PART II
INDUSTRIAL LEADERSHIP

1. LEADERSHIP IN ENABLING AND INDUSTRIAL TECHNOLOGIES

The specific objective is to maintain and build global leadership in enabling technologies and space research and innovation, which underpin competitiveness across a range of existing and emerging industries and sectors.

The global business environment is changing rapidly and the Europe 2020 goals for smart, sustainable and inclusive growth present challenges and opportunities to European industry. Europe needs to accelerate innovation, transforming the knowledge generated to underpin and enhance existing products, services and markets; and to create new ones. Innovation should be exploited in the widest sense, going beyond technology to include business, organisational and social aspects.

To stay at the forefront of global competition with a strong technological base and industrial capabilities, increased strategic investments in research, development, validation and piloting are required in Information and Communication Technologies (ICT); Nanotechnologies; Advanced Materials; Biotechnology; Advanced Manufacturing and Processing; and Space.

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 hi-tech application sectors and the ability to develop effective solutions for societal challenges. The pervasive nature of such activities can spur further progress through complementary inventions and applications, ensuring a higher return on investment in these technologies than in any other field.

These activities will contribute to the objectives of the Europe 2020 Flagship initiatives on Innovation Union, Resource Efficient Europe, An industrial policy for the globalisation era, and A Digital Agenda for Europe as well as Union space policy objectives.

Complementarities with other activities in Horizon 2020

The activities under 'Leadership in Enabling and Industrial Technologies' will be primarily based on research and innovation agendas defined by industry and business, together with the research community and have a strong focus on leveraging private sector investment.

The integration of enabling technologies in solutions for the societal challenges shall be supported together with the relevant challenges. Applications of enabling technologies that do not fall under the societal challenges, but are important for reinforcing the competitiveness of European industry, shall be supported under 'Leadership in Enabling and Industrial Technologies'.

A common approach

The approach shall include both agenda-driven activities and more open areas to promote innovative projects and breakthrough solutions. Emphasis shall be on R&D, large-scale pilots

and demonstration activities, test beds and living labs, prototyping and product validation in pilot lines. Activities shall be designed to boost industrial competitiveness by stimulating industry, and in particular SMEs, to make more research and innovation investment.

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[22]. These multi-disciplinary, knowledge and capital-intensive technologies cut across many diverse sectors providing the basis for significant competitive advantage for European industry. An integrated approach, promoting the combination, convergence and cross-fertilisation effect of KETs in different innovation cycles and value chains can deliver promising research results and open the way to new industrial technologies, products, services and novel applications (e.g. in space, transport, environment, health etc.). The numerous interactions of KETs and enabling technologies will therefore be exploited in a flexible manner, as an important source of innovation. This will complement support for research and innovation in KETs that may be provided by national or regional authorities under the Cohesion Policy Funds within the framework of smart specialisation strategies.

For all the enabling and industrial technologies, including the KETs, a major aim will be to foster interactions between the technologies, and with the applications under the societal challenges. This shall be fully taken into account in developing and implementing the agendas and priorities. It requires that stakeholders representing the different perspectives are fully involved in priority setting and implementation. In certain cases, it will also require actions that are jointly funded by the enabling and industrial technologies, and by the relevant societal challenges. This will include joint funding for public-private partnerships that aim to develop technologies and apply them to address societal challenges.

ICT plays an important role as it embraces some of the KETs and provides the key basic infrastructures, technologies and systems for vital economic and social processes and new private and public products and services. European industry needs to remain at the cutting edge of technological developments in ICT, where many technologies are entering a new disruptive phase, opening up new opportunities.

Space is a rapidly growing sector which delivers information vital to many areas of modern society, meeting its fundamental demands, addresses universal scientific questions, and serves to secure the Union's position as a major player on the international stage. Space research underpins all activities undertaken in space, but is currently fragmented in national programmes run by a subset of Union member states. Union level coordination and investment in space research are required (cf. Article 189 TFEU) to maintain the competitive edge, to safeguard Union space infrastructure such as Galileo and to sustain a future role for the Union in space. In addition, innovative downstream services and applications using space derived information represent an important source of growth and job creation.

[22] COM(2009)512

Partnering and added value

Europe can achieve critical mass through partnering, clusters and networks, standardisation, promoting cooperation between different scientific and technological disciplines and sectors with similar research and development needs, leading to breakthroughs, new technologies and innovative solutions.

The development and implementation of research and innovation agendas through public–private partnerships, the building of effective industry-academia links, the leveraging of additional investments, the access to risk finance, standardisation and the support to pre-commercial procurement and the procurement of innovative products and services are all aspects that are essential in addressing competitiveness.

In this regard, strong links with the EIT are also needed to breed entrepreneurial top talents and to speed up innovation by bringing together people from different countries, disciplines and organisations.

Union level collaboration can also support trade opportunities through the development of European or international standards for new emerging products and services and technologies. Activities in support of standardisation and interoperability, safety and pre-regulatory activities will be promoted.

1.1. Information and Communication Technologies (ICT)

1.1.1. Specific objective for ICT

In line with the Digital Agenda for Europe[23], the specific objective of ICT research and innovation (R&I) is to enable Europe to develop and exploit the opportunities brought by ICT progress for the benefits of its citizens, businesses and scientific communities.

As the world's largest economy and representing the largest share of the world's ICT market, today at more than EUR 2600 billion, Europe can have legitimate ambitions for its businesses, governments, research and development centres and universities to lead developments in ICT, to grow new business, and to invest more in ICT innovations.

By 2020, Europe's ICT sector should supply at least the equivalent of its share of the global ICT market, today at about one third. Europe should also grow innovative businesses in ICT so that one third of all business expenditure in ICT R&D, today at more than EUR 35 billion per year, is invested by companies created within the last two decades. This would require a considerable increase in public investments in ICT R&D in ways that leverage private spending, towards the goal of doubling investments in the next decade, and significantly more European poles of world-class excellence in ICT.

To master increasingly complex and multidisciplinary technology and business chains in ICT, partnering, risk-sharing and mobilisation of critical mass across the Union are needed. Union level action helps industry address a single market perspective and achieve economies of scale and scope. Collaboration around common, open technology platforms with spill-over and leverage effects allow a wide range of stakeholders to benefit from new developments and apply further innovations. Federating and partnering at Union level also enables consensus

[23] COM(2010) 245

building, establishes a visible focal point for international partners, and leads to the development of Union- and world-wide standards and interoperable solutions.

1.1.2. Rationale and Union added value

ICT underpins innovation and competitiveness across a broad range of private and public markets and sectors, and enables scientific progress in all disciplines. Over the next decade, the transformative impact of digital technologies, ICT components, infrastructures and services will be increasingly visible in all areas of life. Unlimited computing, communication and data storage resources will be available to every citizen on the globe. Vast amounts of information and data will be generated by sensors, machines and information-enhanced products, making action at a distance a commonplace, enabling global deployment of business processes and sustainable production sites and bringing a wide range of services and applications. Many critical commercial and public services and all key processes of knowledge production in science, learning, business and the public sector will be provided through ICT. ICT will provide the critical infrastructure for production and business processes, communication and transactions. ICT will also be indispensable in contributing to key societal challenges , as well as societal processes such as community formation, consumer behaviour, and public governance, for example by means of social media.

The Union support to ICT research and innovation is a significant component to prepare the next generation technologies and applications as it makes up a large part of total spending on collaborative, mid-to-high risk R&I in Europe. Public investment in ICT research and innovation at Union level has been and remains essential to mobilise the critical mass leading to breakthroughs and to a wider uptake and better use of innovative solutions, products and services. It continues to play a central role in developing open platforms and technologies applicable across the Union, in testing and piloting innovations in real pan-European settings and in optimising resources when addressing Union competitiveness and tackling common societal challenges. Union support to ICT research and innovation is also enabling high-tech SMEs to grow and capitalise on the size of Union-wide markets. It is strengthening collaboration and excellence amongst Union scientists and engineers, reinforcing synergies with and between national budgets, and acting as a focal point for collaboration with partners outside Europe.

Successive evaluations of ICT activities in the Union's Framework Programme for research and innovation have shown that focused ICT research and innovation investment undertaken at Union level has been instrumental in building industrial leadership in areas like mobile communications, safety-critical ICT systems, and to address challenges like energy-efficiency or demographic change. Union investments in ICT research infrastructures have provided European researchers with the world's best research networking and computing facilities.

1.1.3. Broad lines of the activities

A number of activity lines shall target ICT industrial and technological leadership challenges and cover generic ICT research and innovation agendas, including notably:

(a) *A new generation of components and systems:* Engineering of advanced and smart embedded components and systems*;*

(b) *Next generation computing:* Advanced computing systems and technologies*;*

(c) *Future Internet:* Infrastructures, technologies and services*;*

(d) *Content technologies and information management*: ICT for digital content and creativity;

(e) *Advanced interfaces and robots*: Robotics and smart spaces;

(f) *Micro- and nanoelectronics and photonics:* Key enabling technologies related to micro- and nanoelectronics and to photonics.

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.

These six activity lines shall also include 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 systems, including equipment, tools, support services, clean rooms and access to foundries for prototyping.

1.2. Nanotechnologies

1.2.1. Specific objective for nanotechnologies

The specific objective of nanotechnologies research and innovation is to secure Union leadership in this high growth global market, by stimulating investment in nanotechnologies and their uptake in high added-value, competitive products and services across a range of applications and sectors.

By 2020, nanotechnologies will be mainstreamed, that is seamlessly integrated with most technologies and applications, driven by consumer benefits, quality of life, sustainable development and the strong industrial potential for achieving previously unavailable solutions for productivity and resource efficiency.

Europe must also set the global benchmark on safe and responsible nanotechnology deployment and governance ensuring both high societal and industrial returns.

Products using nanotechnologies represent a world market which Europe cannot afford to ignore. Market estimates of the value of products incorporating nanotechnology as the key component reach EUR 700 billion by 2015 and EUR 2 trillion by 2020, with a corresponding 2 and 6 million jobs respectively. Europe's nanotechnology companies should exploit this double digit market growth and be capable of capturing a market share at least equal to Europe's share of global research funding (i.e. a quarter) by 2020.

1.2.2. Rationale and Union added value

Nanotechnologies are a spectrum of evolving technologies with proven potential, having revolutionary impact in for example materials, ICT, life sciences and healthcare and consumer goods once the research is translated into breakthrough products and production processes.

Nanotechnologies have a critical role to play in addressing the challenges identified by the Europe 2020 strategy for smart, sustainable and inclusive growth. The successful deployment

of these key enabling technologies will contribute to the competitiveness of Union industry by enabling novel and improved products or more efficient processes and provide responses to future challenges.

The global research funding for nanotechnologies has doubled from around EUR 6.5 billion in 2004 to around EUR 12.5 billion in 2008, with the Union accounting for about a quarter of this total. The Union has recognised research leadership in nanosciences and nanotechnologies with a projection of some 4000 companies in the Union by 2015.

Europe now needs to secure and build on its position in the global market by promoting wide scale cooperation in and across many different value chains and between different industrial sectors to realise the process scale-up of these technologies into viable commercial products. The issues of risk assessment and management as well as responsible governance are emerging as determining factors of future impact of nanotechnologies on society and the economy.

Thus, the focus of activities shall be on the widespread and responsible application of nanotechnologies into the economy, to enable benefits with high societal and industrial impact. To ensure the potential opportunities, including setting-up new companies and generating new jobs, research should provide the necessary tools to allow for standardisation and regulation to be correctly implemented.

1.2.3. Broad lines of the activities

(a) Developing next generation nanomaterials, nanodevices and nanosystems

Aiming at fundamentally new products enabling sustainable solutions in a wide range of sectors.

(b) Ensuring the safe development and application of nanotechnologies

Advancing scientific knowledge of the potential impact of nanotechnologies and nanosystems on health or on the environment, and providing tools for risk assessment and management along the entire life cycle.

(c) Developing the societal dimension of nanotechnology

Focusing on governance of nanotechnology for societal benefit.

(d) Efficient synthesis and manufacturing of nanomaterials, components and systems

Focusing on new 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.

(e) Developing capacity-enhancing techniques, measuring methods and equipment

Focusing on the underpinning technologies supporting the development and market introduction of complex nanomaterials and nanosystems.

1.3. Advanced materials

1.3.1. Specific objective for advanced materials

The specific objective of advanced materials research and innovation is to develop materials with new functionalities and improved in-service performance, for more competitive products that minimise the impact on the environment and the consumption of resources.

Materials are at the core of industrial innovation and are key enablers. Advanced materials with higher knowledge content, new functionalities and improved performance are indispensable for industrial competitiveness and sustainable development across a range of applications and sectors

1.3.2. Rationale and Union added value

New advanced materials are needed in developing better performing and sustainable products and processes. Such materials are a part of the solution to our industrial and societal challenges, offering better performance in their use, lower resource and energy requirements, and sustainability at the end-of-life of the products.

Application-driven development often involves the design of totally new materials, with the ability to deliver planned in-service performances. Such materials are an important element in the supply chain of high value manufacturing. They are also the basis for progress in cross-cutting technology areas (for example biosciences, electronics and photonics), and in virtually all market sectors. The materials themselves represent a key step in increasing the value of products and their performance. The estimated value and impact of advanced materials is significant, with an annual growth rate of about 6 % and expected market size of the order of EUR 100 billion by 2015.

Materials shall be conceived according to a full life-cycle approach, from the supply of available materials to end of life (cradle to cradle), with innovative approaches to minimise the resources required for their transformation. Continuous use, recycling or secondary end-of-life utilisation of the materials shall also be covered as well as related societal innovation.

To accelerate progress, a multidisciplinary and convergent approach shall be fostered, involving chemistry, physics, engineering sciences, theoretical and computational modelling, biological sciences and increasingly creative industrial design.

Novel green innovation alliances and industrial symbiosis shall be fostered allowing industries to diversify, expand their business models, re-using their waste as a basis for new productions, e.g. CO_2 as carbon base for fine chemicals and alternative fuels.

1.3.3. Broad lines of the activities

(a) Cross-cutting and enabling materials technologies

Research on functional materials, multifunctional materials and structural materials, for innovation in all industrial sectors.

(b) Materials development and transformation

Research and development to ensure efficient and sustainable scale up to enable industrial manufacturing of future products

(c) Management of materials components

Research and development for new and innovative techniques and systems.

(d) Materials for a sustainable and low-carbon industry

Developing new products and applications, and consumer behaviour that reduce energy demand, and facilitate low-carbon production.

(e) Materials for creative industries

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

(f) 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.

(g) 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. Specific objective for biotechnology

The specific objective of biotechnology research and innovation is to develop competitive, sustainable and innovative industrial products and processes and contribute as an innovation driver in a number of European sectors like agriculture, food, chemical and health.

A strong scientific, technological and innovation base in biotechnology, will support European industries securing leadership in this key enabling technology. This position will be further strengthened by integrating the safety assessment and management aspects of the overall risks in the deployment of biotechnology.

1.4.2. Rationale and Union added value

Powered by the expansion of the knowledge of living systems, biotechnology is set to deliver a stream of new applications and to strengthen the Union's industrial base and its innovation capacity. Examples of the rising importance of biotechnology are in industrial applications including bio-chemicals, of which the market share is estimated to increase by up to 12 %-20 % of chemical production by 2015. A number of the so-called twelve rules of *Green Chemistry* are also addressed by biotechnology, due to the selectivity and efficiency of bio-systems. The possible economic burdens for Union enterprises can be reduced by harnessing

the potential of biotechnology processes and bio-based products to reduce CO_2 emissions, estimated to range from between 1 to 2.5 billion tons CO_2 equivalent per year by 2030.In Europe's biopharmaceutical sector, already some 20 % of the current medicines are derived from biotechnology, with up to 50 % of new medicines. Biotechnology also opens new avenues for exploiting the huge potential of marine resources for producing innovative industrial, health and environmental applications. The emerging sector of marine (blue) biotechnology has been predicted to grow by 10 % a year.

Other key sources of innovation are at the interface between biotechnology and other enabling and converging technologies, in particular nanotechnologies and ICT, with applications such as sensing and diagnosing.

1.4.3. Broad lines of the activities

(a) Boosting cutting-edge biotechnologies as a future innovation driver

Development of emerging technology areas such as synthetic biology, bioinformatics and systems biology, which hold great promise for completely novel applications.

(b) Biotechnology-based industrial processes

Developing industrial biotechnology for competitive industrial products and processes (e.g. chemical, health, mining, energy, pulp and paper, textile, starch, food processing) and its environmental dimension.

(c) Innovative and competitive platform technologies

Development of platform technologies (e.g. genomics, meta-genomics, proteomics, molecular tools) to enhance leadership and competitive advantage in a wide number of economic sectors.

1.5. Advanced manufacturing and processing

1.5.1. Specific objective

The specific objective of advanced manufacturing and processing research and innovation is to transform today's industrial forms of production towards more knowledge intensive, sustainable, trans-sectoral manufacturing and processing technologies, resulting in more innovative products, processes and services.

1.5.2. Rationale and Union added value

The manufacturing sector is of high importance to the European economy, contributing to around 17 % of GDP and accounting for some 22 million jobs in the Union in 2007. With the lowering of economic barriers to trade and the enabling effect of communications technology, manufacturing is subject to strong competition and has been gravitating to countries of lowest overall cost. Due to high wages, the European approach to manufacturing therefore has to change radically to remain globally competitive and Horizon 2020 can help bring together all the relevant stakeholders to achieve this.

Europe needs to continue to invest at an Union level to maintain European leadership and competence in manufacturing technologies and make the transition to high-value, knowledge-

intensive goods, creating the conditions and assets for sustainable, production and provision of lifetime service around a manufactured product. Resource intensive manufacturing and process industries need to further mobilise resources and knowledge at Union level and continue to invest in research, development and innovation to enable further progress towards a competitive low carbon economy and to comply with the agreed Union wide reductions in greenhouse gas emissions by 2050 for industrial sectors[24].

With strong Union policies, Europe would grow its existing industries and nurture the emerging industries of the future. The estimated value and impact of the sector of advanced manufacturing systems is significant, with an expected market size around EUR 150 billion by 2015 and compound annual growth rate of about 5 %.

It is crucial to retain knowledge and competence in order to keep manufacturing and processing capacity in Europe. The emphasis of the research and innovation activities shall be on sustainable manufacturing and processing, introducing the necessary technical innovation and customer-orientation to produce high knowledge content products and services with low material and energy consumption. Europe also needs to transfer these enabling technologies and knowledge to other productive sectors, such as construction, which is a major source of greenhouse gases (GHG) with building activities accounting for around 40 % of all energy consumption in Europe, giving rise to 36 % of the CO_2 emissions. The construction sector, generating 10 % of GDP and providing some 16 million jobs in Europe in 3 million enterprises, of which 95 % are SMEs, needs to adopt innovative materials and manufacturing approaches to mitigate its environmental impact.

1.5.3. Broad lines of the activities

(a) 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.

(b) Technologies enabling Energy-efficient buildings

Reducing energy consumption and CO_2 emissions by the development and deployment of sustainable construction technologies.

(c) Sustainable and low-carbon technologies in energy-intensive process industries

Increasing the competitiveness of process industries, by drastically improving resource and energy efficiencies and reducing the environmental impact of such industrial activities through the whole value chain, promoting the adoption of low-carbon technologies.

(d) New sustainable business models

Deriving concepts and methodologies for adaptive, 'knowledge-based' business models in customised approaches.

[24] COM(2011) 112 final

1.6. Space

1.6.1. Specific objective for space

The specific objective of space research and innovation is to foster a competitive and innovative space industry and research community to develop and exploit space infrastructure to meet future Union policy and societal needs.

Strengthening the European space sector by boosting space research and innovation is vital to maintain and safeguard Europe's capability of access to and operations in space in support of Union policies, international strategic interests and competitiveness amongst established and emerging space faring nations.

1.6.2. Rationale and Union added value

Space is an important, but frequently invisible enabler of diverse services and products crucial to modern day society, such as navigation, communication, weather forecasts, and geographic information. Policy formulation and implementation at European, national and regional levels increasingly depend on space-derived information. The global space sector is rapidly growing and expanding into new regions (e.g. China, South America). European industry is at present a considerable exporter of first class satellites for commercial and scientific purposes. Increasing global competition is challenging Europe’s position in this area. Thus Europe has an interest in ensuring that its industry continues to thrive in this fiercely competitive market In addition, data from European science satellites have resulted in some of the most significant scientific breakthroughs in the last decades in Earth sciences and astronomy. With this unique capacity, the European space sector has a critical role to play in addressing the challenges identified by Europe 2020.

Research, technology development and innovation underpin capacities in space which are vital to European society. While the United States of America spends around 25 % of their space budget on R&D, the Union spends less than 10 %. Moreover, space research in the Union is fragmented in the national programmes of a few Member States. To maintain the technological and competitive edge Union level action is needed to coordinate space research, to promote the participation of researchers from all Member States, and to lower the barriers for collaborative space research projects across national borders. This needs to be done in coordination with the European Space Agency, which has successfully managed industrial satellite development and deep space missions on an intergovernmental basis with a subset of the Member States since 1975. In addition, the information provided by European satellites will offer an increasing potential for further development of innovative satellite-based downstream services. This is a typical activity sector for SMEs and should be supported by research and innovation measures in order to reap the full benefits of this opportunity, and especially of the considerable investments made on the two Union flagships Galileo and GMES.

Space naturally transcends terrestrial boundaries, providing a unique vantage point of global dimension, thus giving rise to large scale projects which (e.g. International Space Station, Space Situational Awareness) are carried out in international co-operation. To play a significant role in such international space activities in the next decades, both a common European space policy and European level space research and innovation activities are indispensible.

Space research and innovation under Horizon 2020 aligns with the Union space policy priorities as they continue to be defined by the Union Space Councils and the European Commission[25].

1.6.3. Broad lines of the activities

(a) Enabling European competitiveness, non-dependence and innovation of the European space sector

This entails safeguarding and developing a competitive and entrepreneurial space industry in combination with a world-class space research community to maintain European leadership and non-dependence in space technology, to foster innovation in the space sector, and to enable space-based terrestrial innovation, for example by using remote sensing and navigation data.

(b) Enabling advances in space technologies

This aims at developing advanced space technologies and operational concepts from idea to demonstration in space, including navigation and remote sensing, as well as the protection of space assets from threats such as debris and solar flares. To develop and apply advanced space technologies requires the continuous education and training of highly skilled engineers and scientists.

(c) Enabling exploitation of space data

A considerably increased exploitation of data from European satellites can be achieved if a concerted effort is made to coordinate and organise the processing, validation and standardisation of space data. Innovations in data handling and dissemination can also ensure a higher return on investment of space infrastructure, and contribute to tackling societal challenges, in particular if coordinated in a global effort such as through Global Earth Observation System of Systems, the European satellite navigation programme Galileo or IPCC for climate change issues.

(d) Enabling European research in support of international space partnerships

Space undertakings have a fundamentally global character. This is particularly clear for activities such as Space Situational Awareness (SSA), and many space science and exploration projects. The development of cutting edge space technology is increasingly taking place within such international partnerships. Ensuring access to these constitutes an important success factor for European researchers and industry.

[25] COM(2011) 152