientific evidence, rational enquiry and fact-based conclusions are being challenged as never before. This is why scientific support to policy-making is so important for Europe. EU policies and activities must be based on robust scientific evidence that is transparently formulated, independent of political interests and which includes insights from different scientific dis-

ciplines. This will improve the credibility and legitimacy of those policies, and their impact in addressing our most pressing challenges.

As the science and knowledge service of the European Commission, the JRC contributes to ensuring that policy-makers have the best available, independent, scientific evidence when taking important decisions that have an impact on EU citizens' daily lives - whether in preparing policies or in implementing them. The JRC's research supports the main priorities of the EU's policy agenda including jobs and economic growth, digital transformation, the Energy Union, the Sustainable Development Goals, civil protection and security, and consumer protection and safety.

What do we have now in Horizon 2020?

- › The JRC shall contribute to the general objective and priorities of Horizon 2020 by providing customer-driven scientific and technical support to EU policies, in collaboration with relevant national and regional research stakeholders, where appropriate, while flexibly responding to new policy demands⁷⁴.
- › The JRC undertakes R&I activities, known as “direct actions” and supported by the programme. Around €2 billion of the Horizon 2020 budget is allocated to the JRC, which is approximately 2.5% of the overall programme budget.

What have we learned from evaluations of the JRC?

- › Ex-post external evaluations of the JRC in previous EU research programmes have consistently rated the JRC's performance and the quality and impact of its scientific outputs as high, and have made positive conclusions on its effectiveness⁷⁵. Following a key recommendation of the FP7 ex-post evaluation in 2015, the JRC developed a long-term strategy for 2016-2030 and initiated a large number of improvements proposed by the external evaluation panel. The Horizon 2020 interim evaluation report on the JRC, published in July 2017, commended the JRC on the rapid implementation and follow-up of the recommendations made in 2015⁷⁶.



What do stakeholders say?

The JRC is a trusted partner in global R&I partnership initiatives, including in the framework of the EU-African Union partnership, the UN (work on climate change and on biodiversity), EU institutions (Science for Parliament, and Science for the Regions). In a survey of national and regional authorities, the JRC-operated Smart Specialisation Platforms (which support regional growth in specific priority areas) received a high satisfaction score (4.5/5); it received the Best Practice European Public Sector Award (EPSA Award) in 2017.

7.2 What do we want to achieve with the JRC in Horizon Europe?

The JRC aims to become a global leader in the creation, management and communication of fit-for-purpose knowledge for public policy, for example through helping to address the concerns raised by the current ‘post-fact’ debate and leading the campaign for evidence-informed policy.

Whilst retaining its focus on excellent scientific support to policy, the JRC aims to better position and focus its research to address the complex, multi-sectoral societal challenges facing Europe. A further goal is to initiate new ways of enabling the JRC’s own research, new open access policy and strategic partnerships to tap into the wealth of scientific knowledge within and outside Europe. This will reinforce the JRC’s role as a core provider of high-quality scientific evidence to the Commission. The overall ambition is to enhance the scientific evidence base for policy making, while also further embedding Responsible Research and Innovation⁷⁷ in the activities of the JRC.

7.3 What will change compared to Horizon 2020 and what are the expected implications?

The JRC will increasingly co-design its programme of activities with the policy departments of the Commission in order to maximise the relevance and impact of its activities. New knowledge and competence centres (see below) will be an important feature of JRC activities post-2020. They represent a new way of working across policy areas, scientific disciplines and sectors, bringing together expertise from many Commission departments and the scientific community. They support multidisciplinary research, thereby delivering integrated advice which strengthens the knowledge base for policy recommendations.

New initiatives to extend JRC’s collaboration with academia and develop a new generation well-versed in science and policymaking, together with a policy of open access to its world-class research infrastructure will build closer links to Member States, industry and the scientific community. Member States’ and regions’ participation in JRC research activities will be promoted via new platforms, such as a proposed set of ‘Science4Policy platforms’. These would bring the JRC’s rich data resources, knowledge, services and networks closer to end-users and citizens.

7.4 What alternatives were considered?

Following a key recommendation of the ex-post evaluation of JRC under FP7, the JRC adopted its 2030 Strategy in 2016. The interim evaluation of the JRC, conducted in the context of the Horizon 2020 interim evaluation in 2017, concluded that the JRC should continue to implement this strategy. Alternatives (business-as-usual with the JRC's activities in FP7) were considered when drafting the strategy. They were discarded because they would not have adequately responded to the need for more integrated approaches (cross-silo, cross-disciplinary, incorporating social aspects). Nor would they have enabled an improved capacity to respond to emerging challenges or resulted in a broader knowledge for increasingly complex policy needs.

7.5 How will this be implemented?

The knowledge management strategy will be implemented through better management of scientific knowledge in delivering evidence for policy-making, and through the establishment of Knowledge Centres and Competence Centres.

The JRC has established four **Knowledge Centres** in the fields of territorial policies, migration and demography, disaster risk management and bioeconomy, which bring together experts and knowledge to inform policy-makers about the status and findings of the latest scientific evidence. The Centres have already

produced innovative tools, such as, the Migration Data Hub used by the Commission and by researchers in Member States. Similarly, new JRC **Competence Centres** focus on analytical tools such as improving the evidence base for impact assessments.

Finally, the JRC will reinforce its activities in supporting a social Europe by exploring the drivers behind 'fairness' and the resilience of societies. The JRC will also invest in maintaining and further developing its scientific excellence. This will ensure that its scientific advice is based on the best and most robust evidence.

7.6 Relevant studies

- Joint Research Centre Implementation Review 2017: In the context of the Interim Evaluation of Horizon 2020. DG JRC, July 2017.
- Joint Research Centre Strategy 2030. DG JRC, May 2016.
- Strengthening Evidence-Based Policymaking through Scientific Advice. European Commission, DG Research and Innovation, May 2015.

8 EUROPEAN INSTITUTE OF INNOVATION AND TECHNOLOGY (EIT)

8.1 Why do we need the European Institute of Innovation and Technology?

The European Institute of Innovation and Technology's overall mission is to contribute to sustainable European economic growth and competitiveness by reinforcing the innovation capacity of EU countries and the EU as a whole. Launched in 2009 and part of Horizon 2020 since the programme started in 2014, the EIT's specific objective is to integrate the "knowledge triangle" of higher education, research and innovation. Thus its main aim is to improve Europe's capacity for innovation, achieving this primarily through its Knowledge and Innovation Communities (KICs). These are large-scale European partnerships that operate within specific societal challenges.

From 2010 until 2017, six KICs operated in the fields of:

- Climate Change (Climate-KIC, established in 2010);
- Energy (KIC InnoEnergy, established in 2010);
- Digital (EIT Digital, established in 2010);
- Health (EIT Health, established in 2015);
- Raw Materials (EIT Raw Materials, established in 2015);
- Food (EIT Food, established in 2017).

In January 2018, the EIT launched a new call for the selection of two additional KICs in the fields of Urban Mobility and Added-Value Manufacturing. These will be the final two KICs selected under Horizon 2020, and the winning applications will be announced in December 2018.

The EIT Regulation sets out the general objectives and the scope of the EIT's operations; while its specific objectives, rationale, EU added value, activities and performance indicators are defined in the Horizon 2020 Regulation. The strategic, long-term priority fields and financial needs for the EIT for 7 years is described in the EIT's Strategic Innovation Agenda. This sets out rules on the selection of KICs and their performance monitoring, in line with the EIT Regulation.

The EIT addresses structural weaknesses in the EU's innovation capacity which are present across many Member States. These include:

- the under-utilisation of existing research strengths to create economic or social value;
- the lack of research results brought to the market; low levels of entrepreneurial activity and lack of entrepreneurial mindset; low leverage of private investment in research and development;
- many existing barriers to collaboration between higher education, research, business and entrepreneurship on a European level.

The EIT addresses these challenges through the KICs.

The EIT provides tailored support to the specific needs and goals of the KICs (i.e. requirements for setting up KICs, simplification measures). Through a systematic focus on cross-KIC activities, sharing of best practices and integrating lessons learnt from the past, the EIT has built up knowledge and experience on which each KIC can draw (i.e. guidance on setting up new KICs). In turn, the KICs provide the EIT with practical insights and feedback on what works on the ground and what does not.

The total budget for the EIT under Horizon 2020 is €2.4 billion⁷⁸. Out of this, a fully mature KIC is expected to receive on average between €70 million and €90 million annually to cover its portfolio of activities (as presented in an annual Business Plan). The duration of EU funding is expected to last up to 15 years, after which the KICs are expected to pursue their activities without EU funding.

Lessons learned and future challenges

- The **Horizon 2020 interim evaluation** identifies the need to rationalise the overall European research and innovation partnership landscape, improve their openness and transparency, and link them with future EU R&I missions and strategic priorities. The EIT/KICs are a unique type of partnership, integrating business, higher education and research practitioners and with education at their core. Thus they are different in nature to other types of EU-level partnerships.
- The **EIT interim evaluation** concluded that it contributes to addressing structural weaknesses in the EU's innovation capacity. The EIT evaluation highlights the need to develop further synergies with other EU initiatives from the programming stage. It also identifies the need to streamline the goals of the EIT and KICs by using clear and measurable objectives. It notes that the role of the KICs in the EU R&I landscape needs to be better defined, while the integration of the KICs into local innovation ecosystems need to improve.
- The **Commission Opinion on the EIT interim evaluation** also stresses the rationale behind the establishment of the EIT and its contribution to the development of the Community and Member States' innovation capacity in order to tackle societal challenges through the integration of the knowledge triangle. It recommends that the KIC must target major structural weaknesses which hamper innovation (in key thematic areas) in the EU: such as the limited entrepreneurial culture, the low level of cooperation between academia and industry and the insufficient development of human potential. The EIT should therefore contribute to closing the innovation gap between the EU and its global competitors.
- The **Lamy High-Level Group** recommends that KICs could be more coherently deployed to address global challenges, and that they should be directly incorporated into Horizon Europe. The report recognises that education plays a central role in the KICs, and calls for Europe's universities to stimulate entrepreneurship, tear down disciplinary borders and institutionalise strong non-disciplinary collaborations between universities and industry.

- > The **Communication on the Horizon 2020 Interim Evaluation** outlines recommendations for the future guiding principles of the EIT and the KICs:
 - > Streamlining the relevant goals which the EIT and the KICs are expected to achieve through clear and measurable objectives;
 - > The role of the KICs in the EU R&I landscape also needs to be better defined;
 - > Improving the openness and transparency of the partnerships (including KICs) and link them with future EU R&I missions and strategic priorities.
- > The **High Level Group on the EIT** identified a clear need to strengthen the role of the EIT headquarters as a provider of shared services and expertise to the KICs.

8.2 What do we want to achieve with a revised role for the EIT/KICs in Horizon Europe?

The focus of the EIT on integrating the knowledge triangle through the development of KICs remains valid, as does the EIT's important role in supporting the KICs and in setting the conditions to create innovation. In order to reinforce the role of the EIT and the KICs in the overall European R&I support system, and taking into account the need to rationalise the range of European R&I partnerships (see Annex 5), a revised role for the EIT/ KICs under Horizon Europe will aim at achieving the following objectives:

- > Reinforce the focus of current and future EIT KICs on delivering on EU strategic priorities, in particular global challenges through the integration of education, research, business and entrepreneurship. It will **foster, grow and strengthen ecosystems for addressing global challenges through research and innovation across Europe** by connecting people, disciplines, sectors, organisations and resources.
- > EIT KICs will play a stronger role in **reinforcing the research and innovation capacity within regions** with modest or moderate innovation activity through its colocation centres acting as hubs for innovation.
- > Reinforce the links between higher education and the innovation ecosystem by scaling up the integration of research, business and higher education players beyond the KICs and by mainstreaming support for the **renewal of European universities**. This will be achieved by stimulating entrepreneurial education, fostering strong non-disciplinary collaborations between industry and academia. The EIT will also identify potential skills for future innovators to address global challenges.
- > Ensure **complementarity and synergies between the EIT and the KICs, the European Innovation Council (EIC)**, and other research and innovation instruments for seamless and complementary support to research and innovation in Europe.

8.3 What changes and what are the expected implications?

Towards a European seamless support to innovation ecosystems through complementarity with the EIC

The EIT will play a stronger role in improving sustainable innovation ecosystems across Europe. Stronger integration of the EIT within Horizon Europe will be sought by creating synergies with other key R&I funding initiatives at EU level. This includes the EIC Accelerator, which will provide scale-up support to start-ups nurtured by the EIC. In turn, the EIT would offer mentoring or coaching for EIC-funded companies in the KICs' thematic fields. The EIT will be complementary with other parts of Horizon Europe by retaining its distinctive focus on entrepreneurial education, identifying new skills needs and supporting them, and by continuing to support strong multidisciplinary collaborations between industry and academia.

The role and visibility of the KICs' colocation centres as physical spaces for experimentation and co-creation around global challenges and future R&I missions will be strengthened, for example through providing for direct feedback from citizens. This will help to develop new innovations in line with societal needs and to support their market uptake, along with boosting the visibility of these hubs for addressing key challenges/missions.

Stronger alignment with Horizon Europe strategic priorities and European R&I partnerships

The EIT and its KICs will be a core part of Horizon Europe which will have a key focus on strengthening innovation ecosystems. The EIT and KICs will also play a key role in address-

ing global challenges, and will contribute to achieving the objectives of future R&I missions and open science policies.

The alignment of the EIT's activities with other parts of Horizon Europe will be improved through the strategic planning process, in line with the EIT's specific rules and governance structure. The EIT will help inform the broad R&I priorities and thematic calls under Horizon Europe.

Reinforced role of the KICs for education and training and the modernisation of universities

The EIT has played a pioneering role in integrating education and training within innovation ecosystems. But in order to strengthen the role of the EIT, there will be a better integration of education into the European innovation ecosystems through increased support to European universities. In particular, the EIT will help stimulate entrepreneurial and open science education and foster multidisciplinary and systemic collaboration between industry and academia.

This will also build on the successful outreach and network-building activities conducted by the EIT Regional Innovation Schemes.

The identification by KICs of potential skills needs and/or curricula for innovation to solve global challenges and R&I missions will be encouraged. New types of profiles and competences could be developed and reinforced in key thematic areas. After identifying emerging skills needs, the EIT and KICs could develop corresponding training activities.

What are the expected implications?



More openness and transparency:

Through the application of impact-based criteria for the selection, implementation, monitoring and phasing out of the KICs, as for other R&I partnerships.



More coherence: Through an overall limited number of European R&I partnerships – including the KICs – with clearer intervention logics based on Horizon Europe objectives; complementarity with the innovation support provided through the European Innovation Council; and a reinforced education focus within the KICs.



More impact: Through a more strategic and revised policy approach for the priority-setting of the KICs, closely linked to the overall strategic programming of Horizon Europe to deliver on global challenges and EU R&I missions.

8.4 What alternatives were considered?

Taking into account suggestions received from stakeholders on improving the EU R&I partnership landscape, the following policy alternatives have been considered and discarded:

> **Reduction or discontinuation of the KICs' activities**

The EIT is highly relevant and has a clear EU added value, with no other instrument that is able to build an EU-wide ecosystems of education, research, business and

other stakeholders. Reducing the scope of the EIT's activities, or phasing out the KICs, would have a very negative impact on continued integration of research, business and education players across Europe. It would also harm Europe's innovation performance.

> **Continuation of strategic approach to EIT/KICs as implemented under Horizon 2020**

EIT/KICs would operate on the basis of their current objectives, scale and operating arrangements. The key challenge of rationalization of the European R&I partnerships landscape in line with the overall objectives of Horizon Europe would not be fulfilled. Coherence between the EIT and other EU innovation policy initiatives and instruments, at both design and implementation stage, would not be achieved.

> **Direct integration of KICs into Horizon Europe (without EIT)**

The EIT/KIC model is based on a long-term approach to innovation, with KICs expected to achieve a long-term impact and eventual sustainability beyond public funding. The EIT's wide range of services go far beyond the management of EU contracts and projects. It has thus built up a wealth of knowledge and experience on innovation that is unique at European scale, and so the decoupling of EIT and the KICs would render them ineffective. The EIT community, built up over a number of years and harbouring much expertise and many connections, would be weakened and diluted. Finally, the current efficiency of the EIT's management of its own and the KICs' operations would be lost.

8.5 How will the changes be implemented?

The EIT Regulation will be amended in order to:

- > Align the EIT with the objectives of Horizon Europe;
- > Align the priority-setting of the EIT with Horizon Europe strategic programming;
- > Reinforce the role of the EIT in developing innovation capabilities through addressing global challenges;
- > Seek an enhanced role for the EIT in embedding innovation and entrepreneurial capabilities, skills identification and talent development in higher education institutions.

8.6 Relevant studies

- > European Commission (2017), Interim evaluation of Horizon 2020, Staff Working Document (SWD).
- > European Commission (2017), Interim evaluation of the European Institute of Innovation and Technology (EIT), Staff Working Document (SWD).
- > European Commission (2017), LAB – FAB – APP: Investing in the European future we want, Report of the independent High Level Group on maximising the impact of EU Research & Innovation Programmes.
- > European Parliament (2017), REPORT on the assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal.
- > European Research Area And Innovation Committee (ERAC) (2017), ERAC Opinion on the Interim Evaluation of Horizon 2020 and preparations for the next Framework Programme.

9 SUPPORT TO EDUCATION IN HORIZON EUROPE

9.1 Why do we need to support education in Horizon Europe

The European Research Area (ERA) is designed to be the backbone of a well-performing science and innovation system in Europe. Conceived as allowing a highly skilled workforce to circulate freely, while researchers benefit from attractive careers and gender equality is ensured. The ERA should also enable Member States to develop common strategic research agendas, to align national plans and define and implement joint programmes – while also improving societal awareness of research and innovation. Without a strong and well-performing ERA, there would be limited opportunity to set common R&I agendas or deepen a culture of cooperation, and it would not be possible achieve the scale of funding and collaboration required for tackling societal challenges.

Demand for highly skilled, socially engaged people is both increasing and changing. Driven by digital technology, jobs are becoming more flexible and complex. An individual's capacity to be entrepreneurial, to manage complex information, to think autonomously and creatively and use digital resources are more crucial than ever. Higher education in Europe must prepare the next generation to be fully equipped for these challenges.

It is more urgent than ever to correct the skills mismatch in Europe. The unmet demand for graduates in the science, technology, engineering and maths (STEM) fields is significant, and equally our students do not yet have the transversal skills necessary to be suc-

cessful in an increasingly competitive labour market. Moreover, carrying out research in a collaborative, transparent and accessible manner is increasingly the norm. Universities and research organisations need to address these issues in order to maintain the flow of skilled graduates.

EU policies thus need to coherently support research, innovation and education in order to stimulate jobs growth, investment, and competitiveness. The future role of education in investing in skills and knowledge is essential to strengthen Europe's ability to effectively tackle societal challenges. Investing in stronger links between education and research will support the development of talented people in addressing global challenges. Universities, as leading centres of innovation, need to be empowered to create more impact through innovation across their activities, including education, research, knowledge transfer and citizen engagement. They should also become regional hubs for education and innovation exchange, promoting joint curricula with industry.

This is in line with three recent EU policy calls to action: the Communication on Strengthening European Identity through Education and Culture⁷⁹; the renewed EU agenda on Higher Education; and the Communication on the Digital Education Action Plan.

Europe's **high-level skills needs** must be addressed through investing in skills development, in particular inter-disciplinary and entrepreneurial skills, in those areas holding the keys to smart economic and social development (such as science, technology, engi-

neering and mathematics, climate change, clean energy, artificial intelligence, robotics, data analysis, design).

The EU's innovation performance is improving, but not fast enough to ensure our future welfare. **Modern universities as leading centres of innovation** need to be empowered to create more innovation impacts, and this must be nurtured by the culture of the university. The core functions of modern universities should enable excellence, innovation and openness to the world. Excellence must be at the centre of research and should include incentives for inter- and trans-disciplinarity. Openness must be at the centre of the research mindset, while cross-border open research practices must be further supported. Models and methods of education must therefore adapt

to cutting-edge research practices by experimenting with new forms of open education and learning empowered by digitisation.

Education and culture are increasingly prominent in debates around Europe's future identity since an EU leaders' meeting in Gothenburg in November 2017. The accompanying 'Strengthening European Identity through Education and Culture' Communication sets out a vision to create a European Education Area by 2025. Key goals include stepping up investment in education to 5% of EU GDP, launching a European Universities initiative and strengthening the mutual recognition of higher education diplomas.

What do we have now on education in Horizon 2020?

Marie Skłodowska-Curie Actions (MSCA) is a bottom-up based set of funding schemes which support inter-sectoral and cross-border mobility activities for researchers. The MSCA fosters new skills and equips researchers with transferable skills that will allow them to face current and future global challenges, matching the future needs of the labour market and enabling the take-up of research results for societal benefit.

The educational dimension has been a major focus of the **European Institute of Innovation and Technology (EIT)** since its creation, which supports the development of a mix of technical and entrepreneurial skills as drivers of innovation. Through its KICs, the EIT supports a variety of education activities which aim to train the next generation of innovators and entrepreneurs. The EIT targets primarily Master and PhD students, as well as a growing number of professionals. Students are awarded degrees from partner universities, on top of which is awarded the EIT Label. This aims to be a guarantee of quality for innovative programmes bridging universities and industry. Students follow new cross-sectoral curricula with innovative models of teaching and learning, aiming at developing technical knowledge and entrepreneurial skills. This goes beyond what is being normally offered by the universities' partners in a KIC, in particular in terms of mobility, industry exposure and networking opportunities,

The Science with and for Society programme part helps to engender Responsible Research and Innovation (public engagement, science education, ethics including research integrity, gender equality, and open access) through enabling changes in Research Funding and Performing Organisations. Results contribute to the implementation of ERA priorities, a greater involvement of all stakeholders in R&I and a more effective societal engagement.

What have we learned from recent evaluations?

According to the Lamy High Level Group – as noted in Annex 8 – a fundamental reform of the role of education should **systematically embed innovation and entrepreneurship in education** across Europe⁸⁰. Europe's universities need urgent renewal, to stimulate entrepreneurship and tear down disciplinary borders. Strong non-disciplinary collaborations between universities and industry should become the rule and not the exception. Horizon Europe should thus provide incentives for the modernisation of universities. Research and higher education institutions that actively promote open science, open innovation and openness to the world (e.g. through new ways of teaching, promoting cross-disciplinarity and entrepreneurship, or attracting researchers and students from around the world) should be rewarded.

The MSCA have contributed to making the science system of the Union more competitive and attractive on a global scale. Evidence shows that the MSCA not only have a **positive structuring impact** on individuals, organisations, and at system level, but also yield high-impact and breakthrough research results and contribute significantly to societal as well as strategic challenges.

The EIT fills a gap in the system of support for innovation provided by the Member States and bring **unique perspectives to education programmes**⁸¹. As outlined in Annex 8, the recent interim evaluation of the EIT found that EIT-labelled educational courses provide graduates with hard and soft entrepreneurial skills, a unique access to businesses and a stronger level of competence in delivering innovation. Some linkages in KICs' knowledge triangle activities are still underexploited, e.g. those between education and innovation-support and acceleration services, and require further efforts in the future. KICs' should better monitor their education offer in view of ensuring a high quality having in mind the goal of increasing the outreach of their educational activities.



What do stakeholders say?⁸²

- A stronger alignment of policies for education, research and innovation, as well as stronger links between the European Research Area and the European Higher Education Area, should be sought.
- Linking education, research and innovation through an alignment of Horizon Europe and the Erasmus programme should be explored.
- While keeping the main focus on research, the possibility of linking research to education and sharing research results with students should be introduced under Horizon Europe.
- Researchers funded through the MSCA and the ERC, for example, should be permitted to engage in teaching activities and to include these activities in their time sheets.
- It should be considered to introduce a funding stream within the MSCA for doctoral schools, aiming to boost the capacity of universities in the education and training of the next generation of researchers.

9.2 What do we want to achieve on education in Horizon Europe?

Integrate research and education across borders, by putting in place strong links between the European Research Area (ERA) and European Higher Education Area (EHEA) initiatives. EU programmes on research and innovation, and on education, need to provide incentives to facilitate knowledge transfer from higher education institutions to companies or spin-offs. Member States, regions and higher education institutions need to be incentivised to work together to upgrade curricula to match changing skills needs, to revise career incentives which recognise entrepreneurial achievements and to reward institutions for new ways of teaching which promote trans-disciplinary and entrepreneurial skills.

Synergies also need to be developed between research and innovation activities and students' education. Horizon Europe and Erasmus should not only promote the transfer of research results to companies and other societal actors, but also the **transfer of research into teaching** activities. This would enable students to connect better with and learn from researchers and their research. Teaching and professional development for teaching need to be promoted and integrated into an academic career as early as possible, through the future EIT and MSCA. Synergies need to be exploited across all relevant funding programmes, both nationally and at European level.

Facilitate knowledge transfer from higher education institutions and research institutes into existing companies or spin-offs and introduce **rewards for academics' entrepreneurial achievements**. To achieve this, the following could be considered:

- To consider excellent teaching and education-focused scholarship as activities equal to excellence in research;
- To recognise excellent service to society, innovation activities or transfer of knowledge outside academic sector;
- To establish reward systems for academics for 'service to society' and for entrepreneurial achievements.

Reward new ways of teaching towards transdisciplinary and entrepreneurial skills:

- The MSCA and EIT KICs already ensure the establishment of training and career development systems that equip students and researchers, including many future academics, with skills based on the 'Triple I' principle, i.e.. international, interdisciplinary, inter-sectoral.
- Future EU programmes could consider including incentives that enable participating higher education institutions to reward and promote excellent university teachers, and to encourage higher education institutions introducing such systems into their general practice.

Upgrade curricula to match changing skills needs. Well-designed higher education programmes and curricula, centred on students' and researchers' learning needs, are crucial for effective skills development. A wider range of course choices and options for continuous professional development will help higher education to respond better to people's needs. As a lot of teaching takes place in research-performing institutions, research must be better exploited as an input for teaching. At the same time, undergraduates should be more involved in research activities.

Digitally-enabled open science provides new possibilities to address this, and the future Erasmus should explore ways to enhance the quality and relevance of learning and teaching. This could be done by promoting a stronger link between teaching, learning and research at all study levels, and by providing incentives to intensify activities that develop creativity, innovation and entrepreneurship. This could for example happen through the **European Universities**⁸³ which would work across borders and fostering the development of new joint and integrated long term and sustainable strategies on education, research and innovation based on trans-disciplinary and cross-sectoral approaches to make the knowledge triangle a reality, providing impetus to economic growth.

9.3 What will change compared to Horizon 2020 and what are the expected implications?

Horizon Europe will explore ways to provide further support for human capital and skills development. A coherent approach on human capital across all programme parts should be ensured and the links between education and research and innovation projects should be strengthened. Follow-up and monitoring of the results of the human capital and skills development as part of the research and innovation projects should be reinforced.

The European Universities initiative, the MSCA and the EIT community could help universities to become more entrepreneurial and supportive of open science practice, for example by developing a complete portfolio of education activities including lifelong learning. This would reduce skills mismatch and boost skills uptake across the whole education chain. European Universities will promote cross-border coop-

eration among higher education institutions, boost mobility for students and teachers and facilitate language learning.

The idea is to promote bottom-up alliances of universities across the EU, bringing together people to cooperate in different languages, across borders and disciplines. European Universities will pioneer studies across disciplines and sectors. This will help address big societal challenges and skills shortages. The initiative aims to drive innovation in education and research in Europe, while making use of the most innovative teaching methods and digital technologies. European Universities will act as models for other higher education institutions in the EU, progressively increasing the international competitiveness of European higher education. See Annex 7, section 11, for further details on this nascent initiative and the potential links with Horizon Europe.

The role played by EIT in relation to strengthening the innovation ecosystem landscape across Europe and in **mainstreaming its educational support for the renewal of European higher education institutions** will be crucial. The EIT community should be able share the outcome of their experimental educational activities widely across Europe, while support for sectoral vocational training will tackle needs identified by the KICs in equipping the next generation of innovators with the relevant skills to thrive in a fast changing economic environment. Some elements of EIT programmes, in particular the mobility components, could be also supported by Erasmus when relevant.

9.4 How will it be implemented?

Options will be explored to ensure that **every researcher** recruited on any R&I project within Horizon Europe benefits from tailored train-

ing and career development, and good working conditions. Career Development Plans for young researchers and innovators could be set up, while mandatory use of the European Charter and Code for Researchers⁸⁴ would ensure adequate working conditions. Implementing an open, transparent, and merit-based recruitment principles in all projects could also be put in place.

The cost for trainings and skills development could become eligible in funding schemes where it is relevant, for example in projects related to specific missions, global challenges or specific innovation activities (in addition to the MSCA and EIT). The role of teaching for researchers and feeding back research results into teaching will be general points of attention. Feeding back results from Horizon Europe projects into teaching should be requirements in dissemination & exploitation and will be closely followed-up, monitored and ex-post evaluated.

MSCA and EIT educational programmes can support training and career development for other parts of Horizon Europe. As the future R&I missions will require highly interdisciplinary skills, proper training is likely to be a strong prerequisite to fulfil a mission's goal. In this respect, the missions could benefit from the support provided under the MSCA and EIT for interdisciplinary and entrepreneurial skills development. This will allow researchers to face current and future global challenges and enable the take-up of research results by the wider economy.

Together with the Horizon Europe programme part on 'Sharing Excellence', measures should be considered under that can stimulate brain circulation to lower-performing EU countries in R&I, but without compromising on the core focus on excellence. The future Euratom Programme could fund the MSCA to provide training & career development in the sector of nuclear research.

The **European Universities** initiative will be a catalyst for R&I activities and projects, innovation hubs and human capital development. The alliances will bring together a new generation of Europeans, who are able to cooperate in different languages, across borders and disciplines, to address the big societal challenges and skills shortages that Europe faces, underpinned by European higher education institutions which seamlessly cooperate across borders. They will aim to increase the international competitiveness of European higher education institutions by:

- fostering development of new joint and integrated long term and sustainable strategies on education, research and innovation based on trans-disciplinary and cross-sectoral approaches to make the knowledge triangle a reality;
- being drivers of educational and research innovation by making use of the most innovative pedagogies and digital technologies;
- creating new joint curricula based on innovative research output forward looking skills and multidisciplinary and inter-sectoral approaches;
- attracting the best talent, students, teachers and researchers across the world and acting as role models for other higher education institutions and the business sector throughout Europe by committing to implement policies on education, research and innovation;
- fostering opportunities for talent, students, teachers, researchers and other public and private actors to co-create knowledge and innovation together (e.g. working together to address global challenges or other priorities identified by Horizon Europe).

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- 1 OECD, Entrepreneurship at a glance 2017, fig. 4.4. The percentage of firms that do not grow at all or by less than 5% was over 45% in Europe compared to 37% in the US (Bravo-Biosca, 2011, A look at business growth and contraction in Europe). The tiny proportion of startups that do grow provide a disproportionate share of the new jobs (Marcin Szczepanski, 2017, Helping European SMEs to grow, LAB-FAB-APP, http://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/hlg_2017_report.pdf July 2017).
 - 2 “Deep tech” refers to companies founded on a scientific discovery or meaningful engineering innovation. Arthur D. Little, 2016, Systemizing Breakthrough Innovation.
 - 3 Arthur D. Little (2016), Systemizing Breakthrough Innovation.
 - 4 The Economist: From clout to rout: June 30, 2016, <https://www.economist.com/news/business/21701480-why-european-companies-have-become-fading-force-global-business-clout-rout>.
 - 5 Equity Funding in the EU, Deloitte (July, 2016).
 - 6 Improving Access to Finance for Beneficiaries of the SME Instrument, InnovFin Advisory (EIB), 2018.
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 - 9 Acemoglu, D., U. Kacigit, N. Bloom, and W. Kerr (2013). Innovation, Reallocation and Growth, National Bureau of Economic Research, NBER Working Paper 18993.
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 - 12 Flash Eurobarometer 2014 “The role of public support in the commercialisation of innovations”.
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 - 14 <https://www.project-syndicate.org/commentary/europe-startups-tech-success-by-william-echikson-2017-04>.
 - 15 <https://techcrunch.com/2017/06/07/venture-investing-in-the-us-and-europe-are-totally-different-industries/85/>.
 - 16 Financing SMEs and Entrepreneurs (2018 OECD Scoreboard, p. 23).
 - 17 Meeting of the OECD Council at Ministerial Level Paris, 7-8 June 2017 (p. 16).
 - 18 Improving access to finance for young innovative enterprises with growth potential: evidence of impact on firms’ outputs, JRC, 2017 (p. 5).
 - 19 Access-to-finance conditions for Key Enabling Technologies (KETs) companies, EIB, 2016 (p. 4).
 - 20 Shortage of Risk Capital for Europe’s High Growth Businesses AFME, March 17 (p. 4).
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 - 22 Citizens of EU-OECD countries score lower on their attitude to entrepreneurship and preference for self-employment than those in the US and China, e.g. the index for attitude towards entrepreneurship in 21 EU countries is 46 (males) and 31 (females), compared to 70 resp. 57 in the US, 62 resp. 54 in China and 57 resp. 35 in Korea (figures 2013): <http://stats.oecd.org/index.aspx?queryid=70778>.
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 - 24 Flash Eurobarometer 433, Innobarometer 2016 – EU business innovation trends.
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 - 26 COM/2016/0733 final - Europe’s next leaders: the Start-up and Scale-up Initiative.
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 - 29 Better regulations for innovation-driven investment at EU level, Commission Staff Working Document 2016: https://ec.europa.eu/research/innovation-union/pdf/innovrefit_staff_working_document.pdf. The importance of regulation for innovations is also mentioned in Atomico, The State of European Tech, 2017, p. 110 <https://2017.stateofeuropeantech.com/>.
 - 30 A.T. Kearny (2014), p. 15: Rebooting Europe’s High-tech industry.

- 31 One US report states that 14 percent of European scale-ups have a “dual model”: moved headquarters abroad since the initial phases of its lifecycle. Such companies would raise 30% more capital than scale-ups that follow a domestic funding path. The most popular destination is Silicon Valley: <http://mindthebridge.com/european-dual-companies/>.
- 32 Cooperation within the innovation projects shall not be a requirement as they are close to the market and companies often prefer to walk that ‘final mile’ alone.
- 33 According to companies participating in the business acceleration services of the SME Instrument, the exposure to a European network is crucial for building real business contacts with potential partners, clients and investors. Report: ‘Is the SME-Instrument delivering growth and market creation? Analysis of first finalized Phase 2 projects, part 2 in-depth case studies, EASME Dec. 2017.
- 34 The Group’s mandate was to provide advice on how to maximise the impact of the EU’s investment in research and innovation based on stakeholder feedback and the findings of the interim evaluation. The recommendations are published in the report LAB-FAB-APP, Investing in the European future we want, Lamy Group Report (2017).
- 35 https://ec.europa.eu/info/news/high-level-group-innovators-offer-key-recommendations-european-innovation-council-2018-jan-24_en.
- 36 Commissioner Moedas met twice with representatives of national innovation agencies to discuss their experiences with promoting market-creating innovation, e.g. through providing coaching, loans and venture capital, lessons for the EU and ways in which EU could add additional value to their existing activities. Three workshops with experts from innovation agencies provided additional insights.
- 37 In 2016 the Commission ran a call for ideas with a wider innovation community which gathered 1022 replies to the online questionnaire and 183 supporting documents. Overview of responses can be accessed here: https://ec.europa.eu/research/eic/pdf/eic_call_for_ideas-overview.pdf.
- 38 These could include topics such as Artificial Intelligence, Quantum computing, Biocontrol or Second generation digital twins, or any other identified in close cooperation with Member States’ networked programmes.
- 39 <https://ec.europa.eu/research/innovation-deals/index.cfm>.
- 40 <https://www.darpa.mil/>.
- 41 Funding – Awareness – Scale – Talent (FAST): Europe is back: Accelerating Breakthrough Innovation, Full set of recommendations from the Independent High-Level Group of Innovators on establishing a European Innovation Council, January 2018.
- 42 Source: Joint Institute of Innovation Policy, see ‘References’ section.
- 43 See section 3.4 of the Commission Communication on the Interim Evaluation, January 2018 (COM(2018) 2 final), and the recommendation of the ex-post evaluation of FP7 on: “bringing science closer to citizens” (COM(2016) 5 final).
- 44 “The process of engagement needs to make the best use of networked technologies, reach a wide number of citizens across the European Union, and show clearly that people in every part of the Union have an opportunity to participate in setting priorities, and opportunities to become further involved in the future”. Citizen Participation in FP9: A model for mission and work programme engagement. Democratic Society, February 2018, p.18.
- 45 See: ‘Mission-Oriented Research and Innovation in the European Union: A problem-solving approach to fuel innovation-led growth. Mariana Mazzucato, January 2018.
- 46 Over 20 Focus Areas were introduced in Horizon 2020, and the interim evaluation found that “their multiplication resulted in some confusion” (p.149, In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final).
- 47 Democratic Society (2018), p. 17.
- 48 “Missions require to set up specific governance structures with full-time professionals and to keep close contacts with all stakeholders. A balanced system of separation of powers between steering, strategic and financial decision-making and the day-to-day management is a must to establish from the outset”. MOP2 study.
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- 51 Nelson, Richard R. “The Moon and the Ghetto Revisited.” *Science and Public Policy* 38, no. 9 (2011): 681–90.
- 52 Weber, K. Matthias, and Harald Rohrer. “Legitimizing Research, Technology and Innovation Policies for Transformative Change: Combining Insights from Innovation Systems and Multi-Level Perspective in a Comprehensive ‘Failures’ Framework.” *Research Policy* 41, no. 6 (2012): 1037–47.
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- 54 Foray, Dominique, David C. Mowery, and Richard R. Nelson. “Public R&D and Social Challenges: What Lessons from Mission R&D Programs?” *Research Policy* 41, no. 10 (2012): 1697–1702.
- 55 A survey conducted for the Joint Institute for Innovation Policy-coordinated survey recorded 80% of respondents agreeing that cross-disciplinary and cross-sectoral calls for projects and proposals in the future is an appropriate tool for mission orientation.

- 56 Weber, K. Matthias, and Harald Rohrer. "Legitimizing Research, Technology and Innovation Policies for Transformative Change: Combining Insights from Innovation Systems and Multi-Level Perspective in a Comprehensive 'Failures' Framework." *Research Policy* 41, no. 6 (2012): 1037–47. See also the Joint Institute for Innovation Policy study for a profiling of different missions and their various drivers (including also geopolitical and technological challenges).
- 57 This is the view of the ESIR expert group. In other words, contrary to the approach of previous EU Framework Programmes, setting up visible targets from the outset so that the future programme provides a reliable long-term framework incentivising private firms to invest in R&I reaping new markets. Public R&I investments have a higher economic impact if they are directed to specific missions, with targets set by policy in close interaction with both public and private actors.
- 58 Foray, Dominique, David C. Mowery, and Richard R. Nelson. "Public R&D and Social Challenges: What Lessons from Mission R&D Programs?" *Research Policy* 41, no. 10 (2012): 1697–1702.
- 59 <https://ec.europa.eu/research/environment/index.cfm?p-g=belmont>.
- 60 <http://mission-innovation.net/>.
- 61 Science, Research and Innovation performance of the EU (2016); World Intellectual Property Indicators, WIPO (2015).
- 62 Within the Programme, peer-reviewed publications with at least one associated or third country have a higher impact than other ones: European Commission (2017), Interim Evaluation of Horizon 2020, SWD(2017) 220, book, p. 115.
- 63 A. Swan, 2015. *Open Access policy effectiveness: A briefing paper for research institutions*, PASTEUR40A project policy resources, DOI: 10.5281/zenodo.54748 (Open Access Policy Alignment Strategies for European Union Research (611742)).
- 64 Not included here are the European Innovation Partnerships (EIPs) as they do not entail EU support for direct R&D activities.
- 65 <https://publications.europa.eu/en/publication-detail/-/publication/cc76ff75-6bff-11e3-9afb-01aa75ed71a1/language-en>.
- 66 As the EIT/KICs are set-up along clear mechanisms specified in the EIT regulation, they are not included here.
- 67 http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en.
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- 70 High Level Expert Group on the Ex-post evaluation of FP7 (2015) https://ec.europa.eu/research/evaluations/pdf/fp7_final_evaluation_expert_group_report.pdf.
- 71 European Parliament - STOA-Project "How to overcome the innovation gap in Europe: Structural shortcomings in the EU-13 and recommendations for a better performance in Horizon 2020"- February 2018.
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- 73 Based on the RHOMOLO model. European Commission, DG JRC.
- 74 Horizon 2020 Regulation, Article 4.
- 75 FP7 (<http://publications.jrc.ec.europa.eu/repository/handle/JRC96870>).
- 76 Available at: <http://data.europa.eu/doi/10.2760/459053>.
- 77 Responsible Research and Innovation is defined as an approach whereby societal actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society.
- 78 Reduced from EUR 2.7 billion following the set-up of the European Fund for Strategic Investments (EFSI).
- 79 COM(2017) 673 final.
- 80 LAB-FAB-APP, Investing in the European future we want, Lamy High Level Group Report (2017).
- 81 COMMISSION STAFF WORKING DOCUMENT on the Interim evaluation of the European Institute of Innovation and Technology (EIT) (SWD(2017) 352 final).
- 82 [http://eua.be/Libraries/publications/home-page-list/eua-next-framework-programme-for-research-and-innovation-\(fp9\).pdf?sfvrsn=2](http://eua.be/Libraries/publications/home-page-list/eua-next-framework-programme-for-research-and-innovation-(fp9).pdf?sfvrsn=2); <https://www.leru.org/publications/excellent-education-in-research-rich-universities>.
- 83 The European Council debated the issue in December 2017 and called for the establishment of bottom-up networks of universities across the EU with the broad aim to strengthen research, innovation and education in Europe and to bring about more European integration through higher education.
- 84 <https://euraxess.ec.europa.eu/jobs/charter>.

ANNEXES

ANNEX 7: RULES FOR PARTICIPATION



ANNEX 7: RULES FOR PARTICIPATION

1 SINGLE SET OF RULES



FACTS

A **single set of participation rules** exists for participants in the programme, for example concerning eligibility criteria for the calls for proposals and the reimbursement rate. This applies to the different types of R&I support provided under the programme.

The rules are **aligned as much as possible to the EU Financial Regulation**, in order to ensure coherence with other EU funding programmes. Some **derogations** from the rules do, however, exist for specific initiatives.

Under FP7, the previous programme covering the 2007-2013 period, different rules including eligibility criteria and reimbursement rates, depending on the programme part and on the type of organisation, were used.

1.1 What is the current situation under Horizon 2020?

A single set of rules was put in place under Horizon 2020. The main aim was to ensure a coherent framework for participation, including within programmes managed by the European Institute of Innovation and Technology (EIT), public-private partnerships managed by Joint Undertakings under Article 187 of the Treaty on the Functioning of the EU (TFEU) and public-public partnerships under Article 185 TFEU.

Following the inter-institutional discussions on Horizon 2020, flexibility was sought by introducing a number of limited derogations, which exist for both Joint Undertakings (under

Article 187) and public-public partnerships (Article 185).

For Joint Undertakings, the scope of derogations from the Rules for Participation is set out in the Rules themselves and developed further through delegated acts – a means by which the Parliament and the Council maintained control on the detailed content of these derogations. For Article 185 initiatives, derogations from the Rules are laid down in the respective basic acts, adopted by the Parliament and Council by ordinary legislative procedure.

Compared to FP7, the single set of rules under Horizon 2020 was a major simplification. Under FP7, participants had to comply with different rules depending on the programme

part. The different funding bodies applied a variety of diverging rules, with different eligibility criteria or funding rates. This triggered fragmentation, reduced legal certainty and increased the administrative burden and resources required to participate. As highlighted in the ex-post evaluation of FP7, the

level of complexity and the lack of consistency between different parts of the programme meant that the rules were too complex. This explains, at least in part, the relatively high error rate associated with FP7 which the Court of Auditors attributed to risks inherent in the programme's design and implementation¹.

Lessons learnt from Horizon 2020

- › The application of the single set of rules is widely seen by beneficiaries as advantageous: it contributes to increased legal certainty, coherence and simplification of the rules. For example: “One single set of simplified EU rules for participation is essential to safeguard a level playing field across borders given the big differences in national legislation ... we welcome the introduction of a single set of rules”.
(CESAER position paper on FP9: “How You Can Boost Worldwide Research and Innovation”, January 2018).
- › “Within the EU funding programmes landscape, Horizon 2020 has achieved remarkable simplification. It has made access to the programme easier, reduced costs for applicants and made the programme more attractive”
(p. 18, LAB-FAB-APP: *Investing in the European future we want. Report of the High Level Group on maximising the impact of EU research and innovation programmes*, July 2017).
- › The interim evaluation of the Article 185 initiatives indicates that “initiatives with fully centralised implementation are considered as more efficient in their programme implementation” while the reporting requirements for participants in decentralised initiatives² were identified “as a challenge”
(p. 32, *Staff Working Document on Evaluation of the Participation of the EU in Research and Development Undertaken by Several Member States Based on Article 185 of the TFEU*, September 2017).
- › The interim evaluation of Joint Undertakings also indicates that uniform application of the Horizon 2020 Rules contributed to the improved operational efficiency of JUs, but this progress was in some cases hampered by the design of the individual JU.
(p. 36, *Staff Working Document on Evaluation of the Participation of the EU in Research and Development Undertaken by Several Member States Based on Article 185 of the TFEU*, September 2017).

1.2 What are the changes?

The new EU Financial Regulation will be used as a common reference. Derogations should be kept to a minimum and are clearly justified in every case.

The Rules for Participation will aim for further simplification, increased legal certainty and reduced administrative burden - for beneficiaries, for other stakeholders and for programme administrators. This will uphold the single set of rules while introducing further improvements. All bodies implementing the programme will be brought together under one roof, including the EIT. Derogations for Article 185 and 187 initiatives, which will adhere to the common set of funding rules and the central management of all financial contributions, will be minimised.

The Participant Guarantee Fund³ (renamed Mutual Insurance Mechanism) will also be extended to cover actions under Horizon Europe managed not only by the Commission, the EU agencies and the EU funding bodies (i.e. JUs and the EIT), but also by non-EU funding bodies (i.e. the bodies implementing the public-public partnerships under Article 185). Moreover, it may also be extended to beneficiaries of any other directly managed Union programme⁴.

1.3 What are the expected implications of the changes?

A single set of rules would deliver on the aim to rationalise Horizon Europe. It would streamline implementation methods and reduce administrative burden for beneficiaries. The accessibility and attractiveness of the

programme, in particular for applicants with limited resources such as SMEs, would be sustained. As a result, legal certainty would increase and participation would be simplified further.

The extension of the coverage by the Participant Guarantee Fund to non-EU funding bodies would lead to more coherence in applying the rules. Provided that proper safeguards are in place, this is expected to be positively perceived by Member States, many of whom previously expressed their wish for including projects funded by Article 185 initiatives under the scope of the Fund.

1.4 What alternatives have been considered?

Keep the Horizon 2020 status quo - this would reproduce all the current programme's benefits and limitations. While this would result in a smoother transition, it would also not lead to further simplification and streamlining and would not take account of the lessons learnt from the Horizon 2020 interim evaluation.

Return to the FP7 situation - this would abandon the single set of rules principle and allow the different bodies to adopt their respective rules as they see fit. However, this flexibility would be granted at the expense of beneficiaries, who would face an excessively complicated set of diverging rules. Simplification efforts would be thwarted, and legal certainty would decrease.

The administrative burden for adjusting to different sets of rules would become prohibitive, hampering participation by beneficiaries with limited resources, in particular SMEs.

2 FUNDING MODEL AND TYPES OF ACTION



FACTS

The single set of rules under Horizon 2020 features a simplified funding model. There is a **single funding rate per type of action** (up to 100% of eligible costs for research actions, but limited to a maximum of 70% for innovation actions, except for non-profit organisations) and a 25% flat rate for indirect costs. A number of different types of action exist.

Under FP7, the previous programme from 2007 to 2013, costs were reimbursed based on a complex matrix of organisation categories and activity types.

2.1 What is the current situation under Horizon 2020?

Funding model

- The Horizon 2020 funding model is based on two main features: a single funding rate (up to 100% of eligible costs for research actions, but limited to a maximum of 70% for innovation actions, except for non-profit organisations), and *a single flat rate* of 25% for indirect costs.
- Under FP7, contrastingly, direct costs were reimbursed based on a matrix of organisation categories and activity types. The indirect costs were calculated using four different methods, including real indirect costs.
- The Horizon 2020 funding model has mobilised and largely satisfied stakeholders. In a simplification survey conducted in 2015, around 78% of respondents expressed the benefit of a single reimbursement rate in a project, and 74% felt the benefit of the single flat rate for indirect costs.
- The Horizon 2020 funding model has had positive effects on stakeholder appreciation, time to grant⁵, attractiveness and has reduced administrative burden. This is reflected in the application statistics and underlined by the interim evaluation of Horizon 2020.

Types of action

The following types of action are used within Horizon 2020:

Type of action and objectives pursued	Target Groups	Changes FP7
GRANT-BASED TYPES OF ACTION		
Research and Innovation Actions (RIA): Action primarily consisting of activities aiming to establish new knowledge and/or to explore the feasibility of a new or improved technology, product, process, service or solution. It may include basic and applied research, technology development and integration, testing and validation on a small-scale prototype in a laboratory or simulated environment	Consortia of partners from different countries, industry and academia	Changes to funding model and further focus on innovation
Innovation Actions (IA): Actions primarily consisting of activities directly aiming at producing plans and arrangements or designs for new, altered or improved products, processes or services. For this purpose they may include prototyping, testing, demonstrating, piloting, large-scale product validation and market replication. They are used for areas where the scientific and technology insights are available and the focus shifts to turning these into applications	Consortia of partners from different countries, industry and academia	New action and changes to funding model
Fast Track to Innovation (IA): Continuously open calls will target innovation projects addressing any technology or societal challenge field	Consortia of partners from different countries	New action
European Joint Programme Cofund (COFUND-EJP): Support to coordinated national R&I programmes in implementing a joint programme of activities (ranging from R&I activities to coordination activities, training and dissemination activities)	Independent legal entities from Member States or Associated Countries owning or managing national R&I programmes	New action
ERA-NET-Cofund: Support public-public partnerships in their preparation, establishment of networking structures, design, implementation and coordination of joint activities as well as Union topping-up of a trans-national call for proposals	Independent legal entities from Member States or Associated Countries owning or managing national R&I programmes	–

Type of action and objectives pursued	Target Groups	Changes FP7
<p>Pre-Commercial Procurements (PCP): PCP actions aim to encourage public procurement of research, development and validation of new solutions that can bring significant quality and efficiency improvements in areas of public interest, whilst opening market opportunities for industry and researchers active in Europe</p>	<p>EU funding for a group of procurers ('byers group') to undertake together one joint PCP/PPI procurement</p>	<p>–</p>
<p>Public Procurement of Innovative solutions (PPI): PPI actions enable groups of procurers to share the risks of acting as early adopters of innovative solutions, whilst opening market opportunities for industry</p>	<p>EU funding for a group of procurers ('buyers group') to undertake together one joint PCP/PPI procurement</p>	<p>–</p>
<p>Coordination and Support Actions: Actions consisting primarily of accompanying measures such as standardisation, dissemination, awareness-raising and communication, networking, coordination or support services, policy dialogues and mutual learning exercises and studies, including design studies for new infrastructure and may also include complementary activities of networking and coordination between programmes in different countries</p>	<p>Single entities or consortia of partners from different countries</p>	<p>–</p>
<p>Marie Skłodowska-Curie Actions (MSCA): Bottom-up funding for international research fellowships in the public or private sector, research training, staff exchanges</p>	<p>Early stage researchers or experienced researchers (of any nationality), managerial, technical or administrative staff supporting the R&I activities, single entities or consortia of partners from different countries, industry and academia</p>	<p>–</p>

Type of action and objectives pursued	Target Groups	Changes FP7
MSCA Co-fund: Support for regional, national and international doctoral and fellowship programmes to foster excellence in researchers' training, mobility and career development, spreading the best practices of the MSCA	Single legal entities from Member States or Associated Countries owning or managing international/ national/ regional R&I programmes, early stage researchers or experienced researchers (of any nationality)	–
European Research Council frontier research grants: Funding for projects evaluated on the sole criterion of scientific excellence in any field of research, carried out by a single national or multinational research team led by a 'principal investigator'	Excellent young, early-career researchers, already independent researchers and senior research leaders. Researchers can be of any nationality and their projects in any research field	–
SME Instrument Phase 1 (IA): The SME Instrument is targeted at all types of innovative SMEs showing a strong ambition to develop, grow and internationalise. It provides staged support covering the whole innovation cycle in three phases complemented by a mentoring and coaching service. Phase 1 – feasibility study verifying the technological/practical as well as economic viability of an innovation idea/concept	Only SMEs can participate. Either a single SME or a consortium of SMEs established in an EU or Associated Country	New action
SME Instrument Phase 2 (IA): Phase 2 – innovation projects that address a specific challenge and demonstrate high potential in terms of company competitiveness and growth underpinned by a strategic business plan	Only SMEs can participate. Either a single SME or a consortium of SMEs established in an EU or Associated Country	New action
Specific Grant Agreement (SGA): The Financial Regulation provides the possibility of Framework Partnership Agreements for long-term partnerships and associated specific grant agreements. Framework Partnership Agreements and Specific Grant Agreements have been used in a limited way when in line with the objectives of the programme parts.		–

Type of action and objectives pursued	Target Groups	Changes FP7
OTHER INITIATIVES UNDER HORIZON 2020		
<p>Prizes: Financial contribution given as a reward following the publication of a contest. Inducement prizes are a 'test-validate-scale' open innovation approach that brings together new and small players that may pursue more radically new concepts than large, institutionalised contestants. Inducement prizes offer an incentive by mobilising new talents and engaging new solver communities around a specific challenge. They are only awarded based on the achievement of the target set, solving the challenge defined. 'Recognition prizes' are used to recognise past achievements and outstanding work after it has been performed, whereas an 'inducement prize' is used to spur investment in a given direction, by specifying a target prior to the performance of the work</p>	<p>Whoever can most effectively meet a defined challenge (future target or past achievement)</p>	<p>New action</p>
<p>Public-Public Partnerships also provided via the Article 185 initiatives: Article 185 of the TFEU allows the integration of national efforts into a programme undertaken jointly by several Member States, with the participation of the EU, including participation in the structures created for the execution of the joint programme.</p>	<p>EU Member States</p>	<p>–</p>
<p>Public-Private Partnerships: Support the development and implementation of R&I activities of strategic importance to the Union's competitiveness and industrial leadership or to address specific societal challenges. They take the form of Joint Undertakings under Article 187 of the TFEU and organise their own research agenda. Contractual PPPs, in which the activities take place under the umbrella of the Horizon 2020 work programmes, may also be supported.</p>	<p>Partnerships between public and private sector</p>	<p>–</p>
<p>Public Procurement: Supply of assets, execution of works or provision of services against payment</p>	<p>By means of tenders and subject to special procurement procedures</p>	

Type of action and objectives pursued	Target Groups	Changes FP7
<p>Financial instruments: Equity or quasi-equity investments; loans; guarantees; other risk-sharing instruments. Horizon 2020's financial instruments operate in conjunction with those of COSME. Strong synergies shall be ensured with the European Fund for Strategic Investments (EFSI) to create the maximum possible impact. Shall be the main form of funding for activities close to market under Horizon 2020</p>	<p>FI are not directly implemented by the Commission (nor via the WP), but via EIB/EIF</p>	<p>Replacing Risk Sharing Finance Facility</p>

Lessons learnt from Horizon 2020

- “The Horizon 2020 funding model puts the focus on the costs that are directly related to the project. It was expected to simplify the financial management of projects, by a reduced complexity of the financial rules; reduce the financial error rate detected in ex-post audits; increase legal certainty for beneficiaries; increase the attractiveness and ease of access to the programme, in particular for newcomers, smaller actors, SMEs and industry; and contribute to the acceleration of the granting processes. The thematic assessments confirm that the expected benefits have largely materialised”.
(p. 54, *In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final, May 2017*).
- “The new funding model has mobilised and largely satisfied stakeholders. It can also be assumed to have contributed to the attractiveness of Horizon 2020 as reflected in application statistics. For around 90% of universities and more than half of research organisations which have used in FP7 the 60% flat rate method for indirect costs, the Horizon 2020 funding model has brought little change compared to FP7 in terms of funding rate and has therefore not had any major impact on the participation pattern of research organisations and universities”.
(p. 56, *In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final, May 2017*).
- Further simplification efforts and more flexibility are needed, for example concerning the additional remuneration scheme and the broader acceptance of beneficiaries’ accounting practices. The additional remuneration scheme has been perceived by Member State representatives and stakeholders as being difficult to implement (see p. 56 of the *Staff Working Document*), and as having a negative financial effect on those beneficiaries whose usual remuneration practices are based on very variable levels of remuneration. Broader acceptance of usual accounting practices (strengthening the current cases under Horizon 2020, with the future possibility to have other cases where the usual cost accounting practices of the beneficiary could be accepted) will be further explored.

2.2 What are the changes?

Funding model

The current funding model will be maintained. The Rules for Participation provisions will be complemented by clear guidance on use of the maximum funding rate, and the possibility to lower this in justified cases.

Types of action

The types of action under Horizon Europe, for example in the area of public-private and

public-public partnerships, will be rationalised and will provide more flexibility for the applicant. An overview of continued, discontinued and new funding instruments can be found in Table 16 below.

For the forms of funding and types of action to be maintained under Horizon Europe, the level of detail within the current Rules for Participation, with some adjustments in the area of prizes, will be maintained. There will be no duplication with the EU Financial Regulation, which will serve as a single rulebook for all actions financed from the EU budget.

Table 16: Mapping of continued, discontinued and new instruments in Horizon Europe

CONTINUED Without Changes	CONTINUED With Changes	DISCONTINUED	NEW
Design – Priorities			
	<ul style="list-style-type: none"> > Excellent Science: <i>becomes</i> Open Science pillar and does not include the FET specific objective > Societal Challenges: <i>becomes</i> Global Challenges and Industrial Competitiveness pillar and covers the LEITs specific objective of the Industrial Leadership pillar > EIT: <i>becomes</i> part of the newly created Open Innovation pillar 	Industrial Leadership as a separate pillar	<ul style="list-style-type: none"> > Open Innovation pillar > ERA foundation (“Strengthening the ERA”): covers SWAFs, Widening, which were separate specific objectives

CONTINUED Without Changes	CONTINUED With Changes	DISCONTINUED	NEW
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Design - Specific objectives

<ul style="list-style-type: none"> > European Research Council > Marie Skłodowska-Curie Actions > Research Infrastructures > Direct Actions (Joint Research Centre) > Support to the European Institute of Innovation and Technology 	<ul style="list-style-type: none"> > Leadership in enabling and industrial technologies (<i>becomes</i> cross-cluster, though in particular in Digital and Industry cluster) > Innovation in SMEs, (<i>included</i> in European Innovation Council) > Societal Challenges 1-7 (<i>becomes</i> Clusters in the Global Challenges pillar) > Science with and for Society (<i>becomes</i> intervention areas within ERA foundation) > Spreading Excellence and Widening Participation (<i>becomes</i> Sharing Excellence, within ERA foundation) 	<ul style="list-style-type: none"> > Future and Emerging Technologies as separate label, but activities included in other parts > Fast Track to Innovation > Access to Risk Finance (moved to InvestEU programme) 	<ul style="list-style-type: none"> European Innovation Council (building on EIC pilot)
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Implementation - instruments

<ul style="list-style-type: none"> > Research and Innovation Actions > Innovation Actions > ERC frontier research > Training and mobility actions > Programme co-fund actions > coordination and support actions > inducement prizes > recognition prizes > public procurements > ERA Chairs > Twinning > Teaming > Policy Support Facility 	<ul style="list-style-type: none"> > Pre-commercial procurements (PCP) and Public procurement of innovative solutions (PPI) (<i>becomes</i> Coordinated innovation procurement) > SME Instrument (integrated into EIC Accelerator and transition activities) > Future and Emerging Technologies (FET) Open (<i>becomes</i> EIC Pathfinder) > Future and Emerging Technologies (FET) Flagships (incorporated within missions concept) > Support to Joint Programming Initiatives, ERA-NETs, Contractual Public Private Partnerships, Institutionalised public-private partnerships (Art. 187) and Institutionalised public-public partnerships (Art. 185): incorporated within European Partnerships initiative 	<ul style="list-style-type: none"> Missions EIC Pathfinder EIC Accelerator EIC transition activities
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CONTINUED Without Changes	CONTINUED With Changes	DISCONTINUED	NEW
Implementation – concepts			

- | | |
|--|---|
| <ul style="list-style-type: none"> > Key Enabling Technologies > Integration of social Sciences and Humanities > Responsible Research and Innovation (Trying to drop this term – better to treat the components separately) > Communication > Gender Equality > Ethics standards | <ul style="list-style-type: none"> > International cooperation (new criteria) > Strategic planning – widened to include the R&I activities from other funding programmes > Governance |
|--|---|

2.3 What are the expected implications of the changes?

Funding model

The proposed changes would:

- > Provide continuity with the current situation, complying with the principles of the Financial Regulation;
- > Be positively perceived by recurrent Horizon 2020 beneficiaries;
- > Facilitate access to the programme for beneficiaries who have difficulties to get other sources of funding for their projects, possibly increasing the number of newcomers and covering a wider range of potential beneficiaries.

However some of the difficulties experienced in Horizon 2020 to date, notably on oversubscription to calls, would most likely continue; alternative ways to address oversubscription are also identified in section 3.4 of the Impact Assessment.

Types of action

The proposed changes would ensure stability while taking account of the lessons learned from Horizon 2020 so far, for example, the need to rationalise the number of existing EU funding instruments for R&I. It would better suit participants' needs by applying simplified forms of funding; thus streamlining further the EU R&I funding landscape. Thus, the result would be a more user-friendly set of EU funding schemes for R&I, coherence with the EU Financial Regulation and greater complementarity between instruments.

2.4 What alternatives have been considered?

Funding model

A single reduced funding rate for all projects (75% funding rate) and linking the flat rate for indirect costs to personnel costs based on an optional unit cost was considered. This could reduce oversubscription (as a higher number of beneficiaries could benefit from EU funding), further simplify the current rules (i.e. no differentiation between funding rates for Research and Innovation Actions and Innovation Actions) and enhance opportunities for newcomers. However, the reduction of the funding intensity would lower the overall attractiveness of the programme, especially for non-profit entities and SMEs, and would negatively affect the principle of excellence.

Different levels of funding for industry compared to other types of beneficiaries were also considered. The funding rates for industry evolved from 50% in FP7 (with a possibility to charge real indirect costs) to 100% (70% in innovation actions) in Horizon 2020 (with a 25% flat rate for indirect costs). Doubling of the nominal funding rate in Horizon 2020, in combination with the 25% flat rate for indirect costs (and no real indirect costs), has had a positive effect in attracting industry and only a minor impact on the effective funding rate for industry. Having a separate (lower) rate for industry could release funds to increase the number of grants and to offer further possibilities for newcomers. However, the introduction of a different funding rate for industry would have a negative impact on industry participation, time-to-grant and would work against the drive for simplification.

3 FORMS OF GRANTS



FACTS

Different **forms of grants**⁶ are provided for under the current EU Financial Regulation and used by the Horizon 2020 programme.

3.1 What is the current situation under Horizon 2020?

To reduce the complexity of the funding rules, Horizon 2020 features a “simplified cost reimbursement system with enhanced use of lump sums, flat rates and unit costs”⁷.

Actual costs (i.e. costs actually incurred by beneficiaries) are the most widely used. Unit costs are used in relation to personnel costs (i.e. for average personnel costs and SME owners without a salary), other direct costs (i.e. internal invoices) and for MSCA, while flat rates are used for the indirect costs. Lump sums are used, for example within Phase 1 of the SME Instrument).

Lessons learnt from Horizon 2020

- “The range of funding schemes for R&I across the EU budget is numerous, complex and not accessible enough ... a minimum objective should be to eliminate one third of R&I funding schemes, instruments and acronyms across the landscape” (*LAB-FAB-APP: Investing in the European future we want, Report of the High Level Group on maximising the impact of EU research and innovation programmes, July 2017*).
- “The use of new instruments such as the pre-commercial public procurement (PCP), public procurement for innovation (PPI) and inducement prizes clearly aim at leveraging demand for future solutions. Evidence of outputs so far is however still lacking on the effects of the PCP and PPI, since the first projects were signed only in 2015 ... overall more could be done to support demand for innovative solutions and user-driven innovation” (p. 110, *In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final, May 2017*).
- Due to the perceived need to focus more on performance rather than auditing of spending, there is a general interest to simplify funding and shift the focus from the reimbursement of costs to the implementation of defined activities. The main step is the new Financial Regulation, whose main purpose is to facilitate and stimulate, as far as possible, the simplified forms of grants. Further simplification of the current actual cost reimbursement system is necessary, in particular in the area of personnel costs.

3.2 What are the changes?

There will be specific provisions on forms of Union contribution (as described under Article 125 of the new Financial Regulation) within the Rules for Participation. These provisions will include, as exists today, the reimbursement of actual costs, flat rate costs and increased use of lump-sum costs (building on the lump-sum pilot under Horizon 2020) and prizes. In addition, the funding of Marie Skłodowska-Curie Actions, fully based on unit costs, will be continued, and other forms of Union funding will be considered.

For projects funded mainly based on incurred costs, the current unit cost options (average personnel costs, internally invoiced goods and services, SME owner unit cost, clinical studies, etc.) calculated in accordance with the beneficiary’s usual practices⁸ will be maintained. In addition, the unit cost for internally invoiced goods and services will allow for a higher acceptance of usual cost accounting practices. This means that beneficiaries will be able, under certain conditions⁹, to calculate unit costs based on actual direct and indirect costs. Public procurement instruments will be aligned to the new Financial Regulation, while some specificities are provided for pre-commercial procurement and procurement of innovative solutions.

Issue	Planned status within Horizon Europe Programme
Actual costs	
Rules on personnel costs	<p>The current Horizon 2020 system of reimbursement of actual personnel costs will be simplified and, where possible, further aligned with the Financial Regulation: the distinction between basic and additional remuneration will be removed and the Horizon 2020 capping on additional remuneration of EUR 8000 per person per year abolished.</p> <p>At the same time, building on Horizon 2020, the costs of personnel will be eligible up to the remuneration that the person would be paid for the time worked in projects funded by national schemes.</p>
Eligibility of costs from third parties	<p>The system of in-kind contributions provided by third parties to beneficiaries will be further aligned to the Financial Regulation: in-kind contributions against payment will be treated and reimbursed according to the conditions set out in this Regulation.</p> <p>The possibility for beneficiaries to declare costs of in-kind contributions provided by third parties (free-of-charge) will be kept and further simplified. Beneficiaries will be able to declare costs related to in-kind contributions provided by third parties (free-of-charge) as eligible up to the direct eligible third parties’ costs. Therefore, no distinction as to whether these resources (e.g. seconded persons, contributed equipment) are used on the beneficiaries or third parties’ premises will be necessary any longer.</p> <p>In addition, the obligation to declare such costs as receipts will be removed in light of the provisions of the Financial Regulation.</p>

Issue	Planned status within Horizon Europe Programme
Flat rate costs	
Indirect costs	The current Horizon 2020 flat rate of 25% for indirect costs will be maintained.
Lump sum costs	
The use of lump sums will be increased based on the experience of the lump sum pilot projects under Horizon 2020.	
Unit costs calculated in accordance with the beneficiary's usual accounting practices	
The current provisions for unit costs (i.e. average personnel costs and costs of internally invoiced goods and services) will be maintained. In addition, the unit cost for internally invoiced goods and services will allow for a higher acceptance of the usual cost accounting practices by allowing beneficiaries, under certain conditions – to be set out in the grant agreement – to calculate such unit cost based on 'actual direct and indirect costs'.	
Unit costs for Marie Skłodowska-Curie Actions	
The current system of unit costs will be maintained (not excluding the use of other forms of Union funding).	
EU financing not linked to costs	
The topics where this form of Union contribution could be used will be identified in the Specific Programme or in the Work Programme. Further details will be set out in subsequent Commission procedure as indicated in the revised Financial Regulation.	
Operating grants	
No specific references in the Rules are necessary to conclude operating grants (which could be specified within the Work Programme).	

3.3 What are the expected implications of the changes?

These changes would provide legal certainty and consistency by offering the complete set

of forms of grants set out in the Financial Regulation to beneficiaries, but outlining the choice of the most appropriate one in the Work Programme. This is also expected to improve and simplify reimbursement of actual costs, while providing flexibility.

3.4 What alternatives have been considered?

Alternative considered	Reason not favoured
Rules for personnel costs	
Provide for an optional unit cost (hourly rate) set out by the Commission for all EU and Euratom programmes.	This would not help deliver the objective of broadening opportunities for participants of the Framework Programme and increasing the leverage effect of the EU funding.
Provide for a unit cost (hourly rate) calculated by the beneficiary based on the average salary of the person in the previous year.	This would require detailed rules to determine the formula to be applied.
Payment of the personnel costs against certain conditions, by fixing an amount to cover the personnel costs for the work done in the project.	This would imply replacing the actual cost system with contribution not linked to costs; however, given the diversity in salary costs across the Union, it would not be possible to set out a fixed amount for personnel across Europe.
Eligibility of costs from third parties	
Fully align to the Financial Regulation by considering in-kind contributions as part of the co-financing and therefore as ineligible costs.	This would imply a significant change and a potential financial loss for beneficiaries, in particular for universities of many Member States whose professors are paid by the ministries. Thus, this would be challenged by Member States, research beneficiaries and stakeholders.

4 FURTHER SIMPLIFICATION/FLEXIBILITY

4.1 What is the current situation under Horizon 2020?



FACTS

Simplification of rules and procedures is a central guiding principle of Horizon 2020, and is fully reflected in the programme's design, rules, financial management and ways of implementation. The aim has been to make the programme simpler and more attractive, in particular to newcomers.

Significant simplification has resulted in the single reimbursement rate, the flat rate for indirect costs, the improved Participant Portal and the electronic grant management processes.

The **Lump Sum** pilot is the main element of the second wave of simplification of Horizon 2020. It will test two options for lump sum funding in the 2018/2020 Work Programme.

Lessons learnt from Horizon 2020

- The Lamy Report recognises the “remarkable simplification achieved” in the context of Horizon 2020. It identifies areas for further simplification for Horizon Europe in order to: (i) make the Participant Portal website a “one-stop-shop” for all steps from application to final reporting; (ii) give participants the choice between cost-based and lump-sum funding; and (iii) further simplifying administrative processes along the project cycle.
- The Horizon 2020 Interim Evaluation highlights that simplification is a continuous endeavour, and identifies possible areas for improvement, such as the broader acceptance of beneficiaries’ usual cost accounting practices or the more extensive use of simplified forms of funding (unit costs, flat rates, lump sum). This is in line with the new Financial Regulation and the EU Budget Focused on Results initiative.
- The European Court of Auditors, in its briefing paper on “A contribution to simplification for research beyond Horizon 2020”¹⁰, identifies among other things the “following proposals to be considered to bring more focus on the discussion in Horizon Europe that is taking place now: (i) further use of simplified cost options, such as lump sums and prizes; (ii) accepting beneficiaries’ accounting practices.

4.2 What are the changes?

Based on the achievements of Horizon 2020, Horizon Europe will aim for further simplification of rules for beneficiaries. This is fully in line with the overall objective of the next EU budgetary cycle to have simple and effective common rules across Programmes, with adequate flexibility in justified cases. The changes are:

- A wider/greater cross-reliance on audits and assessments – with other EU programmes – is envisaged if the costs can be audited or assessed against the same set of rules.
 - Broader acceptance of beneficiaries' usual cost accounting practices, in order to reduce the administrative burden on beneficiaries who will be able to identify their cost components via their own trusted methods.
 - Increased use of lump sums is based on the lessons learned from the lump-sum pilot within the 2018-2020 calls under Horizon 2020. In addition, although not specifically mentioned in the Rules, the two current unit costs calculated in accordance with the beneficiary's practices (average personnel costs and internal invoices) will be maintained.
 - The unit cost for internally invoiced goods and services will allow for a higher acceptance of the usual cost accounting practices by allowing beneficiaries, under certain conditions (to be set out in the grant agreement) to calculate this based on 'actual eligible direct and indirect costs'.
- Secure electronic system will be maintained: the use of a tool for providing secure electronic interaction (currently the Participant Portal) should be made mandatory, in accordance with the Financial Regulation. The Participant Portal will also be extended to other EU programmes.
 - To address oversubscription, a broader use of multi-stage submission could be explored.
 - Simplification measures should also address Article 185 initiatives, e.g. potential inclusion in the Participant Guarantee Fund and the ex-post audit coverage by the Common Audit Service.

4.3 What are the expected implications of the changes?

- The expected reduction of audit efforts should decrease administrative burden and costs for beneficiaries, as well as for Commission services. Implementing additional automated checks and tools for simpler entry of data will also have a positive impact where beneficiaries need to submit information to EC.
- Increased alignment to the Financial Regulation on actual costs, broader use of simplified forms of costs and of acceptance of beneficiaries' usual cost accounting practices will make Horizon Europe less burdensome and more attractive. Further acceptance of the beneficiaries' usual cost accounting practices will reduce the error rate on issues that have seen recurrent and repetitive errors under FP7 and Horizon 2020.

- > Further simplification due to increased use of lump sums under Horizon Europe. The use of lump sums reduces substantially the administrative burden during the lifetime of the project, shifting the focus of project monitoring from financial checks to performance and content.

- > The improvements to the Participant Portal, the single entry point for information providing secure electronic interaction, will offer easier access to the programme. Further improvements of the interfaces, guidance documents, as well as the online version of the Annotated Model Grant Agreement will similarly allow for easier access to information. Integration of ex-post audit support into the Portal will enable a clearer view on the progress of audits and allow for the electronic exchange of documents and notifications, thus reducing administrative burden and costs.

4.4 What alternatives have been considered?

Several alternatives to the simplification measures were considered, and several additional measures may be introduced during Programme implementation.

5 USE OF GRANTS, FINANCIAL INSTRUMENTS AND BUDGETARY GUARANTEES



FACTS

More than **90%** of the Horizon 2020 support is grant based. Less than 10% of support is provided through financial instruments, such as debt and equity.

Horizon 2020 invests **€400 million** per year in risk financing, through the European Investment Bank. This is, however, less than 10% of Horizon 2020's overall budget.

5.1 What is the current situation under Horizon 2020?

Grants are the most widely used and appropriate form of public support for early stage R&I projects. Financial instruments are used for projects closer to the market.

5.2 What are the changes?

Horizon Europe aims to increase the number of young, highly innovative European companies that can scale up rapidly and grow into leading, market-creating innovators worldwide.

Lessons learnt from Horizon 2020

- Only a small number of companies receiving Horizon 2020 grants benefit from such financial instruments, and the programme lacks genuine connections between grant and loan-based financing for companies.
- A key aim of the Horizon 2020 financial instruments is to finance R&I projects closer to the market. But the analysis of Technology Readiness Levels (used to measure the maturity level of innovation) illustrated that the financial instruments financed an equal share of projects with lower level of maturity (TRL 1-3), medium level of maturity (TRL 4-6) and higher level of maturity (7-8).
- “Overall, the InnovFin scheme is performing well against its objectives of improving access to finance for innovative companies and projects, and helping to address related market failures. To the extent that shortcomings have been identified, these are more to do with the implementation of particular InnovFin schemes than being inherent programme design faults” (p. 467, *Annex 2 of Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 221 final, May 2017*).

The availability of flexible, agile funding is a key mechanism that enables scaling up. However, Europe’s innovators, currently cannot access risk finance above the €10 million range. The supply of flexible funding, such as blended finance (combining grants with loans or equity) or crowdfunding, is insufficient. European investors are more cautious than their American counterparts and are typically focused on smaller amounts. The European stock markets provide insufficient source of finance¹¹.

As a result, a major concern for Horizon Europe is to increase the willingness of private investors and lenders to commit to these young, highly innovative European companies. Blended finance will help. Combining grants with equity, loans, soft loans or guarantees, this allows for blending simultaneously, for example, as a grant-plus-equity package. Sequential blending is also possible, as when a grant attracts a later investment by a Venture Capital fund, business angel or corporate Venture Capital arm, or facilitates a loan from a bank or a non-bank lender.

5.3 What are the expected implications of the changes?

- Blended finance will increase the availability of large-scale risk finance in Europe;
- The leverage of EU R&I funding is expected to increase through measures put in place to stimulate private finance;
- Increased risk taking for breakthrough innovation by de-risking technical, commercial or company failure.

5.4 What alternatives have been considered?

Providing grant-based support through Horizon Europe and financial instruments through the InvestEU single fund:

- In Europe, financial intermediaries (banks and investors) remain averse to the risk when investing in high-risk innovative projects. Therefore, available private and corporate financing remains small for innovation activities and market take-up for breakthrough innovations, as financial institutions must limit their risks to maintain their market rating. There is hence a necessity for direct Union intervention. Innovation will thus be reinforced by the InvestEU single fund, providing indirect financial instruments carried out through the European Investment Bank Group or other implementing partners, with a dedicated window for R&I investments and specific products for innovative companies.
- Providing grants only allows lowering the risk of operations and attracting private or corporate finance. This is only partially the case, as some activities too close to market, including deployment and scale-up, may not be covered by grants. However, the alternative of awarding blended finance to a project by allocating grant-type funding (through the Framework Programme) and financial instruments (through InvestEU) might not be fully adapted to the needs of risky breakthrough innovators who need to proceed to the market quickly.

6 PROPOSAL SELECTION AND EVALUATION, INCLUDING EXPERTS



FACTS

Three criteria against which proposals are evaluated – **Excellence; Impact; Quality and Efficiency of the Implementation** (with Excellence only for the European Research Council calls).

There is a higher weighting for **Impact** within Innovation Actions calls.

Independent experts shall be chosen on the basis of their **skills, experience and knowledge** appropriate to carry out their tasks. When appointing, the Commission shall seek a **balanced composition** within the expert groups and evaluation panels in terms of various skills, experience, knowledge, geographical diversity and gender. Where appropriate, private-public sector balance shall also be sought.

6.1 What is the current situation under Horizon 2020?

The approach for the **evaluation and selection of proposals** submitted to Horizon 2020 calls is to ensure a maximum of coherence across the different implementing bodies, with three standard evaluation criteria outlined

in the Rules for Participation. Details of the evaluation criteria, weighting and thresholds, as well as additional eligibility criteria, are laid out in the Work Programmes. As regards the appointment of **independent experts** to evaluate proposals (and other tasks), the key provisions are set out in the Horizon 2020 Framework Programme Regulation rather than the Rules for Participation.

Lessons learnt from Horizon 2020

- › “There is room for improvement in the current evaluation process. The thematic assessments ... highlight dissatisfaction with application procedures, proposal evaluation and selection and reporting procedures. In addition they note that the quality of feedback provided to applicants is an area for improvement. This is also reflected in the stakeholder consultation results, where 62% of respondents assess the quality of the feedback from the evaluations as “good” or “very good”, while 34% judged it as “poor” or “very poor”. Some respondents ask for more transparency and an improved quality of the evaluation feedback they receive. Respondents complain that not enough details are provided, that the quality of the feedback varies greatly from one evaluation panel to the other, and that discordant views can be provided to the participant.

- > In their position papers, some stakeholders from academia, research organisations, public authorities and business commented on the evaluation process and noted that the quality of the current process should improve. A variety of issues was highlighted, in particular: the Evaluation Summary Reports are reportedly too short and provide generic and not tailored feedback. A few stakeholders noted [...] evaluation committees should have a balanced representation of stakeholders including industry, business participants and SSH experts. Business representatives further noted that the selection rules of expert panels, especially around conflicts of interest, seem to dissuade industry experts as evaluators; evaluators should have the necessary expertise and training, while consensus meetings should be reintroduced”. (In-Depth Interim Evaluation of Horizon 2020, SWD(2017) 220 final)
- > “A modernised proposal evaluation system should attract different types of evaluators. Evaluation teams should consist of top people with broad experience well-matched to the call or mission and different competences to evaluate excellence and impact. Resources should be invested in providing meaningful evaluation feedback to applicants, including on the choice of funding instrument”. (p. 15, *LAB-FAB-APP, July 2017*)
- > “The Council invites the Commission to develop the evaluation process further by e.g. promoting diversity in evaluation panels, piloting blind evaluations, where possible”. (p. 8, *Council Conclusions “From the Interim Evaluation of Horizon 2020 towards the Ninth Framework Programme”, December 2017*)
- > “The European Parliament calls for better and more transparent evaluation and quality assurance by the evaluators; stresses the need to improve the feedback given to participants throughout the evaluation process and urges that complaints made by unsuccessful applicants that the Evaluation Summary Reports (ESRs) lack depth and clarity on what should be done differently in order to succeed be taken into consideration; calls on the Commission, therefore, to publish, in conjunction with the call for proposals, detailed evaluation criteria, to provide participants with more detailed and informative ESRs and to organise calls for proposals in such a way as to avoid excessive oversubscription, which badly affects researchers’ motivation and the reputation of the programme”. (p. 13, *European Parliament Report on the assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal, June 2017*)

6.2 What are the changes?

Proposal selection and evaluation

A similar level of detail on the evaluation and selection of proposals should be maintained in the legal acts and call documents of Horizon 2020, with small changes in order to address lessons learned and the specific features of Horizon Europe. Based on the specific recommendations coming from the Horizon 2020 Interim Evaluation, the following issues will be addressed in the design of the new programme:

- › Differentiate the evaluation process according to objectives of the calls.
- › Allow for differentiation of expertise within evaluation stages, where appropriate.
- › Provide flexibility and allow for experimentation.

Thus, the provisions retained in the Rules for Participation include:

- › Clarified time-to-grant and time-to-inform milestones.
- › Outlined award criteria - Excellence, Impact, and Quality and efficiency of the implementation, with the only exception of the ERC, where the sole criterion of excellence will apply.
- › The possibility for selection to take into account factors beyond proposal-by-proposal evaluation (for example, a mechanism to ensure a coherent portfolio of projects).

- › Possible selection on first-come-first-served basis (i.e. no ranking of batches).
- › The main aspects of the proposal review procedure.

Experts

The rules on appointment of external experts are further aligned to the Financial Regulation. Therefore, the following provisions are included in the Rules for Participation for Horizon Europe:

- › Selection criteria: independent experts may be selected without a call for expression of interest, if justified, and the selection is carried out in a transparent manner;
- › Appropriate remuneration;
- › The publication of the names of external experts evaluating grant applications.

6.3 What are the expected implications of the changes?

Experience under Horizon 2020 has made clear the advantage of keeping certain principles fixed across the board, while adjusting the arrangements via the Work Programme. There are no obvious reasons for departing from this approach under Horizon Europe. Furthermore, many of the deficiencies noted (inadequate evaluation feedback; need for a broader pool of experts) should be addressed by the business processes – rather than by provisions in the Rules for Participation.

More widely, the changes detailed above would ensure necessary coherence across the programme but balanced with flexibility (in line with the guiding principle of “evolution not revolution”) – thus enabling further simplification, addressing the lessons learned from the interim evaluation of Horizon 2020 and the Lamy Group report, whilst preparing for expected new features under Horizon Europe.

6.4 What alternatives have been considered?

Firstly, the possibility to specify in further detail the criteria for evaluation and selection of proposals in the Rules themselves (at a similar level of detail as in current Work Programme annexes) was considered. This would ensure a high degree of coherence across Horizon Europe. Different approaches between instruments could still be included in the Rules, but exceptions and derogations would all but disappear. This would provide a measure of stability for applicants. However, it would be virtually impossible to adapt the rules according to experience gained – nor experiment with new approaches. As such, there would be significant loss of flexibility.

Secondly, the possibility to move all or most of the rules out of the Rules for Participation (to the Work Programme, for example) was considered. This would lighten the legislative process, and would be more in line with wider Commission processes. However, with a programme of the breadth of Horizon Europe, and given the experience of Horizon 2020 and previous programmes, it is important to fix certain rules to ensure overall coherence and to avoid re-opening fundamental principles with every set of calls. This approach would maximise flexibility, but it would risk a divergence of rules in practice, jeopardise smooth business processes, and lead to unpredictability for applicants.

7 AUDITS AND CONTROLS



FACTS

A simplification measure introduced for Horizon 2020 was to **reduce the audit burden** on participants through an ex-post control strategy which emphasises risk-based control and fraud detection.

The maximum length of time for an audit after the final payment to a Horizon 2020-funded project was **reduced from five years to two years**.

The Horizon 2020 ex-post audit function has been **centralised** in the Common Audit Service within the Common Support Centre (part of DG Research and Innovation) serving all the Horizon 2020 stakeholders

7.1 What is the current situation under Horizon 2020?

The internal control system as a whole is supported by the Financial Regulation, which identifies the responsibility of the Authorising Officers for the control of budget implementation at programme level. This includes the calculation of the error level and the consequent corrective measures.

According to the existing Financial Regulation “each operation shall be subject at least to an ex-ante control”. Nevertheless, the extent in terms of frequency and intensity of the ex-ante controls shall be determined by the Authorising Officer taking into account risk-based and cost-effectiveness considerations.

The ex-post financial audit rules shall be clear, consistent and transparent and that the Commission shall ensure equal treatment of beneficiaries of a programme, in particular where it is implemented by several Authorising Officers.

The Horizon 2020 control framework is based on the following elements:

- **Operational capacity and financial viability checks:** Article 15 of the Horizon 2020 Rules for Participation and Dissemination states that this is required only for project coordinators when the requested EU contribution is equal or superior to €500,000, or when there are grounds to doubt the financial capacity of participants. It will not be verified for entities guaranteed by a Member State (or an associated country), or by any other legal entity whose financial capacity shall in turn be verified, or for higher or secondary education establishments.
- **Certificate on Methodology to calculate Unit Costs:** Participants that calculate and claim direct personnel costs on the basis of unit costs, in accordance with the Horizon 2020 Rules for Participation, may submit to the Commission a certificate on the methodology (CoMUC). This must comply with the conditions set out in Article 33(2) of the Rules for Participation and Dissemination.

nation¹² and meet the requirements of the grant agreement. Where the Commission accepts a certificate on the methodology, it shall be valid for all actions financed under Horizon 2020 and the participant shall calculate and claim costs on this basis. Once the Commission has accepted a certificate on the methodology, it shall not attribute any systemic or recurrent error to the accepted methodology. However, the certificate is optional has seen very low interest to date.

- › **Certificate of Financial Statements (CFS):** In Horizon 2020, a CFS is required when an amount claimed by a beneficiary for actual/unit costs calculated on the basis of the beneficiary’s usual cost accounting practices is equal or greater to €325,000. This is a derogation from the current Financial Regulation, which states that a CFS is only required if the total grant amount is EUR 750,000 or more, and that a CFS may also be demanded on the basis of a risk assessment by the Authorising Officer. The Horizon 2020 CFS (as the CFS under FP7) is based on “agreed upon procedures” instead of an “audit opinion”.
- › **Ex-post audits** are an important part of the overall control framework and provide inputs to the ex-ante checks. The Horizon 2020 Audit Strategy is supported by the existing Financial Regulation and the Horizon 2020 Regulation.
- › **Acceptance of usual of Cost Accounting Practices:** Under Horizon 2020, the Commission set out certain unit costs on the basis of the usual cost accounting practices of beneficiaries (i.e. average personnel costs and internal invoices) under certain conditions detailed in the MGA. This concept is also used when referring to beneficiaries’ records in the accounts: i.e. beneficiaries must record actual costs in accordance with their usual cost accounting practices. However, those provisions have to be compatible with the other Horizon 2020 eligibility criteria.

In addition, the simplified funding model (see Annex 7, section 2) introduced for Horizon 2020 is expected to reduce the financial error rate detected in ex-post audits, although when the Horizon 2020 interim evaluation was carried out in mid-2017 no ex-post audits had yet been completed.

Lessons learnt from Horizon 2020

- › “In order to reduce the audit burden, the obligation to provide representative ‘error rates’ for the programme should be dropped. Audits should only be carried out when there is a suspicion of fraud or serious financial wrongdoing on a project”. (*LAB-FAB-APP: High Level Group report, July 2017*).
- › “The effects on the simplification of financial management in the projects and on the error rate cannot yet be assessed, as very few financial reports were yet submitted and no ex-post audits were yet finished”. (*p. 57, In-Depth Horizon 2020 Interim Evaluation, SWD(2017) 220 final, May 2017*).
- › Several beneficiaries have repeatedly expressed the need for having their processes confirmed in order to obtain comfort on their reporting. Experience has shown that the current way of auditing under both FP7 and Horizon 2020 does not necessarily provide this assurance to the beneficiaries since the current audit process focuses only on costs declared and not on the beneficiaries systems and their overall accounting practices.

7.2 What are the changes?

The overall objectives remain the following:

- Effectiveness, efficiency and economy of operations;
- Adequate management of the risks relating to legality and regularity, taking into account the multiannual character of programmes and the nature of the payments concerned.
- **Ex-post audits:** the approach under Horizon 2020 is successful and should be maintained; although the intensity of ex-post controls may be adapted.
- **The cross-reliance on assessments and audits:** The explicit reference to this principle in the new EU Financial Regulation allows for broadening its use by accepting other audits (i.e. audits of other EU programmes) as a basis for the assurance to be obtained by the Responsible Authorising Officers. This requires that the costs could be audited or assessed against the same set of rules. In addition, taken into account the balance between trust and control, it is proposed that the opportunity of performing ex-post audits should be reconsidered.

Specific changes include:

- **Certificate on Methodology / Systems and Process audits:** Under Horizon 2020, the Certificate on Methodology to calculate Unit Costs (CoMUC) was optional and the beneficiaries have shown low interest to date, resulting in very little added value as ex-ante controls. In addition, applying for a CoMUC is complex and burdensome. Therefore, it is envisaged to remove the existing CoMUC. Alternatively, a procedure under which beneficiaries may opt to have their systems and processes audited - under conditions to be set out in the Model Grant Agreement - is proposed.
- **Certificate of financial statements (CFS):** The new Financial Regulation does not set any limit. The CFS may be demanded by the Authorising Officer on the basis of a risk assessment. The use of CFS might be broadened in order to provide more assurance, or narrowed as a simplification measure (reduction of administrative burden). Considering the CFS has proved in Horizon 2020 to be a relatively effective ex-ante control (with cost claims with a CFS having on average an error rate 50% lower than those without), it is proposed that the CFS remains mandatory under similar conditions as under Horizon 2020 (thresholds, cost covered).
- **Ensuring equal treatment of beneficiaries when implementing the Framework Programme:** In order to strengthen this common approach, a “coordination and monitoring mechanism” is currently under design and will be effective as of 2018 for Horizon 2020. This is expected to be extended to Horizon Europe.
- **Acceptance of usual of cost accounting practices:** While attractive from a simplification perspective, the acceptance of usual cost accounting practices presents important challenges since neither international nor national standards/rules exist defining a minimum core benchmark of what is an acceptable set of “usual cost accounting practices”. As for Horizon 2020, the usual cost accounting practices of beneficiaries

can be accepted under certain conditions to be detailed in the Model Grant Agreement. Those conditions have to be compatible with the new Financial Regulation and eligibility criteria of Horizon Europe.

7.3 What are the expected implications of the changes?

While the reduction of the audit burden is a shared objective for beneficiaries, Commission and implementing bodies, the expected implications are:

- An alignment of the rules with other EU funding programmes will allow the beneficiaries to apply in a harmonised way their usual accounting practices. This will result in a smoother audit approach since the costs will be audited or assessed against the same set of rules.
- Specific features on the Certificates of Financial Statements (thresholds, frequency...) are foreseen in the Rules, which will result in a lower audit burden for beneficiaries.
- Further efforts in the area of ex-ante controls (through implementing additional automated checks and tools for simpler entry of the data) will have a positive impact where beneficiaries need to submit information to the Commission. The integration of ex-post audit support into the Participant Portal will enable a better view of progress of audits and allow for the electronic exchange of documents and notifications.

7.4 What alternatives have been considered?

It can be envisaged to identify possible common benchmarks / principles or best practices for a broader acceptance of usual cost accounting practices of beneficiaries from different sectors and/or different countries.

The concept of cross-reliance on other audits or assessments with other EU programmes was considered, however its effectiveness depends on the coherence of rules between programmes. Identifying possible common benchmarks / principles or best practises for a broader acceptance of usual cost accounting practices of beneficiaries from different sectors and different countries can be further explored as a second alternative with the aim of moving from a rule-based approach towards a principle-based one.

Such a challenging alternative would be possible, only once having taken into account the eligibility criteria of the different EU programmes.

8 INTELLECTUAL PROPERTY RIGHTS, INCLUDING “EXPLOIT IN THE EU”



FACTS

498 Intellectual Property Right (IPR) applications arising from Horizon 2020 projects have been submitted, of which 212 were awarded. This mainly consists of **patents** (408 applications and 141 awards) and **trademarks** (66 applications and 50 awards). These numbers¹³ will greatly increase as more projects under Horizon 2020 are completed.

8.1 What is the current situation under Horizon 2020?

The Horizon 2020 rules relating to dissemination and exploitation were largely built on the rules of the FP7 Programme: the same level of detail was maintained and the balance of interests between the different types of participants was not fundamentally altered.

Apart from simplification measures, changes were mainly introduced due to new policy objectives (e.g. open access to scientific publications), the inclusion of innovation (e.g. possibility to lay down additional exploitation obligations, publicly known as “Exploit in the EU first”), the need for specific rules deviating from the general framework in certain areas (e.g. security research) and new forms of funding (e.g. pre-commercial procurement).

The general rule in Horizon 2020 for exploitation obligations is that participants, having received EU funding, must use their best efforts to exploit their results, without any further conditions. ‘Exploitation’ is broadly defined.

Therefore, participants enjoy a large degree of flexibility when deciding how, where and by whom to exploit. Additional exploitation obligations may be laid down within the grant agreement, if foreseen in the Work Programme. Beneficiaries must report on their dissemination and exploitation activities during the project.

Lessons learnt from Horizon 2020

- › There is no major support for fundamentally different rules but some areas of improvement have been identified. Recently, national representatives and other stakeholders have also underlined a need to strengthen the rules requiring that Horizon 2020 project results should be exploited preferentially in the EU. Furthermore, the European Parliament resolution of June 2017 on the “assessment of Horizon 2020 implementation in view of its interim evaluation and the Framework Programme 9 proposal” stressed that *“FP9 for R&I should strengthen societal progress and the competitiveness of the EU, creating growth and jobs and bringing new knowledge and innovations in order to tackle the crucial challenges faced in Europe, as well as delivering further progress in developing a sustainable ERA”*.
- › Feedback from R&I projects to other beneficiaries and policy-making must be strengthened, requiring also reporting after the end of the project on the dissemination and exploitation activities of beneficiaries, as those activities often take place after the end of the project. Moreover, if beneficiaries cannot successfully exploit their results, they should pro-actively seek that others are given the opportunity to exploit these results, including through an appropriate online platform.
- › The Horizon 2020 rules require that the Commission be given an opportunity to assume ownership of, and protect, any results that a participant would not wish to protect or for which they want to abandon protection or not extend protection (subject to various conditions). This requirement is perceived as an administrative burden and probably being complied with to a widely variable degree, as the notifications remain rather low. Moreover, experience has shown that if participants do not wish to protect, protection by the Commission is not considered appropriate either.
- › In Horizon 2020, joint owners may only agree not to continue with joint ownership after the results have been generated. This constraint was introduced during the legislative process to help less experienced participants (but the actual benefits are unclear). However, it means that no comprehensive agreement can be reached before the start of the project. This creates legal uncertainty having a negative impact on the cooperation required in multi-partner projects and may lead to a lower quality of projects/results. Moreover, this rule creates the illogic discrepancy that a participant may agree before the results are generated to transfer results it will solely generate but not results it will jointly generate. Restoring flexibility and offering guidance for beneficiaries to understand the issues at stake to help them to reach appropriate agreements for their specific project seems the best way forward.

8.2 What are the changes?

Most provisions of the Horizon 2020 rules will be maintained, with further simplification and improvements. This would entail:

- > Reinforcing the focus on exploitation in particular in the Union, as a general rule, while keeping the possibility for exploitation outside the Union and additional exploitation obligations at Work Programme level.
- > Specifying that the dissemination and exploitation plans must be updated during the project and after its end: the plan should contain a credible strategy if the expected exploitation entails developing, creating, manufacturing and marketing a product or process, or in creating and providing a service.
- > Providing for the possibility to require reporting regarding the beneficiaries' dissemination and exploitation activities beyond the life time of the R&I projects.
- > Removing the requirement to notify the Commission if no protection of results is sought, or if protection is abandoned or not extended.
- > Removing the prohibition to agree on a regime other than joint ownership before results are generated.
- > In view of the shortcomings in exploitation, beneficiaries which do not succeed in exploiting their results, need to use an appropriate online platform to seek exploitation by others.

8.3 What are the expected implications of the changes?

- > These refinements to the IPR rules would help to ensure that the rules under Horizon Europe are fully fit-for-purpose.
- > Improving legal certainty for participants and providing further simplification and flexibility.

8.4 What alternatives have been considered?

Alternative considered	Reason not favoured
Intellectual Property Rights (IPR) – general rules	
<p>Not to have detailed IPR rules, but lists of principles</p>	<p>This would be a radical shift from recent programmes and would be criticised by stakeholders - especially since it would force participants to negotiate all IPR provisions from scratch before starting a project, and could result in projects not having the necessary rules in place with a detrimental effect on the implementation of the project and the exploitation and dissemination of its results.</p>
<p>Include detailed IPR rules and fundamentally alter the balance of interests between the different type of participants</p>	<p>Such a shift does not seem justified given that most types of participants are of the opinion that the current rules are relatively well balanced.</p>
Exploit in the EU first	
<p>Not to have any 'protectionist' rules or provisions</p>	<p>Having no rules at all is not favoured as this approach does not guarantee that the Union will benefit from the exploitation of results.</p>
<p>Apply more stringent 'protectionist' rules across the board.</p>	<p>Having a more stringent general rule was considered not justified as there may be valid reasons why exploitation occurs elsewhere (in which cases the EU often still benefits from such exploitation). Moreover, depending on the type of project the expected results are often not directly exploitable and would require systematically assessing all projects for long after the end of the project and not only those close to market. Finally, such a generalised approach would deter in particular industrial and international participation leading to a loss of excellence and a lower quality of results.</p>

9 DISSEMINATION AND EXPLOITATION OF RESULTS



FACTS

Under Horizon 2020, a **strategy for the dissemination and exploitation of R&I results** was launched in 2015 at Framework Programme level, with dedicated dissemination and exploitation activities. The strategy was reviewed in 2017 and streamlined for the remaining years of Horizon 2020. At the same time, dissemination and exploitation activities were introduced from the various parts of the programme (i.e. the ERC Proof of Concept, the FET Launchpad, the SME Instrument) that support the uptake of results and innovations in the Union.

To assist project consortia in their dissemination and exploitation activities, the Commission provides tailor-made support services in the form of the Common Exploitation Booster (236 projects supported in 2017) and Common Dissemination Booster (260 projects supported in 2017) and the wide use of the Innovation Radar as a methodology to identify the innovations and innovators in R&I projects.

A new methodology tracking of research results obtained through the programme is under development. A new **Horizon 2020 Dashboard** making available all project related data and outputs was also set up.

9.1 What is the current situation under Horizon 2020?

Throughout Horizon 2020, specific calls for proposals, coordination and support actions and public procurements provide targeted assistance to projects in order to increase their dissemination and exploitation capacity and activities.

The uptake of R&I results for policy making, as well as measuring the impacts of the Framework Programme's investment, is improving under Horizon 2020. The Commission is piloting additional methodologies for tracking the research results (outputs, outcomes and impacts) after the completion of the projects. The aim of this is to acquire a more comprehen-

sive view of what the research funded under the Framework Programmes has achieved.

For external stakeholders, CORDIS is the primary public repository and portal to disseminate information on all EU-funded R&I projects and their results; providing user-friendly access to project data and results through faster and broader visibility of projects' outputs and improved search functions. Specifically, project deliverables and project beneficiary information were disseminated for the first time in the history of Framework Programmes. 'Results Packs', a new dissemination function presenting thematic collections of exploitable research results, was developed along with 'Enhanced Results in Brief', a new function that provides additional support in dissemination of research results.

In 2017, the Commission has launched a new platform for advanced visualisation of data on the Framework Programme, the Horizon 2020 Dashboard that provides a wide range of visualisation options for Horizon 2020 projects and proposals. It allows the users to visualise the performance and evolution of the data on the Framework Programmes in terms of impact, participation, investments,

international cooperation, results, etc. The 'Projects for Policy (P4P)' initiative launched in 2017 clusters and uses R&I results for evidence-based policy recommendations. In addition, the Innovation Radar was introduced as a Horizon 2020-wide methodology to identify innovations and innovators within R&I projects.

Lessons learnt from Horizon 2020

- Dissemination and exploitation activities are key to demonstrate the success and the impact of the Framework Programme. The dedicated activities to beneficiaries to better disseminate and exploit their results and increase their market and technology readiness were very successful and popular. Through the optimal use of IT infrastructure and the advanced visualisation of the available data on the Framework Programme (Horizon 2020 Dashboard), the Commission demonstrated the added value of the Programme.
- Although a robust framework has already put in place to help dissemination and exploitation of R&I results from Framework Programme's projects, they are still not fully accessible to all relevant stakeholders and this represents a barrier to knowledge circulation and to innovation uptake. Additional efforts required to access and make available knowledge and results from projects supported under the Programme.
- Current information collection does not systematically cover research results, innovations and market uptake, and therefore does not always allow for the assessment of projects' medium- and long term impacts. New policy challenges should be better matching by the appropriate mechanisms to collect the necessary data.
- The results of most Horizon 2020 R&I projects mainly improve scientific knowledge and advance science in the field(s) in question. Some will have market or technological potential. The uneven exploitation capacity among beneficiaries hinders the market uptake of key exploitable results and incentives for market exploitation are limited once funding has stopped.
- Many R&I projects produce recommendations for policy-makers in various fields. As policy recommendations are less market- and technologically ready than other key exploitable results, projects do not tend to emphasise this kind of output. This hinders the full potential for exploitation of results from the Framework Programme for policy-making at EU and national levels.

(Sources: Horizon 2020 Interim Evaluation, Review of the Strategy for an Effective Dissemination and Exploitation of Research Results in Horizon 2020, studies)

9.2 What are the changes?

Within Horizon 2020, reporting has focused mainly on input information in relation to projects launched and funding granted. However, to address the significant need to report on the impact of R&I investments, equal attention will be given to information on results to develop a clear picture of the number of completed projects, the fields to which these relate, what they delivered and what steps have been taken regarding exploitation of research results.

The following changes are envisaged for the future Programme:

Short term:

- Support R&I stakeholders in fully endorsing the principle of the open access and work with them to make the European Open Science Cloud a reality.
- Put in place a comprehensive go-to-market package to incentivise the exploitation of Framework Programme's results by helping beneficiaries to find the most appropriate instruments and channels for the market uptake of their innovations.
- Pilot the role of Horizon 2020 as a pan-European policy influencer through Projects for Policy initiatives, with the aim of using scientific knowledge and results created by R&I projects.
- Design a methodology for monitoring the Framework Programme's results and foster business intelligence that could build on artificial intelligence, advanced data visualisation and data mining tools to demonstrate impact.

Long term:

- Based on the positive experience of the previous dissemination and exploitation strategy, put in place a more ambitious and comprehensive strategy for increasing the availability of R&I results and accelerating their uptake to boost the overall impact of the Framework Programme and thereby strengthen European innovation.
- Strengthen innovation-friendly framework conditions that allow for unrestricted and constant knowledge circulation and create the necessary incentives for beneficiaries and innovators to share their results for reuse.
- Disseminate clusters of mature research results to EU regions for potential uptake based on their specific needs. This would maximise the benefits coming from synergies with EU initiatives, for increasing regional competitiveness and innovation.
- Provide holistic support throughout the dissemination and exploitation lifecycle to ensure a constant stream of innovations stemming from the Framework Programme.

9.3 What are the expected implications of the changes?

- No major changes envisaged for Horizon Europe's rules for participation. The obligation of beneficiaries towards dissemination, exploitation and impact demonstration shall be reinforced.

- > The possibility of additional reporting specifically on dissemination and exploitation or impact demonstration might be considered within the framework of simplification. This reporting should continue beyond the lifetime of the projects.
- > **Changes in the evaluation phase:** a different consideration of exploitation at evaluation phase, with an evaluation panel featuring clear business experience alongside academic and scientific background would help select proposals better placed for ensuring uptake of research results. For recurring participants in the Framework Programmes (i.e. having participated in previous programmes), consider introducing the requirement to submit, as part of their proposal, an *ex-post Impact or Outcome Statement* of their research conducted under previous Framework Programmes.

9.4 What alternatives have been considered?

- > **Additional incentives:** beneficiaries could be given additional financial or other incentives to enhance their dissemination and exploitation capacity, focus on key exploitable results and their uptake, and/or enhance the impact of their research in real world settings.
- > **More funding for ‘research on research’** would allow researchers to take the time to assess the quality and consistency of scientific results, gather research on a particular topic, identify common themes and develop common responses.

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- 1 Ex-post evaluation of FP7, 2016.
 - 2 **Fully centralised implementation:** This model, used by EMRP and EMPIR, the successive public-public partnerships on metrology under FP7 and Horizon 2020, is the most integrated one. Here the whole programme, including the management of the grants, is implemented by the Dedicated Implementation Structure. **Fully decentralised implementation:** In this model (AAL2 and Eurostars2) the DIS is mainly organising the central evaluation and channels the EU co-funding to the national funding agencies that are managing individual national grant agreements for the funded projects.
 - 3 Under Horizon 2020, actions managed by non-Union funding bodies are not covered by the Participant Guarantee Fund (PGF). Since 2007, two Participant Guarantee Funds were created (EU and Euratom FP7) in order to protect the risk of non-recovery of sums due to the Union and to allow ongoing projects to continue in case of default of one of the beneficiaries in grants administrated by the Commission, executive agencies and the GSA (European Global Navigation Satellite Systems Agency). The positive experiences acquired during the first FP7 PGF justified its continuation in Horizon 2020.
 - 4 The Commission will adopt provisions for participation of beneficiaries of other Union programmes and the associated contributions to the Fund will take account of their risk profiles.
 - 5 “The first three years of Horizon 2020 have shown a significant reduction of the time elapsing between the closure of a call and the signature of the Grant Agreement (i.e. Time to Grant), from an average of 303 days in FP7 to an average of 192.2 days, which is a decrease of 36.6% (more than 110 days)”. (p. 55, *In-Depth Staff Working Document on Horizon 2020 Interim Evaluation, SWD(2017) 220 final, May 2017*).
 - 6 Art. 125 of the new EU Financial Regulation refers to “forms of Union contribution”, however the more user-friendly “forms of grants” term is used in this section of the annex.
 - 7 Recital 13 of the Horizon 2020 Regulation. The flat-rate for indirect costs, the unit cost for the owners of SMEs and the unit cost based on average personnel costs also all mentioned in the core text of the Horizon 2020 Rules for Participation.
 - 8 The conditions for eligibility of these costs will be set out in the model grant agreement.
 - 9 These conditions (e.g. beneficiaries must be able to identify their actual eligible indirect costs, they must use of a fair key or driver to distribute these costs) will be further developed in the model grant agreement.
 - 10 Briefing Paper on ‘A contribution to simplification for research beyond Horizon 2020’, March 2018, available at: https://www.eca.europa.eu/Lists/ECA-Documents/Briefing_paper_H2020/Briefing_paper_H2020_EN.pdf
 - 11 In 2012-2016, the average European venture capital exit via Initial Public Offering (IPO) was nearly \$70 million versus \$220 million for the US: <https://techcrunch.com/2017/06/07/venture-investing-in-the-us-and-europe-are-totally-different-industries/85>.
 - 12 Regulation (EU) No 1290/2013.
 - 13 ‘Horizon 2020: In Full Swing – Three Years On’ brochure, January 2018 (p. 46).

PART 3

IMPACT ASSESSMENT OF THE EURATOM RESEARCH AND TRAINING PROGRAMME 2021-2025



IMPACT ASSESSMENT OF THE EURATOM RESEARCH
AND TRAINING PROGRAMME 2021-2025

1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT



1 INTRODUCTION: POLITICAL AND LEGAL CONTEXT

This impact assessment accompanies the Commission's proposal for the Euratom research and training programme for 2021-2025 (Euratom programme). In turn, the programme complements the Horizon Europe Framework Programme for Research and Innovation (FP) in the area of nuclear research and training.

On 2 May 2018, the European Commission adopted its proposals for a new Multiannual Financial Framework (MFF) for 2021-2027. Under these proposals, the Euratom programmes will have a budget of EUR 2400 mil-

lion over this period¹. This impact assessment report reflects the decisions of the MFF proposals and focuses on the changes and policy choices, which are specific to this instrument.

The Euratom programme is one of the spending programmes that will implement the Commission's vision for the period beyond 2020. Bearing in mind the lessons learned and progress achieved so far, the impact assessment will look at whether the existing programme should continue with its present form or undergo changes to its scope and structure.

1.1 CONTEXT

Research and innovation (R&I) programmes are crucial for implementing the Commission's vision as set out in the proposal for the next MFF. The Commission's reflection paper on the EU's finances² and the its Communication on the future MFF³ both highlight the significant role and added value of research programmes supported from the EU budget. R&I programmes are key in improving people's well-being, creating growth and jobs and finding solutions to a range of challenges.

Nuclear and radiation technologies continue to play an important role in the lives of all Europeans, in that they influence energy and climate change policies, security of supply, energy research and the use of radiation and radionuclides in non-power (medical, industrial, etc.) applications. The secure and safe use of these technologies remains paramount. R&I programmes play a key role in maintaining and using the highest standards of safety, security, waste management and non-proliferation and

in retaining Europe's leadership in the nuclear domain so as not to increase energy and technology dependence — this being one aim of the Energy Union⁴.

The Euratom programme is an EU-funded thematic research and training programme operating in scientific and technical areas covered by the Euratom Treaty⁵. The Council adopts the programme by unanimous agreement based on Article 7 of the Euratom Treaty.

The funded research focuses on nuclear safety, safeguards and security, radioactive waste management, radiation protection and fusion energy. The promotion of nuclear research remains a key provision of the Euratom Treaty (Article 4), which derogates from the general provisions for research under the Treaty on the Functioning of the European Union (TFUE).

As a result, EU R&I programmes (currently Horizon 2020) do not fund topics covered by the

Euratom Treaty; only the Euratom programme supports research at European level in this field. Until today, nuclear researchers were not eligible for funding from bottom-up EU programmes such as the European Research Council (ERC) or Marie Skłodowska-Curie Actions (MSCAs).

The current Euratom programme will end on 31 December 2018⁶. On 1 December 2017 the

Commission submitted to the Council a proposal⁷ to extend this programme until 2020 to bring it into line with the current seven-year MFF, running from 2014 to 2020.

Other MFF-related proposals are closely linked to the Euratom programme and more should be done to exploit the synergies between them (see Table 1).

Table 1 — Synergies with other MFF-related proposals

Proposed programmes for the new MFF	Links to Euratom programme 2021-2025
Horizon Europe Framework Programme for Research and Innovation	The Euratom programme complements the Horizon Europe Framework Programme’s research and innovation activities and shares the same rules for participation. The main features of the delivery mechanism for the Euratom programme (calls, funding model) will also be shared with the Framework Programme. Implementing the specific objectives of the future Euratom programme will require cross-cutting actions with the Framework Programme to tackle today’s societal challenges. Nuclear researchers will be able to access funding schemes under Horizon Europe, such as the MSCA (which will support the Euratom programme’s education and training goals).
Union Funds under shared management	The future Union funds under shared management (in particular the ERDF, ESF+ and EAFRD) will provide a large share of the EU funds for R&I. Holders of Seal of Excellence awards from directly managed Union programme should be eligible for this funding, benefiting from state aid exemptions.
ITER	International Thermonuclear Experimental Reactor (ITER) will be a key research infrastructure for the Euratom programme’s implementation of the European roadmap to fusion electricity, starting in 2025. The Euratom research programme (implemented by the European Commission’s DG Research and Innovation) will be carried out in full complementarity and coordination with the activities of DG Energy (responsible for ITER) in support to the construction of ITER and preparation of operation and Broader Approach activities.
Nuclear Decommissioning Assistance Programmes (NDAP) and Joint Research Centre (JRC) decommissioning	The NDAP and JRC programmes should provide feedback from decommissioning activities as input for future research in this field. The Euratom programme will fund research activities supporting the development and evaluation of technologies for the decommissioning and environmental remediation of nuclear facilities. The programme will also support the sharing of best practices and knowledge on decommissioning.

1.2 SCOPE OF IMPACT ASSESSMENT

This impact assessment focuses on the outcome of the Euratom programme's interim evaluation and stakeholder consultation. This will help determine any changes needed in the programme's scope, aims and delivery method, taking into account cross-cutting objectives under the new MFF (flexibility, focus on performance, coherence and synergies, simplification). It also meets the requirements of the Financial Regulation as regards preparing an ex-ante evaluation for the proposed Council Regulation establishing the Euratom Research and Training Programme 2021-2025.

However, it does not cover the rules for participation. As is currently the case with Horizon 2020 and the Euratom programme, these will be shared with the Horizon Europe Framework Programme for Research and Innovation (see the impact assessment for Horizon Europe). Neither does it cover ITER⁸, which is an essential element of the European fusion roadmap⁹. The impact assessment concerning the financing and the activities of the Fusion for Energy Joint Undertaking (F4E) – the EU's implementing agency for the ITER construction and Broader Approach activities, among others – is provided in a separate document.

The impact assessment for the Horizon Europe Framework Programme provides details of the related structural and policy issues affecting European R&I in general. Many of these issues are equally relevant for the Euratom programme, though the particular features of the nuclear research sector should be borne in mind. These include the need for large and expensive research infrastructures and high levels of public funding in some key areas (e.g. fission and fusion research or advanced materials).

The programme centres specifically on: safety at existing (fission) nuclear power plants; the lower proportion of SMEs in some areas because of the cost of research and related infrastructures; significant involvement from national public bodies/agencies; a sharper focus on education and training; and, last but not least, the fundamental importance of international cooperation. Where the impact assessment for the Horizon Europe is considered inadequate or inapplicable for the specific case of Euratom research, the issues are addressed in this document.

1.3 LESSONS LEARNED FROM PREVIOUS PROGRAMMES

Evaluations of successive Euratom programmes have shown how European support is vital for nuclear research to continuously enhance the safety and security of nuclear technologies.

The key findings from the interim evaluation of the 2014-2018 Euratom programme are set out below¹⁰.

a) Continue supporting nuclear research focused on nuclear safety, safeguards, security, waste management, radiation protection and development of fusion

The interim evaluation concluded that the Euratom programme is highly relevant across all activities, including nuclear safety, security and safeguards, radioactive waste management, radiation protection and fusion energy. Actions at European level in nuclear research continue to be instrumental in maintaining and using the highest standards of safety, security, waste management and non-proliferation, and in retaining Europe's leadership in the nuclear domain¹¹.

b) Further improve, together with beneficiaries, the organisation and management of the European Joint Programmes in the nuclear field.

The interim evaluation of the Euratom programme 2014-2018 found that the introduction of the European Joint Programme (EJP) Cofund action had been a success. The EJP instrument is designed to support coordinated national R&I programmes. It aims at attracting and pooling a critical mass of national resources for the Euratom programme's objectives and at achieving significant econ-

omies of scale by gathering related Euratom resources around a joint effort.

The independent group of experts running the evaluation made specific recommendations to improve the organisation and management of the EJPs in the nuclear field. These recommendations, while not questioning the basic structure or approach, require further refinements and changes to the EJP for it to remain effective going into the next programming period (2021-2025 and beyond). For more details on these recommendations and how the Commission's services addressed them, see section 4 (delivery methods for the funding under the future programme).

c) Continue and reinforce the Euratom education and training actions for developing competencies in the nuclear field which underpin all aspects of nuclear safety, security and radiation protection

The interim evaluation underlined the importance of developing comprehensive action for maintaining and developing nuclear skills in Europe, while also finding synergies with the Framework Programme's actions supporting education and training.

Maintaining competencies in safety, radiation protection and safeguards in nuclear regulatory authorities and the nuclear industry will be one of the critical challenges to effective regulation of nuclear power, nuclear science and ionising radiation technology applications in the coming decades. The challenge arises from the age profile of staff in the regulatory bodies — natural wastage (mostly due to retirement) over the next decades could see

the present nuclear safety knowledge base disappear — and from a decline in the numbers of nuclear science and engineering students.

In this context, the interim evaluation concluded that some specific changes should be implemented to give the Euratom programme greater impact in this area. The Euratom indirect actions in education and training should have more specific and measurable objectives. On the other hand, the JRC should enhance access to its research infrastructures and reinforce its education and training activities — in particular, hands-on practical training and work experience. The independent expert group proposed that students and researchers in the nuclear field should be eligible to take part in MSCAs, which provide mobility grants, and foster career development. In fusion research, the EUROfusion consortium should put more emphasis on training nuclear engineers and technologists for the next phase — the design of a demonstration fusion power plant.

d) Further exploit synergies between the Euratom programme and other thematic areas of the Framework Programme to address cross-cutting aspects such as the medical applications of radiation, climate change, security and emergency preparedness and the contribution of nuclear science

The interim evaluation concluded that the Commission should aim at developing joint research actions on the radiation protection

aspects of medical practices, as well as innovative nuclear medicines. Euratom should not develop such research alone, but do so jointly with the health part of the Framework Programme. The Commission should also seek other synergies between nuclear and non-nuclear activities and nuclear science applications such as security of energy supply, public involvement in decision-making, security of supply of medical radioisotopes and nuclear sciences applications in support of the sustainable development goals.

e) Further exploit synergies between direct and indirect actions of the Euratom programme

The interim evaluation recommended that the Commission should implement coherent programming of the direct and indirect actions of the Euratom programme, with well-defined governance and decision-making processes. This will help achieve maximum synergy between the indirect and direct actions, and enable the programme to operate with maximum efficiency and the most effective results possible. One scenario could be that the JRC might cease to participate in Euratom calls for proposals if a mechanism on the role and participation of JRC in the indirect actions funded by Euratom is established. Instead, when proposing research topics a process should be established to allow the JRC to contribute with its direct actions to the projects with its competences and expertise including an open access to its research infrastructures to all interested consortia.

1.4 FEEDBACK FROM STAKEHOLDERS

To gather information on the programme’s performance and on the research challenges to be addressed in the future, in 2017 and 2018 the Commission held two consultations, a roundtable on decommissioning, and a workshop with stakeholders to explore their specific needs. It also received an opinion from the Euratom Scientific and Technical Committee (STC)¹².

The input given was consistent with the findings from the Euratom programme’s interim evaluation and provides additional insights into issues of importance to nuclear research in Europe. The Commission used this important feedback in drafting this impact assessment and the proposal for the Euratom programme, in particular on the scope and delivery mechanism.

The 2018 consultation, to which the Commission received 353 responses, was addressed

specifically to research stakeholders such as technology platforms, nuclear regulators, public research bodies, universities and technical support organisations. The main purpose of the consultation was to seek stakeholders’ views on the issues that the Euratom programme 2021-2025 should address, the programme’s support for access to infrastructures, education and training, and the integration of direct and indirect actions.

The 2017 consultation¹³ was an open public consultation to evaluate the Euratom programme from 2014 to 2018 and prepare for its extension to 2019 and 2020. The Commission received 323 responses from individuals, research stakeholders and public authorities.

Table 2 provides an overview of the key messages from both consultations.

Table 2 — Key messages from 2017 and 2018 consultations

Scope of programme	<ul style="list-style-type: none"> ➢ The programme should continue to cover current research areas (nuclear safety, security, radioactive waste management, radiation protection, fusion energy) but funding should be more focused to maximise impacts. ➢ Research on ionising radiation and nuclear science (medical applications) should be supported by joint initiatives funded by Euratom and other programmes (for example, the health part of the Horizon Europe) or by research programmes other than Euratom. ➢ The Euratom programme should play a larger role in decommissioning, although stakeholders consider that Programme should be focused mainly on specific issues in decommissioning, such as skills development and exchange of best practices.
Instruments to be used	The future programme should continue to use current instruments to support research (research and innovation actions, innovation actions, coordination and support actions, European Joint Programmes).

European added value	European added value has come in the form of: funding for research, access to knowledge and/or nuclear facilities not available or difficult to acquire at national level, skills development, the establishment of research networks, and acquiring a critical mass of resources.
Access to R&I infrastructures	The Euratom programme should support access to relevant research infrastructures in Europe, including the JRC infrastructures.
Role of direct actions of the Euratom programme (carried out by the Joint Research Centre)	<ul style="list-style-type: none"> > The JRC should provide independent scientific advice in Europe and support for EU policies. > It should carry out research complementing national initiatives and develop a knowledge management centre for Euratom research. > Preferably, it should not compete in Euratom calls for proposals, but instead provide in-kind contribution in research to Euratom indirect actions. It should also play a coordinating role in knowledge management for the research results obtained.
Support for education, training, mobility	The programme should shift more resources towards addressing basic needs in education and training and mobility. Researchers would benefit from individual support when it comes to fellowships for PhD and postdoc researchers. The programme should support networking and exchanges among researchers and access to infrastructures, including the Commission's research infrastructures.
Fusion energy research	The creation of EUROfusion is an improvement (according to more than two-thirds of stakeholders). Researchers should enjoy greater mobility.

In February 2018 the Commission organised a workshop for research stakeholders and representatives of Member States on the following theme: 'Euratom Nuclear Fission Research and Training — What are the new specific needs?' Table 3 below gives the key messages from the workshop¹⁴.

Table 3 — Key messages from 2018 workshop

Research infrastructures in nuclear field	Euratom support for accessing research infrastructures, including the JRC, should be developed taking into account the different needs of stakeholders (open access for academia, commercial access for industry) and the range of access conditions (type of infrastructure, duration of access, size of team, technical support needs, etc.). Funding researchers' travelling, lodging and living costs should be also considered. Mapping research infrastructures and prioritising them for Euratom support should follow once open access is guaranteed.
Nuclear education and training at EU level	Education and training in nuclear issues is closely linked to research infrastructures in this field. The issues are of a complexity that requires hands-on training to pass on know-how efficiently. As both the infrastructures and the workforce are ageing, it is important to maintain the European capabilities necessary for anticipating future nuclear safety challenges in operating the current nuclear fleet. At the same time, it is important to make nuclear education more attractive to a younger generation by laying the foundations for research into forward-looking technologies, and also to be open to countries where major development is ongoing. One of the key challenges is trans-European knowledge-sharing and transfer across different fields and generations.
Nuclear science and ionising radiation technology applications	Nuclear science and ionising radiation technology applications, which go beyond the classical power sector, are increasingly important for medical, industrial and space applications, for instance. Nuclear medicine depends on the development of new pharmaceuticals and the transition from research to clinical practice, security of supply of radioisotopes and is governed by radiation protection and pharmaceutical legislation. The EU is a leader in this field and there is strong societal interest to further develop it. For this reason, maintaining European nuclear infrastructures and knowledge is critical for the development and sustainability of these applications, and the regulatory framework and research funding should be properly coordinated in the EU.
Innovation in nuclear research	In nuclear safety, it is vital to maintain know-how about the existing nuclear fleet and anticipate future nuclear safety challenges needs to be ensured. A bridge between research activities in the medical and non-medical sectors will be beneficial for both. The early involvement of the regulators is needed to facilitate the deployment of innovative technologies.

The 2017 opinion from the STC, the advisory committee appointed by the Council, on future Euratom research and training programmes included the following remarks (excerpt):

- > the urgent need for a coordinated and coherent approach to infrastructure investment. This will ensure that the EU gives value for money; that it provides for appropriate leverage both between and within the 'direct actions' and 'indirect actions' components of the Euratom research and training programme; and that it delivers enduring capacity and capability in facilities that underpin nuclear technology and that are vital for Member States in all related fields, including those essential for medicine and radiation protection, security and safeguards;
- > the need for Europe to continue maintaining skills and knowledge in advanced nuclear systems to be able to fulfil its potential and occupy its rightful position in the evolving international initiatives in this field ensuring the highest standards of safety, security, waste management and non-proliferation are achieved and maintained globally;
- > the need to continue the R&D efforts on waste management and geological disposal in the existing reactor fleet;
- > the significant cross-cutting benefits that can be realised between fission and fusion energy research programmes as the latter evolves from one focused on basic plasma physics to one focused more on technology and nuclear-related aspects;
- > the need to pursue efforts on radiation protection research where the focus remains on low-dose risk, which has important implications for EU citizens in view of the growing exposure from medical diagnostic and therapeutic practices, and in which research actions should therefore be co-funded by the Horizon 2020 health programme. This would free up limited Euratom funding for nuclear technology priorities, such as the efficient production of radioisotopes for medical purposes and biological research;
- > the need for the European programmes to include R&D in dismantling and decommissioning activities, so as to maintain the capacity and capability to undertake them in the future. The report recognises that there is presently no Euratom funding for this type of research;
- > the paramount importance of guaranteeing an adequate supply of experts and trained workers — in view of the increasing demand across all disciplines, coupled with the ageing and imminent retirement of a generation of experts — and the role that the Euratom programme, as a research and training programme, can and should play in ensuring that supply.

- 1 In line with Article 7 of Euratom Treaty the proposal covers 5 years (2021-25). Years 2026 and 2027 will be covered by a separate proposal.
- 2 https://ec.europa.eu/commission/sites/beta-political/files/reflection-paper-eu-finances_en.pdf.
- 3 COM(2018) 98.
- 4 See Energy Union Package, COM(2015) 80.
- 5 Annex 1 to the Euratom Treaty.
- 6 Pursuant to Article 7 of the Euratom Treaty, Euratom research and training programmes can be adopted for five years.
- 7 COM(2017) 698.
- 8 ITER, meaning 'the way' in Latin, is the fusion research facility under construction in southern France as part of a worldwide collaboration.
- 9 Fusion electricity – a roadmap to the realisation of fusion energy (<https://www.euro-fusion.org/eurofusion/roadmap/>)
- 10 COM(2017) 697.
- 11 See Energy Union Package, COM(2015) 80.
- 12 STC opinion on future Euratom research and training programmes, February 2017.
- 13 For details on the 2017 public consultation see Staff Working Document SWD(2017) 427.
- 14 Workshop held on 21 February 2018 in Brussels.

IMPACT ASSESSMENT OF THE EURATOM RESEARCH
AND TRAINING PROGRAMME 2021-2025

2. CHALLENGES AND OBJECTIVES



2. CHALLENGES AND OBJECTIVES

2.1 KEY FEATURES OF THE CURRENT EURATOM PROGRAMME

Key features of the current Euratom research and training programme 2014-2018 are:

- A **five-year cycle** (2014-2018) with a budget of **EUR 1.6 billion**. The Council may extend the programme for two years to match the seven-year duration of the Horizon 2020 Framework Programme and MFF.
- **Support for nuclear research in Europe, with a focus on safety**, waste management and radiation protection, as well as nuclear security and safeguards.
- Allocation of **research funding** through an EU-wide competition based on **excellence** as the guiding principle and main evaluation and selection criterion¹⁵.
- **Central management** of the programme by the Commission.

The Euratom research and training programmes have been implemented by the Commission since 1959. The 2014-2018 programme provides funding for nuclear research in nuclear fission and fusion. Fission research covers nuclear safety, security, safeguards, waste management and radiation protection. Fusion research deals with the development of fusion energy. The Council Regulation establishing the current programme sets out the broad lines of action and the budget envelope. The Euratom work programmes for

direct and indirect actions define the detailed priorities, budget and instruments to be used, usually on a biennial basis.

The Commission implements the programme through direct and indirect actions. The 'direct actions' concern research carried out by the Commission through its JRC and are focused only on fission research (nuclear safety, safeguards and security, radioactive waste management and radiation protection, including support for the relevant EU policies). The 'indirect actions' concern research carried out by trans-European project consortia of private and public research groups. They address not only the safety of nuclear systems, waste management and radiation protection, but also the feasibility of fusion as a power source. Consequently, the indirect actions of the Euratom programme concern both nuclear fission and fusion.

Table 4 illustrates the different types of instruments used by the programme and the budget allocated to them.

Table 4 — Types of funding instruments in the Euratom Programme and % of budget allocated

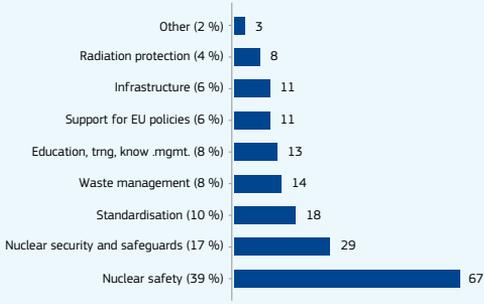
Category of funding instrument	Sub-categories	Purpose of instrument	% of total budget
Grants	EJP	European Joint Programme Cofund actions designed to support coordinated national research and innovation programmes (31% of total Euratom budget)	48%
	RIA	Research and innovation actions to fund research projects tackling clearly defined challenges, which can lead to the development of new knowledge or a new technology (17% of total Euratom budget)	
	IA	Innovation actions focused on closer-to-the-market activities (prototyping, testing, demonstrating)	
	CSA	Coordination and support actions to fund the coordination and networking of research and innovation projects and programmes	
Direct JRC actions		Funding for research carried out by the Joint Research Centre of the European Commission	35%
Contracts based on Article 10 of the Euratom Treaty		Contracts between the Commission and research infrastructure operators, providing researchers with access to the infrastructures	16%
Loan-based financial instruments	InnovFin	Loans to support fission R&I projects for the construction or refurbishing of research infrastructures	1%
Prizes	Recognition Prizes	Financial prize following a contest in order to recognise past achievements and encourage future activities	<1%

Source: European Commission

The bulk of the budget (almost half in all) is used for different types of grants, including EJP Cofund actions, collaborative research and innovation actions, coordination and support actions and innovation actions. Direct research actions implemented by the JRC¹⁶ form the second most important category. The third is made up of contracts supporting the use of research infrastructures in fusion research (based on Article

10 of the Euratom Treaty). Other types of actions include recognition prizes and financial instruments. As for research priorities, 55% of the programme's budget is allocated to fission research¹⁷, in particular nuclear safety, security and safeguards (see Table 5). This research is implemented through all instruments available to the programme, except Article 10 contracts.

Table 5 — Fields of research funded, instruments used and budget allocated under Euratom research and training programme 2014-2018

Field	Average annual budget	Funding instruments used	Annual average budgets per subfield of research (in millions of euros and in %)
Nuclear fission*	175 (55%)	Direct actions, EJP, RIA, IA, CSA, InnovFin	
Fusion energy	145 (45%)	EJP, Article 10 contracts, prizes	
Total	320 (100%)		

* Combined data for direct and indirect actions. Source: European Commission

The programme's second priority, accounting for 45% of the total budget, is fusion research, implemented mainly via EJP Cofund and an Article 10 contract.

The key feature of the programme is the way detailed priorities and assigned budgets are established through work programmes in close consultation with Member States and research stakeholders.

The Euratom direct actions consist of research activities managed and carried out by the JRC on its different nuclear sites. The work programme

for direct actions is a biennial rolling programme revised every year. After a planning phase performed by the JRC, the work programme is sent via inter-service consultation for comments from other Commission departments, and to the JRC Board of Governors (composed of representatives from Member States and associated countries) for their opinion. Once their feedback has been received and processed, the programme is formally adopted in a Commission implementing decision¹⁸, including the key orientations for the JRC work programme¹⁹.

The work programme for indirect actions defines details of the corresponding open calls for proposals. After the Programme Committee (consisting of Member State representatives) has given its view, the Commission formally adopts the Euratom work programmes. Applicants from industry, academia, national nuclear research centres and other stakeholders submit proposals in response to calls; these are then evaluated by panels of independent experts. The list of proposals to be funded has to be approved by the Programme Committee.

Research in fusion energy is implemented by a named beneficiary, the EUROfusion consortium. This consortium, whose members are nominated by the Member States and associated third countries, has a mandate to implement the European fusion roadmap through the EJP with a rolling annual work plan.

2.1.1 What will be the Euratom programme’s expected impacts under the next MFF with an unchanged policy (baseline scenario)?

The continuation of the ongoing programme is expected to promote scientific excellence in nuclear research in Europe, generate new knowledge in the nuclear field and maintain nuclear skills for nuclear safety, safeguards, security, waste management and radiation protection. The future programme with the present objectives (unmodified from its predecessor) will keep delivering impacts in the key areas (see Table 6). Although the specific objectives will remain unchanged, the detailed research priorities may shift in line with evolving needs and be reflected in the biennial work programmes adopted for direct and indirect actions.

Table 6 — Expected impacts of the Euratom programme 2021-25 with unchanged policy (baseline)

Field	Expected impacts
Nuclear safety	Reinforcement of nuclear safety thanks to the research support for the development of: <ul style="list-style-type: none"> > accident management strategies mitigating accidents’ consequences > updated knowledge on fuel properties under normal and accidental conditions and on the ageing and safe long-term operation of nuclear power plants (NPPs). > updated tools and models for safety assessments on operating NPPs, pre-normative materials qualification > safety and risk assessment of different innovative concepts of NPPs and minimisation of long-lived waste > Research results will help Member States implement the 2014 Nuclear Safety Directive
Nuclear security	Improved nuclear security due to: <ul style="list-style-type: none"> > better knowledge of how to mitigate the risks associated with radioactive materials outside regulatory control > better detection and identification (forensics), closer cooperation and greater exchange of knowledge > optimised response to security threats through training activities and transfer of knowledge

Field	Expected impacts
Nuclear safeguards	<p>Euratom and international safeguards systems rendered more effective by:</p> <ul style="list-style-type: none"> ➢ enhancing the measurement capacity for nuclear materials ➢ testing and developing integrated solutions, techniques and models for safeguards ➢ developing further concepts and analysis of open source and trade information
Nuclear standards	<ul style="list-style-type: none"> ➢ Pre-normative research on nuclear structural materials, resulting in codes and standards, novel test techniques and advanced inspection procedures ➢ Development of nuclear reference materials, standards and measurements for benchmarks to control environmental radioactivity measurements and to check conformity assessments
Radioactive waste management	<p>Safer management and disposal of radioactive waste thanks to:</p> <ul style="list-style-type: none"> ➢ better knowledge of the safe start of operations of geological disposal facilities for high-level radioactive waste/spent nuclear fuel ➢ research support to help Member States make progress with their national programmes for waste management in line with requirements of Directive 2011/70/Euratom ➢ mitigation of the risks associated with the management of high-level radioactive waste by developing models for safe disposal and improved design and technologies in support of the facilities ➢ safe management of innovative spent fuels and waste (small modular reactors, accident-tolerant fuels) ➢ improved standards and technology for the characterisation, management and disposal of other radioactive waste categories
Radiation protection	<p>Higher health protection for individuals subject to occupational, medical and public exposure to ionising radiation, thanks to:</p> <ul style="list-style-type: none"> ➢ better knowledge of the long-term effects of low doses of radiation ➢ a higher level of emergency preparedness ➢ more effective monitoring of radioactivity in food and on the environment, and more standardised measurement methods ➢ better knowledge of the effects of the exposure to ionising radiation used for medical diagnosis and treatment and how to reduce it <p>Research results will help Member States implement the Basic Safety Standards Directive</p>

Field	Expected impacts
Fusion energy	<ul style="list-style-type: none"> ➤ A significantly expanded knowledge base of ITER-relevant fusion science will increase ITER's chances of achieving its goals of proving the feasibility of fusion for power generation ➤ Developments in fusion technology will allow for the start of the conceptual design phase for a demonstration fusion power plant ➤ The development of high-tech solutions in the field of fusion technology will, with an appropriate technology transfer programme, generate spin-offs that benefit industry, the economy and society in areas beyond fusion applications
Education and training	<ul style="list-style-type: none"> ➤ Preservation of knowledge and improved transfer between generations and across national programmes in nuclear fission ➤ Training scientists and engineers will secure the human resources needed to run ITER and design future fusion power plants ➤ Knowledge management activities will guarantee that experience from the ITER project will be retained and fed into work to design and construct a demonstration fusion power plant
infrastructures	<p>Support for the availability and accessibility of relevant fission and fusion research facilities will bring all specific objectives of the programme closer. Examples of specific impacts:</p> <ul style="list-style-type: none"> ➤ the scientific/technical basis for power handling components of a fusion power plant ➤ prototyping of technology for a fusion materials testing facility will provide the information needed to start the construction of such a facility ➤ Sharing facilities will put them to full use, step up collaboration and allow for hands-on training
Support for policy	<p>Nuclear and ionising policy formulation based on sound scientific advice</p> <ul style="list-style-type: none"> ➤ Harmonisation of safety assessment methods, standards and tools and sharing of best practice for better implementation of directives in nuclear safety, spent fuel and radioactive waste management ➤ Monitoring of and support for policy implementation ➤ Trustworthy evaluation of policy effectiveness and impact

Negative impacts of the baseline scenario will be as follows:

- Limited (sub-optimal) impacts in **education and training** (no introduction of MSCAs) would result in a shortage of skilled and experienced staff in the nuclear and radiation field. At the international level, the EU might lose its position as world leader in nuclear and radiation technologies and might not be able to play an active role in spreading its high nuclear safety standards and safety culture. There would be insufficient expertise to operate fission technologies and a lack of specialised skills and knowledge transfer in both industry and science.
- Limited development of **knowledge management** would lead to loss of knowledge needed for the safe operation of existing reactors, for the management of spent fuel and radioactive waste (including repositories) and for the highest level of safeguards and security, and could lead to a defective transfer of knowledge.
- Limited **networking, infrastructure-sharing and open access** programmes would result in sub-optimal exploitation of existing and new infrastructures. The lack of new investment and key research infrastructures in fission would be a major hindrance. Hence the genuine need to pool resources at all levels (both private and public and at EU, national and regional levels) to overcome such obstacles.
- Limited emphasis is given in the baseline scenario to **nuclear science and ionising radiation technology applications**. The radiation protection aspects of the effects of ionising radiation used for medical

diagnosis and treatment on patients are included. However, the safe use of nuclear science and ionising radiation technology applications for medical, industrial, space and research applications is an important area which is not sufficiently covered in the baseline scenario. This could mean higher risks of population exposure to ionising radiation in medical treatments, or of environmental exposure to natural or man-made forms of radiation.

- Unless the most is made of the **synergies** between direct and indirect actions in **the Euratom programme** and between the Euratom programme and other thematic areas of the Horizon Europe, future research programmes will not maximise their impact in areas such as nuclear safety, waste management, radiation protection, medical applications of radiation, research infrastructures, etc.
- The **success of ITER** implies maintaining the level of support that is currently provided from the coordinated operation of the various infrastructures in the programme. In addition to this, a forward-thinking programme must make available new research infrastructures of relevance to ITER and DEMO²⁰. These might include a high magnetic field superconducting tokamak and a fusion neutron-relevant materials testing facility. If the necessary resources for such facilities and the accompanying research, training and education actions (including access to MSCAs) are not forthcoming, the successful operation of ITER and the design of DEMO will be significantly damaged, bringing delays to the programme and associated increases in costs.

- No clear direction on **decommissioning** research may lead to delays in implementing decommissioning strategies and modern techniques, and may give rise to shortcomings in sharing best practice and knowledge on decommissioning.

2.1.2 Main challenges and problems to be addressed by the Euratom programme 2021-2025

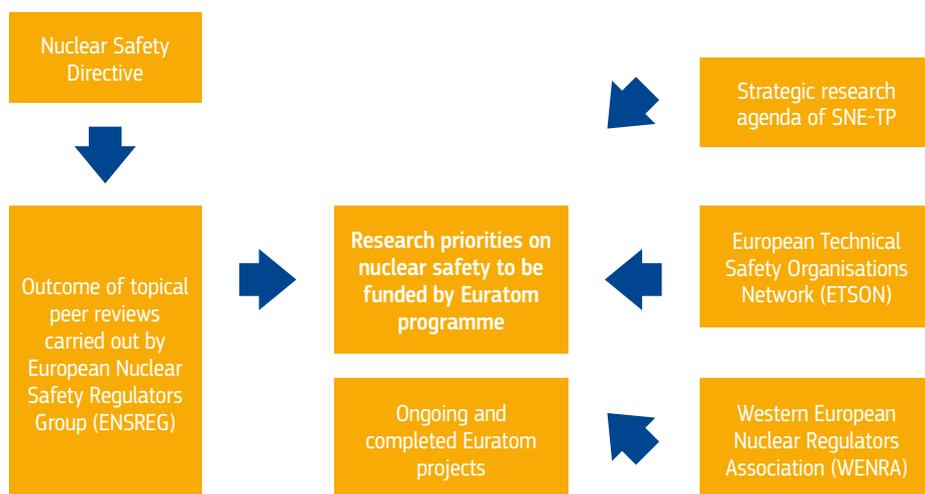
The future Euratom research and training programme should address the following research challenges:

a) Nuclear safety

The safety of nuclear energy production in the EU — and the safety of other nuclear installations such as spent fuel storages and fuel enrichment and reprocessing plants — are the primary responsibility of NPP operators supervised by independent national regulators. An EU-wide approach to nuclear safety is important, since a nuclear accident could badly affect countries across Europe and beyond. Following the Fukushima-Daiichi accident in 2011, Council Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations was revised. The 2014 Directive²¹ introduces a high-level, EU-wide safety objective to prevent accidents and avoid radioactive releases outside a nuclear installation. For plants already in operation, this objective should lead to the implementation of practical safety improvements. For future plants, significant safety enhancements are planned, based on the scientific and technological state of play. The Directive highlights the need for Member States to use research results in its implementation and creates a system of peer reviews.

The research priorities in nuclear safety are continuously evolving (see Figure 1) in line with the state of the art, as witnessed from the feedback from ongoing Euratom projects, updated strategic research agendas (SRAs) from technology platforms such as SNE-TP (NUGENIA), and feedback from implementation of the 2014 Safety Directive. In this regard, the results of the topical peer review on ageing management of nuclear power plants organised by European Nuclear Safety Regulators Group (ENSREG), expected in 2018, will serve as important input for the research agenda. Other leading stakeholders providing inputs are ETSON and WENRA (see Figure 1 below). On this basis, the Commission can ensure that the work programmes containing future calls for proposals funded by the Euratom programme are up-to-date and address current needs, including safety assessments for any innovative concepts.

Figure 1 — Overview of inputs for establishing research priorities in nuclear safety



An example of detailed feedback on current research priorities is given in Table 7 below.

Table 7 — Stakeholder feedback on current research priorities in nuclear safety input from European Technical Safety Organisations Network

- > Safety assessment methods (safety margins methodology, deterministic and probabilistic approaches)
- > Multi-physics multi-scale safety approach
- > Ageing of materials for a long-term operational perspective
- > Fuel behaviour (loss of coolant accident, RIA or reactivity insertion accident, criticality)
- > Human and organisational factors in safety management
- > Instrumentation and control (I&C) systems
- > Internal and external loads and malicious acts (integrity of equipment and structures, fire propagation, etc.)
- > Severe accidents phenomenology and management
- > Emergency preparedness and management
- > Extreme natural and unintended man-made hazards
- > Preventing and controlling abnormal operation and failures
- > Defence in depth — prevention of (severe) accidents through decay heat removal from the reactor core and the spent fuel pool (SFP), and secondly the protection of the containment integrity
- > Controlling severe conditions, including prevention of accident progression and mitigation of severe accident consequences

Source: ETSON views on R&D priorities for implementation of the 2014 Euratom Directive on safety of nuclear installations, Kerntechnik 81(2016), Position paper of the technical safety Organisations: Research needs in nuclear safety for GEN 2 and GEN 3 NPPs, October 2011

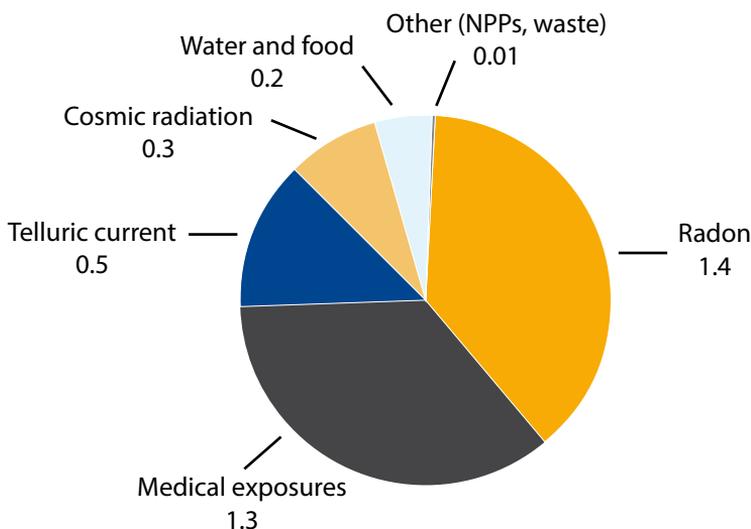
b) Radiation protection and ionising radiation applications

A growing number of different applications of ionising radiation requires protection of the people and the environment from unnecessary exposure to radiation. Ionising radiation technologies are used every day in Europe in a number of fields such as health, industry and research, providing large benefits to European citizens and European economy²². Research plays key role, providing for better

understanding of harmful effects of radiation from natural and artificial sources, and expanding beneficial applications of radiation technologies.

Naturally occurring radioactive isotopes of uranium, thorium, potassium and carbon constitute Europeans’ main source of exposure to radiation. Almost equally important are X-rays, used in medical diagnostics or therapy, whose contribution is increasing as medical procedures continue to rise (see Figure 2).

Figure 2 — Population’s exposure to ionising radiation (in millisiverts, data from France



Source: ASN, 2010

Low dose research

At the European level, efforts have been under way since 2007 to establish and bring together European platforms for radiation protection research in the five key areas of low dose risks, dosimetry, emergency and preparedness, radioecology and medical applications. The platforms concerned are MELODI, EURADOS, NERIS, ALLIANCE and, more recently, EURAMED. Following the establishment in 2015 of the European Joint Pro-

gramme in radiation research (CONCERT), all of these platforms have entered into close cooperation, including the development of SRAs, listing the general and specific research priorities within their disciplines²³.

These SRAs indicate that a key priority for radiation protection research is to improve health risk estimates for cases of exposure matching the dose limits for occupational exposure and the reference levels for the exposure of the population in emergency situations.

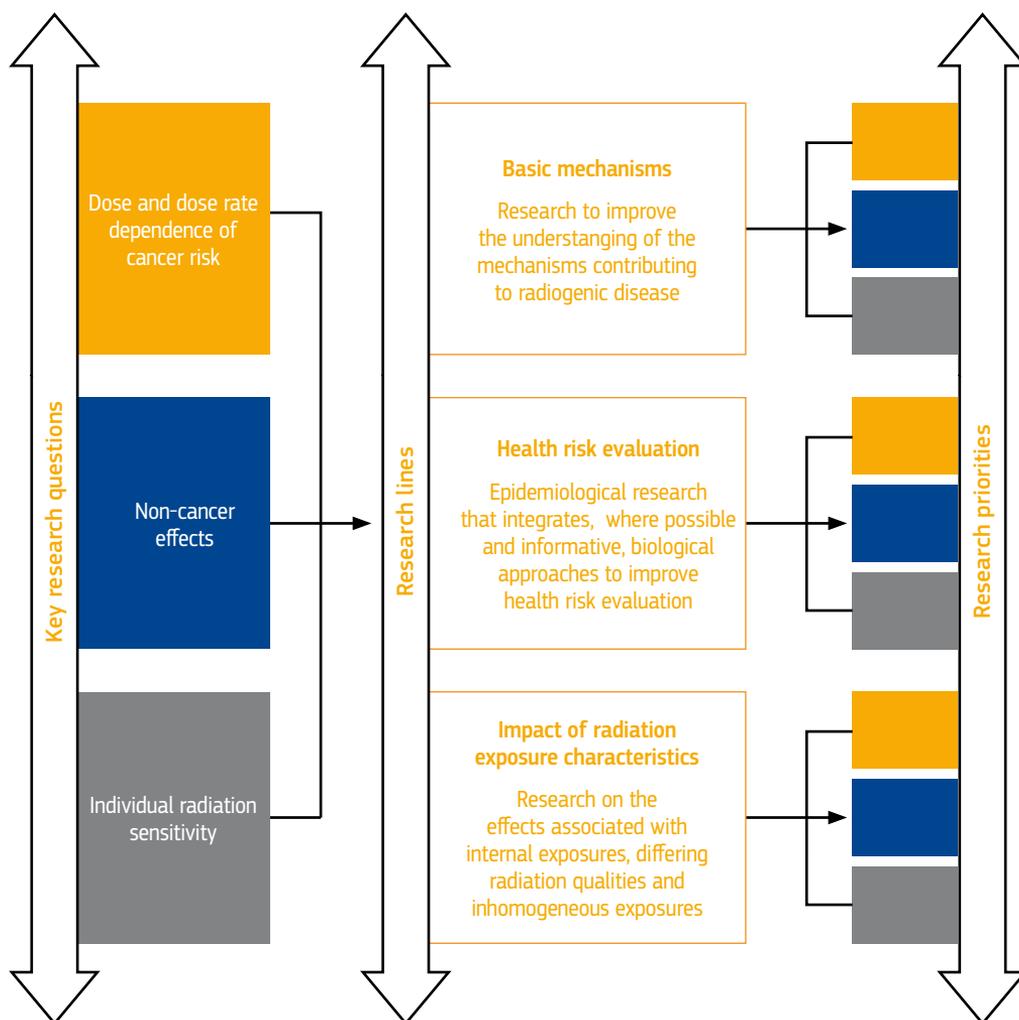
In addition, new challenges have emerged recently with the adoption of the Basic Safety Standards Directive that regulates practices involving ionising radiation in fields such as industry and medicine²⁴.

Recent tests carried out by the JRC in Member State laboratories highlighted major gaps in monitoring radioactivity in drinking water and in air. These should be addressed through support for measurement laboratories. For there to be comparable data between Member State laboratories, further work will

be needed on primary standards, reference materials and measurement methods.

The main uncertainties in radiation health risk evaluation are in the magnitude of cancer risk at low and protracted doses below 100 mSv, the magnitude of non-cancer effects below 500 mSv and the variation in disease risk between individuals in the population. Therefore, the key research questions are: the dose and dose-rate relationship for cancer; non-cancer effects; and individual radiation sensitivity (see Figure 3).

Figure 3 — Key research questions for low dose research



Source: MELODI

Research at low dose rates or low doses presents significant challenges in the investigation of both radiation-related health effects and underlying biological mechanisms because the magnitude of health risk and biological effects is expected to be low. A multi-disciplinary approach is therefore essential.

Medical applications of radiation

The health domain is by far the most important domain in Europe, where ionising radiation is used in terms of the number of people affected and from an economic perspective (employment, market and its growth rate). Radiation technologies are used in the health sector, both for diagnostics (imaging) and treatment (therapy). There are about 100 different nuclear imaging procedures available today and over 10 000 hospitals worldwide use radioisotopes; the vast majority of the medical procedures (about 90%) are for diagnosis²⁵.

Recent increases in medical imaging, particularly with respect to computed tomography (CT) and other high-dose procedures, have led to a significant increase in individual patient doses and in the collective dose for the population as a whole. Regular assessments of the magnitude and distribution of this large and increasing source of population exposure are therefore crucial. The overall per capita effective dose for all medical imaging (X-rays and nuclear medicine procedures) is about 1.12 mSv. The contribution to the total population dose of different procedures is as follows: CT (57%), plain radiography (17%), fluoroscopy (12%), interventional radiology (9%), and nuclear medicine (5%)²⁶.

Development of imaging technologies has to be followed, in order to ensure the fast deployment of dose limitation devices. The

clinical applications of imaging techniques using ionising radiation are very wide. On the other hand, the therapeutic clinical applications of ionising radiation are essentially focused on cancer treatment. Such therapies use high-energy particles or waves, such as X-rays, gamma rays, electron beams or protons, to destroy or damage cancer cells.

In view of the above developments, research challenges for the next 5-10 years must focus on:

- promoting the deployment of dose reduction functionalities in CT and supporting research on evolutionary CT technologies to reduce the dose to patients during CT;
- developing new radioisotopes (other than Mo-99/Tc-99m) for cancer treatment;
- monitoring better the doses received by patients from medical applications; and
- reducing the high variability in radiation doses between hospitals.

Other applications of radiation

Beyond their extensive use in medicine, ionising radiation (IR) technologies are present in a large variety of applications in industry, applied research, agriculture, environment or security, and their beneficial use could be further extended by research, in particular in dose reduction and provision of adequate standards and skilled personnel. The growth potential of new innovative industrial applications based on these IR tools is very large. For instance, nanoparticles (NPs) and nanostructures manufactured with IR tools may be used in a number of areas. Recent advances in particle accelerator technology could be beneficial for many energy and environmental appli-

cations, such as treating drinking water, waste water, and sludge, removing pollutants from stack gases, treating medical waste, conducting environmental remediation of hydrocarbon contaminated soil and conversion of fossil fuels. They may also have synergetic effects in other strategic domains (magnetic separation and superconducting technologies) like increasing the capacity of wind generators, enhancing the magnetic separation of material streams, and increasing the efficiency of electrical power transmission²⁷.

c) Waste management

Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste reaffirms that, ultimately, Member States are responsible for managing the spent fuel and radioactive waste they generate. This includes establishing national policies and implementing them under national programmes. The Directive lays down requirements concerning research as an integral part of their respective national programmes.

The key scientific and technical challenge in radioactive waste management remains the implementation of the disposal options for spent fuel and high-level radioactive waste over a very long time-scale (from hundreds to thousands of years). Research should reduce uncertainties in the safety assessment and demonstration of disposal, and provide analytical tools and methods to deepen understanding of ongoing processes and mechanisms at disposal sites. One important issue around geological disposal is about ensuring appropriate knowledge management and transfer between generations who will be responsible for managing disposal sites.

Research should also address issues concerning the management and disposal of other types of waste and streams, including legacy and pre-conditioned waste, waste from experimental and fuel cycle developments and waste from reactor dismantling, for which no appropriate management and disposal solutions are available. The traditional concepts for research on waste management are also subject to evolution. Waste resulting from accident-tolerant nuclear fuels, developed following the Fukushima accident, and from innovative future reactors present new challenges for disposal which need to be determined and assessed.

d) Decommissioning of nuclear installations

The decommissioning of nuclear power plants will become an increasingly important activity for the European nuclear industry in the coming years, due to the ageing fleet. However, experience in this field is rather limited²⁸. Ninety power reactors in the EU have been shut down, but only three had been completely decommissioned (all in Germany). The international view does not offer much broader experience: although today 166 reactors are in permanent shutdown mode worldwide, only 13 have been completely decommissioned: in addition to the aforementioned three in Europe, all of the others are in the United States. By 2025, it is estimated²⁹ that over a third of the EU's currently operational reactors will be at the end of their lifecycle and in need of shutdown. This equates to 40 additional reactor shutdowns and a total fleet of 130 reactors across the EU undergoing or awaiting decommissioning.

Though various dismantling techniques are already industrially mature, there are still

specific challenges regarding achieving high safety levels for dismantling operations. Public research has a potential role to play in supporting safe decommissioning and in reducing the environmental impact of decommissioning.

The EU must be better prepared for the emerging decommissioning market, and for safe dismantling and management of resulting radioactive waste. This requires the development of standardised practices, innovative technologies for waste and site characterisation, and the use of safeguards in nuclear decommissioning. In turn, all of these rely on scientific and technical support. A roadmap for decommissioning research, resulting from a project to be launched under the Euratom work programme for 2018, will provide guidance to stakeholders and the Commission on the steps needed during the next 10-15 years for the development of knowledge on decommissioning and its safety, economic and environmental aspects. It should support future coordination of R&I efforts, which currently tends to be sporadic and overlapping.

e) Nuclear security and safeguards

The main purpose of nuclear safeguards is to assure that nuclear materials are only used for their declared civil use and are not diverted for non-peaceful applications. The detection and the identification of illegally transported or stored nuclear material constitute a major line of defence against illicit trafficking.

According to Chapter 7 of the Euratom Treaty, the European Commission must fulfil its safeguarding obligations, in particular safeguarding existing radioactive materials in the EU and the obligations relating to the non-proliferation of nuclear weapons.

The role of research is to develop and improve analytical techniques and methodologies for safeguarding nuclear materials and to provide operational support to safeguarding authorities³⁰. Different innovative concepts for safeguards and non-proliferation such as the analysis of nuclear energy systems (safeguards by design, proliferation resistance evaluation, etc.), along with various sources of information, will need to be explored to deal with non-proliferation and security issues in the coming years.

Further research is needed to support nuclear security technologies, above all detection and nuclear forensics, to respond to a nuclear security event and provide substantial training in the field. To prevent the worldwide proliferation of weapons of mass destruction and other sub-national threats, scientific support for the harmonised implementation of trade controls must also be provided.

f) Maintaining nuclear competences and knowledge management

Using of nuclear technologies in all areas of application as well as nuclear safety and security require a highly specialised workforce and preservation of the present knowledge base. Regardless of whether or not new nuclear power plants are built in EU Member States, for several decades there will be an ongoing requirement in the regulatory bodies and the industry to recruit qualified staff. Not only the nuclear power sector, but also those industrial and medical applications making use of ionising radiations, together with fusion energy research, will require highly educated staff with very specific knowledge, skills and competences. The rapid advances in, and growing use of, radiation-based med-

ical imaging are also giving rise to particular concerns regarding the education and training of medical professionals.

The overall workforce situation in the EU (and worldwide) is at risk as highlighted by several reports and studies³¹. The challenge arises partly from the age profile of staff in nuclear fields (staff in the 45-65 age bracket account for more than half of the workforce). Because of retirements over the next decade or so — and partly because of a decline in the numbers of students graduating from courses in nuclear science and engineering and filling the vacancies left by retirees — much of the current nuclear knowledge base could be lost³². This decline is possibly caused by the perceived lack of professional career prospects. It is also becoming increasingly difficult to interest graduates from technical and other studies in taking up a job in the nuclear sector. Moreover, the European sector is rather unattractive for foreign talent, to the development of professional opportunities in nuclear field in other regions.

Knowledge management and knowledge transfer between generations and Member States is essential for maintaining the EU's high safety standards in all nuclear activities.

g) Fusion energy

EU decarbonisation efforts are currently supported through the development of renewables, improvements in energy efficiency, and use of nuclear fission. In this context, all existing energy sources have their disadvantages and limitations. Use of nuclear fission requires continuous safety improvements, develop-

ment of radioactive waste disposal and reduction of risks related to nuclear proliferation.

On a longer timescale, fusion energy is a possible new complementary option for low carbon electricity production, which could help address climate change and a growing energy demand. Fusion would be a continuous energy source that does not face the same safety risks, limited waste and proliferation issues as fission, and does not require disproportionate land use. To prepare Europe for fusion deployment, the research and technology development must first demonstrate the scientific and technical feasibility of fusion energy, and then demonstrate its commercial and economic viability. If found to be a viable new energy source, it could contribute significantly to the well-being of future generations. The main impacts of fusion energy deployment could be:

- Improvement of environmental performance of EU energy sector
- Contribution to the mitigation of climate change and to EU energy security
- Improvement of the EU innovation and competitiveness.

Fusion research is a long-term endeavour due to the need to master hot plasmas in large facilities and to develop materials able to withstand very high temperatures and extreme conditions. For this reason, potential deployment of fusion power plants and their contribution to the decarbonisation of the energy mix in Europe cannot be realistically foreseen until the latter part of the century.

Fusion could come on line later in the century, as electric power needs are predicted to double between 2050 and 2100. These are all arguments for continuous efforts to demonstrate fusion’s feasibility at industrial level, taking into account that all different energy sources will play a key role in completing a coherent energy-mix for future societal development.

Organisation of fusion research

Fusion science and technology has now reached the next stage of development thanks to the successful exploitation of research facilities and progress in the construction of ITER, a research facility under construction in south of France with the aim of demonstrating the scientific and technological feasibility of fusion on Earth as a sustainable energy source. The European Joint Programme (EJP) for fusion research supported by the current 2014-2018 Euratom Programme, which provides 55% of the total funding, plays a crucial role in this process. It is implemented by the EUROfusion consortium, consisting of all national fusion labs and institutes in Europe (under the 2014-18 programme the Commission has a separate contract for the operation of the JET facility which is exploited by EUROfusion). This comprehensive and goal-oriented project covers all aspects needed to realise fusion energy. It includes joint research, use of shared facilities, mobility of researchers, industrial involvement, education and training, international cooperation, etc. The activities of the EUROfusion consortium are focussed on the implementation of the fusion roadmap to fusion electricity³³, which was approved in 2012 by all European labs as the long-term

guiding strategy. After an adoption of the new ITER baseline in 2016, EUROfusion proceeded in 2017 with an update of the roadmap to ensure that it reflects the latest state of play in fusion R&D and that it provides a strategic guidance for the organisation and execution of fusion R&D in Europe.

The establishment of the EUROfusion consortium in 2014 was a key step in this major reorganisation of the fusion research in Europe. The EJP allows considerable flexibility within the consortium to organise and implement research and related activities. The consortium has the complete freedom to allocate the Euratom funding to the beneficiaries according to its own internal procedures. Compared to the fusion research before 2014, the involvement of the Commission’s services is focussed on the broad strategy to achieve fusion as laid out in the roadmap by ensuring that EUROfusion delivers as planned. The Commission pays for the implementation of the roadmap in annual instalments based on the achievement of specified goals in the annual work plans. This should be continued in the next 2021-2025 Euratom programme to all aspects of the fusion research including the funding and use of all relevant infrastructures.

The fusion roadmap provides a list of 8 R&D missions addressing the main scientific and technical challenges for the realisation of fusion energy. Of these 8 missions, 4 of them require the use of highly specialised research infrastructures in addition to ITER (see table below).

Main fusion scientific and technical challenges (research missions)	What is needed to achieve mission?	Infrastructures (existing and future devices which fulfil requirements of the missions)
<p>Mission 1 - Plasma regimes of operation: demonstrate plasma scenarios (i.e. ability to manage hot plasma without disruptions) that increase the success margin of ITER and satisfy the requirements of demonstration power plant</p>	<ul style="list-style-type: none"> ➤ Mission 1 will be achieved in ITER. Before start of ITER exploitation, the research programme needs to investigate operating scenarios for ITER and optimise control measures on the basis of similar fuel mix (deuterium and tritium) and with the same combination of plasma facing materials as planned for ITER. 	<ul style="list-style-type: none"> ➤ JET³⁵ ➤ JT-60SA (available from 202X, in Japan) ➤ Different Medium-sized tokamaks (available now)
<p>Mission 2 - Heat-exhaust systems: demonstrate a system that can handle the large power leaving ITER and DEMO plasmas.</p>	<ul style="list-style-type: none"> ➤ ITER will test if the existing heat-exhaust system (divertor) will provide a sufficient performance needed for fusion power plant. To address possible risks of lower than expected performance there is a need to develop alternative concepts that require specific infrastructures. 	<ul style="list-style-type: none"> ➤ Divertor Testing Facility (planned in Italy by 2023-25)
<p>Mission 3 - Neutron tolerant materials: develop materials that withstand the large 14MeV neutron flux for long periods while retaining adequate physical properties.</p>	<ul style="list-style-type: none"> ➤ Currently available plasma facing materials for ITER were developed on the basis of fission neutron irradiation campaigns, not covering fully the temperature and other operational conditions of fusion power plant. A powerful fusion material neutron source with a fusion-like neutron spectrum is mandatory for the validation and qualification of materials for the demonstration power plant, in particular for licensing and regulatory authorities. 	<ul style="list-style-type: none"> ➤ IFMIF-DONES (planned in Spain by 2023-2025)
<p>Mission 8 - Stellarator: bring the stellarator concept to maturity to determine the feasibility of a stellarator based power plant.</p>	<ul style="list-style-type: none"> ➤ Further investigation is needed to check if stellarator concept is able to deliver and control high performance plasma. 	<ul style="list-style-type: none"> ➤ W-7X stellarator (operating since 2016)

Source: Fusion roadmap

In addition to the missions described in the table above, all research activities are underpinned by the need for a strong numerical modelling. It is therefore important to ensure that the fusion programme embraces developments in computation, especially towards exascale computing³⁶. This will not only require investment in High Performance Computing hardware, but also a significant evolution in the implementation of numerical models to ensure they work efficiently with exascale computer architectures. The challenge is to adapt the current practises and provide much closer integration of researchers and programming specialists. Furthermore, much greater emphasis on validation of numerical modelling will be required for numerical models to play a role in DEMO development.

The fusion roadmap specifies in detail what input is needed from different research facilities in order to address all missions. In addition, the roadmap lists decisions concerning the use of fusion research facilities according to their impacts on the implementation of the roadmap, especially until ITER comes into operation³⁷. These decisions are as follows:

- The decision on a possible exploitation of JET after 2020;
- The decision on the test facility for alternative tokamak exhaust configurations;
- The decision on the future exploitation of the JT-60SA in Japan;
- The decision on the Early Neutron Source (IFMIF-DONES).

The nature of the involvement of the EUROfusion consortium in each of the above facilities/projects after 2020 should be decided by the consortium on the basis of the scientific

and technical knowledge available in order to ensure a successful implementation of the roadmap and the rate of construction of the different facilities where necessary. The role of the Commission services is to provide strategic oversight and ensure that the grant for EUROfusion is used effectively and that EUROfusion reaches subsequent roadmap's milestones.

Challenges for fusion research

During the 2021-2027 MFF fusion research will face two major research challenges:

- extending the physics/technology basis of ITER relevant fusion science to ensure that future ITER operation will be effective and efficient;
- completing a conceptual design of a demonstration fusion reactor (a DEMO) that generates electricity, and starting transitioning into an engineering design phase of DEMO.

For future ITER operation to be successful and efficient, it is crucial that the science base is well understood. In particular, the scenarios for operation of ITER should be tested to ensure they are robust and will have a good performance. Potential problems must also be identified and as much as possible addressed before ITER exploitation starts, because it will be much costlier to resolve issues on ITER itself. This will require a broad experimental programme on existing fusion devices, especially those with the greatest ITER relevance, and complemented by an extensive analysis and simulation programme. A potential problem in this respect could be access to devices that in terms of size and components composition are highly ITER relevant.

In order to achieve the goal of completing a pre-conceptual DEMO design and starting the transition to an engineering design phase in the next MFF, the focus of the fusion programme must gradually shift from physics to technology. Consequently, a continuation and even acceleration of the reorientation of the programme towards fusion technology that started during the 2014-18 Euratom programme is necessary. However, changing the composition of researchers in the fusion programme cannot happen overnight, and it will take a sustained effort to redress the balance between physicists and engineers. Further-

more, as the DEMO design becomes increasingly advanced, it will be necessary to involve industry much more than is currently the case. In addition, it is also important to ensure that the engagement of industry participation is at a sufficient level already early on in the next MFF. If not, there is a clear risk that the knowledge of fusion technology now residing within industry due to the ITER construction will be lost before it becomes indispensable for DEMO. Consequently, appropriate mechanisms for greater industry involvement must be put in place for the next MFF.

2.2 OBJECTIVES OF THE EURATOM PROGRAMME FOR THE NEXT MFF

The Euratom programme is established via a Council Regulation setting out the overall objective, overall budget and specific objectives. For each specific objective the Regulation merely outlines the research and training measures eligible for support. The Euratom work programmes for direct and indirect actions, to be adopted by the Commission after consultation with Member States, define the more detailed priorities, budget and instruments to be used. This approach will mean that the programme can be implemented with the flexibility that the new MFF is seeking across the board.

2.2.1 Main objective of the Euratom programme

The programme's overall objective remains unchanged and is based on the compromise reached unanimously in Council in 2011 following the Fukushima nuclear accident and confirmed recently by the Council's political agreement on the regulation concerning extension of the 2014-18 programme for 2019-2020. It seeks to 'pursue nuclear research and training activities to support continuous improvement of nuclear safety, security and radiation protection, and potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way'. It is implemented through a number of specific objectives setting out detailed research and training activities to be funded by the programme.

2.2.2 Revision of specific objectives and overview of other changes introduced in the future Euratom programme

The programme's overall scope will remain unchanged, with a focus on:

- > nuclear safety and security;
- > radiation protection;
- > radioactive waste management, and
- > fusion energy.

To address issues raised by the interim evaluation and by stakeholders, the Commission intends to introduce a number of modifications. The modifications proposed concern the structure of specific objectives, their content, and some implementing provisions (for example on EJPs). It is also important to remember that the Euratom programme complements the Framework Programme for Research and Innovation, sharing with it the horizontal provisions and rules for participation. As a result, modifications introduced to these provisions and rules will be also applicable to the Euratom programme 2021-25.

An overview of all modifications proposed is provided in Table 8.

Table 8 — Modifications from evaluations and stakeholders to address issues

Issues	Modifications to Euratom programme
Continuation of nuclear research focused on nuclear safety, safeguards, security, radioactive waste management, radiation protection and development of fusion energy	<p>Modification of specific objectives</p> <ul style="list-style-type: none"> Introduction of a single list of specific objectives for direct and indirect actions Reduction in the number of specific objectives Revision of specific objectives for decommissioning and nuclear science and ionising radiation technologies A revised specific objective for developing expertise and excellence
More research on nuclear science and ionising radiation technologies	
Research to provide solutions for decommissioning of nuclear installations	
Exploit synergies between direct and indirect actions of the Euratom programme	
Reinforce education and training actions for developing competencies in nuclear field	Opening Marie Skłodowska-Curie Actions up to nuclear researchers
Cross-cutting actions of Euratom programme and Framework Programme for Research and Innovation	Legal provisions facilitating cross-cutting actions in the Euratom programme and Framework Programme for Research and Innovation
Support access to and more effective use of research infrastructures for nuclear research	<ul style="list-style-type: none"> Development of legal and administrative mechanisms for the optimal use of Commission research infrastructure through open access Development of initiatives for networking and sharing of research infrastructures in Europe and for supporting access

Issues	Modifications to Euratom programme
Knowledge management activities	Reinforced role of the JRC for the management of knowledge produced in the nuclear field.
Improve organisation and management of the European Joint Programmes in nuclear research	Amendment of implementing provisions for EJPs



Detailed description of changes proposed:

- > **Structure of specific objectives:** a single set of specific objectives for direct and indirect actions is introduced in the basic act. This will allow the Commission, when preparing work programmes, to propose combining instruments such as the Commission’s research infrastructures and JRC’s knowledge base. This approach addresses one of the MFF’s cross-cutting objectives concerning synergies and simplification.
- > **Revision of specific objectives** (see also Table 9):
 - > **Reduction in the number of specific objectives** from 13 in the 2014-18 programme for both direct and indirect actions to four.
 - > **Introduction of a specific objective on supporting the policy of the Union on nuclear safety, safeguards and security.**
 - > **Definition of the research support for decommissioning** — the revised objective for radioactive waste management covers decommissioning.

The scope of the eligible actions includes research activities supporting the development and evaluation of technologies for decommissioning and environmental remediation of nuclear facilities, and sharing best practices and knowledge on decommissioning (current programme contains only a short reference to decommissioning in the safety objective). The focus on decommissioning reflects the early decommissioning demand based on the public interest, the principle of environmental remediation, and the current and future high number of permanently shutdown nuclear reactors.

- > **Revision of the scope of research for radiation protection** — it also aims to contribute to the safe use of the nuclear science and technology applications of ionising radiation, including the secure and safe supply and use of radioisotopes. Medical, industrial, space and research applications are some of the options. Any applications of nuclear science and ionising radiation should be performed based on the general principles of radiation protection as

defined in the Basic Safety Standards Directive (2013/56/Euratom).

Single specific objective on fusion research to reflect the shift towards the design of future fusion power plants. The new objective for fusion research combines three specific objectives from the current 2014-2018 programme.

- > **Single specific objective for all actions necessary for maintaining and further developing expertise and excellence in the EU.** It includes education and training actions, support for mobility, access to research infrastructures, technology transfer and knowledge management and dissemination (current programme has separate objectives for these actions).
- > **Specific objective on supporting the policy of the Union on nuclear safety, safeguards and security.**
- > **Opening of Marie Skłodowska-Curie Actions to nuclear researchers:** new provisions proposed for Horizon Europe and Euratom will make nuclear students and researchers eligible for MSCAs. By using a well-established instrument for supporting education and training in Europe the new programme addresses one of the MFF's cross-cutting objectives concerning synergies between funding instruments.
- > **Legal provisions facilitating cross-cutting actions** in the Euratom programme and in the Horizon Europe Framework Programme: both basic acts will provide for cross-cutting actions, the details of which will be decided in the work programmes in consultation with Member States (see also section 4.1(a)).
- > **Amendment of implementing provisions for European Joint Programmes in fission and fusion research:** improvements will address issues impairing mobility and funding for third parties (see also section 4.1(b)).

Table 9 — Overview of changes in the Euratom programme’s specific objectives from 2014-2020 to 2021-25

Specific objectives for 2014-2020		Specific objectives for 2021-2025	Explanation of changes
Supporting safe operation of nuclear systems			Broader definition of nuclear safety
Contributing to the development of safe, longer-term solutions for the management of ultimate nuclear waste, including final geological disposal as well as partitioning and transmutation		Improving the safe and secure use of nuclear energy and non-power applications of ionising radiation, including nuclear safety, security, safeguards, radiation protection, safe spent fuel, radioactive waste management and decommissioning	Revised objective covers a broader scope of activities incl. management and transfer of knowledge and decommissioning (covering limited activities in well-defined areas)
Supporting radiation protection and development of medical applications of radiation, including, inter alia, the secure and safe supply and use of radioisotopes			Revised objective covers broader scope of research for nuclear science and ionising radiation technology applications
Specific objectives for direct actions			Direct actions covered by single set of specific objectives
Supporting the development and sustainability of nuclear expertise and excellence in the Union	 		Maintaining and further developing expertise and excellence in the Union
Promoting innovation and industry competitiveness			
Ensuring availability and use of research infrastructures of pan-European and international relevance			

Specific objectives for 2014-2020		Specific objectives for 2021-2025	Explanation of changes
Moving towards demonstration of feasibility of fusion as a power source by exploiting existing and future fusion facilities	➔	Fostering the development of fusion energy	Three 2014-2020 programme objectives merged into one, with a focus on future fusion power plants
Laying the foundations for future fusion power plants by developing materials, technologies and conceptual design	➔		
European fusion programme	➔		
Policy support provided by direct actions	➔	Supporting the policy of the Union on nuclear safety, safeguards and security	Provision of policy support is maintained as a separate specific objective

- > **More effective use of research infrastructures, including European Commission's research infrastructures:** the Commission will launch initiatives facilitating mobility, networking and sharing of nuclear research infrastructures to improve education and training impacts and to optimise their use. The JRC could play an active role in enabling EU scientists interested in conducting nuclear safety research to use both its own facilities and those in the Member States, and combine these efforts with indirect actions, which allow for a consistent and sustainable approach.
- > **Reinforcement of the JRC's role in knowledge management** related to nuclear science: Following its 2030 strategy and in order to cope with the spe-

cific needs in the nuclear field already described, (paragraph 2.1.2.g) JRC will analyse and communicate in a systematic manner, its own produced knowledge and also the one produced by other sources when appropriate.

- > **Other changes:** in fusion research there will be minor changes to the structure and organisation of the programme. All those involved in fusion research are already embedded in the EUROfusion consortium, and the consortium is an integral part of the global European fusion community. Therefore, it will continue to be the main R&I stakeholder for the implementation of the fusion roadmap's research plan. It is envisaged that this plan will be a continuation of the current programme. However, it will also include new infrastructures of

EU relevance, preparations for ITER operation and the down selection of DEMO technologies for the start of detailed engineering design activities at the end of the programme. However, the Euratom programme 2021-25 should also be seen as a transition towards more industry-led activity and during this period the structure and organisation may further evolve as ITER construction comes to a conclusion and the Fusion for Energy joint undertaking takes more responsibility for the DEMO preparation, in line with its statutes³⁸. It is therefore proposed to ring-fence resources for the industrial effort, which will be managed separately from the European joint programme, with the industrial services being provided as an in-kind contribution to the EUROfusion consortium.

- Percentage of EU students in the nuclear field (fission and fusion, all levels) supported by different programme measures (fellowships, PhD funding, mobility etc.).

2.2.4 Implementation of specific objectives

For fusion research, the specific objectives have to be addressed both via the programme structure and priorities, and via the delivery mechanisms.

In terms of programme structure it is important for fusion research in Europe that the objectives are implemented through a joint programme to ensure that all the Member States (the smaller ones included) are involved in implementing the European fusion roadmap, with its ultimate aim of producing electricity from fusion energy. This also makes for more broad-based coordination across the fusion community in the European Union and associated countries, providing access to the available infrastructures and enabling researchers to move around. Additionally, it allows for dynamic international cooperation on fusion under the Commission's strategic leadership.

The delivery mechanism for such research is equally important, as it has a leverage effect for the Member States. By contributing 55% of the total costs Euratom allows the Member States to pool national resources in pursuit of the goals of the fusion roadmap and to become more involved in a Community joint effort. Also, considering that fusion is still in the research phase, it is important that the delivery mechanism is still a grant. The important role of public funding programmes in this endeavour is a reflection of its long-term objectives. Nonetheless, with the success of ITER and the demonstration of the viability of fusion energy at reactor scale, industry will become more involved. Therefore, it will be necessary to reflect on the possible use of other

2.2.3 Success criteria for the Euratom programme 2021-2025

The future programme's impacts could be measured as follows:

- Use and application of research results from the Euratom programme by end-users (nuclear regulators, NPP operators, nuclear industry, medical sector). Two yardsticks to measure this could be: (1) the participation of end-users in the projects (for the 2014/15 call for proposals the figure was about 45-50% of participants, according to an Ernst & Young study, and (2) a survey on the use of programme outcomes (scientific publications, references materials and measurements, etc.) by end-users.
- Launch of an experimental campaign by ITER supported by the Euratom programme.
- Launch of geological disposal repositories supported by the EJP in radioactive waste management.

financial instruments — such as loans or equity — that can complement the support offered through grants.

For fission research, the same applies.

In terms of programme structure it is important for fission research in Europe that the objectives are implemented through research and innovation actions and joint programmes to ensure that all the Member States (the smaller ones included) are involved in consensus-building around the nuclear safety objectives in the relevant Directive. This key aspect of fission research should remain a priority in a programme structure defining milestones. This also makes for more broad-based coordination across the fission community in the European Union and associated countries, providing access to the available infrastructures and enabling researchers to move around. Additionally, it allows for dynamic international cooperation on fission under the Commission's strategic leadership.

The delivery mechanism for such a programme is equally important, as it has a leverage effect for the Member States. By contributing to research in fission Euratom takes advantage of Member States' experience in the field and helps build an EU safety doctrine aligned with the best Member State know-how. Also, with EU safety objectives being the highest in the world, their practical implementation using the best know-how is of paramount importance.

The direct actions of the programme, implemented by JRC, include the provision of the scientific basis for Union policies related to nuclear safety, security and safeguards, in full alignment and complementarity with MS national research programme. In fields as nuclear safeguards, the Euratom programme provides technical and scientific support to the Euratom safeguards regime and in the nuclear security field an important part of the activities performed will support the Member States with trainings and exercises. There is also a strong international dimension in the JRC's implementation of the programme, for example with IAEA to take into consideration the global dimension of the nuclear safety, safeguards and security.

2.2.5 Expected impacts of the changes proposed by the future Euratom programme

Implementation of the Euratom programme 2021-25 with the proposed changes will continue delivering impacts in the main research fields as indicated for the baseline scenario (see Table 6). The modifications will bring additional impacts in specific fields as indicated in Table 10 Some changes concerning horizontal aspects of the programme such as education, training and infrastructures will further improve impacts in the main research fields.

Table 10 — Expected impacts of the changes for the future programme

Field	Expected impacts
Nuclear science and ionising radiation applications	<ul style="list-style-type: none"> ➢ Support implementation of the 2018 EU strategy for nuclear science and radiation technology applications (under preparation by DG Energy) ➢ Support standardisation of health practices involving radiation (reduction of doses for patients and healthcare workforce, etc.) ➢ Introduce innovative applications of radiation in medical sector ➢ Support the development of centres of excellence in medical isotopes research ➢ Use Euratom programme’s actions in nuclear infrastructures to support EU efforts on the supply of medical isotopes (Mo-99, Tc-99) ➢ Further develop medical applications by resolving issues concerning radioactive waste in the medical sector ➢ Support the sector via Euratom-funded actions in education and training ➢ Deliver up-to-date data on the research sector in the field (staff, students, etc.)
Education and training	<ul style="list-style-type: none"> ➢ Support PhD students working on subjects related to the fusion roadmap ➢ Increase the number of researchers and engineers receiving support from the 210 target for 2014-2020 ➢ Support 10 MSCA fellows per year on fusion topics ➢ Evolve education and training support for the CDA/EDA of DEMO by targeting engineering needs especially as regards nuclear skills ➢ Guarantee sources of new talent with support for internships, mobility access to infrastructures, etc. ➢ Support all PhD students working on subjects related to the EJPs in radiation protection and waste management ➢ Deliver different forms of support (mobility, MSCAs, access to infrastructures) to most students of fission (BSc, PhD, Masters) in the nuclear field in the EU (estimate)
Knowledge management	<p>The JRC will further develop knowledge management tools in several fields related to nuclear safety, waste management, safeguards or nuclear security. These will include communities of practice, users networks, etc.</p>

Field	Expected impacts
Decommissioning	<p>Implement the decommissioning roadmap established by Euratom project funded under WP 2018</p> <p>Provide programme support for sharing of best practices and new solutions applied to all decommissioning projects launched by EC since early 90s</p> <p>Contribute towards safety improvements, time shortening and cost reduction of dismantling, decommissioning and environmental remediation activities</p>
Fusion energy	<p>Provide fusion power plant relevant high-power component technology</p> <p>Provide facilities for fusion-relevant materials testing.</p> <p>Ensure science-technology and gender balance in human resources</p> <p>Increase industry involvement in research activities with the subsequent completion of the DEMO conceptual design</p> <p>Engage in more productive international collaboration</p> <p>Undertake a more proactive technology transfer programme with greater associated benefits</p>
Research infrastructures	<p>Implement strategy for networking of research reactors in EU</p> <p>Open access to JRC infrastructures to improve the quality and impact of collaborative projects and training</p>
Waste management	<p>Improve management and transfer of knowledge and skills between generations and across national programmes over next 10-15 years</p>

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- 15 Funding for indirect actions only. Funding for direct actions is decided in the basic act by the Council.
- 16 Research is carried about by JRC institutes in Geel (BE), Karlsruhe (DE), Ispra (IT) and Petten (NL).
- 17 Direct and indirect actions together.
- 18 C(2017) 1288 final, Commission Implementing Decision of 28 February 2017.
- 19 C(2017) 1288 final, ANNEX 1: Key Orientations for the Multi-Annual JRC Work Programme 2017-2018.
- 20 Demonstration power plant that will generate fusion electricity, the next step after ITER in the Fusion Roadmap.
- 21 Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations, OJ L 219, 25.7.2014, p. 42–52.
- 22 European Study on Medical, Industrial and Research Applications of Nuclear and Radiation Technology, 2018.
- 23 http://www.er-alliance.org/assets/files/attachments/ALLIANCE%20gap%20analysis_Feb%202020.
- 24 Council Directive (2013/59/Euratom) of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.
- 25 Report to the European Commission (SWD(2015) 179) on activities following on from the Council conclusions of 15 December 2009 on the security of supply of radioisotopes for medical use and the Council conclusions of 6 December 2010 and 7 December 2012 entitled 'Towards the Secure Supply of Radioisotopes for Medical Use in the European Union'.
- 26 RADIATION PROTECTION N° 180, Medical Radiation Exposure of the European Population, European Commission, 2015.
- 27 European Study on Medical, Industrial and Research Applications of Nuclear and Radiation Technology, 2018.
- 28 PINC, SWD(2017) 237 final.
- 29 <https://ec.europa.eu/energy/en/topics/nuclear-energy/decommissioning-nuclear-facilities>.
- 30 JRC research and development in nuclear safeguards, <https://ec.europa.eu/jrc/sites/jrcsh/files/jrc-research-development-nuclear-safeguards.pdf>.
- 31 <http://ehron.jrc.ec.europa.eu/>.
- 32 Number of students in nuclear fields in EU (2012 EHRON data): ~500 Masters, ~650 Bachelors, ~800 PhD (~100 in fission and ~700 in fusion (2017 data)).
- 33 <https://www.euro-fusion.org/eurofusion/roadmap/>
- 34 ITER baseline defines scope of the project with regard to performance capabilities, schedule and costs.
- 35 In line with the Commission proposal for extension of the Euratom programme until 2020, the current contract for JET operation will be extended until 2020 when the facility will be handed over to UK.
- 36 Exascale computing refers to computing systems capable of at least one exaFLOPS, or a 10^{18} calculations per second.
- 37 See section 10 of the fusion roadmap.
- 38 See Article 1(2)(c) of the Council Decision of 27 March 2007 (2007/198/Euratom as amended by Council Decision 2015/224/Euratom) establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it: *The tasks of f4E shall be as follows: [...] to prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor and related facilities.* Article 3 of the f4E Statutes annexed to the above Council decision states that: *In preparation for the construction of a demonstration fusion reactor and related facilities, including the IFMIF, the Joint Undertaking shall prepare and coordinate a programme of research, development and design activities other than ITER and Broader Approach Activities.*

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3. PROGRAMME STRUCTURE AND PRIORITIES



3. PROGRAMME STRUCTURE AND PRIORITIES

3.1 WHICH ACTIONS SHOULD BE PRIORITISED UNDER THE EURATOM PROGRAMME 2021-25 TO MEET ITS OBJECTIVES?

Based on experience from the 2014-2018 Euratom programme, the next research and training programme should maintain the overall priorities of the current programme in terms of support for fission and fusion research, as shown below (Table 11).

Table 11 — Overall priorities of Euratom Programme 2021-25

Fission research 55% of the programme			Fusion research 45% of the programme
Nuclear safety, safeguards and security	Radioactive waste management	Radiation protection	Research for implementing fusion roadmap

Such prioritisation is justified by the fact that nuclear research remains instrumental in maintaining the highest standards of safety, security, waste management and non-proliferation, one of the objectives of the Energy Union³⁹. This is followed by the priority of retaining Europe’s leadership in the nuclear domain in order to reduce energy and technology dependence.

3.1.1 Fission research

In 2021-25 research for nuclear safety will remain a top priority, with particular emphasis on accident management, ageing and long-term operation strategies. Both the ageing of the European nuclear fleet and the addi-

tional safety requirements introduced by the Nuclear Safety Directive require increased efforts in developing an understanding of the degradation mechanisms of the safety-relevant components and the impact on safety overall. This would support a science-based assessment of the safety margins and allow for timely implementation of safety improvements. The predictive tools and assessment methods developed by the programme would benefit the periodic safety reviews of existing nuclear installations. They would also help the regulators in assessing new designs.

In line with the interim evaluation findings and stakeholder consultation, the programme will increase emphasis on education and training (E&T), knowledge management, access to

infrastructures and nuclear science and radiation technology applications (see Table 12). Another aspect of the next programme that affects all fields is about guaranteeing innovation and ensuring that commercially interesting research results get to market.

Table 12 — Priorities of Euratom fission research* for 2021-2025

Priority	Field	Description of priorities
1	Nuclear safety	Research on safety to accompany the safe long-term operation of the ageing European nuclear fleet. Research supporting compatibility of current and future systems with the requirements of the amended Nuclear Safety Directive
2	Nuclear security and safeguards	Development of modern nuclear safeguards based on different types of information, trade analysis and multidisciplinary approach. Further development of nuclear detection and forensics and capacity building support
3	Nuclear standards	Provision of nuclear reference materials, standards and measurements to obtain appropriate and comparable scientific results in every nuclear field. Further development of codes and standards for nuclear safety
4	Radioactive waste management	Implementation of European Joint Programme in research for radioactive waste management in accordance with the SRA agreed by stakeholders and national authorities
5	Education, training, knowledge management	Support for: MSCA fellowships for PhD and postdoc researchers; Mobility for students and researchers; Hands-on training via E&T actions within Euratom projects; Implementation of ECVET, accreditation and certification in nuclear professions; Pan-European knowledge-sharing; Management of results of past Euratom projects; More attractive education on ionising radiation and its different applications
6	Research support for EU policies in nuclear field	Technical support for: monitoring the progress of implementation of the Euratom directives for waste management, nuclear safety and Basic Safety Standards; implementation of EU CBRN Action Plan (COM(2017) 610); nuclear safety outside EU borders through the implementation of the Instrument for Nuclear Safety Cooperation; EEAS on nuclear security and non-proliferation

Priority	Field	Description of priorities
7	Fission research infrastructures	Support for: availability and accessibility of key fission research infrastructures; mobility of researchers to access infrastructures; open access to JRC infrastructures
8	Radiation protection and ionising radiation applications	Implementation of European Joint Programme in radiation protection research integrating low dose biology, epidemiology, dosimetry, radiology, nuclear medicine, radioecology and preparedness to nuclear emergencies. Research for ionising radiation applications in medical field
9	Research for decommissioning of nuclear installations	Support for the development and evaluation of technologies for decommissioning and environmental remediation of nuclear facilities. Sharing best practices and knowledge on decommissioning

** direct and indirect actions combined*

Should the Euratom funding during the Euratom programme 2021-25 fall below the 2014-2020 level in absolute terms, the key priority objectives would be affected. This would come at a time when nuclear regulators are frequently called on to assess the safety level of the European nuclear fleet, in the light of the new Nuclear Safety Directive, before long-term operation decisions are taken.

Maintaining the level of innovation for safety improvements will depend on the level of resources and stakeholder support, and on the increasing engagement of industry. With strong support above the critical mass — i.e. with resources equal to or greater than those provided in the 2014-18 programme — it is expected that key safety challenges for fission electricity can be appropriately anticipated. The stakeholder consultation points strongly to the need for an increased budget. The nuclear research community declares its readiness to increase its contribution in co-funding of collaborative research and innovation projects, convinced of the urgent need for a larger research portfolio at European level.

With regard to direct actions, the JRC will need to maintain its competences to comply with its mandate in nuclear safety, safeguards and security, and to support the implementation of EU policies in these areas. These competences are currently under high pressure due to staff and budget cuts under the current Programme. More than half of the JRC budget is dedicated to staff costs; therefore a reduction in the budget for direct actions below current levels will have an impact on the renewal of staff and, by extension, on the transfer of skills and knowledge. Secondly, the running costs of the JRC facilities will be also reduced, with the resulting impact on the competences and achievement of objectives.

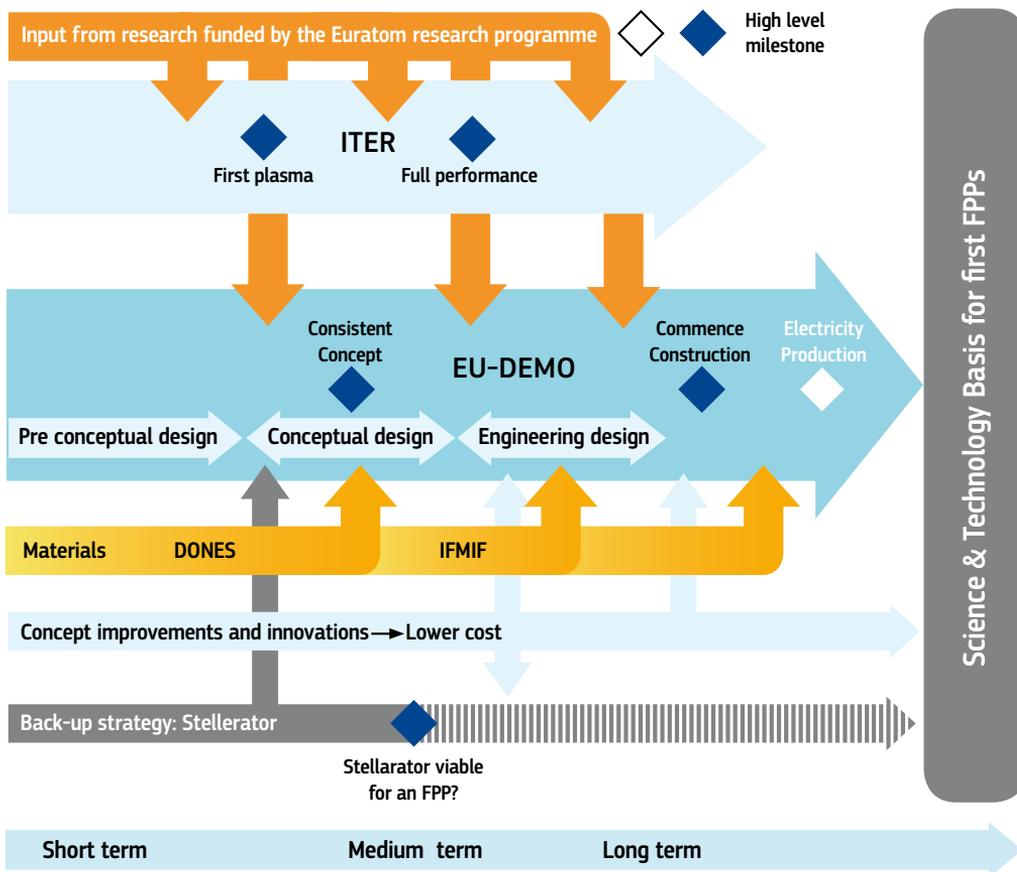
The JRC currently deals with several aspects of nuclear safety, waste management, radiation protection, safeguards, nuclear security and nuclear standards, among other things. It is in the best interest of Europe to sustain a facility such as the JRC, where a large range of nuclear-related skills is present in-house; some of these competences will even need to be reinforced as there will be an increase in their demand.

3.1.2 Fusion research

The European Joint Programme in fusion research carried out by the named beneficiary, the EUROfusion consortium, should be continued in 2021-2025. The programme of activi-

ties should address the priorities set out in the European fusion roadmap. There are several elements in this roadmap, all of which need to be closely integrated, and are outlined below. A pictorial overview is given in Figure 4.

Figure 4 — Overview of the fusion roadmap and role of Euratom programme 2021-2025



Source: EUROfusion, modified by European Commission

Since its inception, the fusion roadmap has been the go-to document for aligning the research priorities of European laboratories and universities in the field of fusion research and development towards the ultimate goal of achieving electricity from fusion energy. Key

facilities in the roadmap are: the international ITER tokamak, under construction in France, that will demonstrate the scientific feasibility of fusion as an energy source; a fusion neutron source facility for materials development and qualification (DONES); and a DEMO

demonstration reactor, which will deliver hundreds of megawatts of electricity to the grid and operate with a closed fuel cycle.

This roadmap is currently being updated by the research stakeholders to take account of the revised ITER baseline⁴⁰. However, the general strategy will remain unchanged. The adoption by the European fusion stakeholders of this first update is expected by mid-2018, following the STC review in February 2018. The objectives specified in this update will become the priorities of the Euratom programme 2021-25 as defined in Table 13. As the EUROfusion grant agreement will be the main action for implementing the fusion research

activities, the programme must ensure that all the administrative and financial elements are in place to enable EUROfusion to continue in 2021-25 in an efficient and effective manner. In this respect, the conditions for involving industry in the work of EUROfusion are crucial. The participation of industry will be managed through a Commission’s Framework Contract providing efficient and effective access of European industry to the DEMO programme needs. Access to relevant infrastructures of both pan-European and international interest are an essential element of the programme and will be provided through operating contracts under Article 10 of the Euratom Treaty.

Table 13 — Priorities of Euratom fusion research in 2021-2025 (main priorities highlighted, not all fusion roadmap’s missions indicated)

Priority	Field	Description of priorities
1	Conceptual design of demonstration power plant	Preparation by 2025 of the conceptual design of a demonstration fusion power plant (DEMO, next step after ITER) with emphasis on involvement of European industry and use of its competencies. Closer collaboration with other international DEMO programmes (e.g. the Chinese CFETR) to address common issues identified in the European fusion roadmap
2	Materials research	Intensification of materials testing programme using available facilities. Euratom programme will support preparations for the construction of a fusion materials testing facility (IFMIF-DONES), including design, licensing, site preparation, etc.
3	Heat exhaust	Conducting research (testing of different plasma and divertor configurations) aimed at finding technically achievable solutions for the heat exhaust in a fusion power plant with support for research infrastructures of EU relevance
4	Preparation for ITER exploitation	Comprehensive experimental programme in facilities of European and international relevance. Continued experimental physics and technology programmes meeting the needs of the ITER project

Priority	Field	Description of priorities
5	Stellarator research	Support for research aimed at demonstrating that the stellarator could be a possible option in addition to the tokamak for a future fusion power plant (improving understanding of stellarator physics)
6	Education and training	Enhance the education and training through further focusing on the human resources' needs in 2021-2030 (support for Masters, PhD and postdoc programmes, use of MSCA for fostering excellence, further development of engineering skills)

The EJP in fusion research will be carried out in full complementarity and coordination with the Euratom activities, in support to the construction of ITER and support the Broader Approach managed by DG Energy.

Fusion research relies on the use of large, expensive infrastructures and long-term commitments. A prime example is the construction and exploitation of the ITER facility which will have a lifespan of some 35 years. Should the Euratom funding during the Euratom programme 2021-25 fall below the 2014-2020 level in absolute terms, key priority objectives such as the materials development and risk mitigation experiments for ITER will not be accomplished, thus delaying important objectives and milestones in the overall implementation of the fusion roadmaps.

Maintaining the level of ambition and innovation as well as the rate of progress in the implementation of the fusion roadmap will depend on the level of resources and stakeholder support, and on the increasing engagement of industry. With strong support above the critical mass — i.e. with resources equal to or greater than those provided in the 2014-2018 Euratom programme — it is expected that the first fusion electricity can be generated in Europe early in the second half of this

century, thus ultimately leading to the introduction of commercial fusion power plants as part of a future sustainable energy mix.

Fusion presents a special opportunity to provide a long-term, robust supply of low-carbon electricity as part of a sustainable energy mix in Europe and worldwide. Fusion distinguishes itself from other low-carbon electricity sources in that it can be an intrinsically safe base-load electricity provider in regions and conditions where this is required, thus eliminating issues of availability of supply and location.

The fusion roadmap outlines the approach chosen by Europe to address the significant remaining scientific, engineering and industrial challenges, many of which have synergies with other science and technology fields. Europe has a leading position in the international fusion research community and has developed expertise in all relevant areas, so is well placed to implement the roadmap. Additionally, Europe is currently developing the necessary industrial expertise to be able to take full advantage of this leadership in terms of know-how, spin-offs and jobs if suitably sustained. Fusion is an international endeavour as exemplified by ITER, and Europe will continue to engage strongly with its international partners.

3.2 SUBSIDIARITY (EU ADDED VALUE/ NECESSITY FOR EU ACTION) AND PROPORTIONALITY DIMENSIONS OF THE EURATOM PROGRAMME

The future Euratom programme will be based on Articles 4 and 7 of the Euratom Treaty. According to Article 4 the Commission is responsible for promoting and facilitating nuclear research in the Member States, and for complementing it by carrying out a Community research and training programme. Such programmes are adopted by the Council, acting unanimously on a proposal from the Commission (Article 7 of the Treaty). In addition, Article 8 of the Treaty establishes the Joint Research Centre for implementing research and other tasks, including introducing uniform nuclear terminology and a standard system of measurements.

This proposal is an initiative in an area of shared competence and, therefore, the necessity and EU added value tests of the subsidiarity principle apply.

The European added value of nuclear research is made explicit in the Euratom Treaty itself and the Commission has an obligation to put forward an R&D programme to complement those in Member States. The justification for Euratom intervention is based mainly on the need to ensure high and uniform levels of nuclear safety in Europe. Moreover, in chapter 3 on health and safety, the Treaty also establishes the obligation for Member States to establish provisions on basic safety standards and to monitor the level of radioactivity in the environment on their territory. Through

the JRC, the Commission provides standards and technical means to ensure that Member States fulfil their obligations properly.

The Commission, in accordance with the chapter 7 of the Treaty, must fulfil its safeguarding obligations, in particular safeguarding the existing radioactive materials in the EU and the obligations assumed under the non-proliferation treaty. Under the Euratom research and training programme the JRC develops methods, standards and techniques and provides scientific and technical support to other Commission departments.

The feedback from research stakeholders and end-users of nuclear research such as nuclear regulators, NPP operators, industry and radiation protection authorities⁴¹ shows that the current programme respects the subsidiarity and proportionality principles (see Table 14). Given the similar features and scope, these findings can be extended to the future Euratom programme 2021-2025.

The Euratom programme's intervention does not replace national R&I actions and does not go beyond what is required to achieve the objectives of the Union. Member States will continue investing in their national research programmes to address specific issues concerning nuclear safety and radiation protection.

Table 14 — Stakeholders and end-users’ views on the EU added value of the Euratom programme (2017 open public consultation) (% of ‘agree’ and ‘tend to agree’ answers)

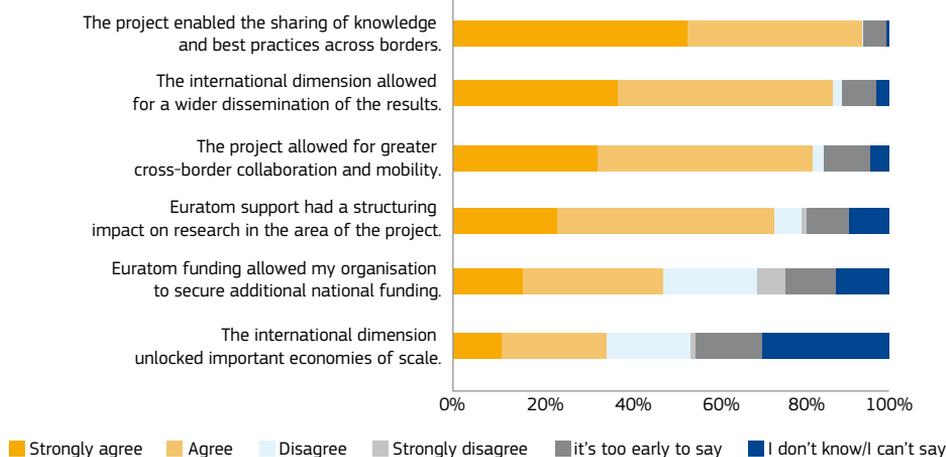
Programme is improving knowledge-sharing and information dissemination	89%
Programme is mobilising a wider pool of high-level, multidisciplinary skills than is available at national level	85%
Euratom is undertaking programmes beyond the reach of individual Member States so that objectives that could not otherwise be achieved can be met	82%

Source: European Commission

The main messages from the 2017 public consultation are also confirmed by the results of the survey carried out by Ernst & Young⁴² to gauge in more detail the added value provided by Euratom research projects, compared to research conducted at national level or on the basis of bilateral international agreements. The respondents were presented with the opportunity to provide their opinion on several aspects of added value (see Figure 5). The main types of European added value underlined by the respondents are better sharing of knowledge and best practices across

borders, the wider dissemination of results allowed by international dimension, greater cross-border collaboration and mobility, and the contribution to the structuring of research. However, the Euratom programme is not seen as exerting a strong influence on the financial aspects of the projects: only 34% of the respondents agree that the European project provides significant economies of scale and a little under half feel that Euratom funding allows their organisation to secure additional national funding.

Figure 5 — Main types of EU added value of the Euratom programme identified by the respondents to the E&Y survey



N = 589

Source: Ernst & Young study

Some respondents also underlined other types of added value. The European programme brings some important nuclear research issues to the European Commission's attention and enhances the creation of a common vision of research challenges across European organisations. European action is also considered as key in training the next generation of nuclear specialists, through cooperation between educational organisations and with nuclear companies.

This picture of the added value of the Euratom programme is similar to the overview of different aspects of the added value of EU-funded research explained in the Impact Assessment for the Horizon Europe Framework Programme for Research and Innovation. This is especially true as regards strengthening scientific excellence, creating a critical mass of resources to address challenges and building multidisciplinary transnational networks for more impact.

- 39 See Energy Union Package, COM(2015) 80.
- 40 Commission Communication COM(2017) 319, EU contribution to a reformed ITER project.
- 41 In all, 63% respondents to the 2017 consultation said that they were 'end-users' of Euratom-funded research.
- 42 A total of 589 replies were received from Euratom project coordinators or members of project consortia launched between 2007 and 2015. For more details see Ernst & Young study 2016.

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4. DELIVERY MECHANISMS



4. DELIVERY MECHANISMS

4.1 MAIN MECHANISMS TO DELIVER FUNDING UNDER THE EURATOM PROGRAMME 2021-25

The Euratom programme complements the Horizon Europe Framework Programme's nuclear research activities and shares the same rules for participation. For this reason,

the main features of the delivery mechanism for the Euratom programme 2021-2025 will also be shared with the EU Framework Programme (see Box 1).

Box 1: Delivery mechanisms shared with the Horizon Europe Framework Programme for Research and Innovation

- › Strategic programming process
- › Single set of rules for participation
- › Calls for proposals
- › Funding model
- › Forms of grants
- › Proposal evaluation and selection
- › Project management
- › Dissemination and exploitation

For more details on these features and how they will help achieve the MFF's cross-cutting objectives (simplification, flexibility, coherence, synergies and focus on performance), please refer to the impact assessment for the Horizon Europe Framework Programme.

Taking into account the specifics of the Euratom programme (such as the importance of EJPs, the role of industry and research infrastructures, and the minor role of SMEs), along with the findings of the 2014-2018 Euratom programme's interim evaluation, some areas for improving delivery mechanisms must be carefully considered post-2020. This is true, in particular, for those areas that will have a strong impact on the cross-cutting objectives of the future MFF:

a) Cross-cutting actions with the Horizon Europe Framework Programme

Implementation of some specific objectives of the future Euratom programme may require cross-cutting actions with the Horizon Europe Framework Programme. This may include:

- › the specific objective of the Euratom programme 2021-2025 concerning applications of ionising radiation, which requires cross-cutting actions with the Horizon Europe Framework Programme (health part). Such actions, for example in medical applications of radiation (e.g. brachytherapy⁴³), may make it possible to address challenging medical and radiation protection aspects at the same time; and

- > the specific objective on education and training, which requires cross-cutting actions with the MSCAs in order to make nuclear researchers eligible for MSCA fellowships.
- > similarly, legal provisions should facilitate the use of the FP's instruments such as MSCAs with financial contribution from the Euratom programme.

b) Improvements in the use of European Joint Programmes (EJPs) by the Euratom Programme

Experience of Horizon 2020 shows that to launch and implement such actions effectively, the following conditions must be met:

- > both the legal acts establishing the Euratom and EU research programmes should contain provisions facilitating the establishment of cross-cutting actions;
- > these provisions should in particular address issues around the joint financing of such actions and appropriate decision-making involving different programme committees;

Under the 2014-2018 Euratom programme, the Euratom funding for EJPs in fission and fusion research accounted for almost a third of the programme's total budget. It is expected that EJPs established in these areas will continue to play a significant role under the future programme, under specific conditions (see Box 2).

Box 2: Conditions for continuation of funding for EJPs in nuclear research

- > Alignment with priorities of the Euratom programme
- > Positive evaluation by independent experts following an open call for proposals (fission) and a named beneficiary (fusion)
- > Up-to-date joint strategic research agenda or research roadmap agreed by EJP members with research topics assigned priority on the basis of actual scientific and societal challenges
- > Open access for all research teams on the basis of scientific excellence
- > Implementation of the best practices for internal organisation of EJP consortium
- > Involvement of all interested EU Member States or associated countries
- > EJP duration of up to 5 years, with possible extension for another two years, if the Euratom programme 2021-2025 is extended
- > Level of Euratom funding close to 50%

As the rules for participation will set only some general principles for the future partnerships, which include EJPs, it is important to ensure that implementing provisions such as Commission decisions on the model grant agreement and on the work programmes address some issues raised by the interim evaluation and by research stakeholders during the consultation.

The first recommendation referred to the **inclusiveness of the European joint programme**. The expert group pointed out that even if the level of excellence remains the key for applying for research funding, emerging contributors with the potential to provide new ideas and innovation, should be able to continue and be further encouraged to participate in the joint programme. During the 2014-18 implementation of the fusion programme, this was done via the option of involving different entities as linked third parties. However, this solution was not always adequate, especially for the involvement of industry, because of the requirement to demonstrate the existence of a past legal link with one of the beneficiaries. This requirement was not always fulfilled, resulting in an inability to involve certain industries in the programme as third parties. This weakness of the EJP as regards involving industry was also underlined by the Fusion Industry Innovation Forum (FIIF) and the EUROfusion consortium in their position papers submitted during the stakeholder consultation.

To address this problem it will be necessary to revise **the conditions for linked third parties participating in the European Joint Programmes (in fission and fusion research)**. In particular, entities with no previous link to a beneficiary must be able to become third parties where research cooperation is deemed important. Furthermore, to boost industry

involvement in the EU fusion programme, it is desirable to have the option of utilising framework contracts between industrial entities and beneficiaries to provide services to and/or framework partnerships with the consortium. In addition, experience shows that, in many cases, the current rules on depreciation of hardware in the grant agreement impede the procurement of components needed by the joint programme. The next Euratom programme might therefore consider reimbursing the cost of the equipment. Also, it would be beneficial for industry involvement to allow for pre-commercial procurement.

Another recommendation from the group of independent experts for the organisation of the European fusion joint programme, and particularly for the fusion EJP, was to **review the system of unit costs**. This system has been used for the mobility of researchers and secondment of staff, but has in practice been found not to be well adapted to the evolving needs of EUROfusion. The EUROfusion consortium also raised this point during the stakeholder consultation. A complicating factor in this context is the significant difference in salaries between researchers in the EU-12 Member States and the rest of the European Union. Furthermore, seconded staff with children face additional problems with costs for schools etc. To make it easier to second staff (from all the Member States) to vital functions within EUROfusion, and to improve mobility for researchers, it will be necessary to revise the current system of unit costs. This could be achieved in three ways: firstly, by introducing a ceiling on unit costs for short-term mobility; secondly, by updating the unit costs for education allowances for children so as not to discriminate against researchers with families; and thirdly by extending the use of unit costs for long-term secondments to third countries with which the Euratom fusion

programme has specific international collaboration, for instance for European exploitation of the Japanese JT-60SA tokamak.

Concerning **better project management** within EUROfusion, the group of independent experts suggested firmer arrangements for EUROfusion project management and making the programme manager responsible for the development and implementation strategy. To follow up on this recommendation, it is proposed that the EJP under the Euratom programme 2021-25 should provide a training package on project management. Likewise, following the recommendation from the FIIF in its position paper, the introduction of a Full Lifecycle Cost management (FLCM) method for the estimation the costs of a DEMO could be envisaged.

As demonstrated in the above paragraphs, the operational experience and consultation with the main stakeholders in fusion research has highlighted many areas where improvements

are desirable. Consequently, in preparing the implementing provisions for the future Euratom programme these will all be taken into account to ensure effective implementation of the EJPs.

c) Funding model

The rules for participation, shared with Horizon Europe Framework Programme, will maintain the single reimbursement rate (up to 100% of eligible costs for Research and Innovation Actions and up to 70% for Innovation Actions). It will be possible to reduce the funding rate for implementing specific actions, where duly justified in the Euratom work programmes, in particular for research topics involving industry. A flexible funding rate could apply to funding for third parties involved in the EJPs.

43 Treatment for cancer involving inserting radioactive implants directly into the tissue.

44 Commission Staff Working Document SWD(2017) 427.

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5. HOW WILL PERFORMANCE BE MONITORED AND EVALUATED?



5. HOW WILL PERFORMANCE BE MONITORED AND EVALUATED?

5.1 FUTURE MONITORING AND EVALUATION ARRANGEMENTS

The future monitoring and evaluation arrangements for the Euratom programme will be shared with the Horizon Europe Framework Programme for Research and Innovation.

An interim evaluation will be performed no later than 2023 (3 years into the programme⁴⁵), according to the evaluation criteria of relevance, coherence, efficiency, effectiveness and EU added value. This evaluation will rely on reports from an independent expert group and the contractors' evaluation of the specific aspects of the programme. It will also provide a comprehensive overview of the state of implementation and report on the longer-term effects of 2014-2020 Euratom programme. The short-term recommendations for improvements from the interim evaluation will feed into implementation

and management over the remaining years of the programme and into preparations for its extension to 2026-27⁴⁶. The longer-term recommendations will serve as inputs for the debate on the future Euratom research and training programmes, and will contribute substantially to future ex-ante impact assessments.

An ex-post evaluation will be carried out in 2029 with the same evaluation criteria. It will rely on in-depth evaluations of each area of the programme (fusion energy, nuclear safety, waste management, radiation protection, nuclear security and safeguards), using the same criteria and common templates. It will be prepared starting in 2027 through the performance of a set of dedicated studies.

5.2 IMPACT INDICATORS

Progress towards achieving the specific objectives of the Euratom programme will be measured using four impact categories using indicators shared with Framework Programme for Research and Innovation⁴⁷.

- > a) **Scientific impacts** - the programme is expected to make progress as regards knowledge for reinforcing nuclear safety

and security; safe applications of ionising radiation, spent fuel and radioactive waste management; radiation protection; and the development of fusion energy. Progress in this area will be measured by indicators concerning scientific publications, progress in the implementation of the fusion roadmap, development of expertise and skills, access to research infrastructures.

Programme objective	Short-term indicators (outputs)	Medium-term indicators (results)	Longer-term
Improving the safe and secure use of nuclear energy and non-power applications of ionizing radiation, including nuclear safety, security, safeguards, radiation protection, safe spent fuel, radioactive waste management and decommissioning	Publications number of Euratom peer-reviewed scientific publications	Citations Field-Weighted Citation Index of Euratom peer-reviewed scientific publications	World-class science Number and share of peer reviewed publications from Euratom programme that are core contribution to scientific fields
	Shared knowledge Share of research outputs (open data/ publication/ software etc.) shared through open knowledge infrastructures	Knowledge diffusion Share of open access research outputs actively used/cited	New collaborations Share of Euratom beneficiaries having developed new transdisciplinary/ trans-sectoral collaborations with users of their open Euratom R&I outputs
Fostering the development of fusion energy	Progress in the implementation of the fusion roadmap Percentage of the fusion roadmap's milestones established for the period 2021-2025 reached by the Euratom programme		

Programme objective	Short-term indicators (outputs)	Medium-term indicators (results)	Longer-term
Maintaining and further developing expertise and excellence in the Union	Skills	Careers	Working conditions
	Number of researchers having benefitted from upskilling activities of the Euratom programme (through training, mobility and access to infrastructures)	Number and share of upskilled researchers with more influence in their R&I field	Number and share of upskilled researchers with improved working conditions
	The number of researchers having access to research infrastructures through the programme support		
	Reference materials delivered and reference measurements incorporated to a library	Number of international standards modified	

- > b) **Societal impacts** – the programme helps addressing EU policy priorities concerning nuclear safety and security, radiation protection and ionising radiation applications through research and innovation, as shown by the portfolios of projects generating outputs contributing to tackling challenges in these fields. Societal impact is also measured in terms of the developments in the field of nuclear security and safeguards.

Programme objective	Short-term indicators (outputs)	Medium-term indicators (results)	Longer-term
Improving the safe and secure use of nuclear energy and non-power applications of ionizing radiation, including nuclear safety, security, safeguards, radiation protection, safe spent fuel, radioactive waste management and decommissioning	Outputs	Solutions	Benefits
	Number and share of outputs aimed at addressing specific EU policy priorities	Number and share of innovations and scientific results addressing specific EU policy priorities	Aggregated estimated effects from use of Euratom-funded results, on tackling specific EU policy priorities, including contribution to the policy and law-making cycle
	Number of services delivered in support of safeguards in EU		Number of technical systems provided and in use
	Number of training sessions delivered to front-line officers		

- > c) **Innovation impacts** - the programme is expected to deliver innovation impacts supporting delivery of its specific objectives. Progress in this area will be measured by indicators concerning intellectual property rights (IPR), innovative products, methods and processes and their use, along with job creation.

Programme objective	Short-term indicators (outputs)	Medium-term indicators (results)	Longer-term
Maintaining and further developing expertise and excellence in the Union	Innovative outputs Number of innovative products, processes or methods from Euratom programme (by type of innovation) and Intellectual Property Rights (IPR) applications	Innovations Number of innovations from the Euratom programme (by type of innovation) including from awarded IPRs	Economic growth Creation, growth and market shares of companies having developed Euratom funded innovations
	Supported employment Number of FTE jobs created and jobs maintained in beneficiary entities for the Euratom project (by type of job)	Sustained employment Increase of FTE jobs in beneficiary entities following Euratom project (by type of job)	Total employment Number of direct and indirect jobs created or maintained due to diffusion of Euratom results (by type of job)
	Amount of public and private investment mobilised with the initial Euratom investment	Amount of public and private investment mobilised to exploit or scale up Euratom results	EU progress towards 3% GDP target due to Euratom programme

- > **d) Policy impact** - The Euratom programme provides scientific evidence for policy-making. This in particular concerns scientific support for other Commission services, such as the support to Euratom safeguards, or to the implementation by Member States of nuclear and ionising radiation-related directives⁴⁸.

Programme objective	Short-term indicators (outputs)	Medium-term indicators (results)	Longer-term
Supporting Union policy on nuclear safety, safeguards and security	Policy-relevant findings Number of Euratom projects producing policy-relevant findings	Policy maker engagement Number of Euratom outputs having a demonstrable impact on the EU policy	Policy uptake Number and share of Euratom projects findings cited in policy/programmatic documents

Targets will be defined for both indirect and direct actions to reflect the expected results for each part of the programme.

The indicators are complemented by a set of key management indicators to gauge implementation of the programme and monitor the related JRC performance (collaborative partnerships, support for international organisations and participation in JRC-managed networks).

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- 45 In accordance with Article 7 of the Euratom Treaty, a Community research programme can be no longer than 5 years in length.
 - 46 An extension is necessary to match the duration of the MFF and Horizon Europe Framework Programme for Research and Innovation.
 - 47 Unless stated otherwise methodology and data collection will be shared with Horizon Europe Framework Programme for Research and Innovation.
 - 48 Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations; Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste; and Commission Regulation (Euratom) No 302/2005 of 8 February 2005 on the application of Euratom safeguards.

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Horizon Europe, the 9th Framework Programme, is the EU's main instrument for investments in research and innovation for the period 2021 – 2027. This book presents the results of the Impact Assessment that underpinned the legislative proposal for the Programme, in line with the Commission's Better Regulation Guidelines. The Impact Assessment builds on the evidence and lessons learnt from the interim evaluation of the 8th Framework Programme, Horizon 2020, and the recommendations of the independent High-Level Group on maximising the impact of EU research and innovation. Horizon Europe is 'an evolution, not a revolution', focusing on a few design improvements to further increase openness and impact and EU added value for citizens. The Impact Assessment therefore identifies the main research and innovation challenges in Europe, outlines the objectives of the future programme and its structure, and provides evidence-based policy and design recommendations for its main features, such as the research and innovation missions, and the European Innovation Council.

Research and Innovation policy

