Amendment 71
Amalia Sartori
on behalf of the Committee on Industry, Research and Energy

Report   **A7-0002/2013**
Maria Da Graça Carvalho
Specific Programme Implementing Horizon 2020 - The Framework Programme for Research and Innovation (2014 - 2020)
COM(2011)0811 – C7-0509/2011 – 2011/0402(CNS)

Proposal for a decision

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AMENDMENTS BY THE EUROPEAN PARLIAMENT[*]

to the Commission proposal

COUNCIL DECISION

establishing the Specific Programme Implementing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020)

(Text with EEA relevance)

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[*] Amendments: new or amended text is highlighted in bold italics; deletions are indicated by the symbol .

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THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 182(4) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national Parliaments,

Having regard to the opinion of the European Parliament[1],

Having regard to the opinion of the European Economic and Social Committee[2],

Having regard to the opinion of the Committee of the Regions[3],

Acting in accordance with a special legislative procedure,

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[1] OJ C , , p.
[2] OJ C , , p.
[3] OJ C , , p.

Whereas:

(1)   In accordance with Article 182(3) of the Treaty, Regulation (EU) No […] of the European Parliament and the Council of … concerning Horizon 2020 – the Framework Programme for Research and Innovation ("Horizon 2020")[1] – is to be implemented through a specific programme which determines the specific objectives and rules for their implementation, fixes its duration and provides for the means deemed necessary.

(2)   Horizon 2020 pursues three priorities, namely generating excellent science ("Excellent science"), creating industrial leadership ("Industrial leadership") and tackling societal challenges ("Societal challenges"). Those priorities should be implemented by a specific programme consisting of *one Part for each of the* three *priorities, one Part for "Spreading excellence and widening participation", one Part for "Science with and for society"* and one Part on the direct actions of the Joint Research Centre (JRC).

(2a)   All three priorities should include an international dimension. International cooperation activities should be maintained at least at the level of the Seventh Framework Programme.

(3)   While Horizon 2020 sets out the general objective of that framework programme, the priorities and the broad lines of the specific objectives and activities to be carried out, the specific programme should define the specific objectives and the broad lines of the activities which are specific to each of the Parts. The provisions set out in Horizon 2020 on implementation apply fully to this specific programme, including those relating to ethical principles.

(4)   Each Part should be complementary to and implemented in a coherent way with the other Parts of the specific programme.

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[1]   OJ , , p.

(5)   There is a critical need to reinforce*, widen* and extend the excellence of the Union's science base and ensure a supply of world class research and talent to secure Europe's long term competitiveness and well-being. Part I "Excellent science" should support the activities of the European Research Council on frontier research, future and emerging technologies, Marie *Skłodowska-*Curie Actions and European research infrastructures. These activites should aim at building competence in the long term, focusing strongly on the next-generation of science, systems and researchers, and providing support for emerging talent from across the Union and from associated countries. Union activities to support excellent science should help consolidate the European Research Area and make the Union's science system more competitive and attractive on a global scale.

(6)   Research actions carried out under Part I "Excellent science" should be determined according to the needs and opportunities of science   . The research agenda should be set in close liaison with the scientific community. Research should be funded on the basis of excellence.

(7)   The European Research Council should replace and succeed the European Research Council established by Commission Decision 2007/134/EC[1]. It should operate according to the established principles of scientific excellence, autonomy, efficiency and transparency.

(8)   In order to maintain and increase the Union's industrial leadership there is an urgent need to stimulate private sector research and development and innovation investment, promote research and innovation with a business driven agenda and accelerate the development of new technologies which will underpin future businesses and economic growth. Part II "Industrial leadership" should support investments in excellent research and innovation in key enabling technologies and other industrial technologies, facilitate access to risk finance for innovative companies and projects, and provide Union wide support for innovation in small and medium-sized enterprises.

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[1]   OJ L 57, 24.2.2007, p. 14.

(9)   Space research and innovation, which is a shared competence of the Union, should be included as a coherent element in Part II "Industrial leadership" in order to maximize the scientific, economic and societal impact and, to ensure an efficient and cost effective implementation.

(10)   Addressing the major societal challenges identified in the Europe 2020 strategy[1] requires major investments in research and innovation to develop and deploy novel and breakthrough solutions that have the necessary scale and scope. These challenges also represent major economic opportunities for innovative companies and therefore contribute to the Union's competitiveness and employment.

(11)   Part III "Societal challenges" should increase the effectiveness of research and innovation in responding to key societal challenges by supporting excellent research and innovation activities. Those activities should be implemented using a challenge-based approach which brings together resources and knowledge across different fields, technologies and disciplines. Social sciences and humanities research is an important element for addressing all of the challenges. The activities should cover the full range of research and innovation*, **including*** innovation-related activities such as piloting, demonstration, test-beds, and support for public procurement, pre-normative research and standard setting, and market uptake of innovations. The activities should support directly the corresponding sectoral policy competences at Union level*, **where appropiate***. All challenges should contribute to the overarching objective of sustainable development.

(11a)   ***An appropriate balance should be struck between smaller and bigger projects within the Societal challenges and the Leadership in enabling and industrial technologies.***

(11b)   ***Part IIIa "Spreading excellence and widening participation" should fully exploit the potential of Europe's talent pool and ensure that the benefits of an innovation-led economy are both maximised and widely distributed across the Union in accordance with the principle of excellence.***

(11c)   *Part IIIb "Science with and for society" should build effective cooperation between science and society, foster the recruitment of new talent for science, and pair scientific excellence with social awareness and responsibility.*

(12)   As an integral part of Horizon 2020, the Joint Research Centre (JRC) should continue to provide independent customer-driven scientific and technical support for the formulation, development, implementation and monitoring of Union policies. In order to achieve its mission the Joint Research Centre should carry out research of the highest quality. In carrying out the direct actions in accordance with its mission, the Joint Research Centre should place particular emphasis on areas of key concern for the Union, namely smart, inclusive and sustainable growth, security and citizenship and Global Europe.

(13)   The direct actions of the Joint Research Centre should be implemented in a flexible, efficient and transparent manner, taking into account the relevant needs of the users of the Joint Research Centre and Union policies, as well as respecting the objective of protecting the Union's financial interests. Those research actions should be adapted where appropriate to these needs and to scientific and technological developments and aim to achieve scientific excellence.

(14)   The Joint Research Centre should continue to generate additional resources through competitive activities, including participation to the indirect actions of Horizon 2020, third party work and, to a lesser extent, the exploitation of intellectual property.

(15)   The specific programme should complement the actions carried out in the Member States as well as other Union actions which are necessary for the overall strategic effort for the implementation of the Europe 2020 Strategy   .

(15a)   *Pursuant to Council Decision 2001/822/EC of 27 November 2001 on the association of the overseas countries and territories with the European Community ('Overseas Association Decision'), as amended, legal entities of the overseas countries and territories are eligible to participate in Horizon 2020 subject to the specific conditions laid down therein.*

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[1]   COM(2010) 2020

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(16)   In order to ensure   the specific conditions for the use of the finance facilities reflect market conditions, the power to adopt acts in accordance with Article 290 of the Treaty on the Functioning of the European Union should be delegated to the Commission to adapt or further   the specific conditions for use of the finance facilities. It is of particular importance that the Commission carries out appropriate consultations during its preparatory work, including at expert level.

The Commission, when preparing and drawing-up delegated acts, should ensure a timely and appropriate transmission of relevant documents to the Council.

(17)   In order to ensure uniform conditions for the implementation of the specific programme, implementing powers should be conferred on the Commission to adopt work programmes for the implementation of the specific programme.

(18)   The implementing powers relating to the work programmes for Parts I, II*, III, IIIa and IIIb*, with the exception of the actions of the European Research Council where the Commission does not depart from the position of the Scientific Council, should be exercised in accordance with Regulation (EU) No 182/2011 of the European Parliament and of the Council of 16 February 2011 laying down the rules and general principles concerning mechanisms for control by the Member States of the Commission's exercise of implementing powers[1].

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[1]   OJ L 55, 28.2.2011, p. 13.

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(19)   The Board of Governors of the Joint Research Centre, set up by Commission Decision 96/282/Euratom of 10 April 1996 on the reorganization of the Joint Research Centre[1], has been consulted on the scientific and technological content of the specific programme on the direct actions of the Joint Research Centre.

(20)   For reasons of legal certainty and clarity, Council Decision 2006/971/EC of 19 December 2006 concerning the specific programme "Cooperation" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[2], Council Decision 2006/972/EC of 19 December 2006 concerning the specific programme "Ideas" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[3], Council Decision 2006/973/EC of 19 December 2006 concerning the specific programme "People" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[4], Council Decision 2006/974/EC of 19 December 2006 concerning the specific programme "Capacities" implementing the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[5], and Council Decision 2006/975/EC of 19 December 2006 concerning the specific programme to be carried out by means of direct actions by the Joint Research Centre under the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)[6], should be repealed,

HAS ADOPTED THIS DECISION:

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[1]   OJ L 107, 30.4.1996, p. 12.
[2]   OJ L 400, 30.12.2006, p. 86.
[3]   OJ L 400, 30.12.2006, p. 243.
[4]   OJ L 400, 30.12.2006, p. 272.
[5]   OJ L 400, 30.12.2006, p. 299.
[6]   OJ L 400, 30.12.2006, p. 368.

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TITLE I

ESTABLISHMENT

Article 1

Subject matter

This Decision establishes the specific programme implementing

Regulation (EU) No XX/2012 of the European Parliament and of the Council[1] and determines

the specific objectives for Union support to the research and innovation activities set out in

Article 1 of that Regulation as well as the rules for implementation.

Article 2

Establishment of the Specific Programme

1. The specific programme implementing Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020) ('the specific programme') is hereby established for the period from 1 January 2014 to 31 December 2020.

2. In accordance with Article 5(2) and 5(3) of Regulation (EU) No XX/2012 [Horizon 2020], the specific programme shall consist of the following Parts:

   (a) Part I 'Excellent science';

   (b) Part II 'Industrial leadership';

   (c) Part III 'Societal challenges';

   (d) Part IV 'Non-nuclear direct actions of the Joint Research Centre (JRC)'.

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[1] OJ L [], [], p. []

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Article 3

Specific objectives

1.   Part I 'Excellent science' shall strengthen the excellence of European research in accordance with the priority "Excellent science" set out in Article 5(2)(a) of Regulation (EU) No XX/2012 [Horizon 2020] by pursuing the following specific objectives:

(a)   strengthening frontier research, through the activities of the European Research Council (ERC);

(b)   strengthening research in Future and Emerging Technologies;

(c)   strengthening skills, training and career development, through the Marie Skłodowska-Curie actions ("Marie *Skłodowska-*Curie actions");

(d)   strengthening European research infrastructures, including e-infrastructures.

The broad lines of the activities for those specific objectives are set out in Part I of Annex I.

2.   Part II ′Industrial leadership′ shall strengthen industrial leadership and competitiveness in accordance with the priority ′Industrial leadership′ set out in Article 5(2)(b) of Regulation (EU) No XX/2012 [Horizon 2020] by pursuing the following specific objectives:

(a)   boosting Europe's industrial leadership through research, technological development, demonstration and innovation in the following enabling and industrial technologies:

(i)   information and communication technologies;

(ii)   nanotechnologies;

(iii)   advanced materials;

(iv)   biotechnology;

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(v)   advanced manufacturing and processing;

(vi)   space;

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(b)   enhancing access to risk finance for investing in research and innovation;

(c)   increasing innovation in small and medium-sized enterprises.

The broad lines of the activities for those specific objectives are set out in Part II of Annex I. There shall be specific conditions for use of finance facilities under the specific objective in point (b). Those conditions are set out in point 2 of Part II of Annex I.

The Commission shall be empowered to adopt delegated acts in accordance with Article 10 *concerning the modifications of the share of investment from the Equity Facility of Horizon 2020 of the total EU investment in expansion and growth-stage investments regarding the financial instruments referred to in point 2 of Part II of Annex I.*

3.   Part III 'Societal challenges' shall contribute to the priority 'Societal challenges' set out in Article 5(2)(c) of Regulation (EU) No XX/2012 [Horizon 2020] by pursuing research, technological development, demonstration and innovation actions which contribute to the following specific objectives:

(a)   improving the lifelong health and wellbeing *of all*;

(b)   securing sufficient supplies of safe*, healthy* and high quality food and other bio-based products, by developing productive*, sustainable* and resource-efficient primary production systems, fostering related ecosystem services *and the recovery of biological diversity*, alongside competitive and low carbon supply*, processing and marketing* chains;

(c)   making the transition to a reliable, *affordable, publicly accepted,* sustainable and competitive energy system, aiming at reducing fossil fuel dependancy in the face of *increasingly scarce resources*, increasing energy needs and climate change;

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(d)	achieving a European transport system that is resource-efficient, **climate- and** environmentally-friendly, safe and seamless for the benefit of **all** citizens, the economy and society;

(e)	achieving a resource -**and water-** efficient and climate change resilient economy and **society, protection and sustainable management of natural resources and ecosystems** and a sustainable supply **and use** of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources **and eco-systems**;

(f)	fostering **a greater understanding of Europe, provide solutions and support** inclusive, innovative and **reflective** European societies in a context of unprecedented transformations and growing global interdependencies;

**(g)	fostering secure European societies in a context of unprecedented transformations and growing global interdependencies and threats, while strengthening the European culture of freedom and justice.**

The broad lines of the activities for those specific objectives are set out in Part III of Annex I.

3a.	*Part (IIIa) 'Spreading excellence and widening participation' shall fully exploit the potential of Europe's talent pool and ensure that the benefits of an innovation-led economy are both maximised and widely distributed across the Union in accordance with the principle of excellence.*

3b.	*Part (IIIb) 'Science with and for society' shall build effective cooperation between science and society, recruit new talent for science and pair scientific excellence with social awareness and responsibility.*

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4.   Part IV 'Non-nuclear direct actions of the Joint Research Centre' shall contribute to all of the priorities set out in Article 5(2) of Regulation (EU) No XX/2012 [Horizon 2020] with the specific objective of providing customer-driven scientific and technical support to Union policies.

        The broad lines of that specific objective are set out in Part IV of Annex I.

5.   The specific programme shall be assessed in relation to results and impact as measured against performance indicators   .

        Further detail on the key performance indicators which correspond to the specific objectives set out in paragraphs 1 to 4 of this Article are set out in Annex II.

Article 4
Budget

1.   In accordance with Article 6(1) of Regulation (EU) No XX/2012 [Horizon 2020], the financial envelope for the implementation of the specific programme shall be *[*EUR 86198 million*]*.

2.   The amount referred to in paragraph 1 shall be distributed among the four Parts set out in Article 2(2) of this Decision in accordance with Article 6(2) of Regulation (EU) No XX/2012 [Horizon 2020]. The indicative budgetary breakdown for the specific objectives set out in Article 3 of this Decision and the maximum overall amount of the contribution to the actions of the Joint Research Centre are set out in Annex II to Regulation (EU) No XX/2012 [Horizon 2020].

3.   No more than 6 % of the amounts referred to in Article 6(2) of Regulation (EU) No XX/2012 [Horizon 2020] for the Parts I, II and III of the specific programme shall be for the Commission's administrative expenditure.

4.   Where necessary, appropriations may be entered in the budget beyond 2020 to cover technical and administrative expenses, in order to enable the management of activities not yet completed by 31 December 2020.

TITLE II

IMPLEMENTATION

Article 5

Work programmes

1.   The specific programme shall be implemented by work programmes.

2.   The Commission shall adopt common or separate work programmes for the implementation of the Parts I, II and III of this specific programme referred to in points (a), (b) and (c) of Article 2(2), except for the implementation of the actions under the specific objective 'Strengthening   frontier research*, through the activities of the European Research Council' referred to in point (a) of Article 3(1)*. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 9(2).

3.   The work programmes for the implementation of the actions under the specific objective 'Strengthening   frontier research, *through the activities of the European Research Council*' as established by the Scientific Council of the European Research Council under *point (b)* of Article 7(2)   , shall be adopted by the Commission, by means of an implementing act*, in accordance with the advisory procedure referred to in Article 9(2a)*. The Commission shall depart from the work programme established by the Scientific Council only when it considers that it is not in accordance with the provisions of this Decision. In that case, the Commission shall adopt the work programme by means of an implementing act in in accordance with the examination procedure referred to in Article 9(2). The Commission shall duly motivate this measure.

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4.   The Commission shall adopt a separate multi-annual work programme, by means of an implementing act, for Part IV of the specific programme concerning the non-nuclear direct actions of the Joint Research Centre referred to in point (d) of Article 2(2).

This work programme shall take into account the opinion provided by the Board of Governors of the Joint Research Centre referred to in Decision 96/282/Euratom.

5.   The work programmes shall take account of the state of science, technology and, innovation at national, Union and international level and of relevant policy, market and societal developments. They shall contain*, where appropriate,* information on coordination with research and innovation activities carried out by Member States *(including their regions)*, including in areas where there are joint programming initiatives. They shall be updated where appropriate.

6.   The work programmes for the implementation of the Parts I, II and III referred to in points (a), (b) and (c) of Article 2(2) shall set out the objectives pursued, the expected results, the method of implementation and their total amount, including indicative information on the amount of climate related expenditure, where appropriate. They shall also contain a description of the actions to be financed, an indication of the amount allocated to each action, an indicative implementation timetable, as well as a multi-annual approach and strategic orientations for the following years of implementation. They shall include for grants the priorities, the *selection and award criteria and the relative weight of the different award* criteria and the maximum rate of *funding of the total eligible costs. They shall also indicate any additional exploitation and dissemination obligations for participants, in accordance with article 40 of Regulation (EU) No XX/2012 [Rules of Participation].* They shall allow for *strategic top-down as well as* bottom-up approaches*, as appropriate,* that address the objectives in innovative ways.

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In addition, those work programmes shall contain a section which identifies the cross-cutting actions as referred to in Article 13 ***and in the box of cross-cutting issues and support measures in Annex I*** of Regulation (EU) No XX/2012 [Horizon 2020], across two or more specific objectives both within the same priority and across two or more priorities. Those actions shall be implemented in an integrated manner.

7. ***The Commission shall adopt, by means of implementing acts, in accordance with the examination procedure referred to in Article 9(2) the following measures:***

   (a) ***the decision on the approval of the funding of indirect actions, where the estimated amount of the Union contribution under this programme is equal to or more than EUR 2.5 million; with the exception of actions under the specific objective referred in point (a) of article 3(1) and with the exception of actions funded under the Fast Track to Innovation.***

   (b) ***the decision on the approval of the funding of actions involving the use of human embryos and human embryonic stem cells and of actions under the specific objective referred in point (g) of article 3(3).***

   (c) ***the decision on the approval of the funding of actions, where the estimated amount of the Union contribution under this programme is equal to or more than EUR 0.6 million for actions under the specific objective referred in point (f) of article 3(3) and for actions referred in article 3(3a) and article 3(3b).***

   (d) ***the drawing up of the terms of reference for the evaluations provided for in Article 26 of the Regulation (EU) No XX/2012 [Horizon 2020].***

Article 6

European Research Council

1.   The Commission shall establish a European Research Council ("ERC"), which shall be the means of implementing the actions under the Part I 'Excellent science' which relate to the specific objective 'Strengthening   frontier research*, through the activities of the European Research Council*'. The European Research Council shall succeed the European Research Council set up by Decision 2007/134/EC.

2.   The European Research Council shall be composed of the independent Scientific Council provided for in Article 7 and the dedicated implementation structure provided for in Article 8.

3.   The ERC shall have a President, who shall be chosen from among senior and internationally respected scientists.

The President shall be appointed by the Commission following a *transparent* recruitment process involving *an independent* dedicated search committee, for a term of office limited to four years, renewable once. The recruitment process and the candidate selected shall have the approval of the Scientific Council.

The President shall chair the Scientific Council and shall ensure its leadership and liaison with the dedicated implementation structure, and represent it in the world of science.

4.   The European Research Council shall operate according to the principles of scientific excellence, autonomy, efficiency, effectiveness, transparency and accountability. It shall ensure continuity with European Research Council actions conducted under Council Decision 2006/972/EC.

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5.   The activities of the European Research Council shall support research carried out across all fields by individual and transnational teams in competition at the European level. European Research Council frontier research grants shall be awarded on the sole criterion of excellence.

6.   The Commission shall act as the guarantor of the autonomy and integrity of the European Research Council and shall ensure the proper execution of the tasks entrusted to it.

The Commission shall ensure that the implementation of the European Research Council actions is in accordance with the principles set out in paragraph 4 of this Article as well as with the overall strategy of the Scientific Council referred to in Article 7(2).

Article 7

Scientific Council

1.   The Scientific Council shall be composed of scientists, engineers and scholars of the highest repute and appropriate expertise, ***of both women and men in different age groups,*** ensuring a diversity of research areas and acting in their personal capacity, independent of extraneous interests.

The members of the Scientific Council shall be appointed by the Commission, following an independent and transparent procedure for their identification agreed with the Scientific Council, including a consultation of the scientific community and a report to the European Parliament and Council.

Their term of office shall be limited to four years, renewable once, on the basis of a rotating system which shall ensure the continuity of the work of the Scientific Council.

2.   The Scientific Council shall establish:

(a)   the overall strategy for the European Research Council;

(b)   the work programme for the implementation of the European Research Council activities;

(c)   the methods and procedures for peer review and proposal evaluation on the basis of which the proposals to be funded are determined;

(d)   its position on any matter which from a scientific   perspective may enhance achievements and impact of the European Research Council, and the quality of the research carried out;

(e)   a code of conduct addressing, inter alia, the avoidance of conflict of interests.

The Commission shall depart from the positions established by the Scientific Council in accordance with points (a), (c), (d), and (e) of the first subparagraph only when it considers that the provisions of this Decision have not been respected. In that case, the Commission shall adopt measures to maintain continuity in the implementation of the specific programme and the achievements of its objectives, setting out the points of departure from the Scientific Council positions and duly motivating them.

3.   The Scientific Council shall act in accordance with the mandate set out in point 1.1, Part I of Annex I.

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4.   The Scientific Council shall act exclusively in the interest of achieving the objectives of the part of the specific programme relating to the specific objective 'Strengthening frontier research*, through the activities of the European Research Council*' according to the principles set out in Article 6(4). It shall act with integrity and probity and shall carry out its work efficiently and with the greatest possible transparency.

Article 8
Dedicated implementation structure

1.   The dedicated implementation structure shall be responsible for the administrative implementation and programme execution, as described in point 1.2 of Part I of Annex I and shall support the Scientific Council in the conduct of all of its tasks.

2.   The Commission shall ensure that the dedicated implementation structure follows strictly, efficiently and with the necessary flexibility the objectives and requirements of the European Research Council alone.

TITLE III

FINAL PROVISIONS

Article 8a

Monitoring and information on implementation

1.   *The Commission shall annually monitor and report on the implementation of Horizon 2020 in accordance with article 25 of Regulation (EU) No XX/2012 [Horizon 2020] and Annex III of this Decision.*

2.   *The Commission shall regularly inform the Committee referred to in article 9 of the overall progress of the implementation of the indirect actions of the specific programme to allow the Committee to provide early appropriate input on the preparation of the work programmes in particular the multi-annual approach and strategic orientations, and shall provide it with timely information on all actions proposed or funded under Horizon 2020 as specified in Annex IV of this Decision.*

Article 9

Committee procedure

1.   The Commission shall be assisted by a Committee. That committee shall be a committee within the meaning of Regulation (EU) No 182/2011**1**.

1a.   *The Committee shall meet in different configurations as set out in annex V, having regard to the subject matter to be discussed.*

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[1]   OJ L 55, 28.2.2011, p. 13.

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2.   Where reference is made to this paragraph, the examination procedure in accordance with Article 5 of Regulation (EU) No 182/2011 shall apply.

2a.   Where reference is made to this paragraph, the advisory procedure in accordance with Article 4 of Regulation (EU) No 182/2011 shall apply.

3.   Where the opinion of the committee referred to in paragraphs 2 *and 2a* is to be obtained by written procedure, that procedure shall be terminated without result when, within the time-limit for delivery of the opinion, the chair of the committee so decides or a simple majority of committee members so request.

Article 10

Exercise of the delegation

1.   The power to adopt delegated acts is conferred on the Commission subject to the conditions laid down in this Article.

2.   The power to adopt delegated acts *referred to in Article 3(2)* shall be conferred on the Commission   from the entry into force of this Decision *and for the duration of the Programme*.

3.   The delegation of power *referred to in Article 3(2)* may be revoked at any time by the Council. A decision of revocation shall put an end to the delegation of the power specified in that decision. It shall take effect the day following the publication of the decision in the *Official Journal of the European Union* or at a later date specified therein. It shall not affect the validity of any delegated acts already in force.

4.   As soon as it adopts a delegated act, the Commission shall notify it to the Council.

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5. A delegated act **adopted pursuant to Article 3(2)** shall enter into force only if no objection has been expressed by the Council within a period of two months of notification of that act to the Council or if, before the expiry of that period, the Council has informed the Commission that it will not object. That period shall be extended by one month at the initiative of the Council.

6. The European Parliament shall be informed of the adoption of delegated acts by the Commission, or any objection formulated to them, or of the revocation of the delegation of powers by the Council.

Article 11

Repeal and transitional provisions

1. Decisions 2006/971/EC, 2006/972/EC, 2006/973/EC, 2006/974/EC and 2006/975/EC are repealed with effect from 1 January 2014.

2. However, actions initiated under Decisions referred to in paragraph 1 and financial obligations related to actions pursued under those Decisions shall continue to be governed by those Decisions until their completion. Where necessary, any remaining tasks of the Committees established by the Decisions referred to in paragraph 1 shall be undertaken by the Committee referred to in Article 9 of this Decision.

3. The financial allocation for the specific programme may also cover technical and administrative assistance expenses necessary to ensure the transition between the specific programme and the measures covered by Decisions 2006/971/EC, 2006/972/EC, 2006/973/EC, 2006/974/EC and 2006/975/EC.

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Article 12

Entry into force

This Decision shall enter into force on the third day following that of its publication in the *Official Journal of the European Union*.

Article 13

This Decision is addressed to the Member States.

Done at Brussels,

For the Council

The President

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ANNEX I

Broad lines of the activities

Common elements for the indirect actions

1.   PROGRAMMING

1.1.   General

Regulation (EU) No XX/2012 (Horizon 2020) provides a set of principles in order to foster a programmatic approach whereby activities contribute in a strategic and integrated way to its objectives and in order to ensure strong complementarities with other related policies and programmes across the Union.

The indirect actions of Horizon 2020 will be implemented through the forms of funding provided for in the Financial Regulation, in particular grants, prizes, procurement and financial instruments. All forms of funding will be used in a flexible manner across all of Horizon 2020's general and specific objectives, with their use being determined on the basis of the needs and the specificities of the particular specific objective.

Particular attention will be paid to ensuring a *balanced* approach to *research and* innovation, which is not only limited to the development of new products and services on the basis of scientific and technological breakthroughs, but which also incorporates aspects such as the use of existing technologies in novel applications, continuous improvement, non-technological and social innovation. Only a holistic approach to innovation can at the same time tackle societal challenges and give rise to new competitive businesses and industries.

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For the societal challenges and the enabling and industrial technologies in particular, there will be a particular emphasis on *research and innovation* activities *complemented with activities* which operate close to the end-users and the market, such as demonstration, piloting or proof-of-concept. This will also include, where appropriate, activities in support of social innovation, and support to demand side approaches such as pre-standardisation or pre-commercial procurement, procurement of innovative solutions, standardisation and other user-centered measures to help accelerate the deployment and diffusion of innovative products and services into the market. In addition, there will be sufficient room for bottom-up approaches *to call for proposals and activities in work programmes will be defined in broad terms. There will be* open, light and fast schemes under each of the challenges and technologies to provide Europe's best researchers, entrepreneurs and enterprises with the opportunity to put forward breakthrough solutions of their choice.

Detailed priority setting during implementation of Horizon 2020 will entail a strategic approach to programming of research, using modes of governance aligning closely with policy development yet cutting across the boundaries of traditional sectoral policies. This will be based on sound evidence, analysis and foresight, with progress measured against a robust set of performance indicators. This cross-cutting approach to programming and governance will allow effective coordination between all of Horizon 2020's specific objectives and will allow to address challenges which cut across them, such as for instance sustainability, climate change*, social sciences and humanities* or marine sciences and technologies.

Priority setting will equally be based on a wide range of inputs and advice. It will include, where appropriate, groups of independent experts set up specifically to advise on the implementation of Horizon 2020 or any of its specific objectives. These experts *groups* shall show the appropriate level of expertise and knowledge in the covered areas and a variety of professional backgrounds, including *academia*, industry and civil society involvement. *Advice on the identification and design of strategic priorities by the European Research Area Committee (ERAC), other ERA-related Groups and the Enterprise Policy Group (EPG) shall, where appropriate, also be taken into consideration.*

Priority setting may also take into account the strategic research agendas of European Technology Platforms, *Joint Programming Initiatives* or inputs from the European Innovation Partnerships. Where appropriate, public-public partnerships and public-private partnerships supported through Horizon 2020 will also contribute to the priority setting process and to the implementation, in line with the provisions laid down in Horizon 2020. Regular interactions with end-users, citizens and civil society organisations, through appropriate methodologies such as consensus conferences, participatory technology assessments or direct engagement in research and innovation processes, will also be a cornerstone of the priority setting process.

As Horizon 2020 is a programme for seven years, the economic, societal and policy context in which it will operate may change significantly during its life-time. Horizon 2020 needs to be able to adapt to these changes. Under each of the specific objectives, there will therefore be the possibility to include support for activities beyond the descriptions set out below, where this is duly justified to address major developments, policy needs or unforeseen events.

Activities supported under the different Parts and their specific objectives should be implemented in a way that ensures complementarity and consistency among them, as appropriate.

1.2. Access to risk finance

Horizon 2020 will help companies and other types of organisation gain access to loans, guarantees and equity finance via two facilities.

The debt facility will provide loans to single beneficiaries for investment in research and innovation; guarantees to financial *intermediaries* making loans to beneficiaries; combinations of loans and guarantees, and guarantees or counter-guarantees for national regional *and local* debt-financing schemes. It will include an SME window targeting R&I-driven SMEs with loan amounts that complement finance to SMEs by the Loan Guarantee Facility under the Programme for the Competitiveness of Enterprises and SMEs *(COSME)*.

The equity facility will provide venture and/or mezzanine capital to individual enterprises in the early stage (start-up window). The facility will also have the possibility to make expansion and growth-stage investments in conjunction with the Equity Facility for Growth under the Programme for the Competitiveness of Enterprises and SMEs *(COSME)*, including in funds-of-funds.

These facilities will be central to the specific objective 'Access to risk finance' but may, where relevant, also be used across all other specific objectives of Horizon 2020.

The equity facility and the SME window of the debt facility will be implemented as part of two EU Financial Instruments that provide equity and debt to support SMEs' R&I and growth, in conjunction with the equity and debt facilities under the Programme for the Competitiveness of Enterprises and SMEs *(COSME)*.

1.3. Communication*, exploitation* and dissemination

A key added value of research and innovation funded at the Union level is the possibility to disseminate*, exploit* and communicate results on a continent wide scale to enhance their impact. Horizon 2020 will therefore include, under all of its specific objectives, dedicated support to dissemination (including through open access to *scientific publications*), communication and dialogue actions, with a strong emphasis on communicating results to end-users, citizens, *academia,* civil society organisations, industry and policy makers. To this extent, Horizon 2020 may make use of networks for information transfer. Communication activities undertaken in the context of Horizon 2020 *will promote the fact that the results were obtained with the support of Union funding and* will also seek to raise public awareness on the importance of research and innovation by means of publications, events, knowledge repositories, databases, websites or a targeted use of social media.

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2. COMPLEMENTARITIES AND CROSS-CUTTING ISSUES AND SUPPORT MEASURES

Horizon 2020 is structured around the objectives defined for its three major parts: generating excellent science, creating industrial leadership and tackling societal challenges. Particular attention will be paid to ensuring adequate coordination between these parts and fully exploiting the synergies generated between all specific objectives to maximise their combined impact on the higher level policy objectives of the Union. The objectives of Horizon 2020 will therefore be addressed through a strong emphasis on finding efficient solutions, going well beyond an approach based simply on traditional scientific and technological disciplines and economic sectors.

Cross-cutting actions will be promoted *across* Part I 'Excellent Science', *Part II 'Industrial Leadership' and Part III 'Societal Challenges'* to develop jointly new knowledge, future and emerging technologies, research infrastructures and key competences. Research infrastructures will also be leveraged for broader usage in society, for example in public services, promotion of science, civil security and culture. Furthermore, priority setting during implementation for the direct actions of the Joint Research Centre and the activities of the European Institute of Innovation and Technology (EIT) will be adequately coordinated with the other parts of Horizon 2020.

Furthermore, in many cases, contributing effectively to the objectives of Europe 2020 and the Innovation Union will require solutions to be developed which are interdisciplinary in nature and therefore cut across multiple specific objectives of Horizon 2020 . Horizon 2020 includes specific provisions to incentivise such cross-cutting actions, including by an efficient bundling of budgets. This includes also for instance the possibility for the societal challenges and enabling and industrial technologies to make use of the provisions for financial instruments and the dedicated SME instrument.

Cross-cutting *actions* will also be vital in stimulating the interactions between the societal challenges and the enabling and industrial technologies needed to generate major technological breakthroughs. Examples of where such interactions may be developed are: the domain of eHealth, smart grids, intelligent transport systems, mainstreaming of climate actions, nanomedicine, advanced materials for lightweight vehicles or the development of bio-based industrial processes and products. Strong synergies will therefore be fostered between the societal challenges and the development of generic enabling and industrial technologies. This will be explicitly taken into account in developing the multi-annual strategies and the priority setting for each of these specific objectives. It will require that stakeholders representing the different perspectives are fully involved in the implementation and in many cases, it will also require actions which bring together funding from the enabling and industrial technologies and the societal challenges concerned.

Particular attention will also be paid to the coordination of activities funded through Horizon 2020 with those supported under other Union funding programmes, such as *those of* the Common Agricultural Policy, *and* the Common Fisheries Policy*, Life*+ or the Erasmus For All: the Union's programme for Education, Training, Youth and Sport or the Health for Growth Programme *and the Union's external and development funding programmes*. This includes an appropriate articulation with the Cohesion policy *in the context of national and regional R&I strategies for smart specialisation*, where support to capacity building for research and innovation at regional level may act as a 'stairway to excellence', the establishment of regional centres of excellence may help close the innovation divide in Europe or support to large-scale demonstration and pilot line projects may aid in achieving the objective of generating industrial leadership in Europe.

A.   Social sciences and humanities

Social sciences and humanities research will be fully integrated into each of the general objectives of Horizon 2020. This will include ample opportunities for supporting such research through the European Research Council, the Marie Skłodowska-Curie actions or the Research Infrastructures specific objective.

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To this end, social sciences and humanities will also be mainstreamed as an essential element of the activities needed to enhance industrial leadership and to tackle each of the societal challenges. For the latter, this includes: understanding the determinants of health and optimising the effectiveness of healthcare provisions, support to policies empowering rural areas, researching and preserving Europe's cultural heritage and richness, promoting informed consumer choices, creating an inclusive digital eco-system based on knowledge and information, robust decision making on energy policy and in ensuring a consumer friendly European electricity grid and a transition to a sustainable energy system, supporting evidence based transport policy and foresight, support to climate change mitigation and adaptation strategies, resource efficiency initiatives and measures towards a green and sustainable economy, and cultural and socio-economic aspects of security, risk and management issues (including legal and human rights aspects).

In addition, the specific objective 'Europe in a changing world: Inclusive, innovative and reflective societies' will support social sciences and humanities research into issues of a horizontal nature such as the creation of smart and sustainable growth, social, cultural and behavioural transformations in European societies, social innovation, innovation in the public sector or the position of Europe as a global actor.

B.   Science and society

The relationship and interaction between science and society as well as the promotion of Responsible Research and Innovation and science education, science communication and culture shall be deepened and public confidence in science and innovation reinforced by activities of Horizon 2020 favouring an informed engagement of and a dialogue with citizens and civil society in research and innovation matters.

C.   Gender

Promoting gender equality in science and innovation is a commitment of the EU. In Horizon 2020, gender will be addressed as a cross-cutting issue in order to rectify imbalances between women and men, and to integrate a gender dimension in research and innovation programming and content.

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D. *Small and medium-sized enterprises (SMEs)*

Horizon 2020 will encourage and support the increased participation of SMEs in an integrated way across all specific objectives.

Further to the establishment of better conditions for SMEs to participate in Horizon 2020, in accordance with Article 18 of Horizon 2020, dedicated measures as set out in the specific objective 'Innovation in SMEs' (dedicated SME instrument) shall be applied in the specific objective 'Leadership in enabling and industrial technologies' and Part III 'Societal challenges'. This integrated approach should lead to a minimum of 20 % of their total combined budgets going to SMEs.

Particular attention shall be paid to the adequate representation of SMEs in public-private partnerships.

DA. *Fast Track to Innovation (FTI)*

The Fast Track to Innovation will speed up time from idea to market significantly and is expected to increase industry participation in Horizon 2020 and first-time applicants.

Fast Track to Innovation in accordance with Art 18a of Horizon 2020 Framework Regulation will support Close-to-Market actions under the specific objective "Leadership in enabling and industrial technologies" and under the societal challenges, with a bottom-up-driven logic on the basis of a continuously open call, and Time to Grant not exceeding six months. FTI will contribute to innovation in Europe, underpinning the Union's competitiveness.

E. *Widening the participation*

The research and innovation potential of the Member States, despite some recent convergence, remain very different, with large gaps between "innovation leaders" and "modest innovators". Activities shall help close the research and innovation divide in Europe by promoting synergies with the European Structural and Investment (ESI) Funds and also by specific measures shall be taken to unlock excellence in low performing RDI

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regions, thereby widening participation in Horizon 2020 and contributing to the realisation of the European Research Area.

F.   International cooperation

International cooperation with partners in third countries is necessary to address effectively many specific objectives defined in Horizon 2020, in particular those relating to Union external and development policies and international commitments. This is the case for all the societal challenges addressed by Horizon 2020, which are common in nature. International cooperation is also essential for frontier and basic research in order to capture the benefits from emerging science and technology opportunities. Promoting researchers and innovation staff mobility at an international scale is therefore crucial to enhance this global cooperation. Activities at the international level are equally important to enhance the competitiveness of European industry by promoting the take-up and trade of novel technologies, for instance through the development of worldwide standards and interoperability guidelines, and by promoting the acceptance and deployment of European solutions outside Europe. All international activities should be supported by an efficient and fair knowledge transfer framework which is critical for innovation and growth.

The focus of international cooperation in Horizon 2020 will be on cooperation with three major country groupings:

(1)   industrialised and emerging economies;

(2)   enlargement and neighbourhood countries; and

(3)   developing countries.

Where appropriate, Horizon 2020 will promote cooperation at bi-regional or multilateral level. International cooperation in research and innovation is a key aspect of the Union's global commitments and has an important role to play in the Union's partnership with developing countries, such as progressing towards the achievement of the Millennium Development Goals.

Article 21 of Horizon 2020 sets out the general principles for participation of organisations from third countries and international organisations. As research and innovation in general benefit largely from an openness towards third countries, Horizon 2020 will continue with the principle of general openness, while encouraging reciprocal access to third country programmes. Where appropriate, and notably to safeguard European interest as regards intellectual property, a more cautious approach may be adopted.

In addition, a range of targeted actions will be implemented taking a strategic approach to international cooperation on the basis of common interest, priorities and mutual benefit and promoting coordination and synergies with Member States activities. This will include a mechanism for supporting joint calls and the possibility of co-funding programmes together with third countries or international organisations. Synergies with other Union policies will be sought.

Strategic advice from the Strategic Forum for International scientific and technological Cooperation (SFIC) will continue to be sought.

Without prejudice to other collaboration opportunities, examples of areas where such strategic international cooperation may be developed are:

(a)   *The continuation of the European and Developing Countries Clinical Trials Partnership (EDCTP2) on clinical trials for medical interventions against HIV, malaria, tuberculosis and neglected diseases;*

(b)   *Support by way of an annual subscription to the Human Frontier Science ~~Frontier~~ Programme (HFSP) to allow non-G7 Member States of the Union to fully benefit from the funding provided by the HFSP;*

(c)   *International consortium on rare diseases, with a number of Union Member States and third countries. The aim of this initiative is to develop by 2020, diagnostic tests for most rare diseases and 200 new therapies for rare diseases;*

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(d)   *Support to the activities of the International Knowledge-Based Bio-Economy Forum and the EU-US Task Force on Biotechnology Research as well as collaborative links with relevant international organisations and initiatives (such as global research alliances on agricultural greenhouse gases and on animal health);*

(e)   *Contribution to multilateral processes and initiatives, such as the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), and the Group on Earth Observations (GEO);*

(f)   *The Space Dialogues between the Union and the United States of America and Russia, the two major space faring nations, is an extremely valuable one and forms the basis for the establishment of strategic cooperation in space partnerships;.*

(g)   *The implementing arrangement for cooperative activities between the European Union and the United States of America in the field of Homeland Security/Civil Security/Research , signed on 18 November 2010;*

(h)   *Cooperation with developing countries, including from Sub-Saharan Africa, in the field of decentralised energy production for poverty alleviation;*

(i)   *Continuation of research collaboration with Brazil on new generation of bio-fuels and other uses of biomass.*

In addition, dedicated horizontal activities will be supported in order to ensure the coherent and effective development of international cooperation across Horizon 2020.

G.   *Sustainable development and climate change*

Horizon 2020 will encourage and support activities towards exploiting Europe's leadership in the race to develop new processes and technologies promoting sustainable development, in a broad sense, and combating climate change. Such horizontal approach, fully integrated in all Horizon 2020 priorities, will help the EU to prosper in a low-carbon,

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resource constrained world while building a resource efficient, sustainable and competitive economy.

H.   *Bridging from discovery to market application*

Bridging actions throughout Horizon 2020 are aimed at bringing discovery to market application, leading to exploitation and commercialisation of ideas whenever appropriate. The actions should be based on a broad innovation concept and stimulate cross-sectoral innovation.

I   *Cross-cutting support measures*

The cross-cutting issues will be supported by a number of transversal support measures, including support to: enhancing the attractiveness of the research profession, including the general principles of the European Charter for researchers; strengthening the evidence base and the development of and support for ERA (including the five ERA initiatives) and the Innovation Union; recognising top performing Horizon 2020 beneficiaries and projects in the different fields through symbolic awards; improving framework conditions in support of the Innovation Union, including the principles of the Commission Recommendation on the management of intellectual property[1] and exploring the possibility of setting up an European Intellectual Property Rights valorisation instrument; administration and coordination of international networks for excellent researchers and innovators (such as COST).

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[1]   Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations (C(2008) 1329, of 10.4.2008).

3.   **PARTNERING**

For achieving sustainable growth in Europe, the contribution of public and private players must be optimised. This is essential for consolidating the European Research Area and for delivering on the Innovation Union, the Digital Agenda and other Europe 2020 flagship initiatives. Furthermore, responsible research and innovation requires that best solutions be derived from interactions between partners having various perspectives but common interests.

Horizon 2020 includes scope and a clear set of criteria for setting up public-public and public-private partnerships. Public-private partnerships can be based on a contractual arrangement between public and private actors and can in limited cases be institutionalised public-private partnerships (such as Joint Technology Initiatives and other Joint Undertakings).

Existing public-public and public-private partnerships may receive support from Horizon 2020, provided they address Horizon 2020 objectives, they ***contribute to realising the ERA, they*** meet the criteria laid down in Horizon 2020 and they have shown to make significant progress under the Seventh Framework Programme for Research, Technological Development and Demonstration (FP7).

Initiatives under Article 185 of the Treaty supported under FP6 and/or FP7 for which further support may be provided under the above conditions include: the European and Developing Countries Clinical Trials Partnership (EDCTP), Ambient Assisted Living (AAL), Baltic Sea Research and Development Programme (BONUS), Eurostars and the European Metrology Research Programme. Further support may also be provided to the European Energy Research Alliance (EERA) established under the Strategic Energy Technology Plan (SET Plan). ***Joint Programming Initiatives may be supported by Horizon 2020 through the instruments referred to in Article 20 of [Framework Regulation], including through initiatives under Article 185 of the Treaty.***

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Joint Undertakings established in FP7 under Article 187 of the Treaty, for which further support may be provided under the above conditions are: the Innovative Medicines Initiative (IMI), Clean Sky, Single European Sky ATM Research (SESAR), Fuel Cells and Hydrogen (FCH), and Embedded computing systems (ARTEMIS) and Nanoelectronics (ENIAC). The latter two may be combined into a single initiative.

Other public-private partnerships supported under FP7 for which further support may be provided under the above conditions are: Factories of the Future, Energy-efficient Buildings, European Green Cars Initiative, Future Internet. Further support may also be provided to the European Industrial Initiatives (EIIs) established under the SET Plan.

Further public-public partnerships and public-private partnerships may be launched under Horizon 2020 where they meet the defined criteria.

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PART I

EXCELLENT SCIENCE

1. EUROPEAN RESEARCH COUNCIL

The European Research Council (ERC) will promote world class frontier research. Research at and beyond the frontiers of current understanding is both of critical importance to economic and social welfare, and an intrinsically risky venture, progressing on new and most challenging research areas and characterised by an absence of disciplinary boundaries.

In order to stimulate substantial advances at the frontiers of knowledge, the ERC will support individual teams to carry out research in any field of basic scientific and technological research which falls within the scope of Horizon 2020, including engineering, social sciences and the humanities. As appropriate, specific   target groups (e.g. ***starting*** researchers/emerging teams) may be taken into account, following the objectives of the ERC and needs for efficient implementation. Particular attention will be paid to emerging and fast-growing areas at the frontier of knowledge, and at the interface between disciplines.

Independent researchers of any age ***and gender***, including starting researchers making the transition to being independent research leaders in their own right, from any country in the world will be supported to carry out their research in Europe.

The ERC shall give particular priority to assisting the best starting researchers with excellent ideas to make the transition to independence by providing adequate support at the critical stage when they are setting up or consolidating their own research team or programme. The ERC will also continue to provide appropriate levels of support for established researchers.

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An "investigator-driven" approach will be followed. This means that the ERC will support projects carried out by researchers on subjects of their choice within the scope of calls for proposals. Proposals will be evaluated on the sole criterion of excellence as judged by peer review, taking account of excellence in new groups, *starting* researchers, as well as established teams, and paying particular attention to proposals which are highly pioneering and involve correspondingly high scientific risks.

The ERC will operate as *an autonomous* science-led funding body consisting of an independent Scientific Council, supported by a lean and cost-effective dedicated implementation structure.

The ERC Scientific Council will establish the overall scientific strategy and will have full authority over decisions on the type of research to be funded.

The Scientific Council will establish the work programme to meet the ERC's objectives based on its scientific strategy as below. It will establish the necessary international cooperation initiatives in line with its scientific strategy, including outreach activities to increase the visibility of the ERC for the best researchers from the rest of the world.

The Scientific Council will continuously monitor the operation of the ERC *and its evaluation procedures* and consider how best to achieve its broader objectives. It will develop the ERC's mix of support measures as necessary to respond to emerging needs.

The ERC will aim for excellence in its own operations. The administrative and staffing costs for the ERC relating to the Scientific Council and dedicated implementation structure will be consistent with lean and cost-effective management. Administrative expenditure will be kept to a minimum, consistent with ensuring the resources necessary for world class implementation, in order to maximise funding for frontier research.

ERC awards will be made and grants operated according to simple*, transparent* procedures that maintain the focus on excellence, encourage initiative and combine flexibility with accountability. The ERC will continuously look for further ways to simplify and improve its procedures in order to ensure that these principles are met.

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Given the unique structure and role of the ERC as a science-led funding body the implementation and management of the activities of the ERC will be reviewed and evaluated on an ongoing basis with the full involvement of the Scientific Council to assess its achievements and to adjust and improve procedures and structures on the basis of experience.

1.1.   The Scientific Council

In order to carry out its tasks, as set out in Article 7, the Scientific Council will:

(1)   Scientific strategy:

– establish the overall scientific strategy for the ERC, in the light of scientific opportunities and European scientific needs;

– on a permanent basis, in accordance with the scientific strategy, ensure the establishment of the work programme and necessary modifications, including calls for proposals and criteria and, as may be required, the definition of specific   target groups (e.g. starting /emerging teams);

(2)   Scientific management, monitoring and quality control:

– as appropriate, from a scientific perspective, establish positions on implementation and management of calls for proposals, evaluation criteria, peer review processes including the selection of experts, the methods for peer review and proposal evaluation and the necessary implementing rules and guidelines, on the basis of which the proposal to be funded will be determined under the supervision of the Scientific Council; as well as any other matter affecting the achievements and impact of the ERC's activities, and the quality of the research carried out, including the principal provisions of the ERC Model Grant Agreement;

– monitor quality of operations and evaluate implementation and achievements and make recommendations for corrective or future actions.

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(3)   Communication and dissemination:

– assure ***transparency in*** communication with the scientific community**,** key stakeholders ***and the general public*** on the ERC's activities and achievements;

– regularly report to the Commission on its own activities.

The Scientific Council has full authority over decisions on the type of research to be funded and is the guarantor of the quality of the activity from the scientific perspective.

Where appropriate, the Scientific Council shall consult with the scientific, engineering and scholarly Community**, *regional and national research funding agencies and other stakeholders***.

The members of the Scientific Council shall be compensated for the tasks they perform by means of an honorarium and, where appropriate, reimbursement of travel and subsistence expenses.

The ERC President will reside in Brussels for the duration of the appointment and devote most of his/her time[1] to ERC business. He/she will be remunerated at a level commensurate with the Commission's top management.

The Scientific Council shall elect from amongst its members three Vice-Chairs who shall assist the President in its representation and the organisation of its work. They may also hold the title of Vice-President of the European Research Council.

Support will be provided to the three Vice Chairs to ensure adequate local administrative assistance at their home institutes.

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[1]   In principle at least 80 %

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1.2.   Dedicated implementation structure

The dedicated implementation structure will be responsible for all aspects of administrative implementation and programme execution, as provided for in the work programme. It will, in particular, implement the evaluation procedures, peer review and selection process in accordance with the strategy established by the Scientific Council and will ensure the financial and scientific management of the grants.

The dedicated implementation structure will support the Scientific Council in the conduct of all of its tasks as set out above, provide access to the necessary documents and data in its possession, and keep the Scientific Council informed of its activities.

In order to ensure an effective liaison with the dedicated implementation structure on strategy and operational matters, the leadership of the Scientific Council and the Director of the dedicated implementation structure will hold regular coordination meetings.

The management of the ERC will be carried out by staff recruited for that purpose, including where necessary, officials from Union institutions, and will cover only the real administrative needs in order to assure the stability and continuity necessary for an effective administration.

1.3.   Role of the Commission

In order to fulfil its responsibilities as set out in Articles 6, 7 and 8 the Commission will:

–   ensure the continuity and renewal of the Scientific Council and provide support for a standing Identification Committee for the identification of future Scientific Council members;

–   ensure the continuity of the dedicated implementation structure and the delegation of tasks and responsibilities to it taking into account the views of the Scientific Council;

–   appoint the Director and the Senior Staff of the dedicated implementation structure taking into account the views of the Scientific Council;

–   ensure the timely adoption of the work programme, the positions regarding implementing methodology and the necessary implementing rules as provided by the ERC Rules of Submission and the ERC Model Grant Agreement, taking into account the positions of the Scientific Council;

–   regularly inform *and consult* the programme committee on the implementation of the ERC activities.

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2.   FUTURE AND EMERGING TECHNOLOGIES

Future and Emerging Technologies (FET) activities will concretise different logics of intervention, from completely open to varying degrees of structuring of topics, communities and funding, structured around three ***strands - FET Open, FET Proactive and FET Flagships***.

2.1.   FET Open: fostering novel ideas

Supporting a large set of ***early stage***, high risk visionary science and technology collaborative research projects is necessary for the successful exploration of new foundations for radically new future ***scientific knowledge and*** technologies. By being explicitly non-topical and non-prescriptive, this activity allows for new ideas, whenever they arise and wherever they come from, within the broadest spectrum of themes and disciplines ***and actively stimulate creative out-of-the-box thinking***. Nurturing such fragile ideas requires an agile, risk-friendly and highly interdisciplinary research approach, going well beyond the strictly technological realms. Attracting and stimulating the participation of new high-potential actors in research and innovation, such as young researchers and high-tech SMEs is also important for nurturing the scientific and industrial leaders of the future.

2.2.   FET Proactive: nurturing emerging themes and communities

Novel areas and themes need to be matured, by working towards structuring emerging communities and supporting the design and development of transformative research themes. The main benefits of this structuring yet explorative approach are emerging novel areas that are not yet ready for inclusion in industry research roadmaps, and building up and structuring of research communities around them. It makes the step from collaborations between a small number of researchers, to a cluster of projects that each address aspects of a research theme and exchange results. ***This will be done in close association with the societal challenges and industrial leadership themes.***

2.3.   FET Flagships: *pursuing* grand interdisciplinary science and technology challenges

Research initiatives within this challenge are science *and technology*-driven, large-scale, multidisciplinary and built around a visionary unifying goal. They tackle grand science and technology challenges requiring cooperation among a range of disciplines, communities and programmes. The scientific *and technological* advance should provide a strong and broad basis for future   innovation and economic exploitation, as well as novel benefits for society *of a potential high impact*. The overarching nature and magnitude implies that they can only be realised through a *collaborative long-term* and sustained effort   .

Activities in the three FET *strands* are complemented, by   networking and community-based activities for creating a fertile and vibrant European base for science-driven research towards future technologies. They will support the future developments of the FET activities, foster the debate on implications of new technologies, and accelerate impact.

2.4.   Specific implementation aspects

A FET Advisory Board*, including scientists and engineers of the highest repute and expertise,* will provide stakeholder input on the overall scientific *and technological* strategy, including *advice on* the definition of the work programme.

FET will continue to be science-*and-technology-*led supported by a light and efficient implementation structure. Simple administrative procedures will be adopted to maintain the focus on excellence in science-driven technological innovation, encourage initiative and combine *speed in decision-making and* flexibility with accountability. The most appropriate approaches will be used for probing the FET research landscape (e.g.,   portfolio analysis) and for involving communities of stakeholders (e.g.,   consultations). The aim will be for continuous improvement, and the search for further ways to simplify and improve procedures in order to ensure that these principles are met. Assessments of the effectiveness and impact of the FET activities will be carried out, complementing those at programme level.

Given its mission of fostering science-driven research towards future technologies, FET strives to bring together actors from science, technology and innovation*, where appropriate including users, and to the extent possible from both public and private sectors*. FET should therefore play an active and catalytic role in stimulating new thinking, new practices and new collaborations.

FET-Open groups activities for an entirely bottom up search for promising new ideas. The high-risk implied by each such idea is countered by exploring many of them. Efficiency in terms of time and resources, low opportunity cost for the proposers, and undisputable openness to non-conventional and interdisciplinary ideas are the key characteristics for these activities. Light-and-fast continuously open submission schemes will seek for high-risk promising new research ideas and will include tracks for new and high potential innovation actors such as young researchers and high tech SMEs. *To complement FET-Open activities, activities under the Industrial Leadership and Societal Challenges priorities may foster radically new use of knowledge and technologies.*

The FET proactive   activity *will* regularly *open* calls on several high-risk, high-potential innovative themes, funded at such a level that several projects can be selected. These projects will be supported by community building actions that foster activities such as joint events, development of new curricula and research roadmaps. The selection of themes will take into account excellence in science-driven research towards future technologies, potential for creating a critical mass and impact on science and technology.

A number of large scale focused initiatives (FET Flagships) *could* be implemented *subject to the positive outcome of FET preparatory projects*. They *should* be based on *open* partnerships that enable *the voluntary combination of* Union, national and private contributions, with a balanced governance that allows programme owners to have appropriate influence, as well as a large degree of autonomy and flexibility in the implementation, enabling the flagship to follow closely a broadly supported research roadmap. The selection *of topics to be implemented as Flagships will be based on scientific and technologial excellence and* will take into account the unifying goal, the *potential* impact, integration of stakeholders and resources under a cohesive research roadmap and*, where appropriate,* support from stakeholders and national/regional research programmes. *These activities shall*

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be realised using the existing funding instruments.

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3.   MARIE *SKŁODOWSKA-*CURIE ACTIONS

3.1.   Fostering new skills by means of excellent initial training of researchers

Europe needs a strong and creative human resource base, mobile across countries and sectors, with the right combination of skills to innovate and to convert knowledge and ideas into products and services for economic and social benefit.

This will be achieved in particular by structuring and raising excellence in a substantial share of the high-quality initial training of early stage researchers and doctoral candidates throughout Member states and associated countries *including, where appropriate, participation from third countries*. By equipping early stage researchers with a diversity of skills that will allow them to face current and future challenges, the next generation of researchers will benefit from enhanced career perspectives in both public and private sectors, thereby enhancing also the attraction of young people to research careers.

The action will be implemented through support to Union-wide competitively selected research training programmes implemented by partnerships of universities, research institutions, *research infrastructures,* businesses, SMEs and other socio-economic actors from different countries across Europe and beyond. Single institutions able to provide the same enriching environment will also be supported. Flexibility in the implementation of the objectives will have to be ensured in order to address the different needs. Typically, successful partnerships will take the form of research training networks *that may offer innovative types of training such as joint or multiple doctoral degrees* or industrial doctorates, while single institutions will usually be involved in innovative doctoral programmes. *Industrial doctorates are an important element to foster an innovative spirit among researchers and create closer links between industry and academia*. In this frame, support is foreseen for the best early stage researchers from any country to join these excellent programmes*, which may include, inter alia, mentoring to transfer knowledge and experience.*

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These training programmes will address the development and broadening of core research competences, while equipping researchers with a creative mind, an entrepreneurial outlook and innovation skills that will match the future needs of the labour market. The programmes will also provide training in transferable competences such as team-work, risk-taking, project management, standardisation, entrepreneurship, ethics, IPR, communication and societal outreach which are essential for the generation, development, commercialisation and diffusion of innovation.

3.2.   Nurturing excellence by means of cross-border and cross-sector mobility

Europe has to be attractive for the best researchers, European and non-European. This will be achieved in particular by supporting attractive career opportunities for experienced researchers in both public and private sectors, and encouraging them to move between countries, sectors and disciplines to enhance their creative and innovative potential.

Funding will be given to the best or most promising experienced researchers, regardless of their nationality, who want to develop their skills through a trans-national or international mobility experience. They can be supported along all the different stages of their career, including the most junior ones just after their doctoral degree or equivalent experience. These researchers will receive funding on the condition that they move from one country to another to broaden or deepen their competences in universities, research institutions, *research infrastructures,* businesses, SMEs or other socio-economic actors of their choice *(e.g. civil society organisations)*, working on research and innovation projects fitting their personal needs and interests. They will be encouraged to move from public to private sector or vice-versa through the support of temporary postings. ***This should enhance the innovativeness of the private sector and promote cross-sector mobility.*** Part-time opportunities allowing combined positions in both public and private sectors will also be supported to enhance the transfer of knowledge between sectors and also encourage the creation of start-ups. Such tailor-made research opportunities will help promising researchers to become fully independent and to facilitate career moves between public and private sectors.

United in diversity

In order to fully exploit the existing potential of researchers, possibilities *to be trained and to acquire new knowledge in a third-country high-level research institution,* to restart a research career after a break *and to (re)integrate researchers into a longer term research position in Europe, including their country of origin, after a trans-national/international mobility experience* will also be supported.

3.3.   Stimulating innovation by means of cross-fertilisation of knowledge

Societal challenges are becoming more and more global and cross-border and cross-sector collaborations are crucial to successfully face them. Sharing of knowledge and ideas from research to market *(and vice-versa)* is therefore vital and can only be achieved through the connection of people. This will be promoted through the support of flexible exchanges of highly skilled research and innovation staff between sectors, countries and disciplines.

European funding will support   exchanges of research and innovation staff within partnerships of universities, research institutions, *research infrastructures,* businesses, SMEs and other socio-economic actors among Europe, as well as between Europe and third countries to reinforce international cooperation. It will be open to research and innovation staff at all career levels, from the most junior (post-graduate) to the most senior (management), including also administrative and technical staff.

3.4.   Increasing structural impact by co-funding the activities

Stimulating regional, national or international programmes to foster excellence and spread best practices of Marie *Skłodowska-*Curie Actions in terms of European-wide mobility possibilities for researchers training, career development and staff exchange will increase the numerical and structural impact of Marie *Skłodowska-*Curie Actions. This will also enhance the attractiveness of centres of excellence across Europe.

This will be achieved by co-funding new or existing regional, national, private and international programmes to open-up to and provide for international, intersectoral and interdicisplinary research training, as well as cross-border and cross-sector mobility of researchers and innovation staff at all stages of their career.

This will allow the exploitation of synergies between Union actions and those at regional and national level, combating fragmentation in terms of objectives, evaluation methods and working conditions of researchers. ***In the framework of co-funding activities, use of employment contracts will be strongly promoted.***

3.5.   Specific support and policy actions

To efficiently meet the challenge it will be essential to monitor progress. The programme will support the development of indicators and the analysis of data related to researchers' mobility, skills*,* careers ***and gender equality*** with a view to identifying gaps ***and barriers*** in the Marie ***Skłodowska-***Curie actions and to increasing the impact of these actions. These activities will be implemented seeking synergies and close coordination with the policy support actions on researchers, their employers and funders carried out under *'**Europe in a changing world -*** Inclusive, innovative and ***reflective*** societies'. Specific actions will be funded to support initiatives to raise awareness on the importance of the research career ***covering also return and reintegration aspects***, and to disseminate research and innovation results emanating from work supported by Marie ***Skłodowska-***Curie actions.

To further increase the impact of the Marie ***Skłodowska-***Curie actions, the networking between Marie ***Skłodowska-***Curie researchers (current and past) will be enhanced through a strategy of alumni services. These will range from supporting a forum for contact and exchange between the researchers, providing possibilities for exploring collaborations and job opportunities, to the organisation of joint events and the involvement of the fellows in outreach activities as ambassadors for Marie ***Skłodowska-***Curie actions and for the European Research Area.

3.6.	Specific implementation aspects

The Marie *Skłodowska-*Curie actions will be open to training and career development activities within all domains of research and innovation addressed under the Treaty, from basic research up to market take-up and innovation services. Research and innovation fields as well as sectors will be chosen freely by the applicants.

To benefit from the worldwide knowledge base, the Marie *Skłodowska-*Curie actions will be open to researchers and innovation staff, as well as to universities, research institutions, *research infrastructures*, businesses and other socio-economic actors from all countries, including third countries under the conditions defined in Regulation (EU) XX/2012 (Rules for Participation).

Throughout all the activities described above, attention will be paid to encourage a strong participation of enterprises, in particular SMEs, as well as other socio-economic actors for the successful implementation and impact of the Marie *Skłodowska-*Curie actions. A long-term collaboration between higher education, research organisations and the *public and* private *sectors*, taking into account the protection of intellectual property rights, is promoted throughout all the Marie *Skłodowska-*Curie actions.

The Marie Skłodowska-Curie actions will be developed in close synergy with other programmes supporting these policy objectives, including the Erasmus for All programme and the Knowledge and Innovation Communities of the EIT.

The possibility is retained, if specific needs arise, to target certain activities under the programme regarding specific societal challenges, types of research and innovation institutions, or geographical locations in order to respond to the evolution of Europe's requirements in terms of skills, research training, career development and knowledge sharing.

In order to be open to all sources of talent, general measures to overcome any distortions in the access to the grants will be ensured, for example by encouraging equal opportunities *for male and female researchers* in all Marie *Skłodowska-*Curie actions and by benchmarking gender participation.. In addition, the Marie *Skłodowska-*Curie actions will support researchers to get established on a more stable career path and to ensure that they can achieve an appropriate work/life balance, taking into account their family situation, and to contribute to facilitate resuming a research career after a break. The principles of the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers promoting open recruitment and attractive working conditions *are recommended* to be endorsed and applied by all the funded participants.

To further enhance dissemination and public engagement, beneficiaries of the Marie *Skłodowska-*Curie actions *may* be required to plan suitable outreach activities to the general public. This plan will be assessed during the evaluation process as well as during the project follow-up.

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4. RESEARCH INFRASTRUCTURES

The activities will aim at developing *excellent* European research infrastructures for 2020 and beyond, fostering their innovation potential and human *resources* and reinforcing European policy. Coordination with the cohesion funding sources will be pursued to ensure synergies and a coherent approach for the development of the research infrastructures. *Synergies with Marie Sklodowska-Curie actions will be encouraged*.

4.1. Developing the European research infrastructures for 2020 and beyond

4.1.1. Developing new world-class research infrastructures

The aim is to *facilitate and support the preparation,* implementation, long-term sustainability and efficient operation of the research infrastructures identified by the European Strategy Forum on Research Infrastructures (ESFRI) and other world-class research infrastructures, which will help Europe to respond to grand challenges in science, industry and society. This objective will address specifically those infrastructures that are *planning to set up, are* setting up or that have set up their governance, e.g. on the basis of the European Research Infrastructure Consortium (ERIC) or any equivalent structure at European or international level.

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The Union funding will contribute to, as appropriate:

(a)   the preparatory phase of future infrastructures (e.g. detailed construction plans, legal arrangements, multiannual planning, *early engagement of industry*);

(b)   the implementation phase (e.g. R&D and engineering work jointly with industry and users, development of regional partner facilities[1] aiming at a more balanced development of the European Research Area); and/or

(c)   the operation phase (e.g. access, data handling, outreach, training and international cooperation activities).

This activity will also support design studies for new research infrastructures through a bottom-up approach.

4.1.2. Integrating and opening existing national *and regional* research infrastructures of *European* interest

The aim is to open up, *where appropriate*, key national *and regional* research infrastructures to all European researchers, from both academia and industry, and to ensure their optimal use and joint development.

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[1]   ***A Regional Partner Facility (RPF) is a research infrastructure of national or regional importance in terms of socio-economic returns, training and attracting researchers and technicians, that is recognised as a partner to a pan-European ESFRI or other world-class research infrastructure. The quality of the RPF including the level of its scientific service, management and access policy must meet the same standards required for pan-European research infrastructures.***

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The Union will support networks *and clusters* that bring together and integrate, on European scale, key national research infrastructures. Funding will be provided to support, in particular, the trans-national and virtual access of researchers and the harmonisation and improvement of the services the infrastructures provide.

4.1.3. Development, deployment and operation of ICT-based e-infrastructures[1]

The aim is to achieve by 2020 *a world-leading capability in networking, computing and scientific data in a* single and open European space for online research where researchers enjoy leading-edge, ubiquitous and reliable services for networking and computing, and seamless and open access to e-Science environments and global data resources.

To achieve this goal, support will be given to: global research and education networks providing advanced, standardised and scalable inter-domain services on-demand; grid and cloud infrastructures providing virtually unlimited computational and data processing capacity; an ecosystem of supercomputing facilities, advancing towards exa-scale; a software and service infrastructure, e.g. for simulation and visualisation; real-time collaborative tools; and an interoperable, open and trusted scientific data infrastructure.

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[1] As all research becomes computer- and data-intensive, access to state of the art e-infrastructures has become essential for all researchers. For example, GÉANT connects 40 million users in over 8,000 institutions across 40 countries, whereas the European grid infrastructure is the world's largest distributed computing infrastructure with over 290 sites in 50 countries. Relentless progress in ICT and the increasing needs of science for computing and processing massive amounts of data pose major financing and organisational challenges for ensuring seamless services to researchers.

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4.2.	Fostering the innovation potential of research infrastructures and their human resources

4.2.1.	Exploiting the innovation potential of research infrastructures

The goal is to stimulate innovation both in the infrastructures themselves and in *industries, such as the* supplier and user industry.

To this end, support will be provided to

(a)	R&D partnerships with industry to develop Union capacities and industrial supply in high-tech areas such as scientific instrumentation or ICT;

(b)	pre-commercial procurement by research infrastructure actors to drive forward innovation and act as early adopters *or developers* of *cutting-edge* technologies;

(c)	stimulate the use of research infrastructures by industry, e.g. as experimental test facilities or knowledge-based centres; and

(d)	encourage the integration of research infrastructures into local, regional and global innovation ecosystems.

The Union actions will also leverage the use of research infrastructures, in particular e-infrastructures, for public services, social innovation, culture and education *and training*.

4.2.2.	Strengthening the human capital of research infrastructures

The complexity of research infrastructures and the exploitation of their full potential require adequate skills for their managers, engineers and technicians, as well as users.

United in diversity

The Union funding will support the training of staff managing and operating research infrastructures of pan-European interest, the exchange of staff and best practices between facilities, and the adequate supply of human resources in key disciplines, including the emergence of specific education curricula. *Synergies with Marie Skłodowska-Curie actions will be encouraged.*

4.3.   Reinforcing European research infrastructure policy and international cooperation

4.3.1. Reinforcing European policy for research infrastructures

The aims are to exploit synergies between national and Union initiatives by setting up partnerships between relevant policy makers*,* funding bodies *or advisory groups* (e.g. ESFRI, e-Infrastructure Reflection Group (e-IRG), EIROforum organisations, national public authorities), to develop complementarities and cooperation between research infrastructures and activities implementing other Union policies (such as regional, cohesion, industrial, health, *environment*, employment, or development policy), and to ensure coordination between different Union funding sources. Union actions will also support survey, monitoring and assessment of research infrastructures at Union level, as well as relevant policy studies and communication tasks.

Horizon 2020 will facilitate the efforts of Member States to optimise their research facilities by supporting an up-to-date EU-wide database on openly accessible research infrastructures in Europe.

4.3.2. Facilitate strategic international cooperation

The aim is to facilitate the development of global research infrastructures i.e. research infrastructures that require funding and agreements on a global scale. The aim is also to facilitate the cooperation of European research infrastructures with their non-European counterparts, ensuring their global interoperability and reach, and to pursue international agreements on the reciprocal use, openness or co-financing of infrastructures. In this respect due account will be taken of the recommendations of the Carnegie Group of Senior Officials on Global Research Infrastructures. Attention will also be given to ensure adequate Union participation in coordination with international bodies such as the UN or the OECD.

4.4.   Specific implementation aspects

During implementation independent expert groups will be consulted, as well as stakeholders and advisory bodies, such as ESFRI and the e-IRG.

The implementation will follow a three-pronged approach: bottom-up where the exact content and partnership of projects are not known; targeted where the specific research infrastructures and/or communities addressed are well-defined; and named beneficiaries, for example where a contribution to operational costs is provided to (a consortium of) infrastructure operator(s).

The aims of the activity lines set under sections 4.2 and 4.3 shall be pursued by dedicated actions, as well as within the actions developed under section 4.1 whenever appropriate.

PART II

INDUSTRIAL LEADERSHIP

1.   LEADERSHIP IN ENABLING AND INDUSTRIAL TECHNOLOGIES

General

The successful mastering*, **integration** and deployment of enabling technologies by European industry is a key factor in strengthening Europe's productivity and innovation capacity and ensuring Europe has an advanced, sustainable and competitive economy, global leadership in high-tech application sectors and the ability to develop **effective and sustainable** solutions for societal challenges **taking into account, inter alia, user needs**. Innovation activities will be combined with R&D, as an integral part of the funding.

> An integrated approach to Key Enabling Technologies
>
> A major component of 'Leadership in Enabling and Industrial Technologies' are Key Enabling Technologies (KETs), defined as micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing systems . Many innovative products incorporate several of these technologies simultaneously, as single or integrated parts. While each technology offers technological innovation, the accumulated benefit from **the numerous interactions of KETs and other industrial enabling technologies and their combinations**, can also lead to technological leaps. Tapping into cross-cutting key enabling technologies will enhance product competitiveness and impact **and stimulate growth and jobs and provide new opportunities to tackle societal challenges**. The numerous interactions of these technologies will therefore be exploited. Dedicated support will be provided for larger-scale pilot line and demonstrator projects **to be implemented in various environments and conditions**.

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This will include **KETs and** cross-cutting **KET (multi KETs)** activities that bring together and integrate various individual technologies, resulting in technology validation in an industrial environment to a complete and qualified system, ready **or close to enter** the market. Strong private sector involvement in such activities **and the demonstration of how project results will contribute to market value for the EU** will be a prerequisite and implementation **could** therefore **take the form of** public private partnerships. To this extent and through **the Horizon 2020 implementation** structure, a joint work programme for cross-cutting KETs activities will be developed. Taking into account market needs and the requirements of the societal challenges, it will aim at providing generic KETs **and multi KETs** building blocks for different application areas, including societal challenges. **In addition, synergies will be sought, where appropriate, between KET activities and the activities under the Cohesion Policy framework in the context of national and regional R&I strategies for smart specialisation, as well as with the European Institute of Innovation and Technology (EIT), the European Investment Bank (EIB) and, where appropriate, with the Member States driven activities under the Joint Programming Initiatives.**

Specific implementation aspects

Innovation activities will include the integration of individual technologies; demonstrations of capacities to make and deliver innovative products**, systems, processes** and services; user and customer pilots to prove feasibility and added value; and large-scale demonstrators to facilitate market take-up of the research results. **Adequate focus will be given to small and medium scale projects. Furthermore, implementation under this Part will encourage the involvement of small and medium sized research teams, also contributing to a more active participation of SMEs.**

Various individual technologies will be integrated, resulting in technology validation in an industrial environment to a complete and qualified system, ready for the market. Strong private sector involvement in such activities will be a prerequisite, **including** public-private partnerships.

Demand-side actions will complement the technology push of the research and innovation initiatives. These include making the best use of public procurement of innovation; developing appropriate technical standards *and technical activities in support of standardisation and regulation*; private demand and engaging users to create more innovation-friendly markets.

For nanotechnology and biotechnology in particular engagement with stakeholders and the general public will aim to raise the awareness of benefits and risks. Safety assessment and the management of overall risks in the deployment of these technologies will be systematically addressed. *Where appropriate, social sciences and humanities will contribute to taking into account user needs preferences and acceptance as well as ensuring societal engagement and informed consumers' choice.*

The activities *supported under this Part* will complement support for research and innovation in enabling technologies, which may be provided by national or regional authorities under the Cohesion Policy funds, within the framework of smart specialisation strategies.

This programme shall, as part of the funding of actions, also support technology transfer activities (both at national and regional level), including the development of international and regional innovation clusters, to promote more effective linkages between universities and the industry.

Strategic international cooperation initiatives will be pursued in areas of mutual interest and benefit with leading partner countries. Of particular, but not exclusive, interest for enabling and industrial technologies are:

–   *access to world-leading scientific and technological expertise;*

–   the development of global standards;

–   *the removal of* bottlenecks in industrial exploitation*, R&D collaboration* and conditions for trade;

–   the safety of nanotechnology-based and biotechnology-based products *and the long-term impact of their use*;

–   the development of materials and methods to reduce energy and resource consumption;

–   industry-led, collaborative international initiatives within the manufacturing community; and

–   the interoperability of systems

1.1.   Information and Communication Technologies (ICT)

A number of activity lines will target *ICT industrial and technological leadership challenges along the whole value chain* and cover generic ICT research and innovation agendas, including notably:

1.1.1.   A new generation of components and systems: Engineering of advanced   embedded *and energy and resource efficient* components and systems

The objective is to maintain and reinforce European leadership in technologies related to *advanced*, embedded *and energy and resource efficient and robust* components and systems. It also includes micro-nano-bio systems, organic electronics, large area integration, underlying technologies for the Internet of Things (IoT)[1] including platforms to support the delivery of advanced services*, sensors,* smart integrated systems, *embedded and distributed systems,* systems of systems and complex systems engineering.

1.1.2.   Next generation computing: Advanced *and secure* computing systems and technologies**, *including cloud computing*

The objective is to leverage European assets in processor and system architecture, interconnect and data localisation technologies, cloud computing, parallel computing, *modelling* and simulation software for all market segments,*including engineering*

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[1]   Internet of things will be coordinated as a cross-cutting issue.

applications (such as, inter alia, uncertainty quantification, risk analysis and decision in engineering).

1.1.3. Future Internet: *Software, hardware,* infrastructures, technologies and services

The objective is to reinforce the competitiveness of European industry in developing, mastering and shaping the next generation Internet that will gradually replace and surpass the current Web, fixed and mobile networks and service infrastructures, and enable the interconnection of trillions of devices (IoT) across multiple operators and domains that will change the way we communicate, access and use knowledge. This includes R&I on networks, software, processes and services, cyber security, privacy*, reliability* and trust, wireless[1] communication and all optical networks, immersive interactive multimedia and on the connected enterprise of the future.

1.1.4. Content technologies and information management: ICT for digital content*, cultural and creative industries*

The objective is to *strenghten Europe's position as provider of products and services based on individual and business creativity. It will do so by providing* professionals and citizens with new tools to create, *access,* exploit*,* preserve *and re-use* all forms of digital content in any language and to model, analyse, and visualise vast amounts of data *(big data),* including linked data. This includes new technologies for *arts,* language, learning, interaction, digital preservation, *web design,* content access*,* analytics *and media*; intelligent *and adaptive* information management systems based on advanced data mining, machine learning, statistical analysis and visual computing technologies.

1.1.5. Advanced interfaces and robots: Robotics and smart spaces

The objective is to reinforce European scientific and industrial leadership in industrial and service robotics*,* cognitive *and communicative* systems, advanced interfaces and smart spaces, and sentient machines, building on increases in computing and networking performance and progress in the ability to *design and* build systems that can learn, *self-assemble,* adapt and react *or that optimise human-machine interactions. Where appropriate,*

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[1]   Including space based networks.

the systems developed and advancements in the state-of-the-art should be validated in real-world environments.

1.1.6.   Micro- and nanoelectronics and photonics: *Key enabling technologies related to micro-and nanoelectronics and to photonics, covering also quantum technologies*

The objective is to take advantage of the excellence of Europe in *these* key enabling *technologies* and support *and further enhance* the competitiveness and market leadership of its industry. Activities will also include research and innovation on design, advanced processes, pilot lines for fabrication, related production technologies and demonstration actions to validate technology developments and innovative business models *as well as underlying next generation technologies exploiting advances in quantum physics*.

These six major activity lines are expected to cover the full range of needs *taking into account the competitiveness of European industry on a global scale*. These would include industrial leadership in generic ICT-based solutions, products and services needed to tackle major societal challenges as well as application-driven ICT research and innovation agendas which will be supported together with the relevant societal challenge. *In view of the ever increasing advancement of technology in all areas of life, the interaction between humans and technology will be important in this respect, and part of the application-driven ICT research mentioned above. Research with a user-centred perspective will contribute to the development of competitive solutions.*

Included under each of the six big activity lines are also ICT-specific research infrastructures such as living labs for   experimentation and infrastructures for underlying key enabling technologies and their integration in advanced products and innovative smart systems, including equipment, tools, support services, clean rooms and access to foundries for prototyping.

This should be implemented in a way that ensures complementarity and consistency with the Research Infrastructures work supported under the "Excellent Science" pillar.

Activities will support research and development of systems in full respect of the fundamental rights and freedoms of natural persons and in particular their right to privacy.

United in diversity

1.2. Nanotechnologies

1.2.1. Developing next generation nanomaterials, nanodevices and nanosystems

Development and integration of knowledge *of nanoscale phenomena* at the cross-roads of different scientific disciplines, aiming at fundamentally new products *and systems* enabling sustainable solutions in a wide range of sectors.

1.2.2. Ensuring the safe *and sustainable* development and application of nanotechnologies

Advancing scientific knowledge of their potential impact on health or on the environment for pro-active, science-based governance of nanotechnologies, and providing validated scientific tools*, methods* and platforms for hazard, exposure and risk assessment and management along the entire life cycle of nanomaterials and nanosystems*, including standardisation issues.*

1.2.3. Developing the societal dimension of nanotechnology

Addressing the human and physical needs of nanotechnology deployment and focussing on governance of nanotechnology for societal *and environmental* benefit*, including communication strategies to ensure social engagement.*

1.2.4. Efficient *and sustainable* synthesis and manufacturing of nanomaterials, components and systems

Focusing on new flexible, scalable and repeatable unit operations, smart integration of new and existing processes, *including technology convergence such as nanobiotechnology,* as well as up-scaling to *enable sustainable high precision large scale* production of products and *flexible and* multi-purpose plants that ensures the efficient transfer of knowledge into industrial innovation.

United in diversity

1.2.5.   Developing *and standardisation of* capacity-enhancing techniques, measuring methods and equipment

Focusing on the underpinning technologies, supporting the development and market introduction of *safe* complex nanomaterials and nanosystems, including *nanometrology,* characterisation and manipulation of matter at the nano-scale, modelling, computational design and advanced engineering at the atomic level.

1.3.   Advanced materials

1.3.1.   Cross-cutting and enabling materials technologies

Research *on materials by design,* functional materials, multifunctional materials *with higher knowledge content, new functionalities and improved performance,* such as self-repairing or biocompatible materials*, self-assembling materials, novel magnetic materials* and structural materials, for innovation in all industrial sectors particularly for high value markets *and including the creative industries.*

1.3.2.   Materials development and transformation

Research and development to ensure efficient*, safe* and sustainable *development and* scale up to enable industrial manufacturing of future *design based* products *towards a "no-waste" management of materials in Europe* e.g. in the metal*,* chemical *or biotechnological* industries*, and to improve the understanding of material degradation mechanisms (wear, corrosion, mechanical reliability)*.

1.3.3.   Management of materials components

Research and development for new and innovative techniques *for materials, components* and systems*,* joining, adhesion, separation, assembly, self-assembly and *the* disassembling, decomposition and deconstruction *of material components, and management of life cycle costs and environmental impacts through novel use of advanced materials technology*.

1.3.4. Materials for a sustainable*, resource-efficient and low-emission* industry

Developing new products and applications*, business models* and *responsible* consumer behaviour that *increase the use of the renewable resources for sustainable applications,* reduce energy demand *in the product's entire life cycle* and facilitate low *emission* production, as well as process intensification, recycling, depollution*, materials for energy storage and materials with potential for* high-added value from waste and remanufacture.

1.3.5. Materials for creative industries*, including heritage*

Applying design and the development of converging technologies to create new business opportunities, including the preservation *and restoration* of Europe's *heritage and* materials with historical or cultural value*, as well as novel materials*.

1.3.6. Metrology, characterisation, standardisation and quality control

Promoting technologies such as characterisation, non-destructive evaluation*, continuous assessing and monitoring* and predictive modelling of performance for progress *and impact* in materials science and engineering.

1.3.7. Optimisation of the use of materials

Research and development to investigate *substitution and* alternatives to the use of materials*, including addressing the challenge of raw materials through tailor-made materials or the substitution of scarce, ~~or~~ critical or dangerous materials*, and innovative business model approaches *and identification of critical resources*.

1.4.	Biotechnology

1.4.1.	Boosting cutting-edge biotechnologies as a future innovation drivers

The objective is to lay the foundations for the European industry to stay at the front line of innovation, also in the medium and long term. It encompasses the development of emerging *technology areas* such as synthetic biology, bioinformatics *and* systems biology*, as well as* exploiting the convergence with other enabling technologies such as nanotechnology (e.g. bionanotechnology) and ICT (e.g. bioelectronics) *and engineering technology*. These and other cutting-edge fields deserve appropriate measures in terms of research and development to facilitate effective transfer and implementation into new applications   .

1.4.2.	Biotechnology-based industrial *products and* processes

The objective is twofold: on the one hand, enabling the European industry (e.g. chemical, health, mining, energy, pulp and paper*, fibre-based products and wood,* textile, starch, food processing) to develop new products and processes meeting industrial and societal demands *using preferably environmentally-friendly and sustainable production methods*; and competitive and enhanced biotechnology-based alternatives to replace established ones; on the other hand, harnessing the potential of biotechnology for detecting, monitoring, preventing and removing pollution. It includes R&I on *novel enzymes with optimised biocatalyst functions,* enzymatic and metabolic pathways, *industrial scale* bio-processes design, *integration of bio-processes in industrial production processes,* advanced fermentation, up- and down-stream processing, gaining insight on the dynamics of microbial communities. It will also encompass the development of prototypes for assessing the techno-economic feasibility *as well as the sustainability* of the developed products and processes.

United in diversity

1.4.3. Innovative and competitive platform technologies

The objective is to develop platform technologies (e.g. genomics, meta-genomics, proteomics, *metabolomics,* molecular tools*, expression systems, phenotyping platforms and cell based platforms)* triggering leadership and competitive advantage on a wide number of   sectors *having econonomic impact*. It includes aspects such as underpinning the development of bio-resources with optimised properties and applications beyond conventional alternatives; enabling exploration, understanding and exploitation in a sustainable manner of terrestrial and marine biodiversity for novel applications*, bio-based products and processes*; and sustaining the development of biotechnology-based healthcare solutions (e.g. diagnostics, biologicals, bio-medical devices).

1.5. Advanced Manufacturing and Processing

1.5.1. Technologies for Factories of the Future

Promoting sustainable, industrial growth by facilitating a strategic shift in Europe from cost-based manufacturing to an approach based on the creation of high added value *products and ICT-enabled intelligent and high performance manufacturing in an integrated system*. This requires addressing the challenge of producing more, while consuming less material, using less energy and *generating* less waste and pollution *aiming at high ecological efficiency*. The focus will be on the development and integration of the adaptive production systems of the future, with particular emphasis on the needs of European SMEs, in order to achieve advanced and sustainable manufacturing systems and processes. *Focus shall also be on methodologies for enhancing flexible, safe and smart production where adequate levels of automation are applied in worker-friendly environments.*

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1.5.2. Technologies enabling Energy-efficient**, *low enviromental impact* buildings *and systems***

Reducing energy consumption and CO_2 emissions by the development and deployment of sustainable construction technologies ***and systems***, implementation and replication of measures for an increased uptake of energy-efficient systems and materials in new, renovated and retrofitted buildings. Life-cycle considerations and the growing importance of design-build-operate concepts will be key in addressing the challenge of a transition to nearly zero energy buildings in Europe by 2020 and the realisation of energy-efficient districts through the engagement with the wide stakeholder community.

1.5.3. Sustainable**, *resource-efficient*** and low-carbon technologies in energy-intensive process industries

Increasing the competitiveness of process industries, such as chemical, ***cement,*** pulp and paper, glass, ***minerals*** or non-ferrous metals and steel, by drastically improving resource and energy efficiencies and reducing the environmental impact of such industrial activities. Focus will be on the development, and validation of enabling technologies for innovative substances, materials and technological solutions for low-carbon products and less energy-intensive processes and services along the value chain, as well as ***on*** the adoption of ultra-low carbon production technologies and techniques**,** to achieve specific GHG emission intensity reductions.

1.5.4. New sustainable business models

Cross-sectoral cooperation in concepts and methodologies for "knowledge-based", specialised production can boost ***organisational learning,*** creativity and innovation with a focus on business models in customised approaches that can adapt to the requirements of globalised value chains and networks, changing markets, and emerging and future industries. ***This includes addressing sustainable business models by covering the whole lifecycle of the product and process.***

1.6. Space

In the field of space research, action at Union level will be carried out in conjunction with the space research activities of the Member States and European Space Agency (ESA), aiming at building up complementarity among different actors.

1.6.1. *Enabling* European competitiveness, non-dependence and innovation *of the European* space *sector*

The objective is to maintain a globally leading role in space by safeguarding and *further* developing a *cost-effective and* competitive *and innovative* space industry *(including SMEs)* and research community and by fostering space-based innovation.

1.6.1.1. Safeguard *and further develop* a competitive*, sustainable and entrepreneurial* space industry and research community *and strenghten European non-dependance in space systems*

Europe is playing a leading role in space research and in the development of space technologies, and *is continually developing* its own *operational* space infrastructures (e.g. Galileo, *Copernicus*). In fact, European industry has established itself as an exporter of first class satellites *and other space related technologies*. Nevertheless, this position *is challenged by* competition from *other* major space powers . The *objective of this measure is the* development of a research-base by providing continuity in space research *and innovation* programmes, for example by a sequence of smaller and more frequent in-space demonstration projects. This will allow Europe to develop its industrial base and space RTD community, thereby contributing to *advancing beyond the current state of the art and to* its non-dependence from imports of critical technologies.

Standardisation should be supported in order to optimise the investments and develop access to market.

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1.6.1.2.   Boost innovation between space and non-space sectors

A number of challenges in space technologies have parallels to terrestrial challenges, for example in the fields of *aeronautics,* energy, *environment,* telecommunications *and ICTs*, natural resource exploration, *sensors*, robotics, *advanced materials*, security and health. These commonalities offer opportunities for early co-development, in particular by SMEs, of technologies across space and non-space communities *including non-space industries*, potentially resulting in breakthrough innovations more rapidly than achieved in spin-offs at a later stage. Exploitation of existing European space infrastructure should be stimulated by promoting *the* development of innovative products and services based on remote sensing*,* geo-positioning *or other types of satellite enabled data*. Europe should furthermore reinforce the incipient development of an entrepreneurial space sector*, where appropriate,* by well targeted measures*, including support for space technology transfer initiatives*.

1.6.2.   Enabling advances in space technologies

The objective is to *develop advanced and enabling space technologies and operational concepts from idea to demonstration in space*.

The ability to access space and to *develop*, maintain and operate   space systems in Earth orbit and beyond, are vital to the future of European society. The necessary capabilities require r*esearch and innovation* investments in a multitude of space technologies (e.g. *for* launchers *and other vehicles*, satellites, robotics, instruments and sensors), and in operational concepts from idea to demonstration in space. Europe is currently one of the three leading space powers *mainly driven by investments by Member States through ESA and national programmes*, but compared to the level of investment in space R&D in the United States of America (e.g. about 20 % of the total NASA budget), the European *focus* in future space technologies   and *applications* needs to be strengthened along the entire chain:

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(a)   *low technology readiness level (TRL)* research, often relying heavily on key enabling technologies, with the potential of generating breakthrough technologies with terrestrial applications;

(b)   improvement of existing technologies, e.g. through miniaturisation, higher energy efficiency, and higher sensor sensitivity;

(c)   demonstration and validation of new technologies and concepts in the space and terrestrial analogue environments;

(d)   mission context, e.g. analysis of the space environment, ground stations, protecting space systems *and infrastructure against damage or destruction* from collision with debris *or other space objects, as well as the* effects of *space weather events including* solar flares (Space Situational Awareness, SSA), fostering innovative data *gathering and transmission* and sample archiving infrastructure;

(e)   *Satellite communication, advanced* navigation and remote sensing technologies, covering the research essential for future generations of Union space systems (e.g. Galileo and *Copernicus*).

1.6.3.   Enabling exploitation of space data

The objective is to ensure more extensive utilisation of space data from existing*, archived* and future European missions in the scientific, public and commercial domain.

Space systems produce information which often cannot be acquired in any other way. Despite world class European missions, publication figures show that data from European missions are not as likely to be used as data from US missions. A considerably increased exploitation of data *from European satellites (scientific, public or commercial) can* be achieved if *further* effort *is* made *for* the processing, *archiving,* validation*,* standardisation *and sustainable availability* of space data from European missions *as well as to support the development of new information products and services resulting from those data and, where appropriate, in combination with data from ground based observations*. Innovations in data acquisition and processing, data fusion, and data dissemination *and interoperability, in particular promotion of access to and exchange of earth science data and metadata,* utilising also innovative ICT enabled forms of collaboration, can ensure a higher return on investment of space infrastructure *and contribute to tackling societal challenges*. Calibration and validation of space data (for individual instruments, between instruments and missions, and with respect to in-situ objects) are key to efficient use of space data in all domains *and there is a need to enhance* the standardisation of space-derived data and reference frames. Data access and exploitation of space missions is a matter that requires global coordination. For Earth observation data, harmonised approaches and best practices are partly achieved in coordination with the intergovernmental organization Group on Earth Observation *(GEO)*, aiming to sustain a Global Earth Observation System of Systems *(GEOSS)*, in which the Union participates, *namely by fully exploiting the Copernicus programme. A fast introduction of these innovations into the relevant application and decision-making processes will be supported. This includes as well the exploitation of data for further scientific investigation.*

1.6.4.   Enabling European research in support of international space partnerships

The objective is to support the European research and innovation contribution to long term international space partnerships.

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Although space information provides great local benefits, space undertakings have a fundamentally global character. This is particularly clear for the cosmic threat to Earth and space systems. The loss of satellites due to space weather and space debris is estimated to *cost around* EUR 100 million per annum. Equally global are *many* space science and exploration *projects*. The development of cutting edge space technology is increasingly taking place within such international *partnerships*, making access to such international projects an important success factor for European researchers and industry. The Union contribution to such global space endeavours needs to be defined in long-term strategic roadmaps (10 years and more), aligning with the Union's space policy priorities, and in coordination with *Member States and* internal European partners, such *as* ESA *and National Space Agencies and when relevant* with international partners and with the space agencies of space-faring nations .

1.6.5. Specific implementation aspects

The implementation priorities of space research and innovation under Horizon 2020 are in line with the Union's space policy priorities as defined by the Space Council and the Communication Towards a space strategy for the European Union that benefits its citizens. The implementation will*, where appropriate,* be *based on strategic research agendas* developed in consultation with *Member States and National Space Agencies, ESA,* stakeholders from European space industry *(including* SMEs*),* academia, technology institutes *and* the Space Advisory Group . As regards the participation in international undertakings, the research and innovation agenda will be defined in collaboration with *European stakeholders and* international partners (e.g. NASA, ROSCOSMOS, JAXA).

The application of space technologies shall be supported through the respective Societal Challenges, where appropriate.

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2.   ACCESS TO RISK FINANCE

Horizon 2020 will set up two facilities (the 'Equity facility' and the 'Debt facility'), composed of various windows. The Equity facility and the SME window of the Debt facility will be implemented *in interdependence with COSME,* as part of two EU Financial Instruments that provide equity and debt to support SMEs' R&I and growth.

The Equity facility and the Debt facility may, where appropriate, allow pooling of financial resources with Member States *or regions* willing to contribute part of the *European* Structural *and Investment* Funds allocated to them, in accordance with Article *33*(1)(a) of the *European* Structural *and Investment* Funds Council Regulation.

Instead of providing loans, guarantees or equity, etc. directly to final beneficiaries, the Commission will delegate financial institutions to provide support via, in particular, risk-sharing, guarantee schemes and equity and quasi-equity investments.

2.1.   Debt facility

The Debt facility will provide loans to single beneficiaries for investment in R&I; *(counter)* guarantees to financial intermediaries making loans to beneficiaries; combinations of loans and *(counter)* guarantees; and guarantees and/or counter-guarantees for national or regional debt-financing schemes. The Debt facility will undertake maturity enhancement activities, and it will support the dedicated SME Instrument*, subject to the level of demand* (see Part II, section   3. *'*Innovation in SMEs' of this Annex). Provisions from the debt facility may be combined, with the possible addition of grants (including lump sums), with provisions from the equity financial instrument in one or more integrated schemes. Soft loans*,* convertible loans*, subordinated loans, participating loans, leasing loans and securitisation*may also be possible.

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As well as providing loans and guarantees on a market-driven, first-come, first-served basis, the debt facility will target, under a series of compartments, particular policies and sectors. Ring-fenced budgetary contributions for this purpose may*, where appropriate,* come from:

(a)   Other parts of Horizon 2020, notably Part III 'Societal challenges';

(b)   Other frameworks, programmes and budget lines in the Union budget;

(c)   Particular regions and Member States that wish to contribute with resources available from the Cohesion Policy funds;

(d)   Specific entities (such as   Joint Technology Initiatives) or initiatives.

Such budgetary contributions may be made or topped up at any time during the course of Horizon 2020.

Risk-sharing and other parameters may vary within policy or sector compartments, provided their values or states comply with the common rules for debt instruments. Furthermore, compartments may have specific communications strategies within the overall promotional campaign for the Debt facility. In addition, specialist intermediaries at national level may be used if specific expertise is needed to assess prospective loans in the domain of a particular compartment.

The SME window under the Debt facility shall target R&I-driven SMEs and small mid-caps with loan amounts exceeding EUR 150 000, thus complementing finance to SMEs by the Loan Guarantee Facility under the Programme for the Competitiveness of Enterprises and SMEs. *The SME window of the Debt Facility shall also cover loans below EUR 150 000 for R&I-driven SMEs and small mid-caps.*

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The leverage of the Debt facility — defined as the total funding (i.e. Union funding plus contribution from other financial institutions) divided by the Union financial contribution — is expected to range from an average 1.5 to 6.5, depending on the type of operations involved (level of risk, target beneficiaries, and the particular debt financial instrument facility concerned). The multiplier effect — defined as the total of investments made by supported beneficiaries divided by the Union financial contribution — is expected to be 5 to 20, again depending on the type of operations involved.

2.2.   Equity facility

The Equity facility will focus on early-stage venture capital funds *and public and private funds-of-funds* providing venture capital and/or mezzanine capital to individual portfolio enterprises. These enterprises may, in addition, seek debt financing from financial intermediaries implementing the Debt facility. *Furthermore, the Equity facility will also explore possibilities to support business angels and other potential sources of equity finance. This could also include support at the phase 3 stage of the SME instrument subject to the level of demand, as well as to technology transfer (including the transfer of research results and inventions stemming from the sphere of public research to the productive sector, for example through proof-of-concept).*

The facility will also have the possibility to make expansion and growth-stage investments in conjunction with the Equity Facility for Growth (EFG) under the Programme for the Competitiveness of Enterprises and SMEs (this includes investments in funds-of-funds with a broad investor base and includes private institutional and strategic investors as well as national public and semi-public financial institutions). In the latter case, the investment from the Equity Facility of Horizon 2020 shall not exceed 20% of the total EU investment except in cases of multi-stage funds, where funding from EFG and the equity facility for RDI will be provided on a pro rata basis, based on the funds' investment policy. Like the EFG, the Equity Facility shall avoid buy-out or replacement capital intended for the dismantling of an acquired enterprise. The Commission may decide to amend the 20% threshold in light of changing market conditions.

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The EU Equity Financial Instrument for SMEs' R&I and Growth referred to in the first paragraph of Section 2 should be of an appropriate size and scale to back innovative companies from the earliest stage through to growth and expansion, in an integrated approach.

Investment parameters will be set in such a way that specific policy objectives, including the targeting of particular groups of potential beneficiaries, can be achieved while still preserving the market-oriented, demand-driven approach of this instrument.

The Equity facility may be supported by budgetary contributions from other parts of Horizon 2020; other frameworks, programmes and budget lines in the Union budget; particular regions and Member States; and specific entities or initiatives.

The leverage of the Equity facility — defined as the total funding (i.e., Union funding plus contribution from other financial institutions) divided by the Union financial contribution — is expected to be around 6, depending on market specificities, with an expected multiplier effect — defined as the total of investments made by supported beneficiaries divided by the Union financial contribution — of, on average, 18.

2.3.   Specific implementation aspects

The implementation of the two facilities will be delegated to the European Investment Bank Group (EIB, EIF) and/or to other financial institutions that may be entrusted with the implementation of financial instruments in compliance with the Financial Regulation. Their design and implementation will be aligned with the general provisions for financial instruments set out in the Financial Regulation and with more specific operational requirements to be set out in Commission guidance. *The use of financial instruments must have a clear European added-value and should provide leverage and function as a complement to national instruments.*

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Financial intermediaries, selected by entrusted entities for the implementation of financial instruments pursuant to Article 139(4) of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union[1] on the basis of open, transparent, proportionate and non-discriminatory procedures, may include private financial institutions as well as governmental and semi-governmental financial institutions, national and regional public banks as well as national and regional investment banks.

Their elements may be combined, with the possible addition of grants (including lump sums), in one or more integrated schemes supporting particular categories of beneficiary or special-purpose project, such as SMEs and mid-caps with growth potential, or the large-scale demonstration of innovative technologies.

Their implementation will be supported by a set of accompanying measures. These may include, amongst other measures, technical assistance for financial intermediaries involved in assessing the eligibility of loan applications or the value of knowledge assets; investment-readiness schemes covering incubating, coaching and mentoring SMEs and fostering their interaction with potential investors; measures to raise the awareness of venture capital firms and business angels about the growth potential of innovative SMEs involved in Union funding programmes; schemes to attract private investors to support the growth of innovative SMEs and mid-caps; *actions to improve cross-border and multi-country debt and equity financing;* schemes for encouraging philanthropic foundations and individuals to support R&I; and schemes to foster corporate venturing and encourage the activities of family offices and business angels.

Bodies such as regional authorities, SMEs associations, chambers of commerce and relevant financial intermediaries, may be consulted, as appropriate, in relation to the preparation and implementation of these activities.

Complementarity will be ensured with the facilities of the Programme for the Competitiveness of Enterprises and SMEs *(COSME)*.

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[1] *OJ L 298, 26.10.2012, p. 1.*

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3.   INNOVATION IN SMES

3.1.   Mainstreaming SME support*, especially through a dedicated instrument*

SMEs will be supported across Horizon 2020. For this purpose*, to participate in Horizon 2020, better conditions for SMEs shall be established. In addition,* a dedicated SME instrument is targeted at all types of innovative SMEs showing a strong ambition to develop, grow and internationalise. It will be provided for all types of innovation, including non-technological*, social* and service innovations*, given each activity has a clear European added-value*. The objective is to help filling the gap in funding for early stage high risk research and innovation, stimulate break-through innovations and increase private-sector commercialisation of research results.

All of the societal challenges and the enabling and industrial technologies shall apply the dedicated SME instrument and allocate an *appropriate* amount to it*, to reach the minimum goal of 20% of total combined budgets for all specific objectives on societal challenges and the specific objective 'Leadership in enabling and industrial technologies' being devoted to SMEs*.

Only SMEs will be allowed to apply for funding and support. They can form collaborations according to their needs, including for subcontracting research and development work. Projects must be of clear interest and potential benefit to SMEs and have a *clear* European dimension.

The SME instrument will cover all fields of science, technology and innovation in a bottom-up approach within a given societal challenge or enabling technology so as to leave sufficient room for all kinds of promising ideas, notably cross-sector and inter-disciplinary projects, to be funded.

The SME instrument will provide simplified and staged support. Its three phases will cover the whole innovation cycle. Transition from one phase to the next will be seamless provided the SME project has proven to be worth further funding during a previous phase. ***There is no obligation for applicants to sequentially cover all three phases.*** At the same time each phase will be open to all SMEs:

– Phase 1: Concept and feasibility assessment:

SMEs will receive funding to explore the scientific or technical feasibility and the commercial potential of a new idea (proof of concept) in order to develop an innovation project. A positive outcome of this assessment***, in which the linkage between project-topic and potential user/buyer needs is an important issue,*** will allow for funding under the following phase(s).

– Phase 2: R&D, demonstration, market replication:

With due attention to the innovation voucher concept, research and development will be supported with a particular focus on demonstration activities (testing, prototype, scale-up studies, design, piloting innovative processes, products and services, ***validation,*** performance verification etc.) and market replication ***encouraging the involvement of end users or potential clients. Innovation Vouchers will promote the participation of young entrepreneurs.***

– Phase 3: Commercialisation:

This phase will not provide direct funding other than support activities, but aims to facilitate access to private capital and innovation enabling environments. Links to the financial instruments (see Part II, section 2 'Access to Risk Finance' of this Annex) are foreseen, for example by giving SMEs that have successfully completed phases 1 and/or 2 priority within a ring-fenced volume of financial resources. SMEs will also benefit from support measures like networking, training, coaching and advice. In addition, this part may connect to measures promoting pre-commercial procurement and procurement of innovative solutions.

Uniform promotion, implementation and monitoring of the SME instrument across Horizon 2020 will ensure easy access for SMEs. Relying on existing SME support networks, *such as the Europe Enterprise Network and other innovation service providers,* a mentoring scheme for the beneficiary SMEs shall be established to accelerate impact from the support provided. *In addition, links will be explored with relevant national and/or regional intermediaries to ensure an efficient implementation of the mentoring scheme.*

A dedicated body of stakeholders and experts in SME research and innovation will be set up with view to promoting and accompanying the specific SME measures of Horizon 2020.

3.2.   Specific support

3.2.1. Support for research intensive SMEs

A specific action will promote *transnational* market-oriented innovation of R&D performing SMEs. It targets research intensive SMEs in *any* sectors that also need to demonstrate their capability to commercially exploit the project results.

The action will cover the entire field of science and technology with a bottom-up approach to fit the *need* of R&D performing SMEs.

The action will be implemented by an Article 185 TFEU initiative building on the *Eurostars* Joint Programme and reorienting it along the lines stated in its interim evaluation.

3.2.2. Enhancing the innovation capacity of SMEs

Transnational activities assisting the implementation and complementing the SME specific measures across Horizon 2020 will be supported, notably to enhance the innovation capacity of SMEs. Activities may include awareness raising, information and dissemination, training and mobility activities, networking and exchange of best practices, developing high quality innovation support mechanisms and services with strong Union added value for SMEs (e.g. intellectual property and innovation management, knowledge transfer, innovative use of ICT and e-skills in SMEs), as well as assisting SMEs to connect to research and innovation partners across the Union, allowing them to spin in technology and develop their innovation capacity. Intermediary organisations representing groups of innovative SMEs shall be invited to conduct cross-sectoral and cross-regional innovation activities with SMEs having mutually reinforcing competences, in order to develop new industrial value chains.

These activities shall be coordinated with similar national measures when appropriate. Close cooperation with the National Contact Point (NCP) Network is envisaged. Synergies with Union cohesion policy will be sought in the context of national and regional innovation strategies for smart specialisation.

A reinforced link with the Enterprise Europe Network (under the Programme for the Competitiveness of Enterprises and SMEs) is envisaged ***ensuring its coordination with the National Contact Points***. The support could range from improved information and advisory services through mentoring, coaching and partner search activities for SMEs wishing to develop cross-border innovation projects, to providing innovation support services. This will consolidate the 'one stop shop' approach of the Enterprise Europe Network to supporting SMEs, together with a strong regional and local presence of the network.

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3.2.3. Supporting market-driven innovation

This will support *transnational* market-driven innovation in view of enhancing the innovation capacity of *SMEs* by improving the framework conditions for innovation as well as tackling the specific barriers preventing the growth of innovative SMEs with potential for fast growth. Specialised innovation support (on e.g. IP exploitation, networks of procurers, support to technology transfer offices, strategic design) and reviews of public policies in relation to innovation will be supported.

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PART III

SOCIETAL CHALLENGES

1.   HEALTH, DEMOGRAPHIC CHANGE AND WELLBEING

Effective health promotion, supported by a robust evidence base, prevents disease*,*
contributes to wellbeing and to contain costs. Promotion of health, active ageing, wellbeing
and   disease prevention also depend on an understanding of the determinants of health, on
effective preventive tools, such as vaccines, on effective health and disease surveillance and
preparedness, and on effective screening programmes.

Successful efforts to prevent, *early detect,* manage, treat and cure disease, disability*, frailty*
and reduced functionality are underpinned by the fundamental understanding of their causes,
processes and impacts, as well as factors underlying good health and wellbeing. *Improved*
understanding of health and disease will demand close linkage between fundamental,
clinical, epidemiological and socio-economic research. Effective sharing of data and the
linkage of these data with real-world large scale cohort studies is also essential, as is the
translation of research findings into the clinic, in particular through the conduct of clinical
trials.

It is a societal challenge to adjust to the   further demands on health and care sectors *due to*
the ageing population. If effective health and care is to be maintained for all ages, efforts are
required to improve *and speed up* decision making in prevention and treatment provision, to
identify and support the dissemination of best practice in the healthcare sector, *to raise*
awareness and to support integrated care. *A better understanding of ageing processes* and
the *prevention of age-related illnesses are the basis for keeping European citizens healthy*
and active throughout the course of their lives. Similarly important is the wide uptake of
technological, organisational and social innovations empowering older persons*, persons with*
chronic diseases as well as disabled persons, to remain active and independent. Doing so will
contribute to increasing, and lengthening the duration of their physical, social, and mental
well-being.

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The programme should address in the relevant activities chronic conditions and diseases including but not limited to: cardiovascular disease (CVD), cancer, metabolic diseases and risk factors including diabetes, chronic pain, neurological, neurodegenerative, mental health and substance use disorders, rare diseases, overweight and obesity, autoimmune diseases, rheumatic and musculo-skeletal disorders and various diseases affecting different organs as well as acute conditions and various functional limitations. Likewise infectious diseases including but not limited to HIV/AIDS, tuberculosis and malaria, neglected and poverty related diseases and animal-borne diseases, emerging epidemics as well as the threat of increasing anti-microbial resistance and occupational diseases and work related disorders should be addressed.

Personalised medicine should be developed in order to suit preventive and therapeutic approaches to patient requirements, and must be underpinned by the early detection of disease.

All of these activities will be undertaken in such a way as to provide support throughout the research and innovation cycle, strengthening the competitiveness of the European based industries and development of new market opportunities. *Support will be given to translational approaches that integrate several steps of the innovation process in the health care industry.*

Specific activities are described below.

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1.1.   *Understanding health, wellbeing and disease*

1.1.1.   Understanding the determinants of health, improving health promotion and disease prevention

A better understanding of the determinants of health is required in order to provide evidence for effective health promotion and disease prevention, and will also allow the development of comprehensive health and wellbeing indicators in the Union *based on existing data sources and indicator systems*. Environmental, behavioural (including life-style), *psychological, organisational, cultural,* socio-economic*, biological* and genetic factors, in their broadest senses will be studied. Approaches will include the long term study of cohorts and their linkage with data derived from "-omics" research*, systems bio-medicine including relevant applications of systems biology* and other methods.

In particular, a better understanding of the environment as a determinant of health will require *an inter-disciplinary approach integrating amongst others, human-relevant* molecular biological, epidemiological and toxicological approaches *and resultant data to study the* modes of action of *various* chemicals, combined exposures to *pollutants* and other environmental and climate related stressors*; to perform* integrated toxicological testing *and to seek* alternatives to animal testing. Innovative approaches to exposure assessment are needed using new-generation biomarkers based on 'omics' and epigenetics, human biomonitoring, personal exposure assessments and modelling to understand combined, cumulative and emerging exposures, integrating socio-economic*, cultural, occupational, psychological* and behavioural factors. Improved links with environmental data using advanced information systems will be supported.

In this way, existing and planned policies and programmes can be assessed and policy support provided. Similarly, improved behavioural interventions, prevention and education programmes can be developed including those pertaining to health literacy in nutrition, *physical activity,* vaccination and other primary care interventions.

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1.1.2. Understanding disease

There is a need for an improved understanding of health and disease, ***throughout the human life cycle***, so that new and better prevention measures, diagnosis***,*** treatments ***and rehabilitation measures*** can be developed. Interdisciplinary, ***basic and*** translational research on the patho-physiology of disease is essential to improve the understanding of all aspects of disease processes, including a re-classification of normal variation and disease based on molecular data, and to validate and use research results in clinical applications.

Underpinning research will encompass and encourage development and use of new tools and approaches for the generation of biomedical data and include ***bio-imaging,*** "-omics", high throughput and systems medicine approaches. These activities will demand close linkage between fundamental and clinical research and with long term cohort studies (and the corresponding research domains) as described above. Close links with research and medical infrastructures (databases, bio-banks etc.) will also be required, for standardisation, storage, sharing and access to data, which are all essential for maximising data utility and for stimulating more innovative and effective ways of analysing and combining datasets.

1.1.3. *Improving surveillance and preparedness*

Human populations are under threat from new and emerging infections, including of zoonotic origin, as well as those which result from drug resistance to existing pathogens and from other direct and indirect consequences of climate change and from the international movement of people. New or improved methods for surveillance, diagnosis, early warning networks, health service organisation and preparedness campaigns are needed for the modelling of epidemics, for effective pandemic response as are efforts to maintain and enhance capabilities to combat drug resistant infectious disease.

1.2.   Preventing disease

1.2.1.   Developing effective prevention and screening programmes and improving the assessment of disease susceptibility

The development of prevention and screening programmes depends on the identification of early biomarkers (including functional and behavioural) of risk and of disease onset, and their design should be informed by internationally accepted criteria. Their deployment depends on the testing and validation of screening methods and programmes. Knowledge should be generated and methods developed for identifying individuals and populations at a clinically relevant increased risk of disease. Identifying individuals and populations at high-risk of disease will allow personalised, stratified and collective strategies for efficacious and cost effective disease prevention to be developed.

1.2.2.   Improving diagnosis ***and prognosis***

An improved understanding of health, disease and disease processes ***throughout the life cycle*** is needed to develop new and more effective diagnostics ***and theranostics***. Innovative and existing ***methods***, technologies ***and tools*** will be developed with the goal of significantly improving disease outcomes through earlier, more accurate diagnosis and ***prognosis and*** by allowing for ***accessible,*** more patient-adapted***,*** treatment.

1.2.3.   Developing better preventive and therapeutic vaccines

There is a need for more effective preventive and therapeutic interventions and vaccines and evidence-based vaccination schemes for an expanded range of diseases, including poverty-related diseases such as HIV/AIDS, tuberculosis, malaria and neglected infectious diseases and also for other major diseases. This relies on a better understanding of disease and disease processes and their consequent epidemics, and that clinical trials and associated studies are undertaken.

1.3. Treating *and managing* disease

1.3.1. *Treating disease, including developing regenerative medicine*

There is a need to support the improvement of cross-cutting support technologies for drugs, *biotherapies,* vaccines and other therapeutic approaches, including transplantation, *surgery,* gene and cell therapy *and nuclear medicine*; to increase success in the drug and vaccine development process (including alternative methods to replace classical safety and effectiveness testing *e.g.* the development of new methods); to develop regenerative medicine approaches, including approaches based on stem cells; to develop *new biopharmaceuticals, including therapeutic vaccines; to develop* improved medical and assistive devices and systems; *to improve palliative therapies; to* maintain and enhance our ability to combat diseases and undertake medical interventions that depend on the availability of effective *and safe* antimicrobial drugs; and to develop comprehensive approaches to treat co-morbidities at all ages and avoid poly-pharmacy. These improvements will facilitate the development of new, more efficient, effective*,* sustainable *and personalised* treatments for disease and for the management of disability *and frailty, including advanced therapies and cellular therapies for the treatment of chronic diseases*.

1.3.2. Transferring knowledge to clinical practice and scalable innovation actions

Clinical trials are *an important* means to transfer biomedical knowledge to application in patients and support for these will be provided, as well as for the improvement of their practice. Examples include the development of better methodologies to allow trials to focus on relevant population groups, including those suffering from other concomitant diseases and/or already undergoing treatment, the determination of comparative effectiveness of interventions and solutions, as well as enhancing the use of databases and electronic health records as data sources for trials and knowledge transfer. *Pre-clinical and/or clinical development of designated orphan drugs will be supported.* Similarly, support for the transfer of other types of interventions such as those related to independent living into real world environments will be provided.

1.4.   Active ageing and self-management of health

1.4.1. Active ageing, independent and assisted living

Multidisciplinary advanced and applied research and innovation with ***socioeconomic,*** behavioural, gerontological, digital and other sciences is needed for cost effective user-friendly solutions for active, independent and assisted daily living (in the home, the workplace***, public spaces,*** etc.) for the ageing population and people with disabilities ***taking into account gender differences***. This applies in a variety of settings and for technologies and systems and services enhancing quality of life and human functionality including mobility, smart personalised assistive technologies, service and social robotics, and ambient assistive environments. Research and innovation pilots to assess implementation and wide uptake of solutions will be supported. ***Involvement of end-users, user communities and formal/informal carers will be emphasised.***

1.4.2. Individual ***awareness and*** empowerment for self-management of health

Empowering individuals to improve and manage their health throughout life will result in ***more cost-effective*** healthcare systems by enabling the management of chronic disease outside institutions and improve health outcomes. This requires research into ***socio-economic factors and cultural values,*** behavioural and social models,   attitudes and aspirations in relation to personalised health technologies, mobile and/or portable tools, new diagnostics***, sensors and devices for monitoring*** and personalised services ***including but not limited to nanomedicine-based tools*** which promote a healthy lifestyle, wellbeing, ***mental health,*** self-care, improved citizen/healthcare professional interaction, personalised programmes for disease and disability management ***to, inter alia, enhance patients' autonomy***, as well as support for knowledge infrastructures. ***Solutions will be developed and tested with the use of open innovation platforms such as large scale demonstrators for social and service innovation.***

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1.5.   *Methods and data*

1.5.1.   *Improving health information and better use of health data*

The integration of infrastructures and information structures and sources (including those derived from cohort studies, protocols, data collections, indicators, health examination surveys, etc.) as well as the standardisation, interoperability, storage, sharing of and access to data, will be supported to enable such data to be sustainable in the long-term and properly exploited. Attention should be given to data processing, knowledge management, modelling, visualisation, ICT-security and privacy related issues. In particular, availability of information and data on negative results and adverse effects of treatment need to be improved.

1.5.2.   *Improving scientific tools and methods to support policy making and regulatory needs*

There is a need to support research, development, integration and use of scientific tools, methods and statistics for rapid, accurate and predictive assessment of the safety, efficacy and quality of health interventions and technologies including new drugs, biologics, advanced therapies and medical devices. This is particularly relevant for new developments in domains including those concerning biopharmaceuticals, vaccines, antimicrobials, cell/tissue and gene therapies, organs and transplantation, specialist manufacturing, bio banks, new medical devices, combination products, diagnostic/treatment procedures, genetic testing, interoperability and e-health, including privacy aspects. Similarly, support for improved risk assessment methodologies, compliance frameworks, testing approaches and strategies relating to environment and health are required. There is also a need to support the development of relevant methods for assisting the assessment of ethical aspects of the above domains.

1.5.3.   *Using in-silico medicine for improving disease management and prediction*

Computer simulation-based medical systems using patient specific data and building on systems medicine approaches and physiological modelling can be used to predict susceptibility to disease, disease evolution and the likely success of medical treatments.

Model based simulation can be used to support clinical trials, predictability of treatment response, and the personalisation and optimisation of treatment.

1.6.   Health care provision and integrated care

1.6.1. Promoting integrated care

Supporting the management of chronic disease*, including patients with disabilities,* outside institutions also depends on improved cooperation between the providers of health and social or informal care. Research and innovative applications will be supported for decision making based on distributed information *addressing both physical and mental health, including psychosocial aspects,* and for providing evidence for large scale deployments and market exploitation of novel solutions, including interoperable tele-health and tele-care services. *Particularly in the context of demographic change, research* and innovation to improve the organisation of long-term care delivery *as well as policy and management innovation* will also be supported. *Implementing new and integrated care solutions shall aim at personal empowerment and enhancement of existing capabilities as well as concentrate on compensation of deficits.*

1.6.2.   Optimising the efficiency and effectiveness of healthcare *provision* and reducing inequalities *by* evidence based decision making and dissemination of best practice, and innovative technologies and approaches

There is a need to support the development of *a systemic approach* to health technology assessment and health economics, as well as the   gathering *of* evidence and dissemination of best practice and innovative technologies and approaches in the healthcare sector, including ICT and e-health applications. Comparative analyses of the reform of public health systems in Europe and in third countries and assessments of their mid to long-term economic and social impacts will be supported. Analyses of future health workforce needs both in terms of numbers and required skills in relation to new patterns of care will be supported. Research on the evolution of health inequalities, of their interplay with other economic and social inequalities and on the effectiveness of policies aiming to reduce them in Europe and beyond will be supported. Finally, there is a need to support the assessment of patient safety solutions and quality assurance systems, including the role of patients on safety and quality of care.

1.7.   Specific implementation aspects

Implementation of the programme will include support for knowledge and technology transfer and other forms of dissemination, for large-scale piloting and demonstration actions, and for standardisation. In this way, market deployment of products and services will be accelerated, and scalable solutions for Europe and beyond will be validated. Such actions will not only support European industrial competitiveness and the involvement of innovative SMEs but will require the active involvement of all stakeholders. Synergies with other relevant programmes and activities, both public and private at Union, national and international levels will be sought. In particular, synergies with activities developed in the context of the Health for Growth Programme will be sought.

The Scientific Panel for Health will be a science-led stakeholder platform which elaborates scientific input concerning this Societal Challenge. It will provide a coherent scientific focused analysis of research and innovation bottlenecks and opportunities related to this Societal Challenge, contribute to the definition of its research and innovation priorities, encourage EU-wide scientific participation in it. Through active cooperation with stakeholders, it will help to build capabilities and to foster knowledge sharing and stronger collaboration across the Union in this field.

Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and relevant public-public and public-private partnerships.

Appropriate links with the actions of relevant European Innovation Partnerships and the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.

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2. FOOD SECURITY, SUSTAINABLE AGRICULTURE AND FORESTRY, MARINE AND MARITIME AND INLAND WATER RESEARCH AND THE BIOECONOMY

2.1. Sustainable agriculture and forestry

Appropriate knowledge, tools, services and innovations are necessary to support more productive, *environmentally-friendly* resource-efficient and resilient agriculture and forestry systems that supply sufficient food, feed, biomass and other raw-materials and deliver ecosystems services while at the same time *protecting biodiversity and* supporting the development of thriving rural livelihoods. Research and innovation will provide options for integrating agronomic and environmental goals into sustainable production, thus: increasing productivity and resource efficiency*, including water use efficiency,* of agriculture*; increasing the safety of animal and plant production;* reducing agricultural greenhouse gases (GHGs) emissions; reducing *the production of waste; reducing* leaching of nutrients *and other chemical inputs* from cultivated lands into terrestrial and aquatic environments; decreasing dependence from international plant derived protein imports to Europe; increasing the level of *diversity* in primary production systems *as well as fostering the recovery of biological diversity*.

2.1.1. Increasing production efficiency and coping with climate change, while ensuring sustainability and resilience

Activities will enhance productivity as well as the adaptive capacity of plants, animals and production systems to cope with rapidly changing environmental/climatic conditions and increasingly scarce natural resources. The resulting innovations will help to move towards a low energy, low emission and low waste economy*, and to reduced natural resources demand* along the entire food and feed supply chain. In addition to contributing to food security, new opportunities will be created for the use of biomass and by-products from agriculture   for a wide range of non-food applications.

Multi-disciplinary approaches will be sought to improve the performance of plants, animals, micro-organisms, while ensuring efficient resource use (water, *land, soil,* nutrients, energy *and other inputs*) and the ecological integrity of rural areas. Emphasis will be placed on integrated and diverse production systems and agronomic practices, including the use of precision technologies and ecological intensification approaches to benefit both conventional and organic agriculture. *Also urban greening will be promoted, with new forms of agriculture, horticulture and forestry in urban and peri-urban areas. These shall be considered by addressing new requirements for plant characteristics, cultivation methods, technologies, marketing and urban design, in relation with human health and well-being, environment and climate change.* Genetic improvement of plants and animals for adaptation*, health* and productivity traits will call for all *appropriate* conventional and modern breeding approaches and for *preservation and* better use of genetic resources. Due attention will be given to   soil *management for increasing the* productivity *of crops. Bearing in mind the overall objective of ensuring high quality and safe food production, plant and animal health will be promoted. Activities in the area of plant health and plant protection will increase knowledge and support the development of integrated environmentally-friendly pest management strategies, products and tools to prevent the introduction of pathogens, control pest and diseases and reduce yield losses at pre- and post-harvest levels. In the area of animal health, strategies* for the eradication *or effective management of* diseases including zoonoses *and* research on antimicrobial resistance *will be promoted. Integrated control of disease, parasites and pests will be strengthened, starting from a better understanding of host-pathogen interactions, to surveillance, diagnostics and treatments.* Studying the effects of practices on animal welfare will help meet societal concerns. The above listed areas will be underpinned by more fundamental research to address relevant biological questions as well as to support the development and implementation of Union policies *and supported by adequate assessment of their economic and market potential*.

2.1.2. Providing ecosystem services and public goods

Agriculture and forestry are unique systems delivering commercial products but also wider societal public goods (including cultural and recreational value) and important ecological services such as functional and in-situ biodiversity, pollination, *water storage and* regulation, *soil functions,* landscape, erosion reduction*, resilience to flooding and droughts* and carbon sequestration / GHG mitigation. Research activities *will contribute to a better understanding of the complex interactions between primary production systems and ecosystems services and* will support the provisions of these public goods and services, through the delivery of management solutions, decision-support tools and the assessment of their *market and* non-market value. Specific issues to be dealt with include the identification of *rural and (peri-)urban* farming/forest systems and landscape patterns likely to achieve these goals. Shifts in the active management of agricultural systems - including the use of technologies and change of practices - will increase GHG mitigation and the adaptive capacity of the agriculture sector to the adverse effects of climate change.

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2.1.3. Empowerment of rural areas, support to policies and rural innovation

Development opportunities for rural communities will be mobilised by strengthening their capacity for primary production and delivery of eco-systems services as well as by opening avenues for the production of new and diversified products (***including*** food, feed, materials, energy), which meet the increasing demand for low-carbon short-chain delivery systems. Socio-economic research ***and science and society studies*** along with the development of new concepts and institutional innovations is needed to ensure cohesion of rural areas and prevent economic and social marginalisation, foster diversification of economic activities (including service sector), ensure appropriate relations between rural and urban areas, as well as facilitate knowledge exchange, demonstration, innovation and dissemination and foster participatory resource management. Also, there is a need to look at ways in which public goods in rural areas can be converted into local/regional socio-economic benefits. Innovation needs defined at regional and local levels will be complemented by cross-sectoral research actions at ***international,*** inter-regional and European levels. By providing the necessary analytical tools, indicators, ***integrated*** models and forward looking activities, research projects will support policy makers and other actors in the implementation, monitoring and assessment of relevant strategies, policies and legislation, not only for rural areas but for the whole bio-economy. Tools and data are also required to allow for proper assessment of potential trade-offs between various types of resource use (land, water***, soil, nutrients, energy*** and other inputs) and bio-economy products. Socio-economic and comparative assessment of farming/forestry systems and their sustainability performance will be addressed.

2.1.4. *Sustainable forestry*

The aim is to sustainably produce bio-based products ecosystems, services (including water-related and climate-mitigation services) and sufficient biomass, with due consideration to economical, ecological and social aspects of forestry as well as to regional differences. Overall, activities in the forestry sector will seek to promote multi-functional forests which deliver a variety of ecological, economic, and social benefits. Activities will focus on the further development of sustainable forestry systems which can address societal challenges and demands, including forest owners' needs, by putting in place multifunctional approaches that reconcile the need for delivering smart, sustainable and inclusive growth taking into account climate change. These sustainable forestry systems are instrumental in the strengthening of forest resilience and biodiversity protection and the need to meet the increased biomass demand. This will need to be underpinned by research on tree health and on forest protection and restoration from fire.

2.2.   Sustainable and competitive agri-food sector for a safe and healthy diet

Consumer needs for safe, healthy*, **high quality*** and affordable food have to be addressed, while considering the impacts of food consumption behaviour and food and feed production on human health*, **the environment*** and the ***global*** ecosystem. Food and feed security and safety, the competitiveness of the European agri-food industry and the sustainability of food production*,* supply ***and consumption*** will be addressed, covering the whole food chain and related services, whether conventional or organic, from primary production to consumption. This approach will contribute to (a) achieving food safety and security for all Europeans and eradication of hunger in the world (b) decreasing the burden of food- and diet-related diseases by promoting the shift towards healthy and sustainable diets, via consumer education and innovations in ***agriculture and*** the food industry (c) reducing water and energy consumption in food processing, transport and distribution and (d) reducing food waste by 50 % by 2030 ***and (e) achieving a broad diversity of healthy, high quality and safe food for all***.

2.2.1. Informed consumer choices

Consumer preferences, attitudes, needs, behaviour, lifestyle*, education and the cultural component of food quality* will be addressed, and communication between consumers and the food chain research community and its *stakeholders* will be enhanced in order to improve *public understanding of food production generally and enable* informed choice, sustainable *and healthy consumption* and their impacts on production, inclusive growth and quality of life, especially of vulnerable groups. Social innovation will respond to societal challenges, and innovative *predictive* models and methodologies in consumer science will deliver comparable data and lay the ground for responses to Union policy needs.

2.2.2. Healthy and safe foods and diets for all

Nutritional needs*, a balanced diet* and the impact of food on physiological functions, physical and mental performance will be addressed as well as the links between diet, *demographic trends (such as* ageing*) and* chronic diseases and disorders   . Dietary solutions and innovations leading to improvements in health and well-being will be identified. Chemical and microbial food and feed contamination, risks and exposures *as well as allergens* will be *analysed,* assessed, monitored, controlled and traced throughout the food*, feed* and drinking water supply chains from production and storage to processing, packaging, distribution, catering, and preparation at home. Food safety innovations, improved *tools for risk and risk-benefit assessment and for* risk communication   and improved food safety standards *to be implemented throughout the food chain* will lead to enhanced consumer trust and protection in Europe. Globally improved food safety standards will also help to strengthen the competitiveness of the European food industry.

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2.2.3. A sustainable and competitive agri-food industry

The needs for the food and feed industry to cope with social, environmental, climate and economic change from local to global will be addressed at all stages of the food and feed production chain, including food design, processing, packaging, process control, waste reduction, by-product valorisation and the safe use or disposal of animal by-products. Innovative and sustainable resource-efficient *technologies and* processes *as well as* diversified, safe, *healthy,* affordable and high quality products will be generated *and underpinned with science-based evidence*. This will strengthen the innovation potential of the European food supply chain, enhance its competitiveness, create economic growth and employment and allow the European food industry to adapt to changes. Other aspects to address are traceability, logistics and services, socio-economic *and cultural* factors, *animal welfare and other ethical issues,* the resilience of the food chain against environmental and climate risks,   the limitation of negative impacts of food chain activities and of changing diets and production systems on the environment.

2.3.   Unlocking the potential of aquatic living resources

One of the main features of living aquatic resources is that they are renewable and their sustainable exploitation relies on in depth understanding and a high degree of quality and productivity of the aquatic ecosystems. The overall objective is to *manage* aquatic living resources to maximise social and economic benefits/returns from Europe's oceans*,* seas *and inland waters*.

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This includes the need to optimise the sustainable contribution of fisheries and aquaculture to food security in the context of the global economy and reduce the heavy Union's dependence on seafood imports (approximately 60 % of total European sea food consumption depends on import and the Union is the world's largest importer of fisheries products), and to boost marine *and maritime innovation through* biotechnologies to fuel *smart* "blue" growth. In line with current policy frameworks, *in particular the Integrated Maritime Policy and the Marine Strategy Framework Directive*, research activities will underpin the ecosystem approach to the management and exploitation of natural resources, *while enabling sustainable use of marine goods and services,* and the 'greening' of the sectors involved.

2.3.1.   Developing sustainable and environmentally-friendly fisheries

The new Common Fisheries Policy, the Marine Strategy Framework Directive and the Union's Biodiversity Strategy call for European fisheries to be more sustainable, competitive, and environmentally-friendly. The move towards an ecosystem approach to fisheries management will require an in depth understanding of marine ecosystems. New insights, tools and models will be developed to improve understanding of what makes marine ecosystems healthy and productive and to assess, evaluate and mitigate the impact of fisheries on marine ecosystems (including deep sea). New harvest strategies *and technologies* will be developed which provide services to society while maintaining healthy marine ecosystems. The socio-economic effects of management options will be measured. The effects and adaptation to environmental changes, including climate change, will also be investigated along with new *assessment and* management tools to deal with risk and uncertainty. Activities will support research on the biology, genetic and dynamics of fish populations, on the role of key species in the ecosystems, on fishing activities and their monitoring, on fishing sector behaviours and adaptation to new markets *(*e.g. eco-labelling*)* on fishing industry involvement in decision making. The shared use of maritime space with other activities, *particularly* in the coastal zone, and its socio-economic impact will also be addressed.

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2.3.2. Developing competitive *and environmentally-friendly* European aquaculture

Sustainable aquaculture has a large potential for the development of healthy, safe and competitive products tailored to consumer needs and preferences as well as for environmental services (bioremediation, land and water management, etc) and energy production but it needs to be fully realised in Europe. Knowledge and technologies will be strengthened in all aspects of domestication of established species and diversification for new species while taking into account the interactions between aquaculture and the aquatic ecosystems *in order to reduce its impact on the environment*, and the effects of climate change and how the sector can adapt to them. *Continuation of research efforts is particularly needed on health and diseases of farmed aquatic organisms (including prevention and mitigation tools and methods), on nutrition issues (including development of alternative tailor-made ingredients and feeds for aquaculture), and on reproduction and breeding which are among the main obstacles in the sustainable development of European aquaculture.* Innovation will also be promoted for sustainable production systems inland, on the coastal zone and offshore. *The specificities of the European ultra-periphery will also be taken into account.* Emphasis will also be given to understanding the social and economic dimensions of the sector to underpin cost and energy efficient production matching with the market and consumer demands, while ensuring competitiveness and attractive prospects for investors and producers.

2.3.3. Boosting marine *and maritime* innovation through biotechnology

More than 90 % of the marine biodiversity remains unexplored, offering a huge potential for discovery of new species and applications in the field of marine biotechnologies, which is foreseen to generate a 10 % annual growth for this sector. Support will be given to further explore and exploit the large potential offered by marine biodiversity and aquatic biomass to bring new innovative *and sustainable* processes, products and services on the markets with potential applications in sectors including chemical and material industries, pharmaceutical, fisheries and aquaculture, energy supply and cosmetic.

2.4. Sustainable and competitive bio-based industries *and supporting the development of a European bio-economy*

The overall objective is to accelerate the conversion of fossil-based European industries to low carbon, resource efficient and sustainable ones. Research and innovation will provide the means to reduce the Union's dependency on fossil fuels and contribute to meeting its energy and climate change policy targets for 2020 (10 % of transport fuels from renewables and a 20 % reduction of greenhouse gases emissions). Estimates conclude that a shift to biological raw materials and biological processing methods could save up to 2.5 billion tons of CO_2 equivalent per year by 2030, increasing markets for bio-based raw materials and new consumer products several-fold. Reaping these potentials requires building a broad knowledge base and developing relevant (bio)technologies, focussing mainly on three essential elements: a) transforming current fossil-based processes by resource and energy efficient biotechnology based ones; b) establishing reliable*, sustainable* and appropriate supply chains of biomass, *byproducts* and waste streams and a wide network of bio-refineries throughout Europe; and c) supporting market development for bio-based products and processes*, taking account of the associated risks and benefits*. Synergies will be sought with the '*Leadership in Enabling and Industrial Technologies*' specific objective.

2.4.1. Fostering the bio-economy for bio-based industries

Major progress towards low carbon, resource efficient and sustainable industries will be supported through discovery and exploitation of terrestrial and aquatic biological resources, while minimising adverse environmental impacts *and water footprint, for example through the establishment of closed circuits of nutrients, including between urban and rural areas.* Potential trade-offs between the various uses of biomass should be examined. *Activities should focus on non-food-competitive biomass and also consider the sustainability of related land use systems.* The development of bio-based products and biologically active compounds for industries and consumers with novel qualities, functionalities and improved sustainability will be targeted. The economic value of renewable resources, bio-waste and by-products will be maximised through new and resource efficient processes*, including the transformation of urban bio-waste into agricultural inputs.*

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2.4.2. Developing integrated biorefineries

Activities will be supported to boost sustainable bioproducts, intermediates and bioenergy/biofuels, predominantly focussing on a cascade approach, prioritising the generation of high added-value products. Technologies and strategies will be developed to assure the raw material supply. Enhancing the range of types of biomass for use in second and third generation biorefineries, including forestry, biowaste and industrial by-products, will help avoid food/fuel conflicts and support economic ***and environmentally-friendly*** development of rural and coastal areas in the Union.

2.4.3. Supporting market development for bio-based products and processes

Demand-side measures will open new markets for biotechnology innovation. Standardisation ***and certification*** at Union and international levels is needed for, amongst others, determination of bio-based content, product functionalities and biodegradability. Methodologies and approaches to life-cycle analysis need to be further developed and continuously adapted to scientific and industrial advances. Research activities supporting product and process standardisation ***(including harmonisation of international standards)*** and regulatory activities in the field of biotechnology are considered essential for supporting the creation of new markets and for realising trade opportunities.

2.5. ***Cross-cutting marine and maritime research***

The aim is to increase the impact of EU seas and oceans on society and economic growth through the exploitation of marine resources as well as the use of different sources of marine energy and the wide range of different uses that is made of the seas. Activities shall focus on cross-cutting marine and maritime scientific and technological challenges with a view to unlocking the potential of seas and oceans across the range of marine and maritime industries, while protecting the environment and adapting to climate change. A strategic coordinated approach for marine and maritime research across all challenges and pillars of Horizon 2020 will also support the implementation of relevant Union policies to help deliver key blue growth objectives.

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Due to the multidisciplinary nature of marine and maritime research, close coordination and joint activities with other parts of Horizon 2020, especially Societal Challenge 5, will be pursued.

2.5.1. Climate change impact on marine ecosystems and maritime economy

Activities will be supported to increase the current understanding of the functioning of marine ecosystems, the interactions between oceans and the atmosphere. This will increase the ability to assess the role of the oceans on climate and the impact of climate change and ocean acidification on marine ecosystems and coastal areas.

2.5.2. Develop the potential of marine resources through an integrated approach

Boosting long-term, sustainable maritime growth and create synergies across all the maritime sectors requires an integrated approach. Research activities will focus on preserving the marine environment as well as the impact of maritime activities and products on non-maritime sectors. This will allow advances in the field of eco-innovation such as new products, processes and the application of management concepts, tools and measures to assess and mitigate the impact of human pressures on the marine environment in order to advance towards a sustainable management of maritime activities.

2.5.3. Cross-cutting concepts and technologies enabling maritime growth

Advances in cross-cutting enabling technologies (e.g. ICT, electronics, nanomaterials, alloys, biotechnologies, etc.) and new developments and concepts in engineering will continue to enable growth. Activities will allow major breakthroughs in the field of marine and maritime research and ocean observation (e.g. deep-sea research, observing systems, sensors, automated systems for monitoring of activities and surveillance, screening marine biodiversity, marine geohazards, Remotely Operated Vehicles, etc.). The aim is to reduce the impact on the marine environment (e.g. underwater noise, introduction of invasive species and pollutants from sea and land, etc.) and minimise the carbon foot-print of human activities. Cross-cutting enabling technologies will underpin the implementation of marine and maritime Union policies.

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2.6. Specific implementation *aspects*

Beyond the general sources of external advice, specific consultations will be sought from the Standing Committee on Agricultural Research (SCAR) on a range of issues, including on strategic aspects through its foresight activity and on the coordination of agricultural research between national and Union levels. Appropriate links with the actions of *relevant* European Innovation *Partnerships* and *the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.*

The impact and dissemination of research results will be actively supported through specific actions on communication, knowledge exchange and the involvement of various actors all along the projects. Implementation will combine a wide range of activities, including substantial demonstration and pilot activities. Easy and open access to research results and best practices will be fostered .

The specific support to SMEs will allow for an increased participation of farms, fishermen and other types of *SMEs* in research and demonstration activities. The specific needs of the primary production sector for innovation support services and outreach structures will be taken into account. Implementation will combine a wide range of activities, including knowledge exchange actions where the involvement of farmers *or other primary producers* and intermediaries will be actively ensured in view of summarising the research needs of end-users. Easy and open access to research results and best practices will be fostered.

Support to *standardisation and regulatory aspects* will be used to help accelerate market deployment for novel bio-based goods and services.

Consideration may be given to support *relevant* Joint Programming Initiatives (JPIs) *and relevant public-public and* public-private partnerships .

Synergies with and further deployment by other Union funds related to this societal challenge, such as the Rural Development Funds and Fisheries Funds will be sought.

Forward looking activities will be undertaken across the sectors of the bio-economy, including the development of data bases, indicators and models addressing global, European, national and regional dimensions. A European bio-economy observatory shall be developed for mapping and monitoring Union and global research and innovation activities *including technology assessment*, developing key performance indicators, and monitoring innovation policies in the bio-economy.

3.   SECURE, CLEAN AND EFFICIENT ENERGY

3.1.   Reducing energy consumption and carbon footprint *by* smart and sustainable *use*

The energy sources and consumption patterns of Europe's industries, transport *systems*, buildings, *districts,* towns and cities are largely unsustainable, leading to significant environmental and climate change impacts. *Real-time energy management for new and existing* near-zero-emission*, near-zero energy and positive energy buildings, retrofitted buldings as well as active* buildings, highly efficient industries and mass take-up of energy-efficient approaches by companies, individuals, communities*,* cities *and districts* will require not only technological advances, but also non-technological solutions such as new advisory, financing and demand management services *and input from the behavioural and social sciences while at the same time taking into account questions of public acceptance*. In this way *improved* energy efficiency may provide one of the most cost effective ways to reduce energy demand, thereby enhancing security of energy supply, reducing environmental and climate impacts and boosting competitiveness. *To meet these challenges the further development of renewable energies and the tapping of energy efficiency potentials are important.*

3.1.1.   Bring to mass market technologies and services for a smart and efficient energy use

Reducing energy consumption and eliminating energy waste, while providing the services that society and economy need, requires not only that more, efficient, cost-competitive, environmentally-friendly, and smarter *equipment,* products and services are brought to mass market but also the integration of components and devices in such a way that they cooperate to optimise the overall energy use of buildings, services and industry.

To ensure full adoption and full benefits for consumers (including the possibility for them to monitor their own consumption), energy performance of these technologies and services needs to be customised and optimised for and in their application environments. This requires researching, developing and testing innovative Information and Communication Technologies (ICT) and monitoring and control techniques *as well as* demonstration projects and pre-commercial deployment activities to ensure interoperability and scalability. Such projects should aim to *contribute to significantly reduce or optimize the overall energy consumption and energy costs by developing* common procedures to collect, collate and analyse energy consumption and emissions data to improve the measurability, transparency, *public* acceptability, planning and visibility of energy use and its environmental impacts. *Security and privacy by design to protect monitoring and control techniques should be safeguarded in these processes. Developing platforms and applying them for verifying the stability of such systems will help to ensure reliability.*

3.1.2. Unlock the potential of efficient and renewable heating-cooling systems

A substantial share of energy is consumed for heating or cooling purposes across the Union and the development of cost-effective and efficient technologies, system integration techniques e.g. network connectivity with standardised languages and services in this area would have a major impact in reducing energy demand. This requires research and demonstration of new *design techniques and* systems and components for industrial, *commercial and* residential applications, for example in decentralised and district supply of hot water, space heating and cooling. This should encompass different technologies: solar thermal, geothermal, biomass, heat pumps, combined heat and power*, recovery of waste energy,* etc, and meet the requirements of near-zero energy buildings and districts *and support smart buildings*. Further breakthroughs are needed, in particular, in *storage for* thermal *energy* from renewable energy sources and to foster the development and deployment of efficient combinations of hybrid heating and cooling systems, for centralised and de-centralised applications.

3.1.3. Foster European Smart cities and Communities

Urban areas are one of the largest consumers of energy in the Union and emit a correspondingly large share of greenhouse gases, while generating a substantial amount of air pollutants. At the same time, urban areas are affected by decreasing air quality and climate change and have to develop their own mitigation and adaptation strategies. Finding innovative energy solutions (*e.g.* energy efficiency, electricity and heating and cooling supply systems*, and integration of renewables in the built environment*), integrated with transport *systems, smart construction and urban planning solutions*, waste and water treatment as well as ICT solutions for the urban environment are therefore crucial in the transformation towards a low carbon society. Targeted initiatives in support to the convergence of industrial value chains of the energy, transport and ICT sector for smart urban applications need to be envisaged. At the same time, new technological, organisational, planning and business models need to be developed and tested at full scale according to the needs and means of cities and communities *and their citizens*. Research is also needed to understand the social, *environmental*, economic and cultural issues that are involved in this transformation.

3.2. Low-cost, low-carbon electricity supply

Electricity will play a central role in the establishment of an environmentally sustainable low-carbon economy. *Renewable energy sources lie at the core of this development.* The uptake of low-carbon electricity generation is too slow due to the high costs involved. There is a pressing need to find solutions that reduce costs significantly, with enhanced performance*,* sustainability *and public acceptance* to accelerate the market deployment of low-*cost, reliable and low* carbon electricity generation. *Activities shall focus on research, development and full scale demonstration of innovative renewables, including small and micro-scale energy systems*, *efficient, flexible and low-carbon emission fossil power plants and carbon capture and storage, or CO2 re-use technologies.*

3.2.1. Develop the full potential of wind energy

The objective for wind energy is to reduce the cost of electricity production of onshore and offshore wind by up to about 20 % by 2020 compared to 2010, to increasingly move offshore, and to enable proper integration in the electricity grid. The focus will be on the development, testing and demonstration of next generation wind energy conversion systems of larger scale *(including innovative energy storage systems)*, higher conversion efficiencies and higher availabilities for both on- and off-shore (including remote locations and hostile weather environments) as well as new serial manufacturing processes. *Environmental and biodiversity aspects of wind energy development will be taken into account.*

3.2.2. Develop efficient, reliable and cost-competitive solar energy systems

The cost of solar energy, covering photovoltaics (PV) and concentrating solar power (CSP), should be halved by 2020 compared to 2010, if it is to *substantially increase its* share of the electricity market.

For PV, this will need *further* research on*, inter alia,* novel concepts and systems *as well as* demonstration and testing of mass production with a view to large-scale deployment *and building integration of PV.*

For CSP, the focus will be on developing ways to increase efficiency while reducing costs and environmental impact, enabling industrial up-scaling of demonstrated technologies by building first-of-a-kind power plants. Solutions to efficiently combine the production of solar electricity with water desalination will be tested.

3.2.3.   Develop competitive and environmentally safe technologies for CO2 capture, transport, storage ***and re-use***

Carbon capture and storage (CCS) is a key option that has to be widely deployed on a commercial scale at global level to meet the challenge of a decarbonised power generation and low carbon industry by 2050. The objective is to minimise the extra-cost of CCS in the power sector for coal-fired***,*** gas-fired ***and oil-shale fired*** power plants compared to equivalent plants without CCS and energy intensive industrial installations.

Support will be given, in particular, to demonstrate the full CCS chain for a representative portfolio of different capture, transport***,*** storage ***and re-use*** technology options. This will be accompanied by research to further develop these technologies and to deliver more competitive capture technologies, improved components, integrated systems and processes, safe geological storage and rational solutions ***and public acceptance*** for the   re-use of captured CO_2 to enable the commercial deployment of CCS technologies for fossil fuel power plants and other carbon-intensive industries going into operation after 2020. ***Support will also be given to clean coal technologies as technologies complementary to CCS.***

3.2.4. Develop geothermal, hydro, marine and other renewable energy options

Geothermal, hydro, and marine energy as well as other renewable energies can contribute to the decarbonisation of the European energy supply while enhancing its flexibility to variable production and use of energy. The objective is to *further develop and* bring to commercial maturity cost-effective and sustainable technologies, enabling large-scale deployment at an industrial scale including grid integration. *Enhanced geothermal systems is a technology that should be further researched, developed and demonstrated notably in the fields of exploration, drilling and heat production.* Ocean energies such as tidal, current or wave energy *and osmotic power* offer zero-emission, predictable energy *and can also contribute to the development of the full potential of off-shore wind energy (combination of marine energies)*. Research activities should include laboratory scale innovative research into low-cost reliable components and materials in a high corrosion, biofouling environment as well as demonstrations under the varied conditions found in European waters.

3.3. Alternative fuels and mobile energy sources

Meeting Europe's energy and CO_2 reduction goals also requires the development of new fuels and mobile energy sources. This is particularly important to meet the challenge of smart, green and integrated transport. Value chains for these technologies and alternative fuels are not sufficiently developed and must be accelerated to demonstration scale.

3.3.1. Make bio-energy *more* competitive and sustainable

The objective for bio-energy is to bring to commercial maturity the most promising technologies, to permit large-scale, sustainable production of advanced   biofuels of different value chains *in a bio-refinery approach* for *surface, maritime and air* transport, and highly efficient combined heat and power *and green gas* from biomass *and waste*, including CCS. The aim is to develop and demonstrate the technology for different bio-energy pathways at different scales, taking account of differing geographical and climate conditions and logistical constraints*, while minimising negative environmental and social impacts linked to land use*. Longer term research will support the development of a sustainable bio-energy industry beyond 2020. These activities will complement upstream (*e.g*. feedstock, bio-resources) and downstream (*e.g*. integration into vehicle fleets) research activities carried out in other relevant Societal Challenges.

3.3.2. Reducing time to market for hydrogen and fuel cells technologies

Fuel cells and hydrogen have a great potential to contribute to addressing energy challenges facing Europe. Bringing these technologies to market competitiveness will require significant cost decrease. As an illustration the cost of fuel cell systems for transportation will have to be reduced by a factor 10 over the next 10 years. To do so, support will be given to
   demonstrations and pre-commercial deployment activities for portable, stationary *and micro-stationary*, transport applications and the related services, as well as long-term research and technology development to build up a competitive fuel cell chain and a sustainable hydrogen production and infrastructure across the Union. Strong national and international cooperation is needed to enable market breakthroughs of a sufficient scale, including the development of appropriate standards.

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3.3.3. New alternative fuels

There is a range of new options with long term potential, such as powdered metal fuel, fuel from photosynthetic microorganisms (in water and land environments) and from artificial photosynthesis mimics *and solar fuels*. These new paths may offer potential for more efficient energy conversion *and* more cost-competitive and sustainable technologies . Support will be given notably to bring these new and other potential technologies from laboratory to demonstration scale size in view of pre-commercial demonstration by 2020.

3.4. A single, smart European electricity grid

Electricity networks have to respond to three interrelated challenges to enable a consumer friendly and increasingly decarbonised electricity system: creating a pan-European market; integrating a massive increase of renewable energy sources; and managing interactions between millions of suppliers and customers (where increasingly households will be both), including owners of electrical vehicles. Future electricity networks will play a key role for the transition to a decarbonised *energy* system, while providing additional flexibility and cost benefits to the consumers. The overriding goal by 2020 is to transmit and distribute about 35 %[1] of electricity from dispersed and concentrated renewable energy sources.

A strongly integrated research and demonstration effort will support the development of new components*,* technologies*, and procedures* which will respond to the particularities of both the transmission and distribution side of the grid, as well as *flexible energy* storage.

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[1] *Commission Staff Working Document SEC(2009) 1295 accompanying the Communication on "Investing in the Development of Low Carbon Technologies (SET-Plan)" COM(2009) 519 final*

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All options to successfully balance energy supply and demand must be considered to minimise emissions and costs. ***New smart energy grid technologies, back-up and balancing technologies enabling higher flexibility and efficiency, including conventional power plants,*** ~~N~~***new grid components to improve the transmiss*** ~~t~~***ion capacity and quality as well as the reliability of grids have to be developed.*** New power systems technologies and a bi-directional digital communication infrastructure must be researched and integrated into the electricity grid ***as well as used to establish smart interactions with other energy grids***. This will contribute to better plan, monitor, control and securely operate networks in normal and emergency conditions as well as to manage the interactions between suppliers and customers and to transport, manage and trade energy flow. For the deployment of future infrastructure, indicators and cost benefit analysis should take into account energy system-wide considerations. In addition, synergies between smart grids and telecommunication networks will be maximised in order to avoid duplication of investments***, to increase safety*** and to accelerate the take up of smart energy services.

Novel energy storage means (including both   batteries ***and large scale such as power-to-gas***) and vehicle systems will provide the required flexibility between production and demand. Improved ICT technologies will further increase the flexibility of electricity demand by providing customers (industrial, commercial and residential) with the necessary automation tools. ***Security, reliability and privacy are important issues here as well.***

New planning, market and regulatory designs need to drive the overall efficiency and cost-effectiveness of the electricity supply chain and interoperability of infrastructures as well as the emergence of an open and competitive market for smart ***energy*** grid technologies, products and services. Large-scale demonstration projects are needed to test and validate solutions and assess the benefits for the system and for individual stakeholders, before deploying them across Europe. This should be accompanied by research to understand how consumers and businesses react to economic incentives, behavioural changes, information services and other innovative opportunities provided by smart grids.

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3.5.   New knowledge and technologies

Novel, more efficient and cost-competitive *as well as clean, safe and sustainable energy* technologies will be required for the long term. Progress should be accelerated through multi-disciplinarily research to achieve scientific breakthroughs in energy related concepts and enabling technologies (e.g. nano-science, material science, solid state physics, ICT, bio-science, *geosciences*, computation, space); *where appropriate safe and environmentally sustainable unconventional gas and oil resources exploration and production* as well as the development of innovations in future and emerging technologies.

Advanced research will also be needed to provide solutions to adapt energy systems to changing climatic conditions. Priorities may be adjusted to new scientific and technological needs and opportunities or newly-observed phenomena which could indicate promising developments or risks to society and that may emerge during the course of implementation of Horizon 2020.

3.6.   Robust decision making and public engagement

Energy research should support and be strongly aligned with the energy policy. Extensive knowledge *and research on the uptake and use* of energy technologies and services, infrastructure, markets (including regulatory frameworks) and consumer behaviour is required to provide policy makers with robust analyses. Support will be given, in particular in the frame of the European Commission's Information System of the SET-Plan, to develop robust and transparent *theories*, tools, methods and models to assess the main economic and social issues related to energy; to build databases and scenarios for an enlarged Union and the assessment of the impact of energy and energy-related policies on security of supply, *consumption,* the environment*, natural resources,* and climate change, society and competitiveness of the energy industry; to carry out socio-economic research activities *as well as science in society studies*.

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Taking advantage of the possibilities offered by web and social technologies, consumer behaviour including that of vulnerable consumers like persons with disabilities and behavioural changes will be studied in open innovation platforms such as the Living Labs and large scale demonstrators for service innovation *as well as through panel surveys, while ensuring privacy*.

3.7.   Market uptake of energy innovation

Innovative market uptake and replication solutions are essential to rollout new energy technologies in time and through a cost effective implementation. In addition to technology-driven research and demonstration, this requires actions with clear Union added value aiming to develop, apply, share and replicate non-technological innovations with a high leverage factor in Union's sustainable energy markets across disciplines and levels of governance.

Such innovations will focus on creating favourable market conditions at the regulatory, administrative and financing level for low-carbon, renewable and energy efficiencies technologies and solutions. Support will be given to measures facilitating the energy policy implementation, preparing the ground for rollout of the investments, supporting the capacity building and acting on public acceptance. *Attention will also be given to innovation for the smart and sustainable use of existing technologies.*

Research and analysis repeatedly confirms the crucial role of the human factor in the success and failure of sustainable energy policies. Innovative organisational structures, the dissemination and exchange of good practices and specific training and capacity building actions will be encouraged.

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3.8.   Specific implementation aspects

The priority setting for the implementation of the activities in this challenge is led by the need to strengthen   energy research and innovation *at the European level*. A main aim will be to support the implementation of the research and innovation agenda of the Strategic Energy Technology Plan (SET Plan)[1] to achieve the objectives of the Union's energy and climate change policy. The SET-Plan roadmaps and implementation plans will therefore provide a valuable input for the formulation of the work programmes. The SET Plan governance structure will be used as a principle basis for strategic priority setting and the coordination of Energy Research and innovation across the Union.

The non-technological agenda will be guided by the Union's energy policy and legislation. The enabling environment for mass deployment of demonstrated technological and service solutions, processes and policy initiatives for low-carbon technologies and energy efficiency across the Union shall be supported. This may involve support to technical assistance for development and roll-out of energy efficiency and renewable energy investments.

In the field of market uptake, activities should also build on the experience of the Intelligent Energy Europe (IEE) initiative.

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[1]   COM(2007) 723

Partnering with European stakeholders will be important to share resources and implement jointly. It may be envisaged, on a case by case basis, that existing European Industrial Initiatives of the SET Plan are turned into formalised public-private partnerships, if considered appropriate, to increase the level and coherence of funding and to stimulate joint research and innovation actions among *both public and private stakeholders.* Consideration will be given to provide support, including with Member States, to alliances of public research performers, in particular, the European Energy Research Alliance established under the SET Plan to pool public research resources and infrastructures to address critical research areas of European interest. International coordination actions shall support the SET Plan priorities according to the variable geometry principle, taking account of countries capabilities and specificities. *Appropriate links with the actions of relevant European Innovation Partnerships and the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.*

Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and relevant public-public and public-private partnerships. Activities shall also focus on increasing the support and promoting the involvement of SMEs.

The European Commission's Information System of the SET-Plan *(SETIS)* will be mobilised to develop, together with stakeholders, key performance indicators (KPIs) to monitor the progress of implementation and which will be revised on a regular basis to account of the latest developments. More broadly, implementation under this Challenge will seek to improve the coordination of relevant Union Programmes, initiatives and policies, such as Cohesion policy, in particular through the national and regional strategies for smart specialisation, and the Emission Trading Scheme mechanisms, for example concerning support to demonstration projects.

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4. SMART, GREEN AND INTEGRATED TRANSPORT

4.1. Resource efficient transport that respects the environment

Europe has set a policy target of achieving a 60 % reduction of CO_2 by 2050 *compared to 1990 levels*. It aims at halving the use of 'conventionally-fuelled' cars in cities and achieving virtually CO_2-free city logistics in major urban centres by 2030. Low-carbon fuels in aviation should reach 40 % by 2050, and CO_2 emissions from maritime bunker fuels should be reduced by 40 % by 2050[1] *compared to 2005 levels*.

It is essential to reduce this environmental impact through targeted technological improvement, bearing in mind that each mode of transport faces varying challenges and is characterised by specific technology integration cycles.

Research and innovation will substantially contribute to the development and take up of the necessary solutions for all transport modes, which will drastically reduce transport's emissions that are harmful to the environment (such as CO_2, NO_x, SO_x *and noise*), lower its dependence on fossil fuels, and hence reduce transport impact on biodiversity and *climate change and* preserve natural resources.

This will be done through work on the following specific activities:

4.1.1. Making aircraft, vehicles and vessels cleaner and quieter will improve environmental performance and reduce perceived noise and vibration

The activities in this domain will focus on the end products, but will also address lean and ecological design and manufacturing processes**, *considering the entire life cycle process and* with recyclability integrated in the design phase. *Activities will also cover the upgrading of existing products and services by integration of new technologies.*

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[1] *Commission White Paper on "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" COM(2011) 144 final.*

(a)   Developing and accelerating the take-up of cleaner **and quieter** propulsion technologies is important for reducing or eliminating **impacts on climate and health of European citizens, e.g**. CO_2**, noise** and pollution from transport. New and innovative solutions are necessary, based on electric engines and batteries, **hydrogen and** fuel cells, **gas-powered engines, advanced architectures and technologies in engines** or hybrid propulsion. Technological breakthroughs will also help improve the environmental performance of traditional **and new** propulsion systems.

(b)   Exploring options for the use of low emission alternative energies will help reduce the consumption of fossil fuels. This includes using sustainable fuels and electricity from renewable energy sources in all modes of transport including aviation, reducing fuel consumption through energy harvesting or diversified energy supply and other innovative solutions. New holistic approaches will be pursued encompassing vehicles, energy storage, energy supply**, fuelling and charging** infrastructure, including vehicle-to-grid interfaces and innovative solutions for the use of alternative fuels.

(c)   **Improving the overall performance** of aircraft, vessels and vehicles **by reducing their weight** and lowering their aerodynamic hydrodynamic or rolling resistance by using lighter materials, leaner structures and innovative design, will contribute to lower fuel consumption.

4.1.2.   Developing smart equipment, infrastructures and services

This will help optimise transport operations and reduce resource consumption. The focus will be on **solutions for** the efficient **planning, design**, use and management of airports, ports, logistic platforms and surface transport infrastructures, as well as on autonomous and efficient maintenance, **monitoring** and inspection systems. **New policies, business models, concepts, technologies and IT solutions are to be adopted to increase capacity**. Particular attention will be given to the climate resilience of **equipment and** infrastructures, cost-efficient solutions based on a life-cycle approach, and the wider take-up of new materials **and technologies** allowing for more efficient and lower cost maintenance. Attention will also be paid to accessibility, **user friendliness** and social inclusiveness.

4.1.3. Improving transport and mobility in urban areas

This will benefit a large and increasing share of the population which lives and works in cities or uses them for services and leisure. New mobility concepts, transport organisation, *multimodal accessibility models*, logistics, *provision of innovative vehicles and urban public services* and planning solutions need to be developed and tested, which will contribute to reduce *congestion*, air pollution and noise, and improve *the* efficiency *of urban transport*. Public and non-motorised transport as well as other resource-efficient transport options *for passengers and freight* should be developed as a real alternative to the use of private motor vehicles, supported by greater use of intelligent transport systems as well as by innovative *supply and* demand management. *Special emphasis shall be given to the interaction between the transport system and other urban systems.*

4.2. Better mobility, less congestion, more safety and security

Relevant European transport policy goals aim to optimise performance and efficiency in the face of growing demands for mobility, to make Europe the safest region for aviation*, railways and waterbone transport* and to move towards the target of zero fatalities in road transport by 2050 *and of halving the road casualties by 2020*. By 2030, 30 % of road freight transport over 300 kilometres should shift to rail and waterborne transport. A *seamless, accessible, affordable, user-oriented and* efficient pan-European transport of people and goods, also internalising external costs, requires a new European multimodal transport management, information and payment system, *as well as efficient interfaces between long distance and urban mobility networks.*

A better European transport system will contribute to a more efficient use of transport, ~~and~~ will improve the quality of life of citizens and support a healthier environment.

Research and innovation will make important contributions to these ambitious policy goals through activities in the following specific activities:

4.2.1. A substantial reduction of traffic congestion

This can be achieved by implementing *an intelligent, multi-modal and* fully intermodal 'door-to-door' transport system and by avoiding unnecessary use of transport. This means promoting greater integration between transport modes, the optimisation of transportation chains and better integrated transport *operations and* services. Such innovative solutions will also facilitate accessibility and *passenger choices*, including for the ageing population and vulnerable users *and provide opportunities to reduce congestion by improving incident management and the development of traffic optimisation schemes.*

4.2.2. Substantial improvements in the mobility of people and freight

This can be achieved through the development, *demonstration* and widespread use of intelligent transport applications and management systems. This entails: planning demand *analysis and* management, information and payment systems that are interoperable Europe-wide; and the full integration of information flows, management systems, infrastructure networks and mobility services into a new common multi-modal framework based on open platforms. This will also ensure flexibility and rapid responses to crisis events and extreme weather conditions by reconfiguring travel *and haulage* across modes. New positioning, navigation and timing applications, made possible through the Galileo and EGNOS satellite navigation systems, will be instrumental in achieving this objective.

(a)   Innovative air traffic management technologies will contribute to a step-change in safety and efficiency with rapidly increasing demand, to achieve improved punctuality, to reduce time spent in travel-related procedures at airports and to achieve resilience in the air transport system. The implementation and further development of the 'Single European Sky' will be supported with *research and innovation activities providing* solutions for increased automation and autonomy in air traffic management and aircraft *operation and* control, better integration of air and ground components, and novel solutions for the efficient and seamless handling of passengers and freight throughout the transport system.

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(b)   For waterborne transport, improved and integrated planning and management technologies will contribute to the emergence of a 'Blue Belt' in the seas around Europe, improving port operations, and to a suitable framework for inland waterways.

(c)   For rail and road, the optimisation of network management *and interoperability* will improve efficient use of infrastructure and make cross-border operations easier. Comprehensive cooperative road traffic management and information systems will be developed, relying on vehicle to vehicle and vehicle to infrastructure communication.

4.2.3.   Developing   new concepts of freight transport and logistics

This can reduce pressure on the transport system and *the environment, and* improve safety and freight capacity. They can, for example, combine high performance and low environmental impact vehicles with smart, secure on-board and infrastructure-based systems . *This should be based on an integrated logistics approach in the field of transport.* Activities will also support the development of the e-Freight vision of a paperless freight transport process, where electronic information flows, services and payments are linked to physical freight flows across transport modes.

4.2.4. Reducing accident rates*, fatalities* and   casualties and improving security

This will be achieved by addressing aspects inherent to the organisation, management and monitoring of performance and risk of transport systems; and by focusing on the design, *manufacturing* and operations of aircraft, vehicles and vessels, infrastructures and terminals. The focus will be on passive and active safety, preventive safety, and enhanced automation and training processes to reduce the *risk and* impact of human errors. To better anticipate, assess and mitigate the impact of weather*, natural hazards *and other crisis situations*, special tools and techniques will be devised. Activities will also focus on the integration of security aspects in the planning and management of passenger and freight flows, on the conception of aircraft, vehicles and vessels, on traffic and system management and on the design of *transport infrastructures and of freight and passenger* terminals. *Intelligent transport and connectivity applications may also provide useful tools for enhanced security. Activities will also focus on improving the safety of all road users especially those at greatest risk, particularly in urban areas.*

4.3.   Global leadership for the European transport industry

By staying ahead in *technological development* and *improving* the *competitiveness* of existing manufacturing processes, research and innovation will contribute to growth and highly skilled jobs in the European transport industry, in the face of growing competition. At stake is the *further development* of the competitiveness of a major economic sector that directly represents 6.3 % of the Union GDP and employs nearly 13 million people in Europe. Specific objectives include the development of the next generation of innovative *and environmentally friendly air, waterborne and land* transport means*, ensuring sustainable manufacturing of innovative systems and equipment and preparing* the ground for *future transport means*, by working on novel *technologies,* concepts and designs, smart control systems, efficient *development and* production processes*, innovative services and certification procedures*. Europe aims at becoming the world-leader in efficiency*, environmental performance* and safety in all modes of transport *and at enhancing its leadership in global markets both for end-products as well as for sub-systems.*

Research and innovation will focus on the following specific activities:

4.3.1.   Developing the next generation of transport means as the way to secure market share in the future

It will help enhance European leadership in aircraft, high speed trains, **conventional and** (sub)urban rail transport, road vehicles, electromobility, passenger cruise ships, ferries and specialised high technology ships and **maritime** platforms. It will also spur the competitiveness of European industries in upcoming technologies and systems and support their diversification towards new markets, including in sectors other than transport. This includes the development of innovative safe **and environmentally friendly** aircraft, vehicles and vessels that incorporate efficient propulsion **systems**, high performance and intelligent **operation and** control systems.

4.3.2. On board, smart control systems

These are needed to realise higher levels of performance and system integration in transport. Appropriate interfaces for communications between aircraft, vehicles, vessels and infrastructures in all relevant combinations will be developed, **taking into account impacts of electromagnetic fields,** with a view to defining common operational standards. **They may include delivering traffic management and user information direct to in-vehicle devices, supported by reliable real-time traffic data on road conditions and congestion from the same devices.**

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4.3.3. Advanced production processes

These will allow customization, lower lifecycle cost and development time and facilitate the standardisation and certification of aircraft, vehicles and vessels *as well as their components, equipment* and related infrastructure. Activities in this area will develop fast and cost efficient design and manufacturing techniques, including assembly, construction, maintenance and recycling, through digital tools and automation, and capacity to integrate complex systems. This will foster competitive supply chains able to deliver with short time-to-market and reduced costs *without compromising operational safety and security. Transport applications of innovative materials are also a priority both for environmental and competitiveness goals as well as for increased safety and security.*

4.3.4. Exploring entirely new transport concepts

This will help enhance Europe's competitive edge in the longer term perspective. Strategic *multidisciplinary* research and proof of concept activities shall address innovative transport systems *solutions. This will include* fully automated and other new types of aircraft, vehicles and vessels with long term potential *and high environmental performance as well as new services.*

4.4.   Socio-economic *and behavioural* research and forward looking activities for policy making

Actions to support policy analysis and development including *gathering evidence to understand behaviour on spatial,* socio-economic *and wider societal* aspects of transport are necessary to promote innovation and *create a shared evidence base to* meet the challenges raised by transport. Activities will target the development and implementation of European research and innovation policies for transport *and mobility*, prospective studies and technology foresight, and strengthening of the European Research Area.

Understanding *local and regional specificities,* user behaviour *and perceptions*, social acceptance, impact of policy measures, mobility*, changing needs and* patterns*, evolution of future demand,* business models and their implications are of paramount importance for the evolution of the European transport system. Scenario development taking into account societal trends, *evidence on causalities,* policy objectives and technology foresight in a 2050 perspective will be carried out. In view of better understanding the links between territorial development*, social cohesion* and the European transport system, robust models are needed on which sound policy decisions can be taken.

Research will focus on how to *reduce* social *and territorial* inequalities in access to mobility, and how to improve the position of vulnerable *transport* users. Economic issues must also be addressed, focusing on ways to internalise the externalities from transport across modes, as well as taxation and pricing models. Prospective research is needed to assess future requirements for skills and jobs*, research and innovation development and uptake as well as transnational cooperation*.

4.5.   Specific implementation aspects

The activities will be organised in such a way as to allow for an integrated and mode-specific approach as appropriate. Multiannual visibility and continuity will be necessary in order to take into account the specificities of each transport mode and the holistic nature of challenges as well as relevant aspects of the strategic research and innovation agendas of European Technology Platforms.

Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and the relevant public-public and public-private partnerships. Appropriate links with the actions of relevant European Innovation Partnership will also be established. Activities shall also focus on increasing the support and promoting the involvement of SMEs.

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5.   CLIMATE ACTION, *ENVIRONMENT,* RESOURCE EFFICIENCY AND RAW
      MATERIALS

5.1.   Fighting and adapting to climate change

Current CO_2 concentrations in the atmosphere are close to 40 % higher than those at the start of the industrial revolution and at the highest levels experienced in the last 2 million years. Non-CO_2 greenhouse gases also contribute to climate change and are playing an increasingly significant role. Without decisive action, climate change could cost the world at least 5 % of GDP each year; and up to 20 % under some scenarios. In contrast, with early and effective action the net costs could be limited to around 1 % of GDP per year. Meeting the 2°C target and avoiding the worst impacts of climate change will require developed countries to cut greenhouse gas emissions by 80-95 % by 2050 compared to 1990 levels.

The aim of this activity is therefore to develop and assess innovative, cost-effective and sustainable adaptation and mitigation measures *and strategies*, targeting both CO_2 and non-CO_2 greenhouse gases *and aerosols*, and underlining both technological and non-technological green solutions, through the generation of evidence for informed, early and effective action and the networking of the required competences.

To achieve this, research and innovation will focus on the following:

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5.1.1. Improve the understanding of climate change and the provision of reliable climate projections

Better understanding of the causes and evolution of climate change and more accurate climate projections are crucial for society to protect lives, goods and infrastructures and ensure effective decision making *and adequate mitigation and adaptation options*. It is essential to further improve the scientific knowledge-base of climate drivers, processes, mechanisms*,* feedbacks *and thresholds* associated with the functioning of   terrestrial*, marine and polar* ecosystems and the atmosphere. Improved *understanding will also allow more accurate detection of* climate *change and attribution to natural and anthropogenic causal factors. Improved reliability of climate projections and* predictions at pertinent temporal and spatial scales will be supported via the *improvement of measurements and via the* development of more accurate scenarios and models, including fully coupled Earth-system models *taking into account paleoclimate history*.

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5.1.2.	Assess impacts, vulnerabilities and develop innovative cost-effective adaptation and risk prevention **and management** measures

There is incomplete knowledge on the ability of society**,** the economy **and ecosystems** to adapt to climate change. Effective, equitable and socially acceptable measures towards a climate resilient environment**,** **economy** and society require the integrated analysis of current and future impacts, vulnerabilities, population exposure, risks **and their management, second order effects such as migration and conflicts**, costs and opportunities associated with climate change and variability, taking into account extreme events and related climate-induced hazards and their recurrence. This analysis will also be developed on the adverse impacts of climate change on biodiversity, ecosystems and ecosystem services, **water resources**, infrastructures and economic and natural assets. Emphasis will be placed on the most valuable natural ecosystems and built environments, as well as key societal, cultural and economic sectors across Europe. Actions will investigate the impacts and growing risks for human health stemming from climate change**, climate induced hazards** and increased greenhouse gases **concentrations** in the atmosphere. Research will evaluate innovative, equitably distributed and cost-effective adaptation responses to climate change, including the protection and adaptation of natural resources and ecosystems, and related effects, to inform and support their development and implementation at all levels and scales. This will also include the potential impacts, costs**,** risks **and benefits,** of geo-engineering options. The complex inter-linkages, conflicts and synergies of adaptation and risk-prevention policy choices with other climate and sectoral policies will be investigated, including impacts on employment and the living standards of vulnerable groups.

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5.1.3. Support mitigation policies*, including studies that focus on impact from other sectoral policies*

The Union's transition to a competitive, resource efficient and climate change resilient economy ***and society*** by 2050 requires the design of effective, long-term, low-emission strategies and major advancements in our capacity to innovate. Research will assess the environmental and socio-economic risks, opportunities and impacts of climate change mitigation options. ***It will also assess impact from other sectoral policies.*** Research will support the development and validation of new climate-energy-economy models, taking into account economic instruments and relevant externalities, with the aim of testing mitigation policy options and low carbon technology pathways at different scales and for the key economic and societal sectors at Union and global level. Actions will facilitate technological, institutional and socio-economic innovation by improving the links between research and application and between entrepreneurs, end users, researchers, ***policy makers*** and knowledge institutions.

5.2.   ***Protection of the environment,*** sustainable ***management of*** natural resources***, water, biodiversity*** and ecosystems

Societies face a major challenge to establish a sustainable balance between human needs and the environment. Environmental resources, including water, air, biomass, fertile soils, biodiversity, ecosystems and the services they provide, underpin the functioning of the European and global economy and quality of life. Global business opportunities related to natural resources are expected to amount to over EUR 2 trillion by 2050[1]. Despite this, ecosystems in Europe and globally are being degraded beyond nature's ability to regenerate them and environmental resources are being over-exploited ***and even destroyed***. For example, 1000 km² of some of the most fertile soils and valuable ecosystems are lost every year in the Union, while a quarter of fresh water is wasted. Continuing these patterns is not an option. Research must contribute to reversing the trends that damage the environment and to ensuring that ecosystems continue to provide the resources, goods and services that are essential for well-being and economic prosperity ***and sustainable development***.

The aim of this activity is therefore to provide knowledge***, and tools*** for the management ***and protection*** of natural resources that achieves a sustainable balance between limited resources and the ***present and future*** needs of society and the economy.

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[1]   Estimates developed by PricewaterhouseCoopers for "sustainability-related global business opportunities in natural resources (including energy, forestry, food and agriculture, water and metals)" and WBCSD (2010) Vision 2050: The New Agenda for Business, World Business Council for Sustainable Development: Geneva, URL: http://www.wbcsd.org/web/projects/BZrole/Vision2050-FullReport_Final.pdf

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To achieve this, research and innovation will focus on the following:

5.2.1.   Further our understanding of ***biodiversity and*** the functioning of ecosystems, their interactions with social systems and their role in sustaining the economy and human well-being

Society's actions risk triggering changes in the environment that are irreversible and which alter the character of ecosystems ***and their biodiversity***. It is vital to anticipate these risks by assessing, monitoring and forecasting the impact of human activities on the environment, ***including land use change,*** and environmental changes on human well-being. Research on marine, (from coastal zones to the deep sea ***including the sustainability of marine resources), polar***, fresh-water, terrestrial and urban ecosystems, including groundwater dependent ecosystems, will improve our understanding of the complex interactions between natural resources and social, economic, and ecological systems, including natural tipping points, and the resilience, or fragility, of human and biological systems. It will examine how ***biodiversity and*** ecosystems function and react to anthropogenic impacts, how they can be restored, and how this will affect economies and human well-being. It will also investigate solutions for addressing resource challenges ***in the European and international context***. It will contribute to policies and practices that ensure that social and economic activities operate within the limits of the sustainability and adaptability of ecosystems and biodiversity.

5.2.2. *Developing integrated approaches to address water-related challenges and the transition to sustainable management and use of water resources and services*

Freshwater availability and quality have become global issues with far-reaching economic and social implications. With ever-growing demand for different and often conflicting uses (e.g. agriculture, industry, recreational activities, public services, ecosystems and landscape maintenance, environmental restoration and enhancement), increased resource vulnerability exacerbated by climate and global change, urbanisation, pollution and over exploitation of freshwater resources, maintaining and improving water quality and availability, and mitigating the impact of human activities on fresh water ecosystems is becoming a critical challenge for the users of water in various sectors as well as for aquatic ecosystems.

Research and innovation will address these pressures and will provide integrated strategies, tools, technologies and innovative solutions to meet current and future needs. It will aim to develop appropriate water management strategies, improve water quality, cope with imbalances between water demand and availability or supply at different levels and scale, close the water cycle, promote sustainable end-user behaviour and address water related risks whilst sustaining the integrity, structure and functioning of the aquatic ecosystems in line with the prevailing EU policies.

5.2.3. Provide knowledge and tools for effective decision making and public engagement

Social, economic and governance systems still need to address both resource depletion and the damage to ecosystems. Research and innovation will underpin policy decisions needed to manage natural resources and ecosystems so as to avoid, or adapt to, disruptive climate and environmental change and to promote institutional, economic, behavioural and technological change that ensure sustainability. ***Research will thus underpin the development of systems to value biodiversity and ecosystem services, including understanding the stock of natural capital and the flow of ecosystems services.*** Emphasis will be put on critical policy relevant ecosystems and ecosystem services, such as fresh water, seas and oceans ***(including coastal areas), forests, polar regions***, air quality, biodiversity, land use and soil. The resilience of societies and ecosystems to ***pollutants and pathogens and to*** catastrophic events, including natural hazards ***(such as seismic and volcanic, flooding and droughts) and forest fires***, will be supported through improving capacities for forecasting, early warning, and assessing vulnerabilities and impacts, including the multi-risk dimension. Research and innovation will thus provide support for environmental and resource efficiency policies, and options for effective evidence-based governance within safe operating limits. Innovative ways will be developed to increase policy coherence, resolve trade-offs and manage conflicting interests, and improve public awareness of research results and the participation of citizens in decision-making.

5.3.   Ensuring the sustainable supply of non-energy and non-agricultural raw materials

Sectors such as construction, chemicals, automotive, aerospace, machinery and equipment, which have a combined added value in excess of EUR 1,000 billion and provide employment for some 30 million people, all depend on access to raw materials. The Union is self-sufficient in construction minerals. Nonetheless, whilst the Union is one of the world's largest producers of certain industrial minerals, it remains a net importer of most of them. Furthermore, the Union is highly dependent on imports of metallic minerals and is totally import dependent for some critical raw materials.

Recent trends indicate that demand for raw materials will be driven by the development of emerging economies and by the rapid diffusion of key enabling technologies. Europe has to ensure a sustainable management and secure a sustainable supply of raw materials from inside and outside its borders for all sectors that depend on access to raw materials. Policy targets for critical raw materials are outlined in the Commission's Raw Materials Initiative[1].

The aim of this activity is therefore to improve the knowledge base on raw materials and develop innovative solutions for the cost-effective and environmentally friendly exploration, extraction, processing, *re-use,* recycling and recovery of raw materials and for their substitution by economically attractive *and environmentally sustainable* alternatives with a lower environmental impact.

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[1]   COM (2008) 699

To achieve this, research and innovation will focus on the following:

5.3.1. Improve the knowledge base on the availability of raw materials

The assessment of the long-term availability of global and Union resources, including access to urban mines (landfills and mining waste), *coastal-sea and* deep-sea resources (e.g., the sea-bed mining of rare earth minerals) and the associated uncertainties will be improved. This knowledge will help society reach a more efficient use, recycling and reuse of scarce or environmentally harmful raw materials. It will also develop global rules, practices and standards governing economically viable, environmentally sound and socially acceptable resource exploration, extraction and processing, including practices in land use and marine spatial planning *on the basis of an ecosystems approach.*

5.3.2. Promote the sustainable supply and use of raw materials, *including mineral resources, from land and sea,* covering exploration, extraction, processing, *re-use,* recycling and recovery

Research and innovation is needed over the entire life cycle of materials, in order to secure an affordable, reliable, and sustainable supply and management of raw materials essential for European industries. Developing and deploying economically viable, socially acceptable and environmentally friendly exploration, extraction and processing technologies will boost the efficient use of resources. *This will include mineral resources, from land and sea, and* will also exploit the potential of urban mines. New and economically viable *and resource efficient* recycling and materials recovery technologies, business models and processes*, including closed-loop processes and systems,* will also contribute to reducing the Union's dependence on the supply of primary raw materials. This will include the need for longer use, high-quality recycling and recovery, and the need to drastically reduce resource wastage. A full life-cycle approach will be taken, from the supply of available raw materials to end of life, with minimum energy and resources requirements.

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5.3.3. Find alternatives for critical raw materials

In anticipation of the possible reduced global availability of certain materials, due for example to trade restrictions, sustainable substitutes and alternatives for critical raw materials, with similar functional performance, will be investigated and developed. This will reduce the Union's dependence on primary raw materials and improve the impact on the environment.

5.3.4. Improve societal awareness and skills on raw materials

The necessary move to a more self-reliant and resource efficient economy will require cultural, behavioural, socio-economic*, systemic* and institutional change. In order to address the growing problem of skills shortage in the Union's raw materials sector, (including the European mining industry), more effective partnerships between universities*,* geological surveys*, industry* and *other stakeholders* will be encouraged. It will also be essential to support the development of innovative green skills. In addition there is still limited public awareness of the importance of domestic raw materials for the European economy. To facilitate the necessary structural changes, research and innovation will aim to empower citizens, policy-makers, practitioners and institutions.

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5.4.	Enabling the transition towards a green economy ***and society*** through eco-innovation

The Union cannot prosper in a world of ever increasing resource consumption, environmental degradation and biodiversity loss. Decoupling growth from the use of natural resources requires structural changes in how such resources are used, re-used and managed, while safeguarding our environment. Eco-innovations will enable us to reduce pressure on the environment, increase resource efficiency, and put the Union on the path to a resource and energy efficient economy. Eco-innovation also creates major opportunities for growth and jobs, and increases European competitiveness within the global market, which is estimated to grow to a trillion Euro market after 2015[1]. Already 45 % of companies have introduced some type of eco-innovation. It has been estimated that around 4 % of eco-innovations led to more than a 40 % reduction of material use per unit of output[2], highlighting the great future potential. ***However, it is not uncommon that highly promising and technically advanced eco-innovative technologies, processes, services and products do not reach the market due to pre-commercialisation challenges and do not realise their full environmental and economic potential as their scaling up and market introduction are perceived as too risky by private investors.***

The aim of this activity is therefore to foster all forms of eco-innovation that enable the transition to a green economy.

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[1]	European Parliament "Policy Department Economic and Scientific Policy, Eco-innovation - putting the EU on the path to a resource and energy efficient economy, Study and briefing notes", March 2009.

[2]	Eco-innovation Observatory "The Eco-Innovation Challenge - Pathways to a resource-efficient Europe - Annual Report 2010", May 2011.

To achieve this, research and innovation will focus on the following:

5.4.1.   Strengthen eco-innovative technologies, processes, services and products *including exploring ways to reduce the quantities of raw materials in production and consumption, and overcoming barriers in this context* and boost their market uptake

All forms of *eco-*innovation, both incremental and radical, combining technological, organisational, societal, behavioural, business and policy innovation, and strengthening the participation of civil society, will be supported. This will underpin a more circular economy, while reducing environmental impacts*, increasing environmental resilience* and taking account of rebound effects on the environment *and potentially on other sectors*. This will include *user-driven innovation,* business models, industrial symbiosis, product service systems, product design, full life cycle and cradle-to-cradle approaches *as well as exploring ways to reduce the quantities of raw materials in production and consumption, and overcoming barriers in this context. The potential to move to more sustainable patterns of consumption will be addressed*. The aim will be to improve resource efficiency by reducing, in absolute terms, inputs, waste and the release of harmful substances (*e.g. those indicated under the REACH Regulation[1] and others)* along the value chain and foster re-use, recycling and resource substitution. Emphasis will be given to facilitate the transition from research to market, involving industry and notably *start-ups and innovative* SMEs, *civil society organisations and end-users,* from the development of prototypes *and demonstration of technical, social and environmental performance, up* to *the first application and* market replication *of eco- innovative techniques, products, services or practices of Union relevance. Actions will contribute to removing barriers to the development and wide application of eco-innovation, creating or enlarging markets for the solutions concerned and improving the competitiveness of Union enterprises, especially SMEs, on world markets.* Networking among eco-innovators will also seek to enhance the dissemination *and exploitation* of knowledge and better link supply with demand.

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[1]   *Regulation (EC) no1907/2006 of the European Parliament and of the Council of 18 December 2006.*

5.4.2. Support innovative policies and societal changes

Structural and institutional changes are needed to enable the transition towards a green economy *and society*. Research and innovation will address the main barriers to societal and market change and will aim to empower consumers, business leaders and policy makers to adopt innovative and sustainable behaviour*, with contributions from Social Sciences and Humanities*. Robust and transparent tools, methods and models to assess and enable the main economic, societal*, cultural* and institutional changes needed to achieve a paradigm shift towards a green economy *and society* will be developed. Research will explore how to promote sustainable *lifestyles and* consumption patterns, encompassing socio-economic research, behavioural science, user engagement and public acceptance of innovation, as well as activities to improve communication and public awareness. Full use will be made of demonstration actions.

5.4.3. Measure and assess progress towards a green economy

It is necessary to develop robust indicators at all appropriate spatial scales that are complementary to GDP, methods and systems to support and assess the transition towards a green economy and the effectiveness of relevant policy options. Driven by a life-cycle approach, research and innovation will improve the quality and availability of data, measurement methods and systems relevant to resource efficiency and eco-innovation and facilitate the development of innovative offset schemes. Socio economic research will provide a better understanding of the root causes of producer and consumer behaviour and thus contribute to the design of more effective policy instruments to facilitate the transition to a resource efficient and climate change resilient economy. Moreover, technology assessment methodologies and integrated modelling will be developed to support resource efficiency and eco-innovation policies at all levels, while increasing policy coherence and resolving trade-offs. The results will enable the monitoring, assessment and reduction in material and energy flows involved in production and consumption, and will enable policy-makers and businesses to integrate environmental costs and externalities into their actions and decisions.

5.4.4. Foster resource efficiency through digital systems

Innovations in information and communication technologies can constitute a key tool to support resource efficiency. To achieve this objective, modern and innovative ICT will contribute to significant efficiency gains in productivity, notably through automated processes, real time monitoring and decision support systems. The use of ICT will look to accelerate a progressive dematerialisation of the economy, by increasing the shift towards digital services, and to facilitate changes of consumption behaviours and business models through the use of the ICT of the future.

5.5. Developing comprehensive and sustained global environmental observation and information systems

Comprehensive environmental observation and information systems are essential to ensure the delivery of the long-term data and information required to address this challenge. These systems will be used to *monitor,* assess and predict the condition, status and trends of the climate, natural resources including raw materials, *terrestrial and marine (from coastal zones to deep sea)* ecosystems and ecosystem services, as well as to evaluate low-carbon and climate mitigation and adaptation policies and options across all sectors of the economy. Information and knowledge from these systems will be used to stimulate the smart use of strategic resources; to support the development of evidence-based policies; to foster new environmental and climate services; and to develop new opportunities in global markets.

Capabilities, technologies and data infrastructures for Earth observation and monitoring must build on advances in ICT, space technologies and enabled networks, remotely sensed observations, novel in situ sensors, mobile services, communication networks, participatory web-service tools and improved computing and modelling infrastructure, with the aim of continuously providing timely and accurate information, forecasts and projections. Free, open and unrestricted access to interoperable data and information will be encouraged, as well as the effective *and - if required - secure* storage, management and dissemination of research results. *Activities shall help define future operational activities of the European Earth Monitoring programme (Copernicus) and enhance the use of Copernicus data for research activities.*

5.6. *Cultural heritage*

Cultural heritage assets are unique and irreplaceable in their tangible form as well as in their intangible value, cultural significance and meaning. They are a major driver of societal cohesion, identity and well-being as well as contributing significantly to sustainable growth and job creation. However, Europe's cultural heritage is subject to deterioration and damage, further exacerbated by increasing exposure to human activities (e.g. tourism) and extreme weather events resulting from climate change as well as due to other natural hazards and disasters.

The aim of this activity is to provide knowledge and innovative solutions, through adaptation and mitigation strategies, methodologies, technologies, products and services for the preservation and management of tangible cultural heritage in Europe at risk from climate change.

To achieve this, multidisciplinary research and innovation will focus on the following:

5.6.1. *Identifying resilience levels via observations, monitoring and modelling*

New and improved damage assessment, monitoring and modelling techniques will be developed to improve the scientific knowledge-base of the impact on cultural heritage of climate change and other environmental and human risk factors. The knowledge and understanding generated with the help of scenarios, models and tools, including analysis of the perception of value, will help provide a sound scientific basis for the development of resilience strategies, policies and standards, within a coherent framework for risk assessment and management of cultural heritage assets.

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5.6.2 *Providing for a better understanding on how communities perceive and respond to climate change and seismic and volcanic hazards*

Research and innovation will, through integrated approaches, develop resource efficient solutions for prevention, adaptation and mitigation, involving innovative methodologies, technologies, products and services for the preservation of cultural heritage assets, cultural landscapes and historic habitats.

5.7. Specific implementation aspects

Activities will enhance the Union's participation in and financial contribution to multilateral processes and initiatives, such as the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), and the Group on Earth Observations (GEO). Cooperation with other major public and private research funders *as well as with major research networks* will improve global and European research efficiency and contribute to global research governance.

S&T cooperation will contribute to the UNFCCC global technology mechanism and facilitate technology development, innovation and transfer in support of climate adaptation and the mitigation of greenhouse gases.

Building on the outcomes of the UN Rio+20 Conference, a mechanism will be explored to systematically collect, collate and analyse scientific and technological knowledge on key sustainable development and green economy issues, which will include a framework for measuring progress. This will complement existing scientific panels and bodies and seek synergies with them.

Research actions under this challenge will contribute to *European Earth Monitoring Programme* (*Copernicus*) operational services by providing a developmental knowledge base for **Copernicus**.

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Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and relevant public-public and public-private partnerships.

Approriate links with the actions of relevant European Innovation Partnerships and the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.

Specific measures will ensure that results from Union research and innovation in the fields of climate, resource efficiency and raw materials are used downstream by other Union programmes, such as the LIFE + programme, *European* Structural *and Investment* funds, and external cooperation programmes.

Activities will also, inter alia, build upon and enhance those undertaken in the Eco-Innovation Programme.

Actions will also provide: the continuous analysis of scientific and technological progress in the Union and its major partner countries and regions; an early investigation of market opportunities for new environmental technologies and practices; foresight for research & innovation and policy.

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6.   ***EUROPE IN A CHANGING WORLD*** - INCLUSIVE, INNOVATIVE AND ***REFLECTIVE*** SOCIETIES

This section includes research and innovation activities contributing to make societies more inclusive, innovative and ***reflective, and also specific measures supporting particular cross-cutting issues mentioned in this Societal Challenge[1].***

6.1.   Inclusive societies

Current trends at play in European societies bring with them opportunities for a more united Europe but also risks ***and challenges***. These opportunities***,*** risks ***and challenges*** need to be understood and anticipated in order for Europe to evolve with adequate solidarity and cooperation at social, economic, political***, educational*** and cultural levels, taking into account an increasingly interconnected ***and interdependent*** world.

In this context, the objective is to ***understand, analyse and develop*** social, economic and political inclusion, ***as well as inclusive labour markets,*** combat poverty ***and marginalisation***, enhance human rights, digital inclusiveness, equality, solidarity and inter-cultural dynamics by supporting ***cutting-edge science,*** interdisciplinary research, ***development of*** indicators, technological advances, organisational ***innovations, development of regional innovation clusters*** and new forms of collaboration and co-creation. Research and other activities shall support the implementation of the Europe 2020 strategy as well as other relevant Union policies. ***Social Sciences and*** Humanities research ***has a leading*** role to play in this context. Specifying, monitoring***,*** assessing ***and addressing*** the objectives of European strategies and policies will require focused research   that ***allows*** policy makers to ***analyse and*** assess the impact and effectiveness of envisaged measures, in particular in favour of social inclusion. ***To this end, full societal inclusion and participation must encompass all areas of life and all ages.***

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[1]   ***Without prejudice to the budget allocated to this Societal Challenge.***

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The following specific objectives will be pursued *to understand and foster or implement*:

6.1.1. *The mechanisms to promote* smart, sustainable and inclusive growth

Europe has developed a specific and rather unique combination of economic progress, social policies aimed at a high level of social cohesion, humanistic shared cultural values embracing democracy and the rule of common law, human rights, respect and preservation of diversity, as well as the promotion of education and science, arts and humanities as fundamental drivers of social and economic progress and wellbeing. The constant quest for economic growth carries a number of important human, social, environmental and economic costs. A smart, sustainable and inclusive growth in Europe implies substantial changes in the way growth and *societal* wellbeing are defined, measured (including through the measurement of progress beyond the commonly used GDP indicator), generated and sustained over time.

Research will analyse the development of *citizen participation,* sustainable lifestyles*, cultural understanding* and socio-economic behaviours and values and how they relate to paradigms, policies and to the functioning of institutions, *communities,* markets, firms, governance and belief systems in Europe *and their relations with other regions and economies*. It will develop tools for a better assessment of the contextual and mutual impacts of such evolutions, *compare public policies against the variety of challenges across Europe,* and *analyse* policy options *and decision making mechanisms* in areas such as employment, taxation, inequalities, poverty, social inclusion, education and skills, community development, competitiveness and the Internal Market *with a view to understanding the new conditions and opportunities for greater European integration and the role of its social, cultural, scientific and economic components and synergies as sources of comparative Union advantages at world level.*

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Implications for growth, the labour market and wellbeing of demographic change due to ageing societies and migration movements will be analysed. In this context, to be able to tackle the challenge of future growth, it is important to take into account the different components of knowledge, focusing research on learning, education and training issues, or on the role and place of young people in the society. Research will also develop better tools for assesing sustainability impacts of different economic policies. It will also analyse how national economies evolve and which forms of governance at European and international level could help prevent macro-economic imbalances, monetary difficulties, fiscal competition, unemployment and employment problems and other forms of *societal,* economic and financial disorders. It will take into account the growing interdependencies between Union and global economies*, markets and financial systems and resulting challenges for institutional development and public administration. Against the background of the European public debt crisis, emphasis will also be put on research to define the framework conditions for stable European financial and economic systems*.

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6.1.2. ***Trusted organisations, practices, services and policies that are necessary to build*** resilient**,** inclusive**,** *** participatory, open and creative*** societies in Europe**,** *** in particular taking into account migration, integration and demographic change***

Understanding social**,** *** cultural and political*** transformations in Europe requires the analysis of changing democratic practices and expectations as well as of the historical evolution of identities, diversity, territories, religions, cultures**,** *** languages*** and values. This includes a good understanding of the history of European integration. ***Research will seek*** to identify ways to adapt and improve the European welfare systems, public services and the broader social security dimension of policies in order to achieve cohesion, ***gender equality, foster participatory, open and creative societies*** and promote more social and economic equality and intergenerational solidarity. Research will analyse how societies and politics become more European in a broad sense through evolutions of identities, cultures and values, the circulation of ***knowledge,*** ideas and beliefs and combinations of principles and practices of reciprocity, commonality and equality**,** *** paying particular attention to migration, integration and demographic change***. It will analyse how vulnerable populations *(**e.g. Roma**)* can participate fully in ***education,*** society and democracy, notably through the acquisition of various skills and the protection of human rights. The analysis of how political systems respond or not to such social evolutions and themselves evolve will thus be central. Research will also address the evolution of key systems that provide underlying forms of ***human and*** social bonds, such as family, work, education and employment and help ***to*** combat ***social inequalities and exclusion and poverty***. ***Social cohesion and fair and reliable justice, education, democracy, tolerance and diversity are factors that need to be carefully considered with a view to identifying and better exploiting European comparative advantages at world level and of providing improved evidence-based support to policies. Research*** will take into account the importance of ***mobility and*** migration**,** *** including intra-European flows,*** and demography in the future development of European policies.

Besides, understanding the strains and opportunities arising from the uptake of ICT, both at individual and collective levels, is important in order to open new paths of inclusive innovation. Given the increasing socio-economic importance of digital inclusion, research and innovation actions will promote inclusive ICT solutions and the effective acquisition of digital skills leading to the empowerment of citizens and a competitive workforce. Emphasis will be given to new technological advances that will enable a radical improvement in personalisation, user-friendliness and accessibility through a better understanding of citizen, consumer and user behaviours and values, including persons with disabilities. This will require an "inclusion by design" research and innovation approach.

6.1.3.   Europe's role as a global actor*, notably regarding human rights and global justice.*

Europe's distinct historical, political, social and cultural system is increasingly confronted with the impact of global changes. In order to further develop its external action in its neighbourhood and beyond and its role as a global actor, Europe has to improve its capacities for defining, prioritising, explaining, assessing and promoting its policy objectives *in interaction* with other world regions and societies to further cooperation or prevent or solve conflicts. In this regard, it also has to improve its capacities for anticipating and responding to the evolution and impacts of globalisation. This requires a greater understanding of *and learning from* the history, cultures and political-economic systems of other world regions, as well as of the role and influence of transnational actors. Finally, Europe also has to contribute effectively to global governance *and global justice,* in key domains like trade, development, work, economic cooperation, *environment, education, gender equality and* human rights, defence and security. This implies the potential to build new capacities whether in terms of tools, *services,* systems and instruments of analysis or in terms of diplomacy in formal and informal international arena with governmental and non governmental actors.

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6.1.4. *The promotion of sustainable and inclusive environments through innovative spatial and urban planning and design*

80% of the EU's citizens live today in and around cities and inadequate urban planning and design can thus have tremendous consequences on their lives. Understanding how they function for all citizens, their design, liveability and their attractiveness to, inter alia, investment and skills is critical to Europe's success in creating growth, jobs and a sustainable future.

European research and innovation should provide tools and methods for a more sustainable, open, innovative and inclusive urban and peri-urban planning and design; a better understanding of the dynamics of urban societies and social changes and of the nexus of energy, environment, transport and land-use including the interplay with surrounding rural areas; an improved understanding of design and use of public space within cities also in the context of migration to improve social inclusion and development and reduce urban risks and crime; new ways to reduce pressures on natural resources and stimulate sustainable economic growth while improving the quality of life of European urban citizens; a forward-looking vision on the socio-ecological transition towards a new model of urban development reinforcing EU cities as hubs of innovation and centres of job creation and social cohesion.

6.2.	Innovative societies

The 	Union share of global knowledge production *remains considerable, yet its socio-economic* impacts *need to be maximized. Efforts will be made to increase* the efficiency of research and innovation policies and *their* transnational policy synergies and coherence. Innovation will be addressed in a wide sense, including large scale policy*, social-,* user- and market-driven innovation. *The experience and innovative power of Creative and Cultural Industries will be taken into account.* These activities will support the achievement and functioning of the European Research Area and in particular the Flagship initiatives of the Europe 2020 strategy in favour of the 'Innovation Union' and the 'Digital Agenda for Europe'.

The following specific objectives will be pursued:

6.2.1.	*Strengthen* the evidence base and support for the Innovation Union and European Research Area

In order to assess and prioritise investments and strengthen the Innovation Union and the European Research Area, the analysis of research*, education* and innovation policies, systems and actors in Europe and third countries as well as the development of indicators, data and information infrastructures will be supported. Forward-looking activities and pilot initiatives, economic *and* gender analysis, policy monitoring, mutual learning, coordination tools and activities and the development of methodologies for impact assessment and evaluations will also be needed, exploiting direct feedback from 	stakeholders, enterprises, public authorities*, civil society organisations and* citizens. *This analysis should be conducted in coherence with studies on higher education systems in Europe and third countries within "Erasmus for all".*

To ensure a single market for research and innovation, measures to incentivise ERA compatible behaviour will be implemented. Activities underpinning policies related to the quality of research training, mobility and career development of researchers will be supported, including initiatives to provide for mobility services, open recruitment, **women's participation in the sciences,** researchers' rights and links with global researcher communities. These activities will be implemented seeking synergies and close coordination with the Marie **Skłodowska-**Curie Actions under 'Excellent science'. Institutions presenting innovative concepts for the rapid implementation of ERA principles, including the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, **the Commission Recommendation on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions[1],** will be supported.

As **regards** coordination of policies, a facility for policy advice will be set up to make expert policy advice available to national authorities when defining their National Reform Programmes and research and innovation strategies.

To implement the Innovation Union initiative, there is also a need to support market-driven innovation, open innovation**, public sector and social innovation** in view of enhancing the innovation capacity of firms and fostering European competitiveness. This will require improving the overall framework conditions for innovation as well as tackling the specific barriers preventing the growth of innovative firms. Powerful innovation support mechanisms (for e.g. improved cluster management, public-private partnerships and network cooperation), highly specialised innovation support services (on e.g. **IP management/exploitation, networking of IPR owners and users**, innovation management**, entrepreneurship skills**, networks of procurers) and reviews of public policies in relation to innovation will be supported. Issues specific to SMEs will be supported under the specific objective 'Innovation in SMEs'.

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[1]   **COM(2008) 1329 final, 10.4.2008**

6.2.2.   *Explore* new forms of innovation, ***with special emphasis on*** social innovation and creativity ***and understand how all forms of innovation are developed, succeed or fail***

Social innovation generates new goods, services, processes and models that meet societal needs and create new social relationships. ***As means of innovation are constantly changing, further research is needed into the development of all forms of innovation and the way innovation meets the needs of society.*** It is important to understand how social innovation and creativity may lead to change in existing structures***, practices*** and policies and how they can be encouraged and scaled-up. ***It is important to assess the impact of*** on-line   platforms networking citizens   . Support will also be given to ***the use of design in companies,*** networking and experimentation of the use of ICT for improving learning processes, as well as to networks of social innovators and social entrepreneurs. ***Research will also focus on the processes of innovation and how they develop, succeed or fail (including risk taking and the role of different regulatory environments)***.

It will be essential to promote innovation in order to foster efficient, open and citizen-centric public services (***e.g.*** eGovernment). This will require multidisciplinary research on new technologies and large-scale innovation related in particular to digital privacy, interoperability, personalised electronic identification, open data, dynamic user interfaces ***lifelong learning and e-learning platforms, distributed learning systems***, citizen-centric public service configuration and integration and innovation driven by users, including in social sciences and the humanities. Such actions will also address social-network dynamics and crowd-sourcing and smart-sourcing for co-production of solutions addressing social problems, based***, for example,*** on open data sets. They will help to manage complex decision-making, in particular the handling and analysis of huge quantities of data for collaborative policy modelling, simulation of decision-making, visualisation techniques, process modelling and participatory systems as well as to analyse changing relationships between citizens and the public sector.

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Specific measures shall be developed to involve the public sector as an agent for innovation and change, at national and EU level, in particular through policy support and cross-border innovation measures at the widest geographical level enabling the smart use of ICT in and by public administrations for seamless delivery of public services for citizens and businesses.

6.2.3. *Make use of the innovative, creative and productive potential of all generations*

Activities will contribute to exploring Europe's opportunities to innovate in terms of new products and technologies, improved services and new business and social models adapted to the changing demographic structure of the society. Activities will enhance taking advantage of the potential of all generations by fostering the development of smart policies to make active ageing a reality in an evolving intergenerational context and by supporting the integration of the generations of young Europeans in all domains of social, political, cultural and economic life, taking into account, amongst others, perception of opportunities for innovation in the context of high unemployment in many EU regions.

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6.2.4. *Promote* coherent and effective cooperation with third countries

Horizontal activities will ensure the strategic development of international cooperation across Horizon 2020 and address cross-cutting policy objectives. Activities to support bilateral, multilateral and bi-regional policy dialogues in research and innovation with third countries, regions, international fora and organisations will facilitate policy exchange, mutual learning and priority setting, promote reciprocal access to programmes and monitor the impact of cooperation. Networking and twinning activities will facilitate optimal partnering between research and innovation actors on both sides and improve competencies and cooperation capacity in less advanced third countries. Activities will promote coordination of Union and national cooperation policies and programmes, as well as joint actions of Member States and Associated Countries with third countries in order to enhance their overall impact. Finally, the European research and innovation 'presence' in third countries will be consolidated and strengthened, notably by *exploring* the creation of European *virtual* 'science and innovation houses' , services to European organisations extending their activities into third countries and the opening of research centres established jointly with third countries to organisations or researchers from other Member States and Associated Countries.

6.3. *Reflective societies - Cultural heritage and European identity*

The aim is to contribute to an understanding of Europe's intellectual basis: its history and the many European and non-European influences; as an inspiration for our lives today. Europe is characterized by a variety of different peoples (including minorities and indigenous people), traditions and regional and national identities as well as by different levels of economic and societal development. Migration and mobility, the media, industry and transport contribute to the diversity of views and lifestyles. This diversity and its opportunities should be recognized and considered.

United in diversity

European collections in libraries, including digital ones, archives, museums, galleries and other public institutions have a wealth of rich, untapped documentation and objects for study. These archival resources, together with intangible heritage, represent the history of individual Member States but also the collective heritage of a European Union that has emerged through time. Such materials should be made accessible, also through new technologies, to researchers and citizens to enable a look to the future through the archive of the past. Accessibility and preservation of cultural heritage in these forms is needed for the vitality of the living engagements within and across European cultures now and contributes to sustainable economic growth.

The focus of activities shall be to:

6.3.1.   Study European heritage, memory, identity, integration and cultural interaction and translation , including its representations in cultural and scientific collections, archives and museums, to better inform and understand the present by richer interpretations of the past

The activities will contribute to a critical analysis of how a European tangible and non-tangible heritage has developed over time, including language, memories, practices, institutions and identities. They will include studies of the interpretations and practices of cultural interactions, integration and exclusion.

An intensified European integration process has underlined that a wider European identity sphere exists – one which complements other types of identities in Europe. A broad spectrum of evidence and testimonies of European identity spheres can be found in European and non-European scientific collections, archives, museums, libraries and cultural heritage sites. They offer materials and documents which enable greater understanding of identity building processes that allow reflections about social, cultural or even economic processes that contribute to past, actual and future forms of European identity. The objective is to develop innovations and to use and analyse objects and/or documentation in cultural and scientific collections, archives and museums to improve our understanding of how European identity can be traced, constructed or debated.

The issues of multilingualism, translation and circulation of ideas across Europe and from and to Europe and how they form part of a common European intellectual heritage will be explored.

6.3.2.   Research into European countries' and regions' history, literature, art, philosophy and religions and how these have informed contemporary European diversity

Cultural diversity is an important facet constituting Europe's singularity and providing a source of strength dynamism and creativity. The activities will address the contemporary European diversity and how this diversity is shaped by history while they will also help to analyse how such diversity is conducive to new intercultural developments, or even tensions and conflicts. The role of arts, media, landscapes, literature, languages, philosophy and religions, in relation to this diversity, will be central as they offer various interpretations of the social, political and cultural realities and influence the visions and practices of individuals and social actors.

6.3.3.   Research on Europe's role in the world, on the mutual influence and ties between the world regions, and a view from outside on European cultures

The activities will address the complexity of the socio-economic and cultural links between Europe and other world regions and assess the potential for improved intercultural exchanges and dialogues taking into account broader social, political and economic developments. They will help to analyse the development of various views in Europe on other world regions and vice-versa.

6.4.   Specific implementation aspects

In order to promote an optimal combination of approaches, cooperation between this Societal Challenge and the pillar Industrial Leadership shall be established in the form of cross-cutting actions targeting the field of interaction between humans and technology. Technological innovation based on ICT will play an important role in enhancing the productivity and engaging the creativity of citizens from all generations in an innovative society.

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Implementation under this Challenge will also enjoy the support of administration and coordination of international networks for excellent researchers and innovators such as COST and EURAXESS, and therefore also contribute to the European Research Area.

Consideration may be given to support relevant Joint Programming Initiatives (JPIs) and relevant public-public and public-private partnerships.

Appropriate links with the actions of relevant European Innovation Partnerships and the relevant aspects of the research and innovation agendas of European Technology Platforms will also be established.

Research and innovation actions under this challenge will contribute to implementing the Union's international research and innovation cooperation activities, by engaging more strategically in science, technology and innovation cooperation with its main third country partners. In this regard, the Strategic Forum for Scientific and Technological Cooperation (SFIC) will continue to give strategic advice to the Council and the Commission on the international dimension of the European Research Area.

7. SECURE SOCIETIES *- PROTECTING FREEDOM AND SECURITY OF EUROPE AND ITS CITIZENS*

The European Union, its citizens and its international partners are confronted with a range of security threats *and challenges* like crime, terrorism and mass emergencies due to man-made or natural disasters. These can span across borders and aim at physical targets or the cyberspace. Attacks against *critical infrastructures, networks and* Internet sites of public authorities and private entities for instance not only undermine the citizen's trust but may seriously affect such essential sectors as energy, transport, health, finance or telecommunications.

In order to anticipate, prevent and manage these threats, it is necessary to develop and apply innovative technologies, solutions, foresight tools and knowledge, stimulate cooperation between providers and users, find civil security solutions, improve the competitiveness of European security, *industry* and services*, including ICT* and prevent and combat the abuse of privacy and breaches of human rights in Internet*, and elsewhere, while ensuring European citizens individual rights and freedom.*

The coordination and improvement of the security research *and innovation* area will thus be an essential element and will help to map present research efforts, including foresight, and improve relevant legal conditions and procedures for coordination, including pre-normative activities.

Activities *within this challenge shall have an exclusive focus on civil applications and* will follow a mission-oriented approach*, promote efficient cooperation of end-users, industry and researchers,* and integrate the relevant societal dimensions *whilst complying with ethical principles*. They will support the Union's policies for internal and external security, *including the Common Foreign and Security Policy and its Common Security and Defence Policy, and improve* cyber security, trust and privacy in the Digital single Market. *The activities will include a focus on the research and development of the next generation of innovative solutions, by working on novel concepts and designs, and interoperable standards. This will be done by developing innovative technologies and solutions that address security gaps and lead to a reduction in the risk from security threats.*

The following specific objectives will be pursued:

7.1. ***Fight*** crime*, **illegal trafficking** and terrorism**, including understanding and tackling terrorist ideas and beliefs**

The ambition is both to avoid an incident and to mitigate its potential consequences. ***This requires new technologies and capabilities for fighting and preventing crime (including cyber crime), illegal trafficking and terrorism (including cyber terrorism), including understanding causes and impacts of radicalisation and violent extremism**, and tackling terrorist ideas and beliefs to also avoid aviation related threats.*

7.2. ***Protect and improve the resilience of critical infrastructures, supply chains and transport modes***

New technologies*, **processes, methods** and dedicated capabilities will help to protect critical infrastructures *(including in urban areas)*, systems and services **which are essential for the good functioning of society and economy** (including communications, transport, **finance,** health, food, water, energy, logistic and supply chain, and environment). This will include analysing and securing public and private critical networked infrastructures and services against any type of threats**, including aviation related threats. This will also include protection of maritime transport routes**.

7.3. ***Strengthen*** security through border management

Technologies and capabilities are also required to enhance systems, equipments, tools, processes, and methods for rapid identification to improve ***land, marine and coastal*** border security ***and management***, including both control and surveillance issues, while exploiting the full potential of EUROSUR. These will be developed and tested considering their effectiveness, compliance with legal and ethical principles, proportionality, social acceptability and the respect of fundamental rights. Research will also support the improvement of the integrated European border management, including through increased cooperation with candidate, potential candidate and European Neighbourhood Policy countries.

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7.4. **Improve** cyber security

Cyber security is a prerequisite for people, business and public services in order to benefit from the opportunities offered by the Internet *or any other additional data networks and communication infrastructures*. It requires providing *an improved* security for systems, networks, access devices, and software and services, including cloud computing, while taking into account the interoperability of multiple technologies. Research *and innovation will be supported to help* prevent, detect and manage in real-time cyber-attacks across multiple domains and jurisdictions, and to protect critical ICT infrastructures. The digital society is in full development with constantly changing uses and abuses of the Internet, new ways of social interaction, new mobile and location-based services and the emergence of the Internet of Things. This requires a new type of research which should be triggered by the emerging applications, usage and societal trends. Nimble research initiatives will be undertaken including pro-active R&D to react quickly to new contemporary developments in trust and security. *Particular attention should be given to the protection of children, as they are highly vulnerable to the emerging forms of cyber crime and abuse.*

Work here should be conducted in close co-ordination with the ICT strand of the "Industrial Leadership" pillar.

7.5. **Increase** Europe's resilience to crises and disasters

This requires the development of dedicated technologies and capabilities to support different types of emergency management operations *in crises and disaster situations* (such as civil protection, fire fighting*, environmental contamination,* marine pollution,   civil defence, development of medical information infrastructures rescue tasks, *disaster recovery processes* as well as law enforcement. Research will cover the whole crisis management chain and societal resilience, and support the establishment of a European emergency response capacity.

7.6. ***Ensure*** privacy and freedom***, including*** in the Internet and enhancing the societal ***legal and ethical understanding of all areas*** of security***, risk and management***

Safeguarding the human right of privacy ***including*** in the digital society will require the development of privacy-by-design frameworks and technologies ***to underpin new*** products and services. Technologies will be developed allowing users to control their personal data and its use by third parties; as well as tools to detect and block illegal content and data breaches and to protect human rights on-line preventing that people's behaviours individually or in groups is limited by unlawful searching and profiling.

Any new security solution and technology needs to be acceptable to the society, comply with Union and international law, be effective and proportionate in identifying and addressing the security threat. Better understanding the socioeconomic, cultural, and anthropological dimensions of security, the causes of insecurity, the role of media and communication and the citizen's perceptions, are therefore essential. Ethical ***and legal*** issues and protection of human values and fundamental rights will be addressed***, as well as risk and management issues***.

7.7. *Enhance standardisation and interoperability of systems, including for emergency purposes*

Pre-normative and standardisation activities will be supported across all mission areas. Attention will be paid to standardization gaps and on the next generation of tools and technologies. Activities across all mission areas will also address the integration and interoperability of systems and services including aspects such as communication, distributed architectures and human factors, including for emergency purposes.

7.7a. *Support the Union's external security policies including through conflict prevention and peace-building*

New technologies, capabilities and solutions are required to support the Union's external security policies in civilian tasks, ranging from civil protection to humanitarian relief, border management or peace-keeping and post-crisis stabilisation, including conflict prevention, peace-building and mediation. This will require research on conflict resolution and restoration of peace and justice, early identification of factors leading to conflict and on the impact of restorative justice processes.

This also requires promoting interoperability between civilian and military capabilities in civilian tasks ranging from civil protection to humanitarian relief, border management or peace-keeping. This will include technological development in the sensitive area of dual-use technologies to enhance interoperability between civil protection and military forces and amongst civil protection forces worldwide, as well as reliability, organisational, legal and ethical aspects, trade issues, protection of confidentiality and integrity of information and traceability of all transactions and processing. **[text moved from previous section 7.5]**

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7.8.   Specific implementation aspects

Whereas research ***and innovation activities*** will have ***an exclusive focus on*** civil ***applications***, coordination with the activities of the European Defence Agency (EDA) will be actively pursued in order to strengthen cooperation with EDA, notably through the already established European Framework Cooperation, recognising that there are areas of dual use technology . Coordination mechanisms with relevant Union Agencies, such as FRONTEX, EMSA*, **ENISA*** and Europol, will also be further strengthened in order to improve the coordination of Union Programmes and policies in the field of both internal and external security, and of other Union initiatives.

Taking into account the particular nature of security, specific arrangements will be put in place with regards to programming and governance, including arrangements with the Committee refered to in Article 9 of this Decision. Classified or otherwise sensitive information related to security will be protected and particular requirements and criteria for international cooperation may be specified in work programmes. This will also be reflected in the programming and governance arrangements for Secure Societies (including the comitology aspects).

PART IIIa

SPREADING EXCELLENCE AND WIDENING PARTICIPATION

[this whole section has been aligned with Framework Regulation]

There are significant disparities across Europe in research and innovation performance which need to be addressed with specific measures. These measures will aim at unlocking excellence and innovation and will be distinct, and where appropriate complementary and synergistic with policies and actions of the European Structural and Investment funds. They include:

– *Teaming of excellent research institutions and low performing RDI regions: Teaming aims at the creation of new (or significant upgrade of existing) centres of excellence in low performing RDI Member States and regions. It will focus on the preparatory phase for setting up or upgrading and modernising such an institution facilitated by a teaming process with a leading counterpart in Europe, including supporting the development of a business plan. A commitment of the recipient region or Member State (e.g. support via European Structural and Investment funds) is expected. Subject to the quality of the business plan, the Commission may provide further seed financial support for the first steps of implementation of the centre. Building links with innovative clusters and recognising excellence in low performing RDI Member States and regions, including through peer reviews and awarding labels of excellence to those institutions that meet international standards, will be considered.*

– *Twinning of research institutions: Twinning aims at significantly strenghtening a defined field of research in an emerging institution through links with at least two internationally-leading institutions in a defined field. A comprehensive set of measures underpinning this linkage would be supported (e.g. staff exchanges, expert visits, short-term on-site or virtual trainings, workshops; conference attendance; organisation of joint summer school type activities; dissemination and outreach activities).*

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–   *'ERA Chairs': Establishing 'ERA Chairs' to attract outstanding academics to institutions with a clear potential for research excellence, in order to help these institutions fully unlock this potential and hereby create a level playing field for research and innovation in the European Research Area. This will include institutional support for creating a competitive research environment and the framework conditions necessary for attracting, retaining and developing top research talent within these institutions. Possible synergies with ERC activities should be explored.*

–   *Policy Support Facility (PSF) : This will aim to improve the design, implementation and evaluation of national/regional research and innovation policies. It will offer expert advice to public authorities at national or regional level on a voluntary basis, covering the needs to access the relevant body of knowledge, to benefit from the insight of international experts, to use state of the art methodologies and tools, to receive tailor-made advice.*

–   *Supporting access to international networks for excellent researchers and innovators who lack sufficient involvement in European and international networks. This will include support provided through COST.*

–   *Strengthening the administrative and operational capacity of transnational networks of National Contact Points, including through training, financial and technical support, while improving the framework for the operation of NCPs and the flow of information between them and the Horizon 2020 implementation bodies, so that NCPs can provide better support to potential participants.*

PART IIIb

SCIENCE WITH AND FOR SOCIETY

[this whole section has been aligned with Framework Regulation]

The aim is to build effective cooperation between science and society, to recruit new talent for science and to pair scientific excellence with social awareness and responsibility.

The strength of the European science and technology system depends on its capacity to harness talent and ideas from wherever they exist. This can only be achieved if a fruitful and rich dialogue and active cooperation between science and society is developed to ensure a more responsible science and to enable the development of policies more relevant to citizens. Rapid advances in contemporary scientific research and innovation have led to a rise of important ethical, legal and social issues that affect the relationship between science and society.

Improving the cooperation between science and society to enable a widening of the social and political support to science and to technology in all Member States is increasingly a crucial issue that the current economic crisis has greatly exacerbated. Public investment in science requires a vast social and political constituency sharing the values of science, educated and engaged in its processes and able to recognise its contributions to knowledge, to society and to economic progress.

The focus of activities shall be to:

(a)   Making scientific and technological careers attractive to young students, and foster sustainable interaction between schools, research institutions, industry and civil society organisations;

(b)   Promoting gender equality in particular by supporting structural changes in the organisation of research institutions and in the content and design of research activities;

(c)   Integrating society in science and innovation issues, policies and activities in order to integrate citizens' interests and values and to increase the quality, relevance,

social acceptability and sustainability of research and innovation outcomes in various fields of activity from social innovation to areas such as biotechnology and nanotechnology;

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(d)   *Developing the accessibility and the use of the results of publicly-funded research;*

(e)   *Developing the governance for the advancement of responsible research and innovation by all stakeholders (researchers, public authorities, industry and civil society organisations), which is sensitive to society needs and demands; promote an ethics framework for research and innovation;*

(f)   *Taking due and proportional precautions in research and innovation activities by anticipating and assessing potential environmental, health and safety impacts;*

(g)   *Improving knowledge on science communication in order to improve the quality and effectiveness of interactions between scientists, general media and the public.*

PART IV

NON-NUCLEAR DIRECT ACTIONS OF THE JOINT RESEARCH CENTRE (JRC)

The Joint Research Centre shall contribute to the general objective and priorities of Horizon 2020 by providing scientific and technical support to Union policies, in collaboration with relevant national and regional research stakeholders, where appropriate. The JRC activities will be conducted taking into account relevant initiatives at the level of regions, Member States or the EU, within the perspective of shaping the European Research Area.

1.   EXCELLENT SCIENCE

The JRC will carry out research to enhance the scientific evidence base for policy making and to examine emerging fields of science and technology, including through an exploratory research programme.

2.   INDUSTRIAL LEADERSHIP

The JRC will contribute to innovation and competitiveness through:

(a)   Continuing to contribute to the strategic orientation and science agenda of relevant instruments of indirect research, such as European Innovation Partnerships as well as public-private partnerships and public-public partnerships.

(b)   Support to knowledge and technology transfer through definition of appropriate Intellectual Property Rights frameworks for different research and innovation instruments, and promotion of cooperation in knowledge and technology transfer among large public research organisations.

(c)   Contributions to facilitating the use, standardisation and validation of space technologies and data, in particular to tackle the societal challenges.

3. SOCIETAL CHALLENGES

3.1. Health, demographic change and wellbeing

The JRC will contribute to harmonisation of methods, standards, and practices in support of Union legislation targeting health and consumer protection through:

(a) Assessment of risks and opportunities of new technologies and chemicals, including nanomaterials, in food, feed and consumer products; development and validation of harmonised measurement, identification and quantification methods, integrated testing strategies and state-of-the-art tools for toxicological hazard assessment, including alternative methods to animal testing; assessment of health effects of environmental pollution.

(b) Development and quality assurance of health testing and screening practices including genetic testing and cancer screening.

3.2. Food security, sustainable agriculture *and forestry*, marine and maritime *and inland water* research and the bioeconomy

The JRC will support the development, implementation and monitoring of European agriculture and fisheries policies, including food security and development of the bio-economy through:

(a) Establishment of a global system and tools for crop forecasting and monitoring of crop productivity; support to improve short- to mid-term outlooks of agricultural commodities, including the predicted effects of climate change

(b) Contribution to biotechnological innovation and improved resource efficiency to produce 'more with less' through techno-economic analyses and modelling.

(c) Scenario modelling for decision-making in agricultural policies and analyses of policy impact at macro/regional/micro levels; analysis of the impact of the "CAP towards 2020" on developing/emerging economies.

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(d)   Further development of methods for fisheries control and enforcement and traceability of fish and fish products; development of robust ecosystem health indicators and bio-economic modelling to better understand the direct effects (e.g. fishing) and indirect effects (climate change) of human activities on the fish stock dynamics, the marine environment, and their socio-economic impact.

3.3.   Secure, clean and efficient energy

The JRC will focus on the 20/20/20 climate and energy targets and the Union's transition to a competitive low-carbon economy by 2050 with research on technological and socio-economic aspects of:

(a)   Security of energy supply, in particular as regards links and interdependencies with the extra-European energy supply and transmission systems; mapping indigenous primary and external energy sources and infrastructures on which Europe depends.

(b)   Energy/electricity transmission networks, in particular modelling and simulation of trans-European energy networks, analysis of smart/super grid technologies, and real-time simulation of power systems.

(c)   Energy efficiency, in particular methodologies for monitoring and assessing the achievements of energy efficiency policy instruments, techno-economic analysis of the use of energy-efficient technologies and instruments and of smart grids.

(d)   Low-carbon technologies (including safety of nuclear energy in the Euratom programme), in particular performance assessment and pre-normative research of prospective low-carbon technologies; analysis and modelling of drivers and barriers of their development and deployment; assessment of renewable resources and bottlenecks, such as critical raw materials, in the supply chain of low-carbon technologies; continuous development of the Strategic Energy Technology Plan Information System (SETIS) and related activities.

3.4.   Smart, green and integrated transport

The JRC will support the 2050 goals of a competitive, smart, resource efficient and integrated transport system for safe and secure transport of people and goods through laboratory studies, modelling and monitoring approaches on:

(a)   Strategic low-carbon transport technologies for all transport modes, including road transport electrification and alternative fuelled aircrafts/vessels/vehicles, and further development of a Commission internal clearing house for collecting and disseminating information on relevant technologies; availability and costs of non-fossil based fuels and energy sources, including impacts of electrified road transport on electricity grids and electricity generation.

(b)   Clean and efficient vehicles, in particular definition of harmonised test procedures and assessment of innovative technologies in terms of emissions, conventional and alternative fuel efficiency and safety; developing improved methodologies for emission measurements and environmental pressures calculations; coordinating and harmonizing emissions inventorying and monitoring activities at European level.

(c)   Smart mobility systems to achieve secure, intelligent and integrated mobility, including techno-economic assessment of new transport systems and components, applications for improved traffic management and contribution to the design of an integrated approach to transport demand and management.

(d)   Integrated transport safety, in particular provision of tools and services for collecting, sharing and analysing incidents and accidents information in the aviation, maritime and land transport sectors; enhance accidents prevention through analysis and cross modal safety lessons while contributing to cost savings and efficiency gains.

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3.5.   Climate action, *environment,* resource efficiency and raw materials

The JRC will contribute to the greening of Europe, security of resource supply and a global sustainable management of natural resources through:

(a)   Enabling access to interoperable environmental data and information through the further development of standards and interoperability arrangements, geo-spatial tools and innovative information communication technology infrastructures such as the Infrastructure for Spatial Information in the European Union (INSPIRE), and other Union and global initiatives.

(b)   Measuring and monitoring key environmental variables and assessing the state and change of natural resources by further developing indicators and information systems contributing to environmental infrastructures. Assessing ecosystem services including their valuation and climate change effects.

(c)   Developing an integrated modelling framework for sustainability assessment based on thematic models such as soil, land use, water, air quality, biodiversity, greenhouse gas emissions, forestry, agriculture, energy and transport, also addressing effects of and responses to climate change.

(d)   Supporting Union development policy goals by promoting technology transfer, monitoring of essential resources (such as forests, soils, food supply), and research to limit impacts of climate change and environmental impacts of resource use, and to resolve trade-offs in the competition for land to produce food or energy with land for e.g. biodiversity.

(e)   Integrated assessment related to sustainable production and consumption policies, including security of supply of strategic raw materials, resource efficiency, low carbon and clean production processes and technologies, products and services development, consumption patterns and trade. Further development and integration in policy analyses of Life Cycle Assessment.

(f)   Integrated impact analysis of options for climate change mitigation and/or adaptation based on the development of a quantitative tool set of models at regional and global scale, ranging from the sectoral to the macro-economic level.

3.6.   *Europe in a changing world -* Inclusive, innovative and *reflective* societies

The JRC will contribute to the goals of the Innovation Union   and Global Europe through the following activities:

(a)   Comprehensive analyses of drivers and barriers of research and innovation and development of a modelling platform for the assessment of their micro- and macro-economic impacts.

(b)   Contributions to the monitoring of the implementation of the Innovation Union via scoreboards, development of indicators etc. and operation of a public information and intelligence system to host relevant data and information.

(c)   Operation of a public information and intelligence platform for assisting national and regional authorities with smart specialisation; quantitative economic analysis of the spatial pattern of economic activity, in particular addressing economic, social and territorial disparities and changes in the pattern in response to technological developments.

(d)   Econometrics and macro-economic analysis of the reform of the financial system to contribute to maintain an efficient Union framework for financial crisis management; continuing to provide methodological support for monitoring of Member State budget positions in relation to the Stability and Growth Pact.

(e)   Monitor the functioning of the European Research Area (ERA) and analysing drivers of and barriers to some of its key elements (such as mobility of researchers, opening up of national research programmes) and proposing relevant policy options; continue to play an important role in the ERA through networking, training, opening its facilities and databases to users in Member States and Candidate and Associated Countries.

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(f)   Develop quantitative economic analysis of the Digital Economy; carry out research on the impact of information and communication technologies on the goals of the Digital Society; study the impact of sensitive security issues on the lives of individuals (Digital Living).

3.7.   Secure societies - Protecting freedom and security of Europe and its citizens

The JRC will contribute to the goals of Security and Citizenship through the following activities:

(a)   Focus on identification and assessment of the vulnerability of critical infrastructures (including global navigation systems, financial markets); improvement of tools for fighting fraud against the Union budget and for maritime surveillance; as well as operational performance assessment of technologies for or affecting personal identity (digital identity).

(b)   Enhance the Union's capacity for disaster risk reduction and management of natural and man-made disasters notably through the development of global multi-hazard early warning and risk management information systems, making use of Earth Observation technologies.

(c)   Continue to provide tools for the assessment and management of global security challenges such as terrorism and non-proliferation (chemical, biological, radiological and nuclear (in the Euratom programme)), threats arising from socio-political instability and communicable diseases. New areas to be addressed include vulnerability and resilience to emerging or hybrid threats, e.g. accessibility to raw materials, piracy, resource scarcity/competition and effects of climate change on occurrence of natural disasters.

4.   SPECIFIC IMPLEMENTATION ASPECTS

In line with the priorities of Global Europe, the JRC will strengthen scientific cooperation with key international organisations and third countries (e.g. UN bodies, OECD, United States of America, Japan, Russia, China, Brazil, India) in areas having a strong global dimension such as climate change, food security, or nanotechnologies. ***This cooperation will be coordinated closely with international cooperation activities of the Union and the Member States.***

In order to provide an enhanced service to policy-making, the JRC will further develop its capacity to analyse and provide cross-sectoral policy options and to carry out related impact assessments. This capacity will be supported in particular through strengthening of:

(a)   Modelling in key areas (e.g., energy and transport, agriculture, climate, environment, economics). The focus will be on both sectoral and integrated models (for sustainability assessments), and cover scientific-technical as well as economic aspects.

(b)   Forward-looking studies which will provide analyses of trends and events in science, technology and society and on how these may affect public policies, influence innovation, reinforce competitiveness and sustainable growth. This would enable the JRC to draw attention to issues that may require future policy intervention and to anticipate customers' needs.

The JRC will strengthen its support to the standardisation process and standards as a horizontal component in support of European competitiveness. Activities will include pre-normative research, development of reference materials and measurements, and harmonization of methodologies. Five focal areas have been identified (energy; transport; Digital Agenda; security and safety (including nuclear in the Euratom programme); consumer protection). Moreover, the JRC will continue to promote dissemination of its results and provide support on the management of Intellectual Property Rights to Union institutions and bodies.

The JRC will establish a capacity in behavioural sciences to support the development of more effective regulation, complementing JRC activities in selected fields such as nutrition, energy efficiency and product policies.

Socio-economic research will be part of activities in relevant areas such as Digital Agenda, sustainable production and consumption or public health.

In order to fulfil its mission as reference centre for the Union, to continue to play a vital role in the ERA, and to enter into new fields of research, it is essential that the JRC disposes of state-of-the-art infrastructure. The JRC will continue its renovation and refurbishment programme to ensure compliance with applicable environmental and safety and security regulations, and will invest into scientific infrastructure, including the development of modelling platforms, facilities for new areas such as genetic testing etc. Such investments will be done in close coordination with the roadmap of the European Strategy Forum of Research Infrastructures (ESFRI) and take into account existing facilities in the Member States.

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ANNEX II

Performance indicators

The following table specifies for the specific objectives of Horizon 2020 a number of key indicators for assessing results and impacts *that may be refined during the implementation of Horizon 2020*.

1.   PART I. PRIORITY 'EXCELLENT SCIENCE'

Indicators for the specific objectives**:**

European Research Council

–   Share of publications from ERC funded projects which are among the top 1 % highly cited *per field of science*

Future and Emerging Technologies

–   Publications in peer-reviewed high impact journals

–   Patent applications *and patents awarded* in Future and Emerging Technologies

Marie *Skłodowska-*Curie actions on skills, training and career development

–   Cross-sector and cross-country circulation of researchers, including PhD candidates

European research infrastructures (including eInfrastructures)

–   *Number of researchers who have access to research* infrastructures through Union support

2. PART II. PRIORITY 'INDUSTRIAL LEADERSHIP'

Indicators for the specific **objectives:**

Leadership in enabling and industrial technologies (ICT, Nanotechnologies, Advanced Materials, Biotechnologies, Advanced manufacturing and Space)

– Patent applications *and patents awarded* in the different enabling and industrial technologies

– *Share of participating firms introducing innovations new to the company or the market (covering the period of the project plus three years)*

– *Number of joint public-private publications*

Access to risk finance

– Total investments mobilised via debt financing and Venture Capital investments

– *Number of organisations funded and amount of private funds leveraged*

Innovation in SMEs

– Share of participating SMEs introducing innovations new to the company or the market (covering the period of the project plus three years)

– *Growth and job creation in participating SMEs*

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3. PART III. PRIORITY 'SOCIETAL CHALLENGES'

Indicators for the **specific objectives:**

For all Societal Challenges:

– Publications in peer-reviewed high impact journals in the area of the different Societal Challenges

– Patent applications *and patents awarded* in the area of the different Societal Challenges

– Number of *prototypes and testing* activities

– *Number of joint public-private publications*

Moreover, for each of the challenges, progress shall be assessed against the contribution to the specific objectives which are detailed in Annex I of Regulation (EU) No XX/2012 [Horizon 2020].

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4. PART IV. NON-NUCLEAR DIRECT ACTIONS OF THE JOINT RESEARCH CENTRE

Indicators for the specific objectives:

– Number of occurrences of tangible specific impacts on European policies resulting from technical and scientific support provided by the Joint Research Centre

– Number of peer reviewed publications in high impact journals

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ANNEX III

Monitoring

The Commission will monitor the implementation of Horizon 2020 and in particular the following:

1. **Contribution to the realisation of the European Research Area**

2. **Widening the participation**

3. **SMEs participation**

4. **Social Sciences and Humanities**

5. **Science and Society**

6. **Gender**

7. **International Cooperation**

8. **Sustainable development and climate change, including information on climate change related expenditure**

9. **Bridging from discovery to market application**

10. **Digital Agenda**

11. **Private Sector Participation**

12. **Funding for Public Private and Public Public Partnerships**

13. **Communication and dissemination**

14. **Participation patterns of independent experts**

ANNEX IV

Information to be provided by the Commission in accordance with article 8a(2)

1.   ***Information on individual projects, enabling the monitoring of the entire lifetime of each proposal, covering in particular:***

–   ***submitted proposals,***

–   ***evaluation results for each proposal,***

–   ***grant agreements,***

–   ***completed projects.***

2.   ***Information on the outcome of each call and project implementation, covering in particular:***

–   ***results of each call,***

–   ***outcome of negotiations on grant agreements,***

–   ***project implementation, including payment data and outcome of projects.***

3.   ***Information on programme implementation, including relevant information at the level of the Framework Programme, the specific programme and each theme and the JRC, as well as the synergies with other relevant Union programmes.***

4.   ***Information on the execution of the Horizon 2020 budget, including information on commitments and payments for article 185 and 187 initiatives.***

ANNEX V

Programme Committee configurations

List of configurations[1] of the Horizon 2020 Programme Committee in accordance with article 9.1a:

1. *Strategic configuration: Strategic overview of the implementation of the whole programme, coherence across the different parts of the programme and cross-cutting issues including "Spreading excellence and widening participation" and "Science with and for society".*

Part I - Excellence Science:

2. *European Research Council (ERC), Future and Emerging Technologies (FET) and Marie Skłodowska-Curie Actions (MSCA)*

3. *Research infrastructures*

Part II - Industrial Leadership:

4. *Information and communication technologies (ICT)*

5. *Nanotechnologies, Advanced materials, Biotechnology, Advanced manufacturing and processing*

6. *Space*

7. *SMEs and Access to risk finance*

Part III - Societal Challenges:

8. *Health, demographic change and wellbeing*

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[1] With a view to facilitating the implementation of the programme, for each meeting of the programme committee as defined in the agenda, the Commission will reimburse, in accordance with its established guidelines, the expenses of one representative per Member State, as well as one expert/adviser per Member State for those agenda items where a Member State requires specific expertise.

9.   *Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy*

10.   *Secure, clean and efficient energy*

11.   *Smart, green and integrated transport*

12.   *Climate action, environment, resource efficiency and raw materials*

13.   *Europe in a changing world – Inclusive, innovative and reflective societies*

14.   *Secure Societies – Protecting Freedom and security of Europe and its citizens*

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