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 systems[20]. 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, wireless[22] 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 CO_2 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