Horizon 2020 work programme 2018-2020

- Strategic Programme Overarching Document -

Important Notice: Working Document

This overarching paper describes the context for the entire strategic programming process, which will guide the preparation of the work programme itself. It is a working document not formally endorsed by the Commission, and its content does not in any way prejudge the final decision of the Commission on the work programme.

The adoption and the publication of the work programme by the Commission are expected in October 2017. Only the adopted work programme will have legal value.

Horizon 2020 Work Programme 2018-20

- Strategic Programme Overarching Document -

1.   Introduction

We support research and innovation at EU level because it makes a huge difference. It addresses common challenges where a combined approach brings together the top talent, solving problems which are more than could be tackled by one entity or country acting alone, increasing efficiencies, reducing overlaps, accelerating progress and boosting impacts. It provides crucial support to EU competitiveness through the development of technology and innovative solutions for societal challenges, creating business, building market share and generating employment.

EU funded research and innovation draws on the world beating excellence of EU universities, research performing and innovative companies including small and mid-sized firms, and the centres of expertise in national laboratories and research organisations, and helps teaming up with the best worldwide. The effect is to increase overall the amount of research and innovation carried out, complementing and leveraging, driving-up quality including the skills of those involved, to give an increased bang for every Euro spent.

This document sets the scene for the final work programme under Horizon 2020 for the years 2018-20, although further work will be needed at a later stage to expand the detail for 2020.

The work programme will have EU funding of around €30 billion, making it far and away the largest single integrated programme of publicly funded research and innovation during this period across the EU. In scale alone it ranks comparably with anything being implemented by the EU's counterparts in the world's major centres for research and innovation.

Horizon 2020 has been aligned to the EU's current agenda and priorities and will also contribute to promoting the policy goals of open innovation, open science and open to the world (three O's).

As such, the final Horizon 2020 work programme has the potential to make a real and sustainable difference to the quality of life in the EU, as well as the EU's position in the world such as the implementation of the Sustainable Development Goals (SDG).

Seizing this huge opportunity is the ambition for the final work programme and has inspired the strategic programming process through which the work programme has been developed. It is based on first taking stock with the progress made with Horizon 2020 including gap analysis of the implementation of the Specific Programme priorities. Learning from experience is also key, including consulting with citizens and experts from all areas of the economy and society, while taking into account the state of play of Europe's economy and the social, economic and environmental challenges being faced. In the process, the strategic programming work has taken into account the EU's major R&I policy initiatives.

Boosting impacts including more effective dissemination and exploitation of programme results has been the guiding thread throughout the planning and development of the work

programme. Impacts take place at multiple levels; Horizon 2020 Specific Programme (including Europe 2020, European Research Area etc.), the Commission's 10 policy priorities, the societal challenges and emerging challenges, and most importantly from the perspective of the goals set by the participants themselves.

Through the strategic programming process, the Work Programme 2018-20 will build on what has already been achieved – with funding for the first Horizon 2020 work programme (2014-15) of around €13 billion, and for the second work programme of around €16 billion, as of mid-October 2016 more than 110,000 eligible proposals have been submitted and over 10,000 grants funded.

The process of consultation behind strategic programming has helped to ensure that this work programme will align with priorities and achievements of actions under Joint Technology Initiatives, TFEU Article 185 initiatives, and the European Institute of Innovation and Technology, while also improving coherence amongst these.

Learning the lessons

We take forward many valuable lessons which will be reflected in the way the next work programme is set up and implemented, notably by incorporating the results of the Interim evaluation of Horizon 2020. Specifically, the timing of this work programme process and of the Interim evaluation have been adjusted in order to facilitate the connection and feed-through between the exercises.

We need to build on the things that are already working well, but where there is potential to do even better. This fits with and supports the Commission's Budget for Results Initiative[1], aiming to maximise the results of EU spending and added value.

Already there are some directions which are clear.

There will be improvements to the open, challenge-led approach of Horizon 2020, which gives flexibility to proposers and helps to focus on solutions and impacts. Overwhelmingly, the evidence (including the consultation feedback and through channels such as National Contact Points and umbrella stakeholder organisations) shows that programme applicants and participants like the challenge-based approach. This next work programme therefore will extend the approach further, with **big mission-oriented high impact calls and broader topics.** At the same time however, this needs to be implemented and closely monitored in an intelligent way, ensuring there is no downward pull on success rates nor that there is any negative impact on the widening participation aims of the programme.

In parallel with the challenge-based approach, we need to keep sufficient flexibility so that we can respond to unforeseen and rapidly developing events, as already has been shown with the events like the Ebola and Zika virus crises.

The increased focus on innovation is one of the standout features so far of Horizon 2020, but again there is still more to do, including addressing regulatory barriers to innovation, and

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[1] http://ec.europa.eu/budget/budget4results/index_en.cfm

giving special attention to market-creating innovation. In this vein also is the approach to support SMEs which already shows substantial achievements and will be developed still further for the final work programme.

There will also be improvements to the way cross-cutting priorities like climate action and sustainable development, gender equality, and the social sciences and humanities are embedded in calls and activities through cross-programme integration. In the case of the latter the measures cover the drafting of topic texts, use of experts in evaluation as well as monitoring and data collection.

Other measures will be taken in all work programme parts to reverse the trend of falling international cooperation including flagship initiatives of large scale and scope on topics dedicated to international cooperation in areas of mutual benefit.

The Horizon 2020 'Simplification Survey' revealed[2] a very positive reaction to the changes introduced as well as the desire for further simplification: reducing administrative burden for participants is a high priority and we can expect therefore to see a new round of simplification plans, focusing on detail improvements rather than fundamental change, introduced during the period covered by the final Horizon 2020 work programme.

There remain, however some key challenges still to be sorted out. One of the biggest concerns has been success rates, which although varying substantially show a marked dip compared with FP7. It is important that while Horizon 2020 will continue to fund only excellent proposals, there should also be a reasonable chance of success and that researchers' time spent in preparing proposals is neither wasted effort, nor perceived as such. Therefore, measures being introduced to alleviate low success rates may include amongst others, further targeted use of two-stage calls where appropriate as well as clearer and better structured expected impact statements in the work programme.

There are other issues to have emerged through the strategic programming process, such as the critical importance of addressing the persistent divide in terms of research and innovation performance between Member States including through measures that reinforce and complement the actions in the Widening part of Horizon 2020, the need to do more to reinforce synergies with other financial instruments, the need for an appropriate balance in the Technology Readiness Levels (TRL) of projects, and the need to reflect the important role that research infrastructures can have on development of the European Research Area (ERA). Ensuring further openness of the programme by attracting newcomers, especially SMEs, also remains high on the agenda.

The Open Science agenda will be supported, notably through dedicated data driven actions, the embedding of approaches and the mainstreaming/promotion of Open Science principles.

There will also be sustained efforts to ensure Responsible Research and Innovation (RRI) in all work programme parts.

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[2] http://ec.europa.eu/research/participants/data/ref/h2020/other/events/survey/h2020_simplification-survey_final-report_en.pdf

It is to be noted that the final work programme (2018-20) of Horizon 2020 and especially coverage for 2020, which is still to be fully described, will provide a bridge linking Horizon 2020 with the successor framework programme following Horizon 2020.

The rest of this document indicates the main strategic orientations which have both defined and then been refined by the strategic programming process. It highlights key priorities for the work programme parts, as well 'focus areas' for cross-programme integrated activities around major challenges.

This aim of this document is to establish a base for the preparation and drafting of the work programmes, notably the calls and topics.

2.   Political Context

Building on the achievements of the previous Horizon 2020 Work Programmes and the experience with implementation so far as well as taking account the Union's policy priorities, the following strategic orientations will be integrated with greater emphasis into the work programmes for 2018-20:

I.   **Increased investment in sustainable development and climate related R&I**: In the light of the Paris Agreement, marking a new era in the fight against climate change, the Horizon 2020 target of investing at least 35% of its total budget for climate action becomes more important as does the 60% target to contribute to Sustainable Development, including in areas like health, food, energy, transport and resource efficiency which call for integrated responses. The focus areas (section 3.3) proposed for this work programme and in particular the one addressing the 'Building a low Carbon, Climate-resilient Future' will provide a very effective means to align R&I investments towards the climate and sustainable development targets. R&I actions should support Europe's priorities to implement the Energy Union, be number one in renewables reduce energy use, and decarbonise the energy system by 2050. This should also cover work related to the circular economy and the proposed focus area on 'Connecting economic and environmental gains – the Circular Economy'. Both, the follow-up to the Paris Agreement and circular economy, should become mutually reinforcing focus areas.

II.   **Integrating digitisation in all industrial technologies and societal challenges:** As emphasised under the Digital Single Market strategy[3], the combination of digital technologies (big data, internet of things, 5G, high performance computing etc.) with other advanced technologies and service innovation offers huge opportunities for increasing industrial competitiveness, growth and jobs and addressing societal challenges. Digitisation also alters the conduct of research (open science, open data, skills needs, user involvement etc.). Consequently the integration of 'digital' in all its forms, notably digital technologies, the use and management of big data and digital-

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[3] Notably the DEI (Digitising European Industry) strategy, COM(2016) 180 – 19 April 2016

physical integration should be substantially increased across Horizon 2020, including in all societal challenges. A dedicated focus area on 'Digitising and transforming European industry and services' should foster a better integration and coordination of the efforts conducted across the various parts of the programme and maximise their impact stressing the 'physical meets digital' dimension and showcasing major initiatives. In addition a particular emphasis needs to be put on cybersecurity (see also point IV.) and on addressing the societal impact of the digital transformation. 'Open Science' will be promoted throughout the Work Programme, in particular the 'Open Research Data' approach, and the creation of a European Open Science Cloud fostering the stewardship and re-use of research data and tools across disciplinary and geographical borders. The Commission is already working both bilaterally (South Africa, Australia) and in multi-lateral settings (G7, OECD, G20) to ensure that the EOSC is aligned to similar initiatives on a global scale, on the grounds of common standards, openness and reciprocity. The Strategic Forum for International Science and Technology Cooperation (SFIC) will be kept regularly informed on the progress of these discussions.

III. **Strengthening international R&I cooperation:** International cooperation is necessary to ensure the EU's scientific leadership and industrial competitiveness. It is indispensable to access research excellence and all types of know-how wherever it is located, and to tap into global innovation networks and value chains. However, the participation of 3rd countries in Horizon 2020 has dropped compared to the previous Framework Programme, and the opportunity to use Horizon 2020 to establish international leadership is underexploited. Measures will be taken in the next work programme across all areas to reverse this trend and to maximise international cooperation for mutual benefit. This should notably include reinforcing and setting up new international cooperation flagship initiatives in areas of mutual interest. SFIC will be kept regularly informed on the implementation of the flagship initiatives. It is also envisaged to increase efforts to attract and retain researchers in Europe as well as to open mobility paths for European researchers elsewhere in the world, including the Marie Skłodowska-Curie actions (MSCA) and the European Research Council;

IV. **Societal Resilience:** Europe is facing multiple and seemingly sudden changes on multiple fronts, such as large migration pressures, cyber-crime, security threats as well as hybrid threats. Such events require, more than ever, capacities for coordinated EU responses.

Research on **security** threats, notably from terrorism (e.g. on the links between terrorism and other forms of serious and organised crime and on the forces leading to radical alienation) can underpin an effective and coordinated EU response. Ensuring cybersecurity requires looking at vulnerabilities of critical infrastructures and digital services and calls for new technological as well as non-technological solutions, e.g. to ensure data protection, so that the full economic and social potential of digital technologies can be safely exploited. A dedicated focus area, 'Boosting the effectiveness of the Security Union', will address these issues.

Migration and more broadly the mobility of highly qualified people (including researchers) offer great opportunities to meet challenges faced by the EU (skills shortage, demographic change, etc.). At the same time, migration flows need to be managed, as highlighted by the European Agenda on migration. Research should help improve our capacity to foresee and address the challenges of (legal and irregular) migration and to develop effective policies for integrating migrants in our society and economy. Synergies will be sought between activities related to the 'Sustainable Development Goals' and 'Migration' to address root causes of migration, including, for example, activities related to poverty alleviation, food safety and security, sustainable agriculture and improved nutrition

V. **Market creating innovation:** Europe does not use its full potential in capturing new markets from market-creating innovation, and Europe's current industrial strengths are likely to be disrupted in the coming years by digital technologies and business model innovations at the interface of different sectors, technologies and disciplines. Innovation-friendly framework conditions are a prerequisite for such new markets to develop in Europe. A major new component in Horizon 2020 will be first elements of a potential European Innovation Council (EIC) which will focus on support for innovative firms and entrepreneurs with the potential to scale up rapidly at the European and global levels. Moreover Horizon 2020 will make better use of prizes and support large-scale demonstrators that not only test technological and non-technological innovations, but also address legal and standardisation requirements as well as citizen/user/consumer involvement. Stronger links will be created between the industrial technologies parts and the societal challenges, in particular, through the focus areas and with view to supporting the modernisation of Europe's industrial and economic base. Coordination and synergies between the European Institute of Innovation and Technology (EIT), other relevant parts of Horizon 2020, and the potential EIC will be ensured as well as with other EU programmes notably ESIF.

3. Key priorities from Strategic Programming

3.1 Consultation and Advice

Stakeholder consultation

The consultation of stakeholders in the widest sense has played an important part in the strategic programming process for Work Programme 2018-20. One of the key messages includes the fact that Horizon 2020 needs to broaden opportunities for businesses to explore innovation trends and develop market-creating innovation, including through raising awareness about and widening the scope of EU financing opportunities. Easing access to EU innovation support for Europe's most ambitious and bold innovators – which could be facilitated through the work of a potential European Innovation Council – and opening up new ways to source finance for innovation purposes – for instance through equity crowdfunding or capacity-building/scale-up support have been identified as priorities.

Overall the stakeholder feedback has been to confirm the current strategic orientations of Horizon 2020.

Advisory Group input

The Horizon 2020 Advisory Groups (AG) have played a major part in providing inputs to the strategic programming process, and for the preparation of scoping papers. Bringing together a broad base of expertise across different research and innovation disciplines, each AG has submitted its own report.[4]

In a new initiative, the chairs of Advisory Groups were also consulted specifically and separately, with the aim to facilitate cross programmes activities. Their conclusion was that more integrated activities across the work programme is essential in order to maximise impact, and one of the ways this this can be achieved is through 'focus area' activities which cut across the work programmes and across policy objectives.

Foresight

A programme of foresight work supported the strategic programming process. This included reviewing existing foresight evidence to analyse important future trends such as globalisation, demographic change, inequalities, climate change and digitalisation as well as potential disruptions such as quantum technologies, synthetic biology and robotics.[5]

The following eight issues were highlighted as deserving serious consideration under this programming cycle as they are expected to impact on society in the coming decades: i.) Hyper-connectivity and big data driving change and innovation; ii) Falling cost of energy fostering innovation (e.g. separation and recycling of raw materials, drinking water from the seas on a vast scale) as one potential game changer; iii) Migration and demographic dynamics challenging European societies; iv) Pressure on health systems and health inequalities; v) Climate change, oceans and space; vi) Primary sector innovation being key for sustainability and well-being; vii) Biotechnology as the next wave of disrupting technologies; viii) Increasing instability as a new reality for societies.

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[4] These will be made publicly available online.

[5] 'Strategic foresight: Towards the third strategic programme of Horizon 2020' (https://ec.europa.eu/research/foresight/index.cfm under 'Publications'). The report explains the methodology used to identify the eight highlighted issues and provides further details.

3.2   Priorities for Work Programme Parts (2018-20)

The following table lists in brief the main priorities which have been identified for each of the work programme parts for 2018-20, as a result of the strategic programming exercise.

Work programme part	Priorities
[European Research Council]	
Future and Emerging Technologies	– Renewing participation in FET - Open and stimulating continuity with other parts of Horizon 2020 – Aligning (part of) FET- Open with EIC – Stimulating innovation from FET projects – Proactive initiative on HPC – Providing sustained support for the implementation of the two ongoing Flagships, Graphene and HBP – Providing support for the definition and implementation of new Flagships – Enhance articulation between FET-Open, FET-Proactive, FET-Flagships and other parts of the programme
Marie Skłodowska-Curie actions	– Empowering researchers – Widening participation – Equal opportunities and inclusion – International mobility and cooperation – Intersectoral mobility and research-business cooperation
European research infrastructures (including eInfrastructures)	– Addressing the long term sustainability of pan European research infrastructures through a life cycle approach – Supporting Interoperability and the European Open Science Cloud – Structuring the European landscape by integrating and opening Research Infrastructures of European interest – Demonstrating the role of Research Infrastructures in the translation of Open Science into Open Innovation
LEIT - Information and communication technologies	– Ensuring future-proof connectivity and preparing for the internet of the future – Building on European strengths and supporting the digitization of industry – Building a competitive and inclusive data-driven economy and society – Setting up large-scale pilots addressing cross-sector challenges – Boosting digital innovation capacity across Europe and supporting standards – Exploring new high-potential areas – Further developing an ambitious international agenda serving our Digitising European Industry strategy
LEIT - Nanotechnologies,	– Industrial Solution Revolution

Advanced materials, Advanced manufacturing and processing, Biotechnology	– Digitising European industry – Decarbonising European industry – Industry in the Circular Economy
LEIT - Space	– Support the market uptake of, investment in and evolution of EU flagship space programmes Copernicus and EGNSS – Strengthening the competitiveness of the European space sector including for critical components and systems – Ensure Europe's accessibility to react to and anticipate disruptive changes in access to space – Managing threats from space
Access to risk finance	– Continuing and sustaining the financial instruments and accompanying measures launched in 2014-2015 and 2016-2017. – Intensified cooperation between InnovFin and EFSI – Support for the preparatory/piloting phase of a potential European Innovation Council
Innovation in small and medium-sized enterprises	– Building further upon the innovation potential of SMEs for the development of new industrial value chains facilitated by clusters and strengthening innovation management capacities in SMEs – Building further upon the innovation potential of SMEs for the development of new industrial value chains facilitated by clusters and strengthening innovation management capacities in SMEs – Helping SMEs explore new innovation trends with disruptive potential to give competitive edge to the most agile of Europe's innovating SMEs, including through the activities of a potential European Innovation Council – Helping innovation-driven SMEs better recognise market opportunities, understand competing innovative solutions; – Addressing skill gaps in SMEs which hamper innovation and scaling-up (such as innovation management capacity, access to skilled workforce, leadership able to manage the scaling-up process) – Stimulate EU-level knowledge exchange, peer-to-peer learning and integration between national research and innovation support programmes for SMEs
Health, demographic change and wellbeing	– Better health and care, economic growth and sustainable health systems – Decoding the role of the overall environment for health and well-being – Digital transformation in health and care – Trusted big data solutions and cybersecurity for health and care
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	– Addressing climate change and resilience on land and at sea – Making the transition towards a circular bioeconomy – Functional ecosystems, sustainable food systems, healthy lifestyles

and the bioeconomy	– Boosting major innovations on land and sea – new products, value chains and markets
	– Developing smart, connected territories and value chains in rural and coastal areas
Secure, clean and efficient energy	– Boosting Europe's global leadership in renewable energy
	– Developing a smart citizen-centred energy system, including Smart Cities and Communities
	– Strengthening the efficient use of energy in buildings and industry
	– Decarbonising the use of fossil fuels
Smart, green and integrated transport	– Towards an integrated, sustainable and robust transport system
	– Technologies transforming the transport system
	– Global leadership, competitiveness, business models and markets
	– Accounting for the people: demand, needs and behaviours; inclusion and access
Climate action, environment, resource efficiency and raw materials	– Climate action in support of the Paris Agreement (including cities)
	– Greening the economy in line with the SDGs (including circular economy, water, raw materials, natural and cultural assets)
Europe in a changing world – inclusive, innovative and reflective Societies	– Migration and the refugee crisis
	– Cultural and technological transformations for human and social progress: Values, identity and belonging; Human-technology interface
	– Governance for the future
Secure societies – Protecting freedom and security of Europe and its citizens	– Borders and external security
	– Fighting crime and counter-terrorism
	– Secure and resilient societies
	– Cybersecurity and digital privacy
	– Competitive European security industry
Spreading excellence and widening participation	– Expanding the research and innovation potential across the EU
	– Fine-tuning Widening actions to better address needs and expectations
	– Enhance inclusive networking in Europe
Science with and for society (SwafS)	– Accelerating and catalysing processes of institutional change
	– Building the territorial dimension of SwafS partnerships
	– Exploring and supporting citizen science.
	– Building the knowledge base for SwafS

3.3 Implementation

The strategic orientations of section 2 and priorities in section 3.2 will be translated into calls for proposals. Each programmed call will have a clearly defined mission, within a broad challenge, which will be reflected in an expected impact statement at the level of the call, including relevant indicators which should support both effective proposal evaluation and ex post evaluation of achievement towards the expected impacts, at project and programme levels.

Additional support to each of the strategic orientations is provided through several specific mechanisms:

- Focus areas cover the strategic orientations: I ('Increased investment in sustainable development and climate related R&I'); II ('Integrating digitisation in all industrial technologies and societal challenges'); and IV (security part of 'Societal Resilience');
- International flagships as already outlined above, will address strategic orientation III ('Strengthening international R&I cooperation');
- A potential European Innovation Council addresses the strategic orientation IV ('Market Creating Innovation').

Focus areas

A small number of missions cut across the programme boundaries are implemented as **focus areas.** Each of these aligns with major political or policy drivers, and will be endowed with a substantial budget to allow for work of sufficient scale, depth and breadth. Focus areas are expected to create an exceptional impact, addressing 'big ticket' challenges. This focus area approach has been developed in the light of experience from previous Horizon 2020 work programmes, is simpler and has the potential for achieving greater impact.

Focus areas are in effect 'virtual calls', which constitute the linking of topics from respective parts of Horizon 2020 through a new rationale, and thereby unlocking new types of impact and added value. This will be achieved through aligning aspects of the implementation such as proposal submission deadlines and evaluation procedures, and also putting in place measures to share information and create synergies between ongoing projects throughout the life-cycle (e.g. publicity, project monitoring). At the same time, the 'contributing' calls and topics will remain within the structure and logic of their respective work programme parts in Horizon 2020. Overall the effect is to get more from the same investment and build critical mass where it is needed.

The choice of focus areas accommodates both top-down perspectives i.e. in line with the political drivers, and bottom-up i.e. drawing on ideas generated at the thematic level.

Accordingly, focus areas are selected using criteria including:

- degree of fit with politically derived drivers;
- European added value, with convincing description of expected impact;

- potential for engagement of the stakeholder community;
- integration across the work programme;
- achieving integration of cross-cutting objectives, including coverage of the innovation chain.

The intervention logic of the focus areas will be addressed through a coherent set of topics, and calls which will be implemented in a coordinated way as described above.

Four focus areas are described in Annex 1. The details regarding implementation will be finalised through the respective work programme parts and the General Introduction of the work programme, following the normal full engagement of Horizon 2020 Programme Committee.

Other important cross-cutting priorities will be given visibility and managed in a coherent way across the programme, but without the characteristics of a focus area. For example, migration remains a pressing challenge and while not implemented as a focus area, it will be addressed in the Work Programme across several thematic areas through an integrated and interdisciplinary approach to issues such as root causes, the management of migration and the integration of migrants in host societies. The goal is to mobilise expertise across disciplines, sectors and stakeholders that can spur innovative solutions, practices and policies.

Market creating innovation

A major new component to be piloted in Horizon will focus on support for innovative firms and entrepreneurs with the potential to scale up rapidly at the European and global levels. The aim is to bring together those instruments e.g. SME instrument, prizes, FET-Open, Fast track to innovation which can deliver breakthrough innovations and close to market solutions. The Commission therefore intends to introduce a number of changes in the remaining period of Horizon 2020. The changes for the Work Programme 2018-20 will include making the SME instrument fully 'bottom up' so that innovative projects that cut across sectors and technologies can be supported. Moreover Horizon 2020 will make better use of inducement prizes to deliver breakthrough technology solutions. The Commission will also seek to provide simpler access to EU innovation support and ensure that the evaluation process targets innovations with the potential to create and capture new markets. These actions build on ideas generated by the Call for Ideas conducted in spring 2016, and will provide the first elements towards a potential European Innovation Council.

Focus Area: Building a low-carbon, climate resilient future

The transition to a low-carbon economy, fighting the causes of climate change while building more climate-resilient societies will be one major priority of the Horizon 2020 Work Programme 2018-20.

Climate change is a reality, with effects that are already being felt in Europe and world-wide. Urgent and concerted action – underpinned by research and innovation (R&I) – is needed to fight the causes of climate change, while also building more climate-resilient societies.

The COP21 Paris Agreement marked the beginning of a new era in the fight against climate change. Governments agreed to limit global temperature rise to 'well below' 2°C and to make efforts to limit this to 1.5°C. These goals are ambitious, and achieving them will require a trajectory of full decarbonisation with accelerated pathways towards climate neutrality. R&I will be essential to find the ground-breaking solutions needed, including in particular the energy system where there are great opportunities for innovation to capitalise on the EU's strengths and to reinforce competitiveness. While mitigation is essential, countries must also adapt to the impacts of climate change, which will continue due to the inertia of the earth system, and improve the resilience of their societies in relation to the multiple risks they face. All action taken must be based on the best available science and evidence.

This Focus Area will therefore cover all actions that can contribute to the goals of the Paris Agreement, offering very large solution-oriented funding opportunities, providing a coherent framework of analysis and evaluation of the impacts, and promoting broad international cooperation activities. It will also underpin the Communication 'Accelerating Clean Energy Innovation', due to be adopted in November 2016. Moreover, it will help to achieve the expenditure target of 35% for climate action in Horizon 2020, to which many other actions in the Work Programme will also contribute to varying degrees.

As an ambitious research and innovation endeavour, this Focus Area will challenge applicants on goals that go beyond current policy objectives, such as to develop solutions capable of achieving the carbon neutrality and climate resilience of Europe by 2050. This will require a highly integrated approach, addressing the development of solutions through the multiple angles of society, economy, technology, environment and governance.

The focus area aims to achieve:

− **operationalisation of the Paris Agreement (PA) goals, on the basis of high quality policy-relevant evidence from the scientific community.** The ambitious goals of the PA need to be translated into pathways for action, demonstrating how the required economic and social transformations can occur. Over the next decade, science is needed to underpin the next cycle of IPCC reports (2018-2022) that will contribute to the UNFCCC Global Stocktake process. At the same time, the accuracy and reliability of current greenhouse gas (GHG) emission monitoring needs to be improved to enable the signatories of the PA to assess their man-made GHG emissions at country and regional scales, and hence the effectiveness of the implementation of their mitigation policies.

– **accelerated transformation towards carbon neutrality, through the co-design, co-development and co-deployment of technologies and services by researchers, entrepreneurs and citizens.** The pathway to climate neutrality requires decisive action in the energy system, but it is crucial that mitigation also takes place in sectors such as transport, industry (including through key enabling technologies and in energy-intensive industries and manufacturing), agriculture and forestry, in the built environment and in land use. This should go hand in hand with fostering resilience, through an integrated approach that considers the complex nexus of natural resources and human activities. The integration of digital technologies will play a central role. Smart logistics and mobility, smart manufacturing, smart buildings, smart energy and smart and precision agriculture are potentially the most promising areas. Critical innovation in services and in business models is also needed to support the deep economic and societal transformation required. Better understanding, quantifying and valuing of the co-benefits of mitigation action such as improved efficiency of resource and infrastructure use, environmental protection, quality of life, nutrition and health, will also be crucial.

– **enhanced climate resilience in Europe and beyond.** In sectors such as infrastructure, water, agriculture and forestry, as well as in cities, research is needed into multiple risks and impacts, together with development of innovative solutions to minimise the adverse consequences of climate change, such as early warning systems, disaster risk management and nature-based solutions. Tailored tools, such as climate services, and approaches for understanding and implementing adaptation action at all levels, including local, are needed.

– **long term mitigation and adaptation policy planning, deployment of technology to reduce emissions and enhanced climate change resilience in developing countries.** International cooperation will be vital to inform and support countries' mid-century low-emission development strategies and first updates of their (Intended) Nationally Determined Contributions by 2020, as well as to address those regions which are most vulnerable to climate change. Technological cooperation, such the one envisaged by Mission Innovation, is also essential. Science diplomacy in this field should be a component of climate diplomacy, and actions will ensure coherence with EU Climate Diplomacy goals.

Components of the focus area are likely to include actions from the LEIT-NMBP, LEIT-Space, SC1, SC2, SC3, SC4 and SC5 work programme parts.

Focus area: Digitising and transforming European industry and services

Over the past decades, information and communication technologies have proven instrumental in enabling innovations across all sectors of the economy and the society. Many recent studies demonstrate the huge potential still offered by a further digitisation of products and services in terms of growth and creation of jobs. Advances related to digitisation, underpinned by key enabling technologies[6] (KETs), are also needed to provide solutions to several major societal challenges, from improving the monitoring of health and the support to the elderly, to tackling climate change, through reducing energy consumption, improving the management of the energy system and increasing the safety and the efficiency of transport systems or improving agriculture sustainability for example.

In April 2016, the Commission issued a communication outlining its strategy for allowing the European Union to fully seize these digital opportunities. Beyond the support to key technological areas, an essential aspect is to foster the uptake of digital technologies and innovations, as well as synergies with other key enabling technologies. This will contribute to the Digital Single Market Strategy of the Commission.

The ongoing digitisation of industry and services has a profound effect across all sectors. On the manufacturing side, it leads to customised products, distributed and localised production and new innovation models that leverage community interaction, networking as well as knowledge and facilities sharing. It is underpinned by research and innovation in relation to several technological trends. The Internet of Things, Big Data, Cloud, high-performance computing and artificial intelligence are the most prominent ones. In many application cases, disruptive innovation actually comes through the convergence of these trends. Moreover, the full transformative potential of digitisation can only be realised if it is demand-driven and if it responds to the needs of the 'physical' world, through a close involvement of users across all industrial sectors with a true multidisciplinary approach. Such transformation will substantially change the working environment and will strongly impact the workforce, people and the whole society.

It is thus essential to support digitisation as a driver of this major transformation in an integrated manner. Grouping digitisation and related transformation in a single focus area will reinforce coordination, allow to address uptake and investment barriers, and lead to synergies, knowledge transfer and common technological developments and standards that will support platforms and applications across sectors. This will in turn enable economies of scale and foster the emergence of user driven innovative solutions, products and services cutting across sectorial silos. By reaching out beyond EU Programmes towards MSs and Regions, it will increase political visibility and critical mass.

The focus area aims to achieve:

- **enabling all sectors and application areas to adapt, transform and benefit from digitisation**, notably by allowing also smaller and newer players to capture value;

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[6] KETs comprise micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies (see COM(2009) 512).

- **developing industrial strategies, including new business models**, and leverage this major transformation to increase the competitiveness of EU industries and create new markets;
- **connecting to Member States and regions** in order to better align research and innovation agendas and develop synergies;
- **removing barriers for innovation enabled by digitisation,** by addressing issues such as up- and cross-skilling, harmonising regulatory frameworks and standardisation.

Components of the focus area

- **innovation hubs:** with the rapid pace of change in digital technologies, most industrial stakeholders, and especially SMEs, point out to the urgent need for facilities to experiment with and test digital innovations and other key enabling technologies before investing. For digital, innovation hubs solve this problem by providing easy access to the latest digital innovations and experimentation facilities and fostering synergies with other key enabling technologies. For materials, they bring together all the competencies and facilities required for up-scaling, fast adoption and wide spread technology transfer of, novel nano and material technologies in an open innovation environment.
- **cross-sectorial and integrated digital platforms and large-scale pilots for experimentation and co-creation with users:** pilots and demonstrators could notably address the digital transformation of manufacturing, health and care, agriculture, connected and automated driving, and include integration of space data and associated platforms.

Components of the focus area are likely to include actions from the LEIT-ICT, LEIT-NMBP, LEIT-Space, Societal Challenges 1, 2, 4 and 6.

Focus Area: Connecting economic and environmental gains – the Circular Economy

Europe can lead the way in developing and reinventing a circular economy that minimises waste and pollution and uses resources efficiently. The European Commission has adopted an ambitious Circular Economy package that includes a series of actions to stimulate Europe's transition towards this ideal. The package covers the whole cycle: production, consumption, waste management and secondary raw materials.

The circular economy package highlights the key role of research and innovation and is designed to incentivise innovation. The potential benefits of the circular economy are significant: Europe's industrial base will be renewed and competitiveness will improve; jobs and growth will no longer imply an ever increasing consumption of resources, energy, water and primary raw materials; fewer resources will have to be extracted and there will be much less waste. The contribution of this focus area will therefore be in renewing Europe's industrial capacities and boosting growth, in a world of resource constraints. Combining a strong business and a strong environmental logic, in addition to technological development, the circular economy will deliver on sustainability and climate-change objectives.

To make the circular economy a reality, we need new technologies and new business models and their uptake by industry and SMEs; we must link different industrial sectors and public bodies to enable industrial symbiosis; we must develop more integrated value chains; and we need better ways of engaging society and consumers in this transformational process. The circular economy needs more than traditional R&D or a piecemeal approach to different technologies: it needs changes in entire systems through the joint efforts of researchers, technology centres, industry, the primary sector, new entrepreneurs, users, governments and civil society.

This focus area reflects these needs and will capitalise on the opportunities. It will consolidate relevant R&I initiatives to make a strong contribution to the Sustainable Development Goals, as well as to economic and industrial competitiveness.

The focus area aims to achieve:

- **A much better use of resources, including energy and raw materials**
- **Significant reductions in waste and pollution**
- **Sustaining and making use of natural cycles**
- **Competitive advantages for existing businesses**
- **Opportunities for new businesses, including disruptive innovation**

The focus area will integrate the industrial leadership part of Horizon 2020 with societal challenges, in order to exploit value chains using EU-developed technologies, with demonstrators targeting high technology readiness levels (up to TRL 7).

The focus area will address the entire lifecycle, from production to consumption, secondary raw materials and waste management. It will also reflect the interface between products, material supply and other utility activities, waste and chemicals. This will be linked to the work related to the plastics strategy and the product policy framework. There will be support

for moving towards a non-toxic environment. The approach can lead to more efficient products, in terms of energy, materials and cost, and more sustainable chemicals.

Components of the focus area are likely to include actions from the LEIT-NMBP, and Societal Challenges 2, 3 and 5.

Focus area: Boosting the effectiveness of the Security Union

Working to ensure a high level of security for Europeans is an objective set by the Treaties and 'a common European responsibility'. The EU is designed to deliver an area of freedom, security and justice, without internal borders for its citizens.

The majority of the Member States depend entirely on Horizon 2020, which represents 50% of the overall public funding for security research in the EU, to cover their needs regarding the development of innovative security solutions. As highlighted by President Juncker in his Political Guidelines: 'Combatting cross-border crime and terrorism is a common European responsibility'.

A central aim of the Focus Area will be to support the implementation of the Security Union, reflecting the priorities set out by the Commission.

The role of the Focus Area will be to maximise the synergies among the different parts of Horizon 2020. The goal will be to deliver concrete solutions for security practitioners in the EU, while at the same time supporting the implementation of the EU policies related to security.

The focus area aims to achieve:

- **reductions to loss of human life, environmental, economic and material damage from natural and man-made disasters**, including from extreme weather events, organized crime and terrorism threats, through the development and adoption of innovative solutions.
- **new technologies, solutions and processes for fighting and preventing crime** (including cyber-crime and cyber security), illegal trafficking and terrorism (including cyber-terrorism), and understanding and tackling terrorist ideas and beliefs.
- **research on innovative processes and technologies for action and recovery from post disaster situations**.

Components of the focus area

The Focus Area would span over a broad cross-section of security- and resilience-related topics, from social science investigating how to better cope with violent radicalization, to research and development and innovation in disaster resilience and security missions and operations, in cybersecurity, in communication, observation and detection systems and devices, in dedicated information systems.

- **strengthen the potential impact of security-related research**;
- **better match R&D objectives with security policy needs**;
- **bring security-related research closer to other policies and societal challenges** in the parts of Horizon 2020 where they belong today;

– **jointly contribute to several sets of policy objectives** (e.g. Space policy, Transport policy (also taking into account priorities set in the context of Joint Undertakings/Joint Technology Initiatives), Health policy, Environment policy, Security policy, etc.)

Components of the focus area are likely to include actions from the LEIT-ICT, LEIT-Space and Societal Challenges 6 and 7.

Annex 2:

Consultation and advice - process

Stakeholder consultation and Advisory Groups

Consultation activities were tailored to the needs and characteristics of the various Horizon 2020 parts, taking account of different R&I environments and target groups as well as the results of recent stakeholder consultations on related policy initiatives, for example in the framework of the Digital Single Market, the Energy Union, including the strategy 'Accelerating Clean Energy Innovation', or the 'call for ideas' for the European Innovation Council. Work has included open public consultations via the 'Your Voice in Europe' in areas where also citizens could directly contribute (Societal challenge 'Food' and 'Science with and for society') as well as open consultations using other platforms for ICT related issues[7]. Eight areas conducted dedicated written consultations targeted at respective stakeholder groups[8] and four organised specific consultation events[9].

The consultation also extended to the existing thematic groupings and networks like European Technology Platforms, European Innovation Partnerships, Public-Public and Public-Private Partnerships or Joint Programming Initiatives, as well as the Committee of the Regions, European Agencies (e.g. European Medicines Agency, FRONTEX, EUROPOL) and international bodies like the OECD. The work of specific expert groups (e.g. High Level Group on European Open Science Cloud), the results of FP projects like CIMULACT[10] enabling direct interaction with citizens, studies and conferences/workshops reflecting stakeholder views were also integrated in the consultation process.

All 19 Horizon 2020 Advisory Groups were renewed for 2016-2017, resulting in a turnover of around half of the members. All of the Advisory Groups have submitted a report with suggestions for priorities in the various programme parts, or for integration of cross-cutting policy priorities. In addition, two meetings were held for the chairs of the Advisory Groups.

The multifaceted and targeted approach allowed capturing opinions, latest trends and evidence that have not only helped to set the priorities of the scoping papers and this strategic programming document, but will also feed into the elaboration of future calls and their implementation. Further information on the consultation activities can be found on the webpage 'Horizon 2020 – What is a work programme?'.

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[7] 'Future and Emerging Technologies', 'Research e-Infrastructures', LEIT-ICT and eHealth
[8] Future and Emerging Technologies (FET), Research Infrastructures, LEIT-NMBP, Space, Societal Challenges 'Health', 'Transport', 'Climate action' and 'Security'
[9] Space, Innovation in SME, Societal Challenge 'Secure Society', Spreading Excellence and Widening Participation
[10] http://www.cimulact.eu/