



EUROPEAN COMMISSION

Brussels, 30.11.2011
COM(2011) 811 final

2011/0402 (CNS)

Proposal for a

COUNCIL DECISION

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

(Text with EEA relevance)

{SEC(2011) 1427-Volume 1}

{SEC(2011) 1428-Volume 1}

EXPLANATORY MEMORANDUM

1. CONTEXT OF THE PROPOSAL

The set of proposals for "Horizon 2020", drawn up fully in line with the Commission Communication 'A Budget for Europe 2020'¹, wholly supports the Europe 2020 strategy, which identified research and innovation as central to achieving the objectives of smart, sustainable and inclusive growth. The set consists of the proposals for:

- (1) a Framework Programme for Horizon 2020 (Treaty on the Functioning of the European Union – 'TFEU');
- (2) a single set of Rules for Participation and Dissemination (TFEU);
- (3) a single specific programme to implement Horizon 2020 (TFEU); as well as
- (4) a single proposal for the parts of Horizon 2020 corresponding to the Euratom Treaty.

The overall political narrative and background to these legislative proposals is provided by a Commission Communication adopted together with them, which addresses a number of major cross-cutting elements such as simplification and how the approach to innovation has been strengthened.

Horizon 2020 contributes directly to tackling the major societal challenges identified in Europe 2020 and its flagship initiatives. It will contribute equally to creating industrial leadership in Europe. It will also increase excellence in the science base, essential for the sustainability and long term prosperity and wellbeing of Europe. To achieve these aims, the proposals include a full range of support that is integrated across the research and innovation cycle. Horizon 2020 therefore brings together and strengthens activities currently funded under the 7th Framework Programme for research, the innovation parts of the Competitiveness and Innovation Framework Programme, and the European Institute of Innovation and Technology. In this way, the proposals are also designed to realise a substantial simplification for participants.

2. RESULTS OF CONSULTATIONS WITH THE INTERESTED PARTIES AND IMPACT ASSESSMENTS

The preparation of the four proposals took full account of the responses to an extensive public consultation based on a Green Paper, "From challenges to opportunities: towards a common strategic framework for EU research and innovation funding", COM(2011)48. Views were expressed by the European Council, Member States and a wide range of stakeholders from industry, academia and civil society.

The proposals also rely on two in-depth impact assessments, drawing on stakeholder consultations, internal and external evaluations, and contributions from international experts. The assessments found that the Horizon 2020 option would bring more clarity of focus, best achieve the necessary critical mass of effort at programme and project level, and lead to

¹ COM(2011) 500 final

greatest impact on the policy objectives and downstream economic, competitiveness, and social benefits, while at the same time helping to simplify matters by e.g. easing the administrative burden for participants, streamlining the applicable rules and procedures, ensuring consistency between instruments and pointing to a new risk/trust balance.

3. LEGAL ELEMENTS OF THE PROPOSAL

3.1. Legal base

The proposal integrates research and innovation activities in a seamless way in order to achieve the policy objectives.

As such, Horizon 2020 will be based on the TFEU Titles "Industry" and "Research and technological development and space" (Articles 173 and 182). The related Rules for participation and dissemination will be based on the same TFEU Titles (Articles 173, 183 and 188). The "Industry" basis in both cases will relate predominantly to the European Institute of Innovation and Technology (EIT), which will be funded by a financial contribution from Horizon 2020. The EIT will not appear at the specific programme level.

It is recalled that innovation activities have been explicitly included in various Framework Programmes based on the Research Title of the Treaty on the Functioning of the European Union and that the current Framework Programmes also includes a range of innovation activities. As a consequence, the specific programme that will implement Horizon 2020 will be based on the TFEU Title "Research and technological development and space" (Article 182) as the activities foreseen in them will fall under those covered by this Title.

The proposal for the Euratom research and training programme contributing to Horizon 2020 is based on Article 7 of the Euratom Treaty.

3.2. Subsidiarity and proportionality principles

The proposals have been designed to maximise Union added value and impact, focusing on objectives and activities that cannot be efficiently realised by Member States acting alone. Union level intervention can strengthen the overall research and innovation framework and coordinate Member States' research efforts thereby avoiding duplication, retaining critical mass in key areas and ensuring public financing is used in an optimal way. Union level intervention enables continent-wide competition to select the best proposals, thereby raising levels of excellence and providing visibility for leading research and innovation. The Union level is also best placed to support trans-national mobility, thereby improving training and career development for researchers. A Union level programme is more able to take on high risk and long-term R&D, thereby sharing the risk and generating a breadth of scope and economies of scale that could not otherwise be achieved. Union level intervention can leverage additional public and private investments in research and innovation; contribute to the European Research Area whereby knowledge, researchers and technology circulate freely; and accelerate the commercialisation and diffusion of innovations across the Single Market. Union level programmes are also needed to support policy making as well as the objectives set by a range of policies. Full evidence is presented in the accompanying impact assessments.

4. BUDGETARY IMPLICATION

The budget of all proposals is presented in current prices. The legislative financial statement attached to this proposal sets out the budgetary, human and administrative resource implications. The Commission may use, on the basis of a cost-benefit analysis, existing executive agencies for the implementation of Horizon 2020, as provided for in Council Regulation (EC) No 58/2003 laying down the statute for executive agencies to be entrusted with certain tasks in the management of Union programmes.

Proposal for a

COUNCIL DECISION

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

(Text with EEA relevance)

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 Parliament²,

Having regard to the opinion of the European Economic and Social Committee³,

Having regard to the opinion of the Committee of the Regions⁴,

Acting in accordance with a special legislative procedure,

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")⁵ – 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 three Parts on indirect actions and one Part on the direct actions of the Joint Research Centre (JRC).

² OJ C , , p.

³ OJ C , , p.

⁴ OJ C , , p.

⁵ OJ , , p.

- (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.
- (5) There is a critical need to reinforce 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 Curie Actions and European research infrastructures. These activities 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, without pre-determined thematic priorities. 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/EC⁶. 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.
- (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 strategy⁷ requires major investments in research and innovation to develop and deploy novel and breakthrough solutions that have the necessary scale and scope. These challenges

⁶ OJ L 57, 24.2.2007, p. 14.

⁷ COM(2010) 2020

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 with an emphasis on 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. All challenges should contribute to the overarching objective of sustainable development.
- (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, in particular with actions in the policy areas of cohesion, agriculture and rural development, education and vocational training, industry, public health, consumer protection, employment and social policy, energy, transport, environment, climate action, security, marine and fisheries, development cooperation and enlargement and neighbourhood policy.
- (16) In order to ensure that the evaluations of Horizon 2020 properly reflect the state of the art and that 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 elaborate the performance indicators corresponding to the specific objectives of the specific programme and 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 and III, 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 powers⁸.
- (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 Centre⁹, 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)¹⁰, 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)¹¹, 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)¹², 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)¹³, 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)¹⁴, should be repealed,

HAS ADOPTED THIS DECISION:

⁸ OJ L 55, 28.2.2011, p. 13.

⁹ OJ L 107, 30.4.1996, p. 12.

¹⁰ OJ L 400, 30.12.2006, p. 86.

¹¹ OJ L 400, 30.12.2006, p. 243.

¹² OJ L 400, 30.12.2006, p. 272.

¹³ OJ L 400, 30.12.2006, p. 299.

¹⁴ OJ L 400, 30.12.2006, p. 368.

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 Council¹⁵ 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)".

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;

¹⁵

- (c) strengthening skills, training and career development, through the Marie Skłodowska-Curie actions ("Marie 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;
 - (v) advanced manufacturing and processing;
 - (vi) space;
- (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 for the purpose of adapting those specific conditions if economic market conditions so require or according to the results achieved by the Competitiveness and Innovation Programme Loan Guarantee Facility and the Risk Sharing Instrument of the Seventh Framework Programme Risk Sharing Financial Facility.

- 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;

- (b) securing sufficient supplies of safe and high quality food and other bio-based products, by developing productive and resource-efficient primary production systems, fostering related ecosystem services, along side competitive and low carbon supply chains;
- (c) making the transition to a reliable, sustainable and competitive energy system, in the face of increasing resource scarcity, increasing energy needs and climate change;
- (d) achieving a European transport system that is resource-efficient, environmentally-friendly, safe and seamless for the benefit of citizens, the economy and society;
- (e) achieving a resource-efficient and climate change resilient economy and a sustainable supply of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources;
- (f) fostering inclusive, innovative and secure European societies in a context of unprecedented transformations and growing global interdependencies.

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

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, including, where appropriate, publications in high impact journals, the circulation of researchers, the accessibility of research infrastructures, investments mobilised via debt financing and venture capital, SMEs introducing innovations new to the company or the market, references to relevant research activities in policy documents as well as occurrences of specific impacts on policies.

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.

The Commission shall be empowered to adopt delegated acts in accordance with Article 10 for the purpose of adapting those indicators in view of new developments or further elaborating them.

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 Europe's science base in frontier research”. 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 Europe's science base in frontier research” as established by the Scientific Council of the European Research Council under Article 7(2)(b), shall be adopted by the Commission, by means of an implementing act. 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 accordance with the examination procedure referred to in Article 9(2). The Commission shall duly motivate this measure.
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 information on coordination with research and innovation activities carried out by Member States, 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 essential evaluation criteria and the maximum rate of co-financing. They shall allow for bottom-up approaches that address the objectives in innovative ways.

In addition, those work programmes shall contain a section which identifies the cross-cutting actions as referred to in Article 13 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.

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 Europe's science base in frontier research”. 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 recruitment process involving a 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.
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, 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 and perspective may enhance the 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.
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 Europe's science base in frontier research” 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 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 182/2011¹⁶.
2. Where reference is made to this paragraph, Article 5 of Regulation (EU) No 182/2011 shall apply.
3. Where the opinion of the committee referred to in paragraph 2 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 shall be conferred on the Commission for an indeterminate period of time from the entry into force of this Decision.
3. The delegation of power 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.
5. A delegated act 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.

¹⁶ OJ L 55, 28.2.2011, p. 13.

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.

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

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 broad approach to 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.

For the societal challenges and the enabling and industrial technologies in particular, there will be a particular emphasis on supporting 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 and 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 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 group shall show the appropriate level of expertise and knowledge in the covered areas and a variety of professional backgrounds, including industry and civil society involvement.

Priority setting may also take into account the strategic research agendas of European Technology Platforms 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.

1.2. 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 Curie actions or the Research Infrastructures specific objective.

Social sciences and humanities are also mainstreamed as an essential element of the activities needed to tackle each of the societal challenges to enhance their impact. This includes: understanding the determinants of health and optimising the effectiveness of healthcare systems, support to policies empowering rural areas and promoting informed consumer choices, robust decision making on energy policy and in ensuring a consumer friendly European electricity grid, 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.

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

1.3. Small and medium-sized enterprises (SMEs)

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

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 is expected to lead to around 15 % of their total combined budgets going to SMEs.

1.4. 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 beneficiaries making loans to beneficiaries; combinations of loans and guarantees, and guarantees or counter-guarantees for national and regional 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.

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, 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 and SMEs.

1.5. Communication and dissemination

A key added value of research and innovation funded at the Union level is the possibility to disseminate 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 research results), communication and dialogue actions, with a strong emphasis on communicating results to end-users, citizens, 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 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.

2. 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 policies and international commitments. This is the case for all the societal challenges addressed by Horizon 2020, which are global 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.

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 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. For a number of areas, however, a more cautious approach may be advisable to safeguard European interest.

In addition, a range of targeted actions will be implemented taking a strategic approach to international cooperation on the basis of common interest 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.

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 and tuberculosis;
- (b) Support by way of an annual subscription to the *Human Science Frontier Programme* (HSFP) to allow non-G7 Member States of the Union to fully benefit from the funding provided by the HSFP;
- (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;
- (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 such as the International Space Station or launchers, and collaboration in cutting edge space RTD projects.

3. COMPLEMENTARITIES AND CROSS-CUTTING ACTIONS

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 between Part I 'Excellent science' and the societal challenges and the enabling and industrial technologies 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. Particular attention will be given to responsible research and innovation. 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. 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 action 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 the Common Agricultural Policy, the Common Fisheries Policy or the Erasmus For All: the Union's programme for Education, Training, Youth and Sport or the Health for Growth Programme. This includes an appropriate articulation with the Cohesion policy funds, 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.

4. 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 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 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. This may include partnerships on Information and Communication Technologies in the areas of Photonics and Robotics, on

sustainable process industries, on bio-based industries and on security technologies for maritime border surveillance.

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 research topics or target groups (e.g. new generation 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, 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.

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, new generation 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 a 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 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 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.

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 topics or 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.
- (3) Communication and dissemination:
 - assure communication with the scientific community and key stakeholders 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.

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 time¹⁷ 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.

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;

¹⁷ In principle at least 80%

- 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 the programme committee on the implementation of the ERC activities.

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 pillars:

2.1. FET Open: fostering novel ideas

Supporting a large set of embryonic, high risk visionary science and technology collaborative research projects is necessary for the successful exploration of new foundations for radically new future 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. 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.

2.3. FET Flagships: tackling grand interdisciplinary science and technology challenges

Research initiatives within this challenge are science-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 advance should provide a strong and broad basis for future technological innovation and economic exploitation, as well as novel benefits for society. The overarching nature and magnitude implies that they can only be realised through a federated and sustained effort (in the order of 10 years duration).

Activities in the three FET pillars are complemented, by a wide range of *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 will provide stakeholder input on the overall scientific strategy, including the definition of the work programme.

FET will continue to be science-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 flexibility with accountability. The most appropriate approaches will be used for probing the FET research landscape (e.g., for portfolio analysis) and for involving communities of stakeholders (e.g., for 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. 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. It will be complemented with activities to actively stimulate creative out-of-the-box thinking.

FET proactive: this activity regularly opens 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) will be implemented. They will be based on partnerships that enable combining 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 will take into account the unifying goal, the impact, integration of stakeholders and resources under a cohesive research roadmap and support from stakeholders and national/regional research programmes

3. MARIE 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. 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, 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 or industrial doctorates, while single institutions will usually be involved in innovative doctoral programmes. In this frame, support is foreseen for the best early stage researchers from any country to join these excellent programmes.

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, businesses, SMEs or other socio-economic actors of their choice, working on research and innovation projects fitting their personal needs and interests. They will also be encouraged to move from public to private sector or vice-versa through the support of temporary postings. 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.

In order to fully exploit the existing potential of researchers, possibilities to restart a research career after a break 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 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 short term exchanges of research and innovation staff within partnerships of universities, research institutions, 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 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 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 interdisciplinary 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.

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 and careers with a view to identifying gaps in the Marie 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 'Inclusive, innovative and secure societies'. Specific actions will be funded to support initiatives to raise awareness on the importance of the research career, and to disseminate research and innovation results emanating from work supported by Marie Curie actions.

To further increase the impact of the Marie Curie actions, the networking between Marie 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 Curie actions and for the European Research Area.

3.6. Specific implementation aspects

The Marie 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 Curie Actions will be open to researchers and innovation staff, as well as to universities, research institutions, 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 Curie actions. A long-term collaboration between higher education, research organisations and the private sector, taking into account the protection of intellectual property rights, is promoted throughout all the Marie Curie actions.

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 in all Marie Curie actions and by benchmarking gender participation. In addition, the Marie 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 will have to be endorsed and applied by all the funded participants.

To further enhance dissemination and public engagement, beneficiaries of the Marie Curie actions will 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.

4. RESEARCH INFRASTRUCTURES

The activities will aim at developing the European research infrastructures for 2020 and beyond, fostering their innovation potential and human capital 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.

4.1. Developing the European research infrastructures for 2020 and beyond

4.1.1. Developing new world-class research infrastructures¹⁸

The aim is to ensure the 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 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.

The Union funding will contribute to, as appropriate:

- (a) the *preparatory phase* of future infrastructures (e.g. detailed construction plans, legal arrangements, multiannual planning);
- (b) the *implementation phase* (e.g. R&D and engineering work jointly with industry and users, development of regional partner facilities 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 research infrastructures of pan-European interest

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

The Union will support networks 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. Around one hundred networks of infrastructures in all fields of science and technology would require such support, with up to twenty thousands researchers per year benefitting from access to these facilities.

¹⁸ The ESFRI Roadmap includes around fifty infrastructures of key relevance for Europe (with estimated annual operating cost of two billion Euro) covering all scientific disciplines. Other European world-class facilities include infrastructures such as GÉANT or those identified in the CERN European Strategy for Particle Physics. All of them need partnership between Member States and long-term commitment for their implementation.

4.1.3. *Development, deployment and operation of ICT-based e-infrastructures*¹⁹

The aim is to achieve by 2020 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.

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

4.2.1. *Exploiting the innovation potential of research infrastructures*

The goal is to stimulate innovation both in the infrastructures themselves and in their 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 of 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.

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.

¹⁹ 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.

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.

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 and funding bodies (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, 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.

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 objectives under the last two activities will be pursued through their own specific actions and, whenever appropriate, through the actions under the first activity.

Part II

Industrial Leadership

1. LEADERSHIP IN ENABLING AND INDUSTRIAL TECHNOLOGIES

General

The successful mastering 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 unique solutions for societal challenges. 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 systems²⁰. Many innovative products incorporate several of these technologies simultaneously, as single or integrated parts. While each technology offers technological innovation, the accumulated benefit from combining a number of enabling technologies can also lead to technological leaps. Tapping into cross-cutting key enabling technologies will enhance product competitiveness and impact. The numerous interactions of these technologies will therefore be exploited. Dedicated support will be provided for larger-scale pilot line and demonstrator projects.

This will include cross-cutting activities that bring together and integrate various individual technologies, 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 and implementation will therefore notably be through public private partnerships. To this extent and through a dedicated governance 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 building blocks for different application areas, including societal challenges.

Specific implementation aspects

Innovation activities will include the integration of individual technologies; demonstrations of capacities to make and deliver innovative products 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.

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

²⁰ COM(2009)512

private sector involvement in such activities will be a prerequisite, notably through 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; 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.

These activities 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.

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

- the development of global standards;
- removing bottlenecks in industrial exploitation and conditions for trade;
- the safety of nanotechnology-based and biotechnology-based products;
- 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* and cover generic ICT research and innovation agendas, including notably:

1.1.1. A new generation of components and systems: engineering of advanced and smart embedded components and systems

The objective is to maintain and reinforce European leadership in technologies related to smart embedded components and systems. It also includes micro-nano-bio systems, organic electronics, large area integration, underlying technologies for the Internet of Things (IoT)²¹ including platforms to support the delivery of advanced services, smart integrated systems, systems of systems and complex systems engineering.

²¹ Internet of Things will be coordinated as a cross-cutting issue

1.1.2. Next generation computing: advanced computing systems and technologies

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

1.1.3. Future Internet: 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 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 and services, cyber security, privacy and trust, wireless²² 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 and creativity

The objective is to provide professionals and citizens with new tools to create, exploit and preserve all forms of digital content in any language and to model, analyse, and visualise vast amounts of data, including linked data. This includes new technologies for language, learning, interaction, digital preservation, content access and analytics; intelligent 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 systems, advanced interfaces and smart spaces, and sentient machines, building on increases in computing and networking performance and progress in the ability to build systems that can learn, adapt and react.

1.1.6. Micro- and nanoelectronics and photonics

The objective is to take advantage of the excellence of Europe in this key enabling technology and support 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.

These six major activity lines are expected to cover the full range of needs. 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.

Included under each of the six big activity lines are also *ICT-specific research infrastructures* such as *living labs for large-scale experimentation* and *infrastructures for underlying key enabling technologies* and their integration in advanced products and innovative smart

²² Including space based networks

systems, including equipment, tools, support services, clean rooms and access to foundries for prototyping.

1.2. Nanotechnologies

1.2.1. Developing next generation nanomaterials, nanodevices and nanosystems

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

1.2.2. Ensuring the safe 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 and platforms for hazard, exposure and risk assessment and management along the entire life cycle of nanomaterials and nanosystems.

1.2.3. Developing the societal dimension of nanotechnology

Addressing the human and physical infrastructure needs of nanotechnology deployment and focussing on governance of nanotechnology for societal benefit.

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

Focusing on new flexible, scalable and repeatable unit operations, smart integration of new and existing processes, as well as up-scaling to achieve mass production of products and multi-purpose plants that ensures the efficient transfer of knowledge into industrial innovation.

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

Focusing on the underpinning technologies, supporting the development and market introduction of complex nanomaterials and nanosystems, including characterising and manipulating 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 functional materials, multifunctional materials such as self-repairing or biocompatible materials and structural materials, for innovation in all industrial sectors particularly for high value markets.

1.3.2. Materials development and transformation

Research and development to ensure efficient and sustainable scale up to enable industrial manufacturing of future products e.g. in the metal or chemical industries.

1.3.3. Management of materials components

Research and development for new and innovative techniques and systems, joining, adhesion, separation, assembly, self-assembly and disassembling, decomposition and deconstruction.

1.3.4. Materials for a sustainable industry

Developing new products and applications and consumer behaviour that reduce energy demand and facilitate low-carbon production, as well as process intensification, recycling, depollution and high added-value materials from waste and remanufacture.

1.3.5. Materials for creative industries

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

1.3.6. Metrology, characterisation, standardisation and quality control

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

1.3.7. Optimisation of the use of materials

Research and development to investigate alternatives to the use of materials and innovative business model approaches.

1.4. Biotechnology

1.4.1. Boosting cutting-edge biotechnologies as 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 tools such as synthetic biology, bioinformatics, systems biology and exploiting the convergence with other enabling technologies such as nanotechnology (e.g. bionanotechnology) and ICT (e.g. bioelectronics). These and other cutting-edge fields deserve appropriate measures in terms of research and development to facilitate effective transfer and implementation into new applications (drug delivery systems, biosensors, biochips, etc).

1.4.2. Biotechnology-based industrial processes

The objective is twofold: on the one hand, enabling the European industry (e.g. chemical, health, mining, energy, pulp and paper, textile, starch, food processing) to develop new products and processes meeting industrial and societal demands; 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 enzymatic and metabolic pathways, bio-processes design, 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 of the developed products and processes.

1.4.3. Innovative and competitive platform technologies

The objective is to develop platform technologies (e.g. genomics, meta-genomics, proteomics, molecular tools) triggering leadership and competitive advantage on a wide number of economic sectors. 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; 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. This requires addressing the challenge of producing more, while consuming less material, using less energy and creating less waste and pollution. 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.

1.5.2. Technologies enabling Energy-efficient buildings

Reducing energy consumption and CO₂ emissions by the development and deployment of sustainable construction technologies, 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 and low-carbon technologies in energy-intensive process industries

Increasing the competitiveness of process industries, such as chemical, pulp and paper, glass, 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 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 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.

1.6. Space

1.6.1. *Enable European competitiveness, non-dependence and innovation in space activities*

The objective is to maintain a globally leading role in space by safeguarding and developing a competitive space industry and research community and by fostering space-based innovation.

1.6.1.1. Safeguard a competitive space industry and research community

Europe is playing a leading role in space research and in the development of space technologies, and has developed its own space infrastructures (e.g. Galileo). In fact, European industry has established itself as an exporter of first class satellites. Nevertheless, important challenges to this position are the fragmented character of the European markets and research institutions, competition from major space powers benefitting from large domestic markets, and limited systematic investments in space research and technology development and capacity building in Europe. The development of a research-base by providing continuity in space research 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 its non-dependence from imports of critical technologies.

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 energy, telecommunications, natural resource exploration, robotics, security, and health. These commonalities offer opportunities for early co-development, in particular by SMEs, of technologies across space and non-space communities, 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 development of innovative products and services based on remote sensing and geo-positioning. Europe should furthermore reinforce the incipient development of an entrepreneurial space sector by well targeted measures.

1.6.2. *Enabling advances in space technologies*

The objective is to ensure the capability to access space and to operate space systems to the benefit of European society in the next decades.

The ability to access space and to maintain and operate European or international space systems in Earth orbit and beyond, are vital to the future of European society. The necessary capabilities require constant investments in a multitude of space technologies (e.g. launchers, 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, 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 level of investment in future space technologies is insufficient (less than 10 % of total expenditure in space) and needs to be strengthened along the entire chain:

- (a) fundamental technological 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 from collision with debris and effects of solar flares (Space Situational Awareness, SSA), fostering innovative data and sample archiving infrastructure;
- (e) Advanced navigation and remote sensing technologies, covering the research essential for future generations of Union space systems (e.g. Galileo).

1.6.3. Enabling exploitation of space data

The objective is to ensure more extensive utilisation of space data from existing 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 could be achieved if a concerted effort were made to coordinate and organise the processing, validation and standardisation of space data from European missions. Innovations in data acquisition and processing, data fusion, and data dissemination, utilising also innovative ICT enabled forms of collaboration, can ensure a higher return on investment of space infrastructure. 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, but have been hampered by the lack of Union-level bodies or institutes mandated to ensure 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, aiming to sustain a Global Earth Observation System of Systems, in which the Union participates.

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.

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 be in the order of EUR 100 million per annum. Equally global are activities such as the International Space Station (ISS), which is built and operated by Europe, the United States, Canada, Japan and Russia, and robotic space science and exploration activities. The development of cutting edge space technology is increasingly taking place within such international frameworks, 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 internal European partners,

such ESA; with international partners, such as COSPAR, UNOOSA; and with the space agencies of space-faring nations such as NASA and ROSCOSMOS.

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*²³. The implementation will be developed in consultation with stakeholders from European space industry, SMEs, academia, and technology institutes, represented by the Space Advisory Group and important partners such as the European Space Agency and national space agencies. As regards the participation in international undertakings, the research and innovation agenda will be defined in collaboration with international partners (e.g. NASA, ROSCOSMOS, JAXA).

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 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 willing to contribute part of the Structural Funds allocated to them, in accordance with Article 31(1)(a) of the Structural 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; guarantees to financial intermediaries making loans to beneficiaries; combinations of loans and 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 (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 and convertible loans may also be possible.

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 come from:

- (a) Other parts of Horizon 2020, notably Part III 'Societal challenges';
- (b) other frameworks, programmes and budget lines in the Union budget;

²³ COM(2011) 152

- (c) particular regions and Member States that wish to contribute with resources available from the Cohesion Policy funds;
- (d) specific entities (such as Eureka or 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 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 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.

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.

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.

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; 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.

Complementarity will be ensured with the facilities of the Programme for the Competitiveness of Enterprises and SMEs.

3. INNOVATION IN SMEs

3.1. Mainstreaming SME support

SMEs will be supported across Horizon 2020. For this purpose 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 and service innovations. 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 amount to it.

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 distinct 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. 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 will allow for funding under the following phase(s).

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

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, performance verification etc.) and market replication.

– 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 a mentoring scheme for the beneficiary SMEs shall be established to accelerate impact from the support provided.

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 market-oriented innovation of R&D performing SMEs. It targets research intensive SMEs in high-technology 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 needs 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

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.

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. 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.

3.2.3. Supporting market-driven innovation

This will support market-driven innovation in view of enhancing the innovation capacity of firms by improving the framework conditions for innovation as well as tackling the specific barriers preventing the growth of innovative firms, in particular SMEs and enterprises of intermediate size 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.

Part III

Societal Challenges

1. HEALTH, DEMOGRAPHIC CHANGE AND WELLBEING

Effective health promotion, supported by a robust evidence base, prevents disease, improves wellbeing and is cost effective. Health promotion 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, manage, treat and cure disease, disability and reduced functionality are underpinned by the fundamental understanding of their causes, processes and impacts, as well as factors underlying good health and wellbeing. 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.

An increasing disease and disability burden in the context of an aging population places further demands on health and care sectors. If effective health and care is to be maintained for all ages, efforts are required to improve decision making in prevention and treatment provision, to identify and support the dissemination of best practice in the healthcare sector, and to support integrated care and the uptake of technological, organisational and social innovations empowering older persons in particular to remain active and independent. Doing so will contribute to increasing, and lengthening the duration of their physical, social, and mental well-being.

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.

Specific activities are described below.

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. Environmental, behavioural (including life-style), socio-economic 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, and other methods.

In particular, a better understanding of the environment as a determinant of health will require integrated molecular biological, epidemiological and toxicological approaches to investigate health-environment relationships, including studies of modes of action of chemicals, combined exposures to pollution and other environmental and climate related stressors,

integrated toxicological testing as well as 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 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, vaccination and other primary care interventions.

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

The development of screening programmes depends on the identification of early biomarkers of risk and of disease onset, and their deployment depends on the testing and validation of screening methods and programmes. 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.

1.3. Improving surveillance and preparedness

Human populations are under threat from new and emerging infections (including those resulting from climate change), from drug resistance to existing pathogens and from other direct and indirect consequences of climate change. Improved methods for surveillance, early warning networks, health service organisation and preparedness campaigns are needed for the modelling of epidemics, for effective pandemic response, for responses to non infectious disease consequences of climate change, as are efforts to maintain and enhance capabilities to combat drug resistant infectious disease.

1.4. Understanding disease

There is a need for an improved understanding of health and disease, in people of all ages, so that new and better prevention measures, diagnosis and treatments can be developed. Interdisciplinary, 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 "-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.

1.5. Developing better preventive vaccines

There is a need for more effective preventive vaccines (or alternative preventive interventions) and evidence-based vaccination schemes for an expanded range of 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.

1.6. Improving diagnosis

An improved understanding of health, disease and disease processes at all ages is needed to develop new and more effective diagnostics. Innovative and existing technologies will be developed with the goal of significantly improving disease outcomes through earlier, more accurate diagnosis and by allowing for more patient-adapted treatment.

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

Computer simulation 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.

1.8. Treating disease

There is a need to support the improvement of cross-cutting support technologies for drugs, vaccines and other therapeutic approaches, including transplantation, gene and cell therapy; 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 improved medical and assistive devices and systems; to maintain and enhance our ability to combat communicable, rare, major and chronic diseases and undertake medical interventions that depend on the availability of effective 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 and sustainable treatments for disease and for the management of disability.

1.9. Transferring knowledge to clinical practice and scalable innovation actions

Clinical trials are the 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. Similarly, support for the transfer of other types of interventions such as those related to independent living into real world environments will be provided.

1.10. Better use of health data

The integration of infrastructures and information structures and sources (including those derived from cohort studies, protocols, data collections, indicators, etc.) as well as the

standardisation, interoperability, storage, sharing of and access to data, will be supported to enable such data to be properly exploited. Attention should be given to data processing, knowledge management, modelling and visualisation.

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

There is a need to support the development of scientific tools, methods and statistics for rapid, accurate and predictive assessment of the safety, efficacy and quality of health technologies including new drugs, biologics, advanced therapies and medical devices. This is particularly relevant for new developments in domains including those concerning vaccines, cell/tissue and gene therapies, organs and transplantation, specialist manufacturing, bio banks, new medical devices, diagnostic/treatment procedures, genetic testing, interoperability and e-health, including privacy aspects. Similarly, support for improved risk assessment methodologies, 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.

1.12. Active ageing, independent and assisted living

Multidisciplinary advanced and applied research and innovation with 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, etc.) for the ageing population and people with disabilities. 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.

1.13. Individual empowerment for self-management of health

Empowering individuals to improve and manage their health throughout life will result in cost savings to healthcare systems by enabling the management of chronic disease outside institutions and improve health outcomes. This requires research into behavioural and social models, social attitudes and aspirations in relation to personalised health technologies, mobile and/or portable tools, new diagnostics and personalised services which promote a healthy lifestyle, wellbeing, self-care, improved citizen/healthcare professional interaction, personalised programmes for disease and disability management, as well as support for knowledge infrastructures.

1.14. Promoting integrated care

Supporting the management of chronic disease 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, and for providing evidence for large scale deployments and market exploitation of novel solutions, including interoperable tele-health and tele-care services. Research and innovation to improve the organisation of long-term care delivery will also be supported.

1.15. Optimising the efficiency and effectiveness of healthcare systems and reducing inequalities through evidence based decision making and dissemination of best practice, and innovative technologies and approaches.

There is a need to support the development of health technology assessment and health economics, as well as the of gathering 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.

1.16. Specific implementation aspects

Support provided will cover the full spectrum of activities from knowledge and technology transfer to large scale demonstration actions, leading to scalable solutions for Europe and beyond.

2. FOOD SECURITY, SUSTAINABLE AGRICULTURE, MARINE AND MARITIME RESEARCH AND THE BIO-ECONOMY

2.1. Sustainable agriculture and forestry

Appropriate knowledge, tools, services and innovations are necessary to support more productive, 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 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 of agriculture; reducing agricultural greenhouse gases (GHGs) emissions; reducing leaching of nutrients from cultivated lands into terrestrial and aquatic environments; decreasing dependence from international plant derived protein imports to Europe; increasing the level of biodiversity in primary production systems.

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, 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 and forestry 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, nutrients, energy) 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. Genetic improvement of plants and animals for adaptation and productivity traits will call for all appropriated conventional and modern breeding approaches and for a better use of genetic resources. Due attention will be given to on-farm soil management for increasing soil fertility as a basis for crop productivity. Animal and plant health will be promoted and integrated disease/pest control measures will be further developed. Strategies for the eradication of animal diseases including zoonoses will be tackled along with research on antimicrobial resistance. 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.

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 regulation, landscape, erosion reduction and carbon sequestration / GHG mitigation. Research activities will support the provisions of these public goods and services, through the delivery of management solutions, decision-support tools and the assessment of their non-market value. Specific issues to be dealt with include the identification of 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.

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 (food, feed, materials, energy), which meet the increasing demand for low-carbon short-chain delivery systems. Socio-economic research 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 inter-regional and European levels. By providing the necessary analytical tools, indicators, 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 and other inputs) and bio-economy products. Socio-economic and comparative assessment of farming/forestry systems and their sustainability performance will be addressed.

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

Consumer needs for safe, healthy and affordable food have to be addressed, while considering the impacts of food consumption behaviour and food and feed production on human health and the total ecosystem. Food and feed security and safety, the competitiveness of the European agri-food industry and the sustainability of food production and supply 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 the food industry (c) reducing water and energy consumption in food processing, transport and distribution and (d) reducing food waste by 50 % by 2030.

2.2.1. Informed consumer choices

Consumer preferences, attitudes, needs, behaviour, lifestyle and education will be addressed, and communication between consumers and the food chain research community and its operators will be enhanced in order to improve informed choice, sustainable 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 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 and the impact of food on physiological functions, physical and mental performance will be addressed as well as the links between diet, ageing, chronic diseases and disorders and dietary patterns. 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 will be assessed, monitored, controlled and traced throughout the food and drinking water supply chains from production and storage to processing, packaging, distribution, catering, and preparation at home. Food safety innovations, improved risk communication tools and improved food safety standards 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.

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 processes and diversified, safe, affordable and high quality products will be generated. 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 factors, the resilience of the food chain against environmental and climate risks, and 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 sustainably exploit aquatic living resources to maximise social and economic benefits/returns from Europe's oceans and seas. 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 biotechnologies to fuel "blue" growth. In line with current policy frameworks, research activities will underpin the ecosystem approach to the management and exploitation of natural resources, 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 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 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, in particular in the coastal zone, and its socio-economic impact will also be addressed.

2.3.2. Developing competitive European aquaculture

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, and the effects of climate change and how the sector can adapt to them. Innovation will also be promoted for sustainable production systems in inland, on the coastal zone and offshore. 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 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 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

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 CO₂ 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 and appropriate supply chains of biomass and waste streams and a wide network of bio-refineries throughout Europe; and c) supporting market development for bio-based products and processes. 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. Potential trade-offs between the various uses of biomass should be examined. 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.

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 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 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 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. Specific implementation actions

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 will be established with the actions of the European Innovation Partnership 'Agricultural Productivity and Sustainability'.

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, where appropriate via databases.

The specific support to SMEs will allow for an increased participation of farms, fishermen and other types of micro-enterprises 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 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 standard setting will be used to help accelerate market deployment for novel bio-based goods and services.

Consideration may be given to support to the Joint Programming Initiatives (JPIs) including 'Agriculture, Food Security and Climate Change'; 'A Healthy Diet for a Healthy Life'; and 'Healthy and Productive Seas and Oceans' and to implementing possible public-private partnerships in the field of bio-based industries.

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, 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 through smart and sustainable usage

The energy sources and consumption patterns of Europe's industries, transport, buildings, towns and cities are largely unsustainable, leading to significant environmental and climate change impacts. The development of near-zero-emission buildings, highly efficient industries and mass take-up of energy-efficient approaches by companies, individuals, communities and

cities will require not only technological advances, but also non-technological solutions such as new advisory, financing and demand management services. In this way 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.

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 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 not only researching, developing and testing innovative Information and Communication Technologies (ICT) and monitoring and control techniques but also large-scale demonstration projects and pre-commercial deployment activities to ensure interoperability and scalability. Such projects should aim to develop common procedures to collect, collate and analyse energy consumption and emissions data to improve the measurability, transparency, social acceptability, planning and visibility of energy use and its environmental impacts.

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 systems and components for industrial as well as 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 etc, and meet the requirements of near-zero energy buildings and districts. Further breakthroughs are needed, in particular, in thermal storage 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 (energy efficiency, electricity and heating and cooling supply systems), integrated with transport, 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. Research is also needed to understand the social, 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. 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 and sustainability, to accelerate the market deployment of low carbon electricity generation. In particular to:

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, 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.

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 gain share of the electricity market.

For PV, this will need long term research on novel concepts and systems, demonstration and testing of mass production with a view to large-scale deployment.

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 and storage

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 and gas-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 and storage 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 for the large-scale re-use of captured CO₂ to enable the commercial deployment of CCS technologies for fossil fuel power plants and other carbon-intensive industries going into operation after 2020.

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 bring to commercial maturity cost-effective and sustainable technologies, enabling large-scale deployment at an industrial scale including grid integration. Ocean energies such as tidal, current or wave energy offer truly zero-emission, predictable energy. 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 CO₂ 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 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 second generation biofuels of different value chains for transport, and highly efficient combined heat and power from biomass, 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. Longer term research will support the development of a sustainable bio-energy industry beyond 2020. These activities will complement upstream (feedstock, bio-resources) and downstream (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 large scale demonstrations and pre-commercial deployment activities for portable, 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.

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. These new paths may offer potential for more efficient energy conversion, more cost-competitive and sustainable technologies, and almost neutral "greenhouse gases" emitting processes that do not compete for agricultural lands. 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 fully decarbonised electricity system, while providing additional flexibility and cost benefits to the consumers. The overriding goal by 2020 is to transmit and distribute about 35 % of electricity from dispersed and concentrated renewable energy sources.

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

All options to successfully balance energy supply and demand must be considered to minimise emissions and costs. New power systems technologies and a bi-directional digital communication infrastructure must be researched and integrated into the electricity grid. 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 and to accelerate the take up of smart energy services

Novel energy storage means (including both large scale and batteries) 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.

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 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.

3.5. New knowledge and technologies

Novel, more efficient and cost-competitive technologies will be required for the long term. Progress should be accelerated through multi-disciplinary research to achieve scientific breakthroughs in energy related concepts and enabling technologies (e.g. nano-science, material science, solid state physics, ICT, bio-science, computation, space); 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 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 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, the environment and climate change, society and competitiveness of the energy industry; to carry out socio-economic research activities.

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.

3.7. Market uptake of energy innovation, empowering markets and consumers

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.

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.

3.8. Specific implementation aspects

The priority setting for the implementation of the activities in this challenge is led by the need to strengthen the European dimension of energy research and innovation. A main aim will be to support the implementation of the research and innovation agenda of the Strategic Energy Technology Plan (SET Plan)²⁴ to achieve the objectives of the Union's energy and climate change policy. The SET-Plan roadmaps and implementation plans will therefore provide a

²⁴ COM(2007) 723

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.

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 national funding and to stimulate joint research and innovation actions among Member States. 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.

The European Commission's Information System of the SET-Plan 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.

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 CO₂ by 2050. It aims at halving the use of 'conventionally-fuelled' cars in cities and achieving virtually CO₂-free city logistics in major urban centres by 2030. Low-carbon fuels in aviation should reach 40 % by 2050, and CO₂ emissions from maritime bunker fuels should be reduced by 40 % by 2050.

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 CO₂, NO_x, and SO_x), lower its dependence on fossil fuels, and hence reduce transport impact on biodiversity 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, with recyclability integrated in the design phase.

- (a) Developing and accelerating the take-up of cleaner propulsion technologies is important for reducing or eliminating CO₂ and pollution from transport. New and innovative solutions are necessary, based on electric engines and batteries, fuel cells, or hybrid propulsion. Technological breakthroughs will also help improve the environmental performance of traditional 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 and energy supply infrastructure, including vehicle-to-grid interfaces and innovative solutions for the use of alternative fuels.
- (c) Reducing the weight of aircraft, vessels and vehicles 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 the efficient use and management of airports, ports, logistic platforms and surface transport infrastructures, as well as on autonomous and efficient maintenance and inspection systems. Particular attention will be given to the climate resilience of infrastructures, cost-efficient solutions based on a life-cycle approach, and the wider take-up of new materials allowing for more efficient and lower cost maintenance. Attention will also be paid to accessibility 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, logistics and planning solutions need to be developed and tested, which will contribute to reduce air pollution and noise, and improve efficiency. Public and non-motorised transport as well as other resource-efficient transport options 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 demand management.

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 and to move towards the target of zero fatalities in road transport by 2050. By 2030, 30 % of road freight transport over 300 kilometres should shift to rail and waterborne transport. A continuous and efficient pan-European transport of people and goods, also internalising

external costs, requires a new European multimodal transport management, information and payment system.

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 a 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 services. Such innovative solutions will also facilitate accessibility, including for the ageing population and vulnerable users.

4.2.2. Substantial improvements in the mobility of people and freight

This can be achieved through the development and widespread use of intelligent transport applications and management systems. This entails: planning, demand 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 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 solutions for increased automation and autonomy in air traffic management and aircraft 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.
- (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 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 and applying new concepts of freight transport and logistics

This can reduce pressure on the transport system 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 (e.g. road trains). 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 and fatal 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 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 impact of human errors. To better anticipate, assess and mitigate the impact of weather and other natural hazards, 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 terminals.

4.3. Global leadership for the European transport industry

By staying ahead in new technologies and reducing the costs 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 preservation 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 transport means and to prepare the ground for the following one, by working on novel concepts and designs, smart control systems and efficient production processes. Europe aims at becoming the world-leader in efficiency and safety in all modes of transport.

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, (sub)urban rail transport, road vehicles, electromobility, passenger cruise ships, ferries and specialised high technology ships and marine 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 aircraft, vehicles and vessels that incorporate efficient propulsion units, high performance and intelligent 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, with a view to defining common operational standards.

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, 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.

4.3.4. Exploring entirely new transport concepts

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

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

Actions to support policy analysis and development including on socio-economic aspects of transport are necessary to promote innovation and meet the challenges raised by transport. Activities will target the development and implementation of European research and innovation policies for transport, prospective studies and technology foresight, and strengthening of the European Research Area.

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

Research will focus on how to prevent social inequalities in access to mobility, and how to improve the position of vulnerable road 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.

4.5. Specific implementation aspects

In establishing the priorities in the work programme, in addition to the input of the external independent advice and of the various European Technology Platforms, account will be taken of the work carried out in the framework of the Strategic Transport Technology Plan.

5. CLIMATE ACTION, RESOURCE EFFICIENCY AND RAW MATERIALS

5.1. Fighting and adapting to climate change

Current CO₂ 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-CO₂ 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, targeting both CO₂ and non-CO₂ greenhouse gases, 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:

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. It is essential to further improve the scientific knowledge-base of climate drivers, processes, mechanisms and feedbacks associated with the functioning of oceans, terrestrial ecosystems and the atmosphere. Improved climate predictions at pertinent temporal and spatial scales will be supported via the development of more accurate scenarios and models, including fully coupled Earth-system models.

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

There is incomplete knowledge on the ability of society and the economy to adapt to climate change. Effective, equitable and socially acceptable measures towards a climate resilient environment and society require the integrated analysis of current and future impacts, vulnerabilities, population exposure, risks, 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, 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 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 and risks, 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.

5.1.3. Support mitigation policies

The Union's transition to a competitive, resource efficient and climate change resilient economy 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. 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 and knowledge institutions.

5.2. Sustainably managing natural resources 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 2050²⁵. Despite this, ecosystems in Europe and globally are being degraded beyond nature's ability to regenerate them and environmental resources are being over-exploited. 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.

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

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

5.2.1. Further our understanding of 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. It is vital to anticipate these risks by assessing, monitoring and forecasting the impact of human activities on the environment, and environmental changes on human well-being. Research on marine, (from coastal zones to the deep sea), 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 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. 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. 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

²⁵ 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

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. Emphasis will be put on critical policy relevant ecosystems and ecosystem services, such as fresh water, seas and oceans, air quality, biodiversity, land use and soil. The resilience of societies and ecosystems to catastrophic events, including natural hazards, 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 Initiative²⁶.

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, recycling and recovery of raw materials and for their substitution by economically attractive alternatives with a lower environmental impact.

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), 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.

²⁶ COM (2008) 699

5.3.2. *Promote the sustainable supply and use of raw materials, covering exploration, extraction, processing, 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 also exploit the potential of urban mines. New and economically viable recycling and materials recovery technologies, business models and processes 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.

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 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 and geological surveys and industry 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.

5.4. Enabling the transition towards a green economy 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 2015²⁷. Already 45 % of companies have introduced some type of eco-innovation. It has been estimated that around 4 % of eco-innovations led to more

²⁷ 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

than a 40 % reduction of material use per unit of output²⁸, highlighting the great future potential.

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

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

5.4.1. Strengthen eco-innovative technologies, processes, services and products and boost their market uptake.

All forms of 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 and taking account of rebound effects on the environment. This will include business models, industrial symbiosis, product service systems, product design, full life cycle and cradle-to-cradle approaches. The aim will be to improve resource efficiency by reducing, in absolute terms, inputs, waste and the release of harmful substances 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 SMEs, from the development of prototypes to their introduction in the market and replication. Networking among eco-innovators will also seek to enhance the dissemination of knowledge and better link supply with demand.

5.4.2. Support innovative policies and societal changes

Structural and institutional changes are needed to enable the transition towards a green economy. 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. Robust and transparent tools, methods and models to assess and enable the main economic, societal and institutional changes needed to achieve a paradigm shift towards a green economy will be developed. Research will explore how to promote sustainable 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

²⁸ Eco-innovation Observatory "The Eco-Innovation Challenge - Pathways to a resource-efficient Europe - Annual Report 2010", May 2011

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 assess and predict the condition, status and trends of the climate, natural resources including raw materials, 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 storage, management and dissemination of research results.

5.6. 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 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 Global Monitoring for Environment and Security (GMES) operational services by providing a developmental knowledge base for GMES.

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, regional and structural funds, and external cooperation programmes.

An Advisory Network of Institutes may be established to 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.

6. INCLUSIVE, INNOVATIVE AND SECURE SOCIETIES

6.1. Inclusive societies

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

In this context, the objective is to enhance social, economic and political inclusion, combat poverty, enhance human rights, digital inclusiveness, equality, solidarity and inter-cultural dynamics by supporting interdisciplinary research, indicators, technological advances, organisational solutions 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 foreign policies. Humanities research may have an important role to play in this context. Specifying, monitoring and assessing the objectives of European strategies and policies will require focused research on high-quality statistical information systems, and the development of adapted instruments that allow policy makers to assess the impact and effectiveness of envisaged measures, in particular in favour of social inclusion.

The following specific objectives will be pursued:

6.1.1. Promoting smart, sustainable and inclusive growth

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 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 sustainable lifestyles and socio-economic behaviours and values and how they relate to paradigms, policies and to the functioning of institutions, markets, firms, governance and belief systems in Europe. It will

develop tools for a better assessment of the contextual and mutual impacts of such evolutions and policy options in areas such as employment, taxation, inequalities, poverty, social inclusion, education and skills, community development, competitiveness and the Internal Market. 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 economic and financial disorders. It will take into account the growing interdependencies between Union and global economies, markets and financial systems.

6.1.2. Building resilient and inclusive societies in Europe

Understanding social 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 and values. This includes a good understanding of the history of European integration. 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. It is essential 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 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 ideas and beliefs and combinations of principles and practices of reciprocity, commonality and equality. It will analyse how vulnerable populations can participate fully in 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 social bonds, such as family, work, education and employment and help combat poverty. It will take into account the importance of migration and demography in the future development of European policies.

Given the increasing socio-economic importance of digital inclusion, research and large-scale 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. Strengthening Europe's role as a global actor.

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 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 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 in key domains like trade, development, work, economic cooperation, human rights, defence and security. This implies the potential to build new capacities whether in terms of tools, systems

and instruments of analysis or in terms of diplomacy in formal and informal international arena with governmental and non governmental actors.

6.1.4. Closing the research and innovation divide in Europe

There are significant regional disparities across Europe in research and innovation performance which need to be addressed. Measures will aim at unlocking excellence and innovation and will be distinct, complementary and synergistic with policies and actions of the Cohesion policy Funds. They include:

- Linking in a competition emerging institutions, centres of excellence and innovative regions in less developed Member States to international leading counterparts elsewhere in Europe. This will involve teaming of excellent research institutions and less developed regions, twinning of staff exchanges, expert advice and assistance and the development of joint strategies for the establishment of centres of excellence that may be supported by the Cohesion policy funds in less developed regions. Building links with innovative clusters and recognising excellence in less developed regions, including through peer reviews and awarding labels of excellence to those institutions that meet international standards, will be considered.
- 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.
- 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 and National Contact Points.
- Supporting the development and monitoring of smart specialisation strategies. A policy support facility will be developed and policy learning at regional level will be facilitated through international evaluation by peers and best practice sharing.

6.2. Innovative societies

The shrinking Union share of global knowledge production emphasizes the need to maximise the socio-economic impacts and efficiency of research and innovation policies and to increase substantially transnational policy synergies and coherence. Innovation will be addressed in a wide sense, including large scale policy, user- and market-driven innovation. 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. Strengthening 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 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 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 research stakeholders, enterprises, public authorities and citizens.

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, researchers' rights and links with global researcher communities. These activities will be implemented seeking synergies and close coordination with the Marie 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, will be supported.

As regard 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 (private and public) market-driven 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. IPR management/exploitation, innovation management, 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'.

6.2.2. Exploring new forms of innovation, including social innovation and creativity

Social innovation generates new goods, services, processes and models that meet societal needs and create new social relationships. It is important to understand how social innovation and creativity may lead to change in existing structures and policies and how they can be encouraged and scaled-up. Grassroots on-line and distributed platforms networking citizens and allowing them to collaborate and co-create solutions based on an extended awareness of the social, political and environmental context can be a powerful tool to support the objectives of Europe 2020. Support will also be given to networking and experimentation of the use of ICT for improving learning processes, as well as to networks of social innovators and social entrepreneurs.

It will be essential to promote innovation in order to foster efficient, open and citizen-centric public services (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, 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 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.

6.2.3. Ensuring societal engagement in research and innovation.

Enabling all societal actors to interact in the innovation cycle increases the quality, relevance, acceptability and sustainability of innovation outcomes by integrating society's interests and values. This requires developing specific skills, knowledge and capacities at individual and organisational as well as at national and transnational levels. A scientifically literate, responsible and creative society will be nurtured through the promotion of and research on appropriate science education methods. Gender equality will be promoted in particular by supporting changes in the organisation of research institutions and in the content and design of research activities. In order to improve knowledge circulation within the scientific community and the wider public, the accessibility and use of the results of publicly funded research will be further developed. An Ethics Framework for research and innovation, based on the fundamental ethical principles including those reflected in the Charter of Fundamental Rights and all the relevant Union laws and Conventions, will be promoted in coordination with relevant international organisations.

6.2.4. Promoting 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 promoting the creation of European '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. Secure societies

The European Union, its citizens and its international partners are confronted with a range of security threats like crime, terrorism and mass emergencies due to man-made or natural disasters. These threats can span across borders and aim at physical targets or the cyberspace. Attacks against 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 the European security, ICT and services industries and prevent and combat the abuse of privacy and breaches of human rights in Internet.

The coordination and improvement of the security research 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 will follow a mission-oriented approach and integrate the relevant societal dimensions. They will support the Union's policies for internal and external security, defence policies, and the relevant new provision of the Lisbon Treaty, and ensure cyber security, trust and privacy in the Digital single Market. The following specific objectives will be pursued:

6.3.1. Fighting crime and terrorism.

The ambition is both to avoid an incident and to mitigate its potential consequences. This requires new technologies and capabilities (including against cyber crime and cyber terrorism) for the support to health, food, water and environmental security which are essential for the good functioning of society and economy. New technologies and dedicated capabilities will help to protect critical infrastructures, systems and services (including communications, transport, 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.

6.3.2. Strengthening security through border management

Technologies and capabilities are also required to enhance systems, equipments, tools, processes, and methods for rapid identification to improve border security, 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.

6.3.3. Providing cyber security

Cyber security is a prerequisite for people, business and public services in order to benefit from the opportunities offered by the Internet. It requires providing security for systems, networks, access devices, and software and services, including cloud computing, while taking into account the interoperability of multiple technologies. Research will 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.

6.3.4. Increasing Europe's resilience to crises and disasters

This requires the development of dedicated technologies and capabilities to support different types of emergency management operations (such as civil protection, fire fighting and marine pollution, humanitarian aid, civil defence, conflict prevention, development of medical information infrastructures rescue tasks and post-crisis-stabilisation) 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.

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. This also requires integrating civilian and military capabilities in 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 guarantee 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.

6.3.5. Ensuring privacy and freedom in the internet and enhancing the societal dimension of security

Safeguarding the human right of privacy in the digital society will require the development of privacy-by-design frameworks and technologies since the conception of 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 issues and protection of human values and fundamental rights will be addressed.

6.3.6. Specific implementation aspects

Whereas research will have a civil security orientation, 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 relevant for both civil and military applications. Coordination mechanisms with relevant Union Agencies, such as e.g. FRONTEX, EMSA 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 referred 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 IV

Non-Nuclear Direct Actions of the Joint Research Centre (JRC)

1. EXCELLENT SCIENCE

The JRC will carry out research to enhance the scientific evidence base for policy making, to promote understanding of natural processes underlying societal challenges, 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, marine and maritime research and the bio-economy

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.
- (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.

3.5. Climate action, 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, 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. Inclusive, innovative and secure societies

The JRC will contribute to the goals of the Innovation Union, Security and Citizenship 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.
- (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).
- (g) 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).

- (h) 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.
- (i) 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.

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.

Annex II

Performance indicators

The following table specifies for the specific objectives of Horizon 2020 a limited number of key indicators for assessing results and impacts.

1. PART I. PRIORITY 'EXCELLENT SCIENCE'

Specific objectives:

- European Research Council
 - Share of publications from ERC funded projects which are among the top 1 % highly cited
 - Number of institutional policy and national/regional policy measures inspired by ERC funding
- Future and Emerging Technologies
 - Publications in peer-reviewed high impact journals
 - Patent applications in Future and Emerging Technologies
- Marie Curie actions on skills, training and career development
 - Cross-sector and cross-country circulation of researchers, including PhD candidates
- **European research infrastructures (including eInfrastructures)**
 - Research infrastructures which are made accessible to all researchers in Europe and beyond through Union support

2. PART II. PRIORITY 'INDUSTRIAL LEADERSHIP'

Specific objectives:

- **Leadership in enabling and industrial technologies** (ICT, Nanotechnologies, Advanced Materials, Biotechnologies, Advanced manufacturing and Space)
 - Patent applications obtained in the different enabling and industrial technologies
- **Access to risk finance**
 - Total investments mobilised via debt financing and Venture Capital investments
- **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)

3. PART III. PRIORITY 'SOCIETAL CHALLENGES'

Specific objectives:

For each of the challenges, progress shall be assessed against the contribution to the following specific objectives which are detailed in Annex I of Horizon 2020 together with descriptions of the substantive advancement needed for the achievement of the challenges and policy relevant indicators:

- Improve the lifelong health and wellbeing of all
- Secure sufficient supplies of safe and high quality food and other bio-based products, by developing productive and resource-efficient primary production systems, fostering ecosystem services, along side competitive and low carbon supply chains.
- Make the transition to a reliable, sustainable and competitive energy system, in the face of increasingly scarce resources, increasing energy needs and climate change.
- Achieve a European transport system that is resource-efficient, environmentally-friendly, safe and seamless for the benefit of citizens, the economy and society
- Achieve a resource efficient and climate change resilient economy and a sustainable supply of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources.
- Foster inclusive, innovative and secure European societies in a context of unprecedented transformations and growing global interdependencies.

Additional performance indicators are:

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

- Patent applications in the area of the different Societal Challenges
- Number of Union pieces of legislation referring to activities supported in the area of the different Societal Challenges

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

Specific objectives:

- **Provide customer-driven scientific and technical support to Union policies**
 - 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

LEGISLATIVE FINANCIAL STATEMENT

1. FRAMEWORK OF THE PROPOSAL/INITIATIVE

- 1.1. Title of the proposal/initiative
- 1.2. Policy area(s) concerned in the ABM/ABB structure
- 1.3. Nature of the proposal/initiative
- 1.4. Objective(s)
- 1.5. Grounds for the proposal/initiative
- 1.6. Duration and financial impact
- 1.7. Management method(s) envisaged

2. MANAGEMENT MEASURES

- 2.1. Monitoring and reporting rules
- 2.2. Management and control system
- 2.3. Measures to prevent fraud and irregularities

3. ESTIMATED FINANCIAL IMPACT OF THE PROPOSAL/INITIATIVE

- 3.1. Heading(s) of the multiannual financial framework and expenditure budget line(s) affected
- 3.2. Estimated impact on expenditure
 - 3.2.1. *Summary of estimated impact on expenditure*
 - 3.2.2. *Estimated impact on operational appropriations*
 - 3.2.3. *Estimated impact on appropriations of an administrative nature*
 - 3.2.4. *Compatibility with the current multiannual financial framework*
 - 3.2.5. *Third-party participation in financing*
- 3.3. Estimated impact on revenue

LEGISLATIVE FINANCIAL STATEMENT

1. FRAMEWORK OF THE PROPOSAL/INITIATIVE

1.1. Title of the proposal/initiative

The Specific Programme implementing Horizon 2020 – The Framework Programme for Research and Innovation (2014-2020)

1.2. Policy area(s) concerned in the ABM/ABB structure²⁹

- 08 - Research and Innovation
- 09 - Information Society and Media
- 02 - Enterprise and Industry
- 05 - Agriculture
- 32 - Energy
- 06 - Mobility and Transport
- 15 - Education and Culture
- 07 - Environment and climate action
- 10 - Joint Research Centre

1.3. Nature of the proposal/initiative

✓ The proposal/initiative relates to **a new action**

.. The proposal/initiative relates to **a new action following a pilot project/preparatory action**³⁰

.. The proposal/initiative relates to **the extension of an existing action**

.. The proposal/initiative relates to **an action redirected towards a new action**

1.4. Objectives

1.4.1. *The Commission's multiannual strategic objective(s) targeted by the proposal/initiative*

The Specific Programme implementing Horizon 2020 – The Framework Programme for Research and Innovation (2014-2020) ('SP') is pursuing the general objective of Horizon 2020 – The Framework Programme for Research and Innovation (2014-2020) ('Horizon 2020'), which is to contribute to the Europe 2020 strategy, including

²⁹

³⁰

ABM: Activity-Based Management – ABB: Activity-Based Budgeting.
As referred to in Article 49(6)(a) or (b) of the Financial Regulation.

the completion of the European Research Area, by stimulating smart, sustainable and inclusive growth:

- Smart growth – develop an economy based on knowledge and innovation (implementing the Innovation Union flagship initiative).
- Sustainable growth – promote a more resource efficient, greener and more competitive economy.
- Inclusive growth – foster a high-employment economy delivering economic, social and territorial cohesion.

1.4.2. Specific objective(s) and ABM/ABB activity(ies) concerned

- Part I: Priority 'Excellent Science'
- Part II: Priority 'Industrial Leadership'
- Part III: Priority 'Societal Challenges'
- Part IV: Non-nuclear direct actions of the Joint Research Centre

ABM/ABB activity(ies) concerned

- 08 - Research and Innovation
- 09 - Information Society and Media
- 02 - Enterprise and Industry
- 05 - Agriculture
- 32 - Energy
- 06 - Mobility and Transport
- 15 - Education and Culture
- 07 - Environment and climate action
- 10 - Joint Research Centre

1.4.3. *Expected result(s) and impact*

Specify the effects which the proposal/initiative should have on the beneficiaries/groups targeted.

The SP will cover the most substantial part of the Horizon 2020. It is estimated that by 2030 Horizon 2020 is expected to generate an extra 0.92 per cent of GDP, 1.37 per cent of exports, -0.15 per cent of imports, and 0.40 per cent of employment.

For more information, please read the Commission Staff Working Paper on the impact assessment of Horizon 2020 ('IA') accompanying this legislative proposal.

1.4.4. *Indicators of results and impact*

Specify the indicators for monitoring implementation of the proposal/initiative.

The following table specifies for the general and specific objectives of the SP a limited number of key indicators for assessing results and impacts.

Additional – including newly developed – indicators will be used to capture the various types of results and impacts for the different specific activities.

General objective:

Contribute to the objectives of the Europe 2020 strategy and to the completion of the European Research Area

- The Europe 2020 R&D target (3 % of GDP)

Current: 2.01 % of GDP (EU-27, 2009)

Target 3 % of GDP (2020)

- The Europe 2020 innovation headline indicator

Current: New approach

Target: Substantial weight of fast-growing innovative enterprises in the economy

Part I: Priority 'Excellent Science'

Specific Objectives

*** European Research Council**

- Share of publications from ERC funded projects which are among the top 1 % highly cited

Current: 0.8 % (EU publications from 2004 to 2006, cited until 2008)

Target: 1.6 % (ERC publications 2014 - 2020)

- Number of institutional policy and national/regional policy measures inspired by ERC funding

Current: 20 (estimate 2007 – 2013)

Target: 100 (2014 – 2020)

*** Future and Emerging Technologies**

- Publications in peer-reviewed high impact journals

Current: New approach

Target: 25 publications per 10 Million €funding (2014 - 2020)

- Patent applications in Future and Emerging Technologies

Current: New approach

Target: 1 patent application per 10 Million €funding (2014 – 2020)

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

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

Current: 50.000, around 20 % PhD candidates (2007 - 2013)

Target: 65.000, around 40 % PhD candidates (2014 - 2020)

*** European research infrastructures (including eInfrastructures)**

- Research infrastructures which are made accessible to all researchers in Europe and beyond through Union support

Current: 650 (2012)

Target: 1000(2020)

Part II: Priority 'Industrial Leadership'

Specific Objectives

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

- Patent applications obtained in the different enabling and industrial technologies

Current: New approach

Target: 3 patent applications per 10 Million €funding (2014 – 2020)

*** Access to risk finance**

- Total investments mobilised via debt financing and Venture Capital investments

Current: New approach

Target: EUR 100 million total investment per EUR 10 million Union contribution (2014 - 2020)

*** 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)

Current: New approach

Target: 50 %

Part III: Priority 'Societal Challenges'

Specific Objectives

For each of the challenges, progress shall be assessed against the contribution to the following specific objectives which are detailed in Annex I of Horizon 2020 together with descriptions of the substantive advancement needed for the achievement of the challenges and policy relevant indicators:

- Improve the lifelong health and wellbeing of all.

- Secure sufficient supplies of safe and high quality food and other bio-based products, by developing productive and resource-efficient primary production systems, fostering ecosystem services, along side competitive and low carbon supply chains.

- Make the transition to a reliable, sustainable and competitive energy system, in the face of increasingly scarce resources, increasing energy needs and climate change.

- Achieve a European transport system that is resource-efficient, environmentally-friendly, safe and seamless for the benefit of citizens, the economy and society.

- Achieve a resource efficient and climate change resilient economy and a sustainable supply of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources.

- Foster inclusive, innovative and secure European societies in a context of unprecedented transformations and growing global interdependencies.

Additional performance indicators are:

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

Current: New approach (For FP7(2007-2010), 8149 publications in total - preliminary figure)

Target:	On average, 20 publications per 10 Million €funding (2014 – 2020)
	- Patent applications in the area of the different Societal Challenges
Current:	153 (FP7 Cooperation Programme 2007-10, preliminary figures)
Target:	On average, 2 patent applications per 10 Million € funding (2014 – 2020)
	- Number of Union pieces of legislation referring to activities supported in the area of the different Societal Challenges
Current:	New approach
Target:	On average, 1 per 10 Million €funding (2014 - 2020)
Part IV: Non-nuclear direct actions of the Joint Research Centre	
Provide customer-driven scientific and technical support to Union policies	
	- Number of occurrences of tangible specific impacts on European policies resulting from technical and scientific policy support provided by the Joint Research Centre
Current:	175 (2010)
Target:	230 (2020)
	- Number of peer reviewed publications
Current:	430 (2010)
Target:	500 (2020)

1.5. Grounds for the proposal/initiative

1.5.1. Requirement(s) to be met in the short or long term

-Improve the contribution of research and innovation to the resolution of key societal challenges.
-Boost Europe’s industrial competitiveness through promoting technological leadership and getting good ideas to market.
-Strengthen Europe’s science base.
-Achieve the European Research Area and increase its effectiveness (cross-cutting objectives).
-For more information, please read the Commission Staff Working Paper on the impact assessment of Horizon 2020 (‘IA’) accompanying this legislative proposal.

1.5.2. *Added value of EU involvement*

There is a clear case for public intervention to tackle the problems outlined in 1.5.1 above. Markets alone will not deliver European leadership in the new techno-economic paradigm. Large-scale public intervention through both supply and demand measures will be needed to overcome the market failures associated with systemic shifts in basic technologies.

However, Member States acting alone will not be able to make the required public intervention. Their investment in research and innovation is comparatively low, is fragmented and suffers from inefficiencies - a crucial obstacle when it comes to technological paradigm shifts. It is difficult for Member States on their own to accelerate technology development over a sufficiently broad portfolio of technologies, or to tackle the lack of transnational coordination.

As highlighted in the proposal for the next Multi-annual Financial Framework, the Union is well positioned to add value by delivering the large-scale investment in "blue sky" frontier research, in targeted applied R&D, and in the associated education, training and infrastructures which will help to strengthen our performance in thematically focused R&D and enabling technologies; by supporting companies' efforts to exploit research results and to turn them into marketable products, processes and services; and by stimulating the uptake of these innovations. A series of cross-border actions - concerning the coordination of national research funding, Union-wide competition for research funding, researcher mobility and training, coordination of research infrastructures, transnational collaborative research and innovation, and innovation support - are most efficiently and effectively organised at European level. Ex-post evaluation evidence has convincingly demonstrated that Union research and innovation programmes support research and other activities that are of great strategic importance for participants, and that in the absence of Union support would simply not take place. In other words, there are no substitutes for Union level support.

Evidence also demonstrates the European added value of policy support actions, which derives from bringing together knowledge and experience from different contexts, supporting cross-country comparisons of innovation policy tools and experiences, and providing the opportunity to identify, promote and test best practices from over the widest possible area.

The direct actions of the Joint Research Centre ('JRC') provide European added value because of their unique European dimension. These benefits range from responding to Commission's need to have in-house access to scientific evidence independent of national and private interests to direct benefits to the Union citizens through contributions to policies which lead to improved economic, environmental and social conditions.

For more information, please read the Commission Staff Working Paper on the impact assessment of Horizon 2020 ('IA') accompanying this legislative proposal.

1.5.3. *Lessons learned from similar experiences in the past*

The programme builds on the experience accumulated from past Framework Programmes for Research and Technological Demonstration (FP), the Competitiveness and Innovation Programme (CIP), and the European Institute of Technology and Innovation (EIT).

Over a period spanning several decades, Union programmes have:

- succeeded in involving Europe's best researchers and institutes,
- produced large-scale structuring effects, scientific, technological and innovation impacts, micro-economic benefits, and downstream macro-economic, social and environmental impacts for all Member States.

Together with the success, there are important lessons to be learned from the past:

- Research, innovation and education should be addressed in a more coordinated manner;
- Research results better disseminated and valorised into new products, processes and services;
- The intervention logic should be more focused, concrete, detailed and transparent;
- Programme access should be improved and participation increased from start-ups, SMEs, industry, less performing Member States and extra-Union countries;
- Monitoring and evaluation of the programme need to be strengthened.

The recommendations for direct actions in recent evaluation reports note i.a. that the JRC can

- promote stronger integration in the production of knowledge in the Union;
- introduce impact analyses and cost-benefit studies of specific work;
- enhance cooperation with industry in order to strengthen effects for the benefit of the competitiveness of the European economy.

For more information, please read the Commission Staff Working Paper on the impact assessment of Horizon 2020 ('IA') accompanying this legislative proposal.

1.5.4. *Coherence and possible synergy with other relevant instruments*

In the context of the achievement of the Europe 2020 objectives, synergies will be established and developed with the other Union programmes like the Common Strategic Framework for Economic, Social and Territorial Cohesion and with the Competitiveness and SMEs Programme.

1.6. Duration and financial impact

Ÿ Proposal/initiative of **limited duration**

- Ÿ Proposal/initiative in effect from 01/01/2014 to 31/12/2020
- Ÿ Financial impact from 2014 to 2026

¨ Proposal/initiative of **unlimited duration**

- Implementation with a start-up period from YYYY to YYYY,
- followed by full-scale operation.

1.7. Management mode(s) envisaged³¹

Ÿ **Centralised direct management** by the Commission

Ÿ **Centralised indirect management** with the delegation of implementation tasks to:

- Ÿ executive agencies
- Ÿ bodies set up by the Communities³²
- Ÿ national public-sector bodies/bodies with public-service mission
- ¨ persons entrusted with the implementation of specific actions pursuant to Title V of the Treaty on European Union and identified in the relevant basic act within the meaning of Article 49 of the Financial Regulation

¨ **Shared management** with the Member States

¨ **Decentralised management** with third countries

Ÿ **Joint management** with international organisations, including the European Space Agency

If more than one management mode is indicated, please provide details in the "Comments" section.

Comments

The Commission intends to use a variety of management modes to implement this activity building on the management modes used under the current financial perspectives. These management modes include centralised management and joint management.

Management will be through the services of the Commission, through the existing Executive Agencies of the Commission renewing and extending their mandates in a

³¹ Details of management modes and references to the Financial Regulation may be found on the BudgWeb site: http://www.cc.cec/budg/man/budgmanag/budgmanag_en.html

³² As referred to in Article 185 of the Financial Regulation.

balanced manner and through other externalised bodies such as entities created under Articles 187 (e.g. Joint Undertakings with renewed mandates after assessment and new ones to be set up in the context of implementing e.g. the 'Societal Challenges' part), 185 (programmes undertaken jointly by several member states, where national public-sector bodies/bodies with public-service mission will play a role) of the Lisbon Treaty as well as through financial instruments.

Activities already externalised under the current financial perspective (e.g. Frontier Research, Marie Curie Actions, SME actions), which will be continued under this SP, will be implemented keeping the current form of externalisation. This may entail deepening the specialisation and simplifying management of the respective externalised bodies and bringing them to a comparable operational size.

Externalisation of further activities of the SP, in particular through recourse to existing Executive Agencies of the Commission, is foreseen as long as it is compatible with keeping core policy competences within Commission services. The externalisation means retained to implement these activities will be selected on the basis of their proven effectiveness and efficiency. At the same time, the staff assigned to the Executive Agencies of the Commission will have to increase in proportion to the part of the budget corresponding to the externalised activities and taking into account the commitment on staffing made by the Commission (A Budget for Europe 2020 COM(2011) 500).

Where higher leverages can be achieved, the European Space Agency may be involved in the implementation of space-related activities of Horizon 2020.

2. MANAGEMENT MEASURES

Simplification

The SP must attract the most excellent researchers and the most innovative European enterprises. This can only be reached by a programme with the least possible administrative burden for participants and by appropriate funding conditions. **Simplification** in the SP will therefore target **three overarching goals**: to reduce the administrative costs of the participants; to accelerate all processes of proposal and grant management and to decrease the financial error rate. Moreover, simplification of research and innovation funding will also result from the revision of the Financial Regulation (e.g. no interest bearing accounts for pre-financing, eligible VAT, limitation of extrapolation of systematic errors).

Simplification in the SP will be achieved along several dimensions.

Structural simplification is provided through

- Integration of Union research and innovation related funding instruments into this SP;
- This single Specific Programme implementing Horizon 2020;
- One single set of participation rules covering all components of Horizon 2020.

Major **simplification of funding rules** will make the preparation of proposals and the management of projects easier. At the same time, they will reduce the number of financial errors. The following approach is proposed:

Main funding model for grants:

- Simplified reimbursement of real direct costs, with a broader acceptance of beneficiaries' usual accounting, including the eligibility of certain taxes and charges;
- The possibility of using unit personnel costs (average personnel costs) for beneficiaries for which this is their usual accounting method, and for SME owners without a salary;
- Simplification of time-recording by providing a clear and simple set of minimum conditions, in particular abolition of time-recording obligations for staff working exclusively on a Union project;
- One single reimbursement rate for all participants instead of 3 different rates by type of participant;
- One single flat rate covering indirect costs, instead of 4 methods to calculate indirect costs, as a general rule;
- Continuation of the system of unit costs and flat rates for mobility and training actions (Marie Curie);

- Output-based funding with lump sums for whole projects in specific areas.

A revised control strategy, as described in section 2.2.2, achieving a new balance between trust and control will further reduce the administrative burden for participants.

Beyond the simpler rules and controls, all **procedures and processes** for project implementation will be rationalised. This includes the detailed provisions on the content and shape of proposals, the processes for turning proposals into projects, the requirements for reporting and monitoring, as well as the related guidance documents and support services. A major contribution to reduced administrative costs for participation will come from a single user-friendly IT platform, based on the Union's Seventh Framework Programme for R&D (2007-2013) ('FP7') Participant Portal.

2.1. Monitoring and reporting rules

Specify frequency and conditions.

A new system will be developed for the evaluation and monitoring of the indirect actions of the SP. It will be based on a comprehensive, well-timed and harmonised strategy, with a strong focus on throughput, output, results and impacts. It will be supported by an appropriate data archive, experts, a dedicated research activity, and increased cooperation with Member States and Associated States, and it will be valorised through appropriate dissemination and reporting. For direct actions, the JRC will continue to improve its monitoring by further adjusting its indicators measuring output and impact.

The system will include information concerning cross-cutting topics such as sustainability and climate change. Climate related expenditure will be calculated in accordance with the tracking system based on Rio markers.

2.2. Management and control system

A 2 % error limit was adopted as chief indicator in the area of legality and regularity concerning the area of research grants. However, this has caused a number of unexpected or undesirable side-effects. There has been a strong feeling, amongst the beneficiaries as well as amongst the legislative authority, that the control burden has become too great. This runs the risk of lowering the attractiveness of the Union's Research programme, and so negatively affecting Union research and innovation.

The European Council of February 4th 2011 concluded that 'it is crucial that EU instruments aimed at fostering R&D&I be simplified in order to facilitate their take-up by the best scientists and the most innovative companies, in particular by agreeing between the relevant institutions a new balance between trust and control and between risk taking and risk avoidance' (see EUCO 2/1/11 REV1, Brussels 8 March 2011).

The European Parliament, in its Resolution of 11 November 2010 (P7_TA(2010)0401) on simplifying the implementation of the Research Framework Programmes explicitly supports a higher risk of errors for research funding and "expresses its concern that the current system and the practice of FP7 management

are excessively control-oriented, thus leading to waste of resources, lower participation and less attractive research landscapes; notes with concern that the current management system of 'zero risk tolerance' seems to avoid, rather than to manage, risks".

The sharp increase in the number of audits and the subsequent extrapolation of results has also provoked a wave of complaints from the world of research (e.g. the Trust Researchers initiative³³, with over 13,800 signatures so far).

There is therefore an acceptance among stakeholders and Institutions that the current approach needs to be reviewed. There are other objectives and interests, especially the success of the Research policy, international competitiveness and scientific excellence, which should also be considered. At the same time, there is a clear need to manage the budget in an efficient and effective manner, and to prevent fraud and waste. These are the challenges for the SP.

It remains the ultimate objective of the Commission to achieve a residual error rate of less than 2% of total expenditure over the lifetime of the programme, and to that end, it has introduced a number of simplification measures. However, other objectives such as the attractiveness and the success of the EU research policy, international competitiveness, scientific excellence and in particular the costs of controls (see point 2.2.2) need to be considered.

Taking these elements in balance, it is proposed that the Directorates General charged with the implementation of the research and innovation budget will establish a cost-effective internal control system that will give reasonable assurance that the risk of error over the course of the multiannual expenditure period is, on an annual basis, within a range of 2-5 %, with the ultimate aim to achieve a residual level of error as close as possible to 2 % at the closure of the multi-annual programmes, once the financial impact of all audits, correction and recovery measures have been taken into account.

2.2.1. *Internal control framework*

The internal control framework for grants is built on:

- the implementation of the Commission's Internal Control Standards;
- procedures for selecting the best projects and translating them into legal instruments;
- project and contract management throughout the lifetime of every project;
- ex-ante checks on 100% of claims, including receipt of audit certificates and ex-ante certification of cost methodologies;
- ex post audits on a sample of claims;
- and scientific evaluation of project results.

³³ <http://www.trust-researchers.eu/>

For direct actions, financial circuits include ex-ante checks for procurement and ex-post controls. Risks are assessed annually and progress in the execution of work and the consumption of resources is monitored regularly, based on defined objectives and indicators.

2.2.2. *Costs and benefits of the controls*

The cost of the internal control system for the Directorates General charged with the implementation of the research and innovation budget is estimated at €67m per year (based on the 2009 Tolerable Risk of Error exercise). It has also led to a considerable burden on beneficiaries and Commission services.

43 % of the total costs of control of the Commission services (not including the costs of the beneficiary) are borne at the stage of project management, 18 % on selection of proposals, and 16 % on negotiation of contracts (16 %). Ex post audits and their resulting implementation amounted to 23 % (€1m) of the total.

However, this considerable control effort has not managed to fully achieve its objective. The estimated "residual" error rate for FP6, after taking account of all recoveries and corrections that have been or will be implemented, remains over 2 %. The current rate of error from audits of FP7 carried out by the Directorate General Research and Innovation is around 5 %, and although this will be reduced due to the effects of the audits, and is somewhat biased because it is concentrated on beneficiaries not previously audited, it is unlikely whether the 2 % residual error will be attained. The rate of error identified by the European Court of Auditors is in a similar range.

2.2.3. *Expected level of risk of non-compliance*

The starting point is the status quo, based on audits carried out in FP7 so far. This preliminary representative error rate is close to 5 % (for the Directorate General Research and Innovation). The majority of errors detected arise because the present system of research funding is based on the reimbursement of the actual costs of the research project declared by the participant. This leads to considerable complexity regarding the assessment of eligible costs.

An analysis of error rates has been carried out for the FP7 audits so far performed in the Directorate General Research and Innovation shows that:

- Around 27% by number, and 35% by amount, relate to errors in the charging of personnel costs. Regular problems identified are charging average or budgeted costs (rather than actual costs), failure to keep adequate records of time spent on the programme, charging of ineligible items.
- Around 40% by number, and 37% by value, relate to other direct costs (not personnel). Regular errors identified are the inclusion of VAT, lack of a clear link to the project, failure to provide invoices or proof of payment and incorrect calculation of depreciation charging the full cost of equipment rather than the depreciated amount, subcontracting without prior authorization, or without respecting the rules of value for money, etc.

- Around 33% by number, and 28% by amount, relate to errors in indirect costs. The same risks apply as for personnel costs, with the additional risk of an inaccurate or unfair allocation of overheads to Union projects.

In a number of cases the indirect costs are a flat rate percentage of direct costs, and so the error in indirect costs is proportional to the error in direct costs.

Horizon 2020 introduces a significant number of important simplification measures (see point 2 above) applicable to this SP that will lower the error rate in all the categories of error. However, the consultation of stakeholders and the institutions on further simplification, and the Horizon 2020 impact assessment, clearly indicate that the continuation of a funding model based on the reimbursement of actual costs is the favoured option. A systematic resort to output based funding, flat rates or lump sums appears premature at this stage as such a system has not been tested in previous programmes. Retaining a system based on the reimbursement of actual costs does however mean that errors will continue to occur.

An analysis of errors identified during audits of FP7 suggests that around 25-35% of them would be avoided by the simplification measures proposed. The error rate can then be expected to fall by 1.5%, i.e. from close to 5% to around 3.5%, a figure that is referred to in the Commission Communication striking the right balance between the administrative costs of control and the risk of error.

The Commission considers therefore that, for research spending under Horizon 2020, a risk of error, on an annual basis, within a range between 2-5 % is a realistic objective taking into account the costs of controls, the simplification measures proposed to reduce the complexity of rules and the related inherent risk associated to the reimbursement of costs of the research project. The ultimate aim for the residual level of error at the closure of the programmes after the financial impact of all audits, correction and recovery measures will have been taken into account is to achieve a level as close as possible to 2 %.

The ex-post audit strategy for expenditure under Horizon 2020 takes account of this target. It will be based on the financial audit of a single representative sample of expenditure across the whole programme, complemented by a sample compiled on the basis of risk considerations.

The overall number of ex-post audits will be limited to that strictly necessary to the achievement of this target and the strategy. The governance of the ex-post audit activities will ensure that the audit burden on participants is minimized. As a guide, the Commission considers that a maximum of 7% of participants in Horizon 2020 would be subject to audit over the whole programming period. Past experience shows that the expenditure subject to audit would be considerably higher.

The ex-post audit strategy regarding legality and regularity will be complemented by reinforced scientific evaluation and the anti-fraud strategy (see point 2.3 below).

This scenario is based on the assumption that the measures of simplification are not subject to substantial modifications in the decision making process.

Note: this section only concerns the process of grant management, for administrative and operational expenditure implemented through public procurement processes the 2% ceiling will apply as tolerable risk of error.

2.3. Measures to prevent fraud and irregularities

Specify existing or envisaged prevention and protection measures.

The Directorates General charged with the implementation of the research and innovation budget are determined to fight against fraud at all stages of the grant management process. They have developed, and are implementing, anti-fraud strategies, including an enhanced use of intelligence, especially using advanced IT tools, and training and information for staff. Sanctions have been developed to provide deterrents to fraud, as well as appropriate penalties if they are identified. These efforts will continue. The proposals for Horizon 2020 have been subject to fraud proofing and an assessment of their impact. Overall the measures proposed should have a positive impact on the fight against fraud, especially the greater emphasis on risk based audit and reinforced scientific evaluation and control.

It should be underlined that detected fraud has been very low in proportion to total expenditure, nevertheless the Directorates General charged with the implementation of the research budget remain committed to combat it.

The Commission shall take appropriate measures ensuring that, when actions financed under this Regulation are implemented, the financial interests of the Union are protected by the application of preventive measures against fraud, corruption and any other illegal activities, by effective checks and, if irregularities are detected, by the recovery of the amounts wrongly paid and, where appropriate, by effective, proportionate and deterrent penalties.

The Commission or its representatives and the Court of Auditors shall have the power of audit, on the basis of documents and on-the-spot, over all grant beneficiaries, contractors and subcontractors who have received Union funds under the Programme.

The European Anti-fraud Office (OLAF) may carry out on-the-spot checks and inspections on economic operators concerned directly or indirectly by such funding in accordance with the procedures laid down in Regulation (Euratom, EC) No 2185/96 with a view to establishing whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the Union in connection with a grant agreement or grant decision or a contract concerning Union funding.

Without prejudice to the paragraphs above, cooperation agreements with third countries and international organisations and grant agreements and grant decisions and contracts resulting from the implementation of this Regulation shall expressly empower the Commission, the Court of Auditors and OLAF to conduct such audits, on-the-spot checks and inspections.

3. ESTIMATED FINANCIAL IMPACT OF THE PROPOSAL/INITIATIVE

3.1. Heading(s) of the multiannual financial framework and expenditure budget line(s) affected

- Existing expenditure budget lines (Not applicable)

In order of multiannual financial framework headings and budget lines.

Heading of multiannual financial framework	Budget line	Type of expenditure	Contribution			
	Number [Description.....]	Diff./non-diff (34)	from EFTA ³⁵ countries	from candidate countries ³⁶	from third countries	within the meaning of Article 18(1)(aa) of the Financial Regulation
	[XX.YY.YY.YY]	Diff./non-diff.	YES/N O	YES/N O	YES/N O	YES/NO

- New budget lines requested

In order of multiannual financial framework headings and budget lines.

Heading of multiannual financial framework	Budget line	Type of expenditure	Contribution			
	Number [Heading 1 - Smart and Inclusive Growth]	Diff./non-diff.	from EFTA countries	from candidate countries	from third countries	within the meaning of Article 18(1)(aa) of the Financial Regulation
	<i>Administrative Expenditures</i> <i>Indirect Research:</i> XX 01 05 01 Expenditure related to Research Staff XX 01 05 02 External staff for Research XX 01 05 03 Other management expenditure for Research <i>Direct Research:</i> 10 01 05 01 Expenditure related to Research Staff 10 01 05 02 External staff for Research 10 01 05 03 Other management expenditure for Research	NDA	YES	YES	YES	YES

³⁴ Diff. = Differentiated appropriations / Non-Diff. = Non-differentiated appropriations

³⁵ EFTA: European Free Trade Association.

³⁶ Candidate countries and, where applicable, potential candidate countries from the Western Balkans.

	10 01 05 04 Other expenditure for major research infrastructures ³⁷					
	<p><i>Operational Expenditures</i></p> <p>XX 02 01 01 Horizontal Actions</p> <p><i>Excellent science</i></p> <p>08 02 02 01 European Research Council</p> <p>15 02 02 00 Marie Curie actions on skills, training and career development</p> <p>08 02 02 02 European Research Infrastructures (including eInfrastructures)</p> <p>09 02 02 01 European Research Infrastructures (including eInfrastructures)</p> <p>08 02 02 03 Future and Emerging Technologies</p> <p>09 02 02 02 Future and Emerging Technologies</p> <p><i>Industrial leadership</i></p> <p>08 02 03 01 Leadership in enabling and industrial technologies</p> <p>09 02 03 00 Leadership in enabling and industrial technologies</p> <p>02 02 02 01 Leadership in enabling and industrial technologies</p> <p>08 02 03 02 Access to risk finance</p> <p>02 02 02 02 Access to risk finance</p> <p>08 02 03 03 Innovation in SMEs</p> <p>02 02 02 03 Innovation in SMEs</p> <p><i>Societal challenges</i></p>	DA	YES	YES	YES	YES

³⁷

The JRC requests a new budget line for infrastructure investments. Most of the JRC facilities date from the 60's and 70's and are not state of the art anymore. As a consequence, new facilities and the upgrading of the existing infrastructure are necessary to carry out the JRC multi-annual work-programme in compliance with EU safety and security standards as well as with the EU/20/20/20 environmental objectives. The JRC has established its "Infrastructure Development plan 2014 – 2020"; identifying the investment needs till 2020 for all JRC sites that are reflected in the new budget line proposed.

<p>08 02 04 01 Health, demographic change and wellbeing</p> <p>08 02 04 02 Food security, sustainable agriculture, marine and maritime research and the bio-economy</p> <p>05 02 01 00 Food security, sustainable agriculture, marine and maritime research and the bio-economy</p> <p>08 02 04 03 Secure, clean and efficient energy</p> <p>32 02 02 00 Secure, clean and efficient energy</p> <p>08 02 04 04 Smart, green and integrated transport</p> <p>06 02 02 00 Smart, green and integrated transport</p> <p>08 02 04 05 Climate action, resource efficiency and raw materials</p> <p>07 02 02 00 Climate action, resource efficiency and raw materials</p> <p>02 02 03 01 Climate action, resource efficiency and raw materials</p> <p>08 02 04 06 Inclusive, innovative and secure societies</p> <p>02 02 03 02 Inclusive, innovative and secure societies</p> <p>09 02 04 00 Inclusive, innovative and secure societies</p> <p>10 02 01 00 Non-nuclear direct actions of the Joint Research Centre</p>					
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3.2. Estimated impact on expenditure

3.2.1. Summary of estimated impact on expenditure

EUR million (to 3 decimal places)

Heading of multiannual financial framework:		Number	[Heading 1 - Smart and Inclusive Growth]							
DGs: Research and Innovation / Information Society and Media/ Education and Culture/ Enterprise and Industry/ Agriculture and Rural Development/ Energy/ Mobility and Transport/ JRC direct research/ Environment		2014	2015	2016	2017	2018	2019	2020	=2021	TOTAL
ÿ Operational appropriations										
Horizontal actions										
XX 02 01 01	Commitments	^(1a)	pm	pm	pm	pm	pm	pm	pm	pm
	Payments	^(2a)	pm	pm	pm	pm	pm	pm	pm	pm
08 02 02 01 European Research Council	Commitments	^(1b)	1640,417	1753,575	1879,819	2009,349	2144,525	2284,826	2427,130	14139,641
	Payments	^(2b)	204,154	1055,485	1335,717	1661,563	1868,955	2063,161	2199,449	3751,158
08 02 02 02 European Research Infrastructures (including eInfrastructures)	Commitments	^(1c)	199,794	211,723	225,177	238,964	253,364	268,311	283,451	1680,784
	Payments	^(2c)	24,865	128,015	161,107	199,448	223,066	244,699	259,212	440,372

08 02 02 03 Future and Emerging Technologies**	Commitments	(1d)	283,318	300,310	320,217	469,448	606,917	642,722	678,989		3301,921
	Payments	(2d)	48,847	251,487	316,496	391,819	438,217	480,715	509,225	865,115	3301,921
09 02 02 02 Future and Emerging Technologies**											
08 02 03 01 Leadership in enabling and industrial technologies	Commitments	(1e)	545,193	577,744	614,457	652,078	691,372	732,159	773,472		4586,474
	Payments	(2e)	67,851	349,323	439,624	544,249	608,697	667,728	707,329	1201,673	4586,474
08 02 03 02 Access to risk finance**	Commitments	(1f)	447,955	474,700	504,865	535,776	568,062	601,574	635,520		3768,450
	Payments	(2f)	447,955	474,700	504,865	535,776	568,062	601,574	635,520	0	3768,450
02 02 02 02 Access to risk finance**											
08 02 03 03 Innovation in SMEs**	Commitments	(1g)	78,373	83,053	88,330	93,738	99,387	105,250	111,189		659,320
	Payments	(2g)	9,754	50,216	63,197	78,238	87,502	95,988	101,681	172,744	659,320
02 02 02 03 Innovation in SMEs**											
08 02 04 01 Health, demographic change and wellbeing	Commitments	(1h)	1030,952	1051,848	1073,128	950,146	1398,959	1481,491	1565,088		8551,612
	Payments	(2h)	126,578	651,675	820,134	1015,317	1135,546	1245,671	1319,549	2237,142	8551,612

08 02 04 02 Food security, sustainable agriculture, marine and maritime research and the bio-economy**	Commitments	(1i)	525,695	557,082	592,481	628,757	666,645	705,974	745,810		4422,444
	Payments	(2i)	65,424	336,830	423,901	524,785	586,927	643,848	682,032	1158,697	4422,444
05 02 01 00 Food security, sustainable agriculture, marine and maritime research and the bio-economy**	Commitments	(1i)	732,073	775,781	825,079	875,596	928,359	983,126	1038,601		6158,614
	Payments	(2i)	91,108	469,063	590,317	730,805	817,344	896,610	949,786	1613,580	6158,614
32 02 02 00 Secure, clean and efficient energy**	Commitments	(1k)	861,218	912,637	970,631	1030,059	1092,129	1156,559	1221,820		7245,052
	Payments	(2k)	107,180	551,811	694,454	859,727	961,532	1054,781	1117,337	1898,231	7245,052
08 02 04 04 Smart, green and integrated transport**	Commitments	(1k)	861,218	912,637	970,631	1030,059	1092,129	1156,559	1221,820		7245,052
	Payments	(2k)	107,180	551,811	694,454	859,727	961,532	1054,781	1117,337	1898,231	7245,052
06 02 02 00 Smart, green and integrated transport**											

08 02 04 05 Climate action, resource efficiency and raw materials**	Commitments	(1l)	400,096	423,983	450,925	478,534	507,370	537,302	567,620		3365,830
	Payments	(2l)	49,793	256,354	322,622	399,403	446,698	490,019	519,081	881,860	3365,830
02 02 03 01 Climate action, resource efficiency and raw materials **											
07 02 02 00 Climate action, resource efficiency and raw materials **											
08 02 04 06 Inclusive, innovative and secure societies**	Commitments	(1m)	483,533	512,402	544,963	578,329	613,179	649,353	685,994		4067,754
	Payments	(2m)	60,177	309,815	389,903	482,696	539,855	592,210	627,332	1065,767	4067,754
09 02 04 00 Inclusive, innovative and secure societies**											
02 02 03 02 Inclusive, innovative and secure											

societies**											
09 02 02 01 European Research Infrastructures (including eInfrastructures)	Commitments	(1n)	113,951	120,755	128,428	136,291	144,504	153,029	161,664		958,622
	Payments	(2n)	14,181	73,012	91,886	113,754	127,224	139,562	147,839	251,163	958,622
09 02 03 00 Leadership in enabling and industrial technologies	Commitments	(1o)	1005,176	1065,189	1132,878	1202,241	1274,686	1349,886	1426,056		8456,112
	Payments	(2o)	125,096	644,049	810,537	1003,436	1122,258	1231,095	1304,108	2215,533	8456,112
02 02 02 01 Leadership in enabling and industrial technologies	Commitments	(1p)	194,477	206,088	219,184	232,604	246,620	261,169	275,907		1636,048
	Payments	(2p)	24,203	124,608	156,819	194,140	217,129	238,186	252,313	428,651	1636,048
15 02 02 00 Marie Curie actions on skills, training and career development	Commitments	(1q)	728,274	771,756	820,798	871,052	923,542	978,025	1033,212		6126,659
	Payments	(2q)	90,635	466,629	587,254	727,013	813,103	891,958	944,858	1605,208	6126,659
10 02 01 00 Non-nuclear direct actions of the Joint Research Center	Commitments	(1r)	32,459	33,108	33,771	34,445	35,134	35,838	36,554		241,311
	Payments	(2r)	12,325	27,672	31,582	33,891	34,568	35,261	35,965	30,048	241,311

* An additional amount of EUR 1628,002 million shall be made available for the years 2018-2020 pro-rata from the budgets of the Societal challenges and Leadership in enabling and industrial technologies, on an indicative basis and subject to the review set out in Article 26(1).

** The repartition between DGs is not determined at this stage.

			2014	2015	2016	2017	2018	2019	2020	=2021	TOTAL
ÿ TOTAL operational appropriations	Commitments	(4)	9302,954	9831,734	10425,13	11017,41	12194,75	12926,59	13668,08	0	79366,65
	Payments	(5)	1570,126	6220,744	7740,415	9496,06	10596,68	11613,07	12312,62	19816,94	79366,65
ÿ TOTAL appropriations of an administrative nature financed from the envelope for specific programmes			(6)								
XX 01 05 01 Expenditure related to Research Staff*		(6a)	225,330	229,437	234,401	239,375	244,140	249,023	254,004		1675,710
XX 01 05 02 External staff for Research*		(6b)	163,655	226,831	250,789	281,464	307,748	333,028	367,472		1930,987
XX 01 05 03 Other management expenditure for Research*		(6c)	136,441	160,039	170,285	182,771	193,866	204,350	218,071		1265,823
10 01 05 01 Expenditure related to Research Staff		(6d)	151,686	156,996	162,490	168,178	174,064	180,156	186,461		1180,031
10 01 0,5 02 External staff for Research		(6e)	34,280	35,052	35,840	36,647	37,471	38,314	39,176		256,781
10 01 05 03 Other management expenditure for Research		(6f)	65,312	66,618	67,950	69,309	70,695	72,109	73,551		485,545
10 01 05 04 Other expenditure for major research infrastructures		(6g)	6,551	6,682	6,816	6,952	7,091	7,233	7,378		48,703
ÿ TOTAL administrative appropriations			(6)	783,255	881,655	928,571	984,696	1035,075	1084,213	1146,113	6843,58
TOTAL appropriations under HEADING 1 of the multiannual financial framework	Commitments	=4+ 6	10086,21	10713,39	11353,70	12002,11	13229,83	14010,8	14814,19		86210,23
	Payments	=5+ 6	2353,381	7102,399	8668,986	10480,76	11631,76	12697,28	13458,73	19816,94	86210,23

*** These figures are based on an almost full use of the authorised maximum administrative expenditures foreseen in the legal base. They are presented for illustrative purposes in terms of the numbers of personnel that could be employed with these amounts.**

If more than one heading is affected by the proposal / initiative:

ÿ TOTAL operational appropriations	Commitments	(4)	n.a.							
	Payments	(5)	n.a.							
ÿ TOTAL appropriations of an administrative nature financed from the envelope for specific programmes		(6)	n.a.							
TOTAL appropriations under HEADINGS 1 to 4 of the multiannual financial framework (Reference amount)	Commitments	=4+ 6	n.a.							
	Payments	=5+ 6	n.a.							

Heading of multiannual financial framework:

5

" Administrative expenditure "

EUR million (to 3 decimal places)

		Year N	Year N+1	Year N+2	Year N+3	... enter as many years as necessary to show the duration of the impact (see point 1.6)			TOTAL
DG: <.....>									
Ÿ Human resources		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Ÿ Other administrative expenditure		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
TOTAL DG <.....>		Appropriations		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

TOTAL appropriations under HEADING 5 of the multiannual financial framework		(Total commitments = Total payments)	n.a.							
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EUR million (to 3 decimal places)

		Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	Year =2021	TOTAL
TOTAL appropriations under HEADINGS 1 to 5 of the multiannual financial framework	Commitments	10086,21	10713,39	11353,7	12002,11	13229,83	14010,80	14814,19	0	86210,23
	Payments	2353,381	7102,399	8668,986	10480,76	11631,76	12697,28	13458,73	19816,94	86210,23

3.2.2. Estimated impact on operational appropriations

- " The proposal/initiative does not require the use of operational appropriations
- ρ The proposal/initiative requires the use of operational appropriations, as explained below:

Commitment appropriations in EUR million (to 3 decimal places)/ current prices

Indicate objectives and outputs			Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	TOTAL								
	OUTPUTS																	
	Type of output ³⁸	Average cost of the output	Number of outputs	Cost	Number of outputs	Cost	Number of outputs	Cost	Number of outputs	Cost	Total number of outputs	Total cost						
SPECIFIC OBJECTIVE No 1 ³⁹ Excellent science																		
- Output																		
- Output																		
- Output																		
Sub-total for specific objective N°1 Excellent science			2965,755	3158,119	3374,440	3725,105	4072,852	4326,913	4584,446	26207,628								
SPECIFIC OBJECTIVE No 2 Industrial leadership																		
- Output																		

³⁸ Outputs are products and services to be supplied (e.g.: number of student exchanges financed, number of km of roads built, etc.).

³⁹ As described in Section 1.4.2. "Specific objective(s)..."

Sub-total for specific objective N°2 Industrial leadership			2271,175		2406,774		2559,714		2716,437		2880,127		3050,036		3222,143		19106,407
SPECIFIC OBJECTIVE No 3 Societal challenges																	
- Output																	
Sub-total for specific objective N°3 Societal challenges			4033,56 5		4233,73 1		4457,207		4541,423		5206,640		5513,803		5824,934		33811,304
SPECIFIC OBJECTIVE No 4 Provide integrated and timely scientific and technical support to the European policy making process : Joint Research Centre																	
- Output																	
Sub-total for specific objective N°4 Provide integrated and timely scientific and technical support to the European policy making process : Joint Research Centre			32,459		33,108		33,771		34,445		35,134		35,838		36,554		241,311
TOTAL COST			9302,95 4	0	9831,7 32	0	10425,1 3	0	11017,4 1	0	12194,7 5	0	12926,5 9	0	13668,0 8	0	79366,6 5

3.2.3. Estimated impact on appropriations of an administrative nature

3.2.3.1. Summary

- ☐ The proposal/initiative does not require the use of administrative appropriations
- ☑ The proposal/initiative requires the use of administrative appropriations, as explained below:

EUR million (to 3 decimal places)

	Year 2014 ⁴⁰	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	TOTAL
HEADING 5 of the multiannual financial framework	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Human resources	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Other administrative expenditure	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Subtotal HEADING 5 of the multiannual financial framework	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Outside HEADING 5⁴¹ of the multiannual financial framework								
Human resources*	574,951	648,316	683,520	725,664	763,423	800,521	847,113	5043,509
Other expenditure of an administrative nature*	208,304	233,339	245,051	259,032	271,652	283,692	299	1800,071
Subtotal outside HEADING 5 of the multiannual financial framework	783,255	881,655	928,571	984,696	1035,075	1084,213	1146,113	6843,58
TOTAL**	783,255	881,655	928,571	984,696	1035,075	1084,213	1146,113	6843,58

* These figures are based on an almost full use of the authorised maximum administrative expenditures foreseen in the legal base. They are presented for illustrative purposes in terms of the numbers of personnel that could be employed with these amounts.

** These figures might be adjusted as a result of the envisaged externalisation procedure.

⁴⁰ Year N is the year in which implementation of the proposal/initiative starts.

⁴¹ Technical and/or administrative assistance and expenditure in support of the implementation of EU programmes and/or actions (former "BA" lines), indirect research, direct research.

3.2.3.2. Estimated requirements of human resources

- ☐ The proposal/initiative does not require the use of human resources
- ☑ The proposal/initiative requires the use of Commission human resources, as explained below:

Estimate expressed in full amounts (or at most to one decimal place)

	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020
Ÿ Establishment plan posts (officials and temporary agents)							
XX 01 01 01 (Headquarters and Commission's Representation Offices)	100	100	100	100	100	100	100
XX 01 01 02 (Delegations)							
XX 01 05 01 (Indirect research)**	1677.5	1677.5	1677.5	1677.5	1677.5	1677.5	1677.5
10 01 05 01 (Direct research)	1390	1390	1390	1390	1390	1390	1390
Ÿ External personnel (in Full Time Equivalent unit: FTE)⁴²							
XX 01 02 01 (CA, INT, SNE from the "global envelope")							
XX 01 02 02 (CA, INT, JED, LA and SNE in the delegations)							
XX 01 04 yy ₄₃	- at Headquart ers ⁴⁴						
	- in delegation s						
XX 01 05 02 (CA, INT, SNE - Indirect research)*	865	865	865	865	865	865	865
10 01 05 02 (CA, INT, SNE - Direct research)	593	593	593	593	593	593	593

⁴² CA= Contract Agent; INT= agency staff ("*Intérimaire*"); JED= "*Jeune Expert en Délégation*" (Young Experts in Delegations); LA= Local Agent; SNE= Seconded National Expert;

⁴³ Under the ceiling for external personnel from operational appropriations (former "BA" lines).

⁴⁴ Essentially for Structural Funds, European Agricultural Fund for Rural Development (EAFRD) and European Fisheries Fund (EFF).

Other budget lines (specify)							
TOTAL	4625.5						

* The above figures will be adjusted in accordance with the results of the envisaged externalisation process.

** The workload corresponding to the implementation of EIT and Innovation is estimated at some 100 establishment plan posts for the Commission.

XX is the policy area or budget title concerned.

The human resources required will be met by staff from the DG who are already assigned to management of the action and/or have been redeployed within the DG, together if necessary with any additional allocation which may be granted to the managing DG under the annual allocation procedure and in the light of budgetary constraints.

Description of tasks to be carried out:

Officials and temporary agents	The total number of officials and temporary agents will be used to contribute to the objectives of Horizon 2020 during all the process, from the preparation of the Work Programme to the final dissemination of results during 2014-2020. These human resources include all the needs in the various management modes as indicated in point 1.7 of the LFS
External personnel	The total number of external personnel will assist officials and temporary agents to contribute to the objectives of Horizon 2020 during all the process, from the preparation of the Work Programme to the final dissemination of results during 2014-2020. These human resources include all the needs in the various management modes as indicated in point 1.7 of the LFS

3.2.4. *Compatibility with the current multiannual financial framework*

- Proposal/initiative is compatible the current multiannual financial framework.
- Proposal/initiative will entail reprogramming of the relevant heading in the multiannual financial framework.

Not applicable .

- Proposal/initiative requires application of the flexibility instrument or revision of the multiannual financial framework⁴⁵.

Not applicable .

3.2.5. *Third-party contributions*

- The proposal/initiative provides for the co-financing estimated below:

Appropriations in EUR million (to 3 decimal places)

⁴⁵ See points 19 and 24 of the Interinstitutional Agreement.

	Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020	Total
Specify the co-financing body	Third countries associated to the programme							
TOTAL appropriations co-financed *	pm							

* Bilateral Association Agreements are not fixed yet and that is why they will be added at a later stage.

3.3. Estimated impact on revenue

- ☐ Proposal/initiative has no financial impact on revenue.
- ☐ Proposal/initiative has the following financial impact:
 - ☐ on own resources
 - ☐ on miscellaneous revenue

EUR million (to 3 decimal places)

Budget revenue line:	Appropriations available for the ongoing budget year	Impact of the proposal/initiative ^{46*}						
		Year 2014	Year 2015	Year 2016	Year 2017	Year 2018	Year 2019	Year 2020
Item 6011								
Item 6012		pm	pm	pm	pm	pm	pm	pm
Item 6013								
Item 6031								

* Bilateral Association Agreements are not fixed yet and that is why they will be added at a later stage.

For miscellaneous assigned revenue, specify the budget expenditure line(s) affected.

02 03 01 Appropriations accruing from contributions form third parties
 05 03 01 Appropriations accruing from contributions from third parties
 06 03 01 Appropriations accruing from contributions form third parties
 07 03 01 Appropriations accruing from contributions form third parties
 08 04 01 Appropriations accruing from contributions form third parties
 09 03 01 Appropriations accruing from contributions form third parties
 10 02 02 Appropriations accruing from contributions form third parties
 15 03 01 Appropriations accruing from contributions form third parties
 32 03 01 Appropriations accruing form contributions from third parties

Specify the method for calculating the impact on revenue.

Certain associated states may contribute to a supplementary funding of the framework programme through association agreements. The method of calculation

⁴⁶ As regards traditional own resources (customs duties, sugar levies), the amounts indicated must be net amounts, i.e. gross amounts after deduction of 25% for collection costs.

will be agreed in these Association Agreements and is not necessarily the same in all agreements. Mostly the calculations are based on the GDP of the Associated State compared to the GDP of the Member States whilst applying this percentage to the overall budget voted.