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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

"Preparing for our future: Developing a common strategy for key enabling technologies in the EU"

{SEC(2009) 1257}

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1. THE IMPORTANCE OF KEY ENABLING TECHNOLOGIES FOR SOCIETY AND ECONOMY

The shape and potential of industries worldwide will be transformed over the next 5 to 10 years. New goods and services will be created. A significant part of the goods and services that will be available in the market in 2020 are as yet unknown, but the main driving force behind their development will be the deployment of key enabling technologies (KETs). Those nations and regions mastering these technologies will be at the forefront of managing the shift to a low carbon, knowledge-based economy, which is a precondition for ensuring welfare, prosperity and security of its citizens. Hence the deployment of KETs in the EU is not only of strategic importance but is indispensible.[1]

Indeed, the EU needs a strong innovative performance in order to equip itself with all the means needed to address major societal challenges ahead, such as fighting climate change, overcoming poverty, fostering social cohesion and improving resource and energy efficiency. Following this path will enable the EU to grasp global opportunities, while at the same time offering sustainable employment opportunities with high quality jobs. KETs are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly-skilled employment. They enable process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration. KETs can assist technology leaders in other fields to capitalise on their research efforts.

The market is highly competitive and technologies are typically created within a business environment, where SMEs play an important role, especially by providing inputs and innovative solutions to global companies. Therefore, building synergies and reaching critical mass is important. Moreover, as research in KETs often takes place in close proximity to assembly and production sites, deployment in industries in the EU should result in a modernisation of the industrial base and in the further strengthening of the research base in Europe. While the required R&D and its specific applications are primarily the responsibility of businesses, policy makers need to put in place the right framework conditions and support instruments for strengthening the EU's industrial capacities for the development of KETs.

[1] The Conclusions of the Competitiveness Council of 28 May 2009 pointed out "that it is of particular importance to maintain strong R&D investments in high-tech industries in Europe. They provide the most important manufacturing sectors with indispensable technologies" and looked forward "to the Commission's initiative to develop a pro-active policy for enabling high-tech industries".

Currently the EU has very good research and development capacities in some key enabling technology areas; however it is not as successful in commercialising research results through manufactured goods and services. Improving this situation requires a more strategic approach to research, innovation and capitalisation. Moreover, until now, there has been no shared understanding within the EU on exactly what should be considered to be a KET. The EU already presented a more strategic approach in some areas such as in life sciences and biotechnology, nanosciences and nanotechnologies or energy technologies.[2] But there is no coherent strategy on a European level on how these technologies can be better brought to industrial deployment. This Communication therefore tries to launch a process of identifying the KETs that strengthen the EU's industrial and innovation capacity to address the societal challenges ahead and it proposes a set of measures to improve the related framework conditions. As such, it forms part of the development of EU industrial policy and of the preparation for the new European plan for innovation.[3]

2. IDENTIFYING KEY ENABLING TECHNOLOGIES

Several Member States have started to identify enabling technologies that are relevant to their future competitiveness and prosperity and to target their R&D spending accordingly (see SEC (2009) 1257). However, there are differences between Member States on what should be regarded as KETs, which might be explained by the strengths and limits of their research and industrial landscapes. Discussions have been also taken place at European level but have so far not led to a shared understanding on which of these technologies needs a more strategic cooperation to improve industrial competitiveness.[4] According to the latest Science, Technology and Competitiveness report, leading countries such as China, Japan and the US are also focusing on enabling technologies, especially biotechnology, ICT and nanotechnology.[5] Within ICT, specific fields such as micro- and nanoelectronics and photonics deserve immediate policy actions given the situation of the EU industry in global competition and the challenges stemming from the economic crisis.[6] Carbon capture and storage systems (CCS) is another activity on which the EU has offered cooperation to international partners, hence it must itself possess the necessary, affordable technologies.

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2 "Life sciences and biotechnology – A Strategy for Europe" COM(2002)27, "Nanosciences and nanotechnologies: An action plan for Europe 2005-2009" COM(2005) 243 and a European strategic energy technology plan (SET Plan) COM(2007) 723

3 The Conclusions of the European Council of 12 December 2008 calls for "the launching of a European plan for innovation … encompassing all the conditions for sustainable development and the main technologies of the future".

4 Synthesis report of the key technologies expert group (2005); Creative system disruption: towards a research strategy beyond Lisbon.

5 Science, Technology and Competitiveness key figures report 2008/2009.

6 Other important ICT areas, such as software and communication technologies, including the development of Future Internet or high-speed broadband are supported by separate EU initiatives and are therefore not in the focus of this Communication; see for instance, A Strategy for ICT R&D and Innovation in Europe: Raising the Game COM (2009) 116.

Based on current global research and market trends the following could be regarded as the most strategically relevant KETs, given their economic potential, contribution to solving societal challenges and knowledge intensity :[7]

Nanotechnology holds the promise of leading to the development of smart nano and micro devices and systems and to radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing;

Micro- and nanoelectronics, including semiconductors, are essential for all goods and services which need intelligent control in sectors as diverse as automotive and transportation, aeronautics and space. Smart industrial control systems permit more efficient management of electricity generation, storage, transport and consumption through intelligent electrical grids and devices;

Photonics is a multidisciplinary domain dealing with light, encompassing its generation, detection and management. Among other things it provides the technological basis for the economical conversion of sunlight to electricity which is important for the production of renewable energy, and a variety of electronic components and equipment such as photodiodes, LEDs and lasers.

Advanced materials offer major improvements in a wide variety of different fields, e.g. in aerospace, transport, building and health care. They facilitate recycling, lowering the carbon footprint and energy demand as well as limiting the need for raw materials that are scarce in Europe;

Biotechnology brings cleaner and sustainable process alternatives for industrial and agri-food operations. It will for example allow the progressive replacement of non-renewable materials currently used in various industries with renewable resources, however the scope of applications is just at the beginning;

The potential of these technologies is largely untapped. Increasingly systemic solutions will need to evolve in order to address major societal challenges, such as ensuring high-speed communication, ensuring food supply, the environment, finding appropriate transport solutions, ensuring high levels of health care for an ageing population, unlocking the potential of services, ensuring internal and external security and addressing the energy question. Low carbon technologies and applications will play a vital role in reaching European energy and climate change targets. For instance, CCS and CO_2-related transport grids will be needed to reduce CO_2 emission in countries that will continue to rely heavily on fossil energy sources. KETs, such as new materials for energy production, transportation and storage play an essential role. They could lead to better resource and energy efficiency and their environmental impact needs to be assessed in a life-cycle perspective, taking advantage of the related initiatives promoted at EU level in this context.[8] For a rounded policy approach to KETs, legitimate health and environmental consequences also need to be actively addressed.

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7 For a more in depth analysis of the various KETs, see the accompanying Staff Working Paper (SEC (2009) 1257)

8 See the Integrated Product Policy Communication COM (2003) 302; The Strategic Energy Technology Plan COM (2007) 723 has the main objective to accelerate the development of key technologies such as CCS and renewable technologies; The European Energy Research Alliance (EERA) launched within the framework

In the supply chain of KETs, advanced manufacturing systems are important to produce high value marketable knowledge-based goods and the related services (e.g. modern robotics). This is especially relevant in capital intensive industries with complex assembly methods such as the production and assembly of modern aircraft which involves the whole spectrum of manufacturing technologies from the simulation and programming of robotic assembly lines to reducing energy and materials consumption. Given the rapid development in science and research the above technologies may rapidly become global in the years to come and other technologies may emerge. A detailed description of these technologies including their estimated current market potential is presented in the SEC (2009) 1257.

3. REPORT ON PROGRESS, ACHIEVEMENTS AND CHALLENGES

Overall, the EU has an R&D intensity of only 25% in high-tech manufacturing compared to 30% in the US. Moreover the high tech share within total manufacturing industry in Japan is 33% larger and in the US even 50% larger than in Europe. High-tech industries are the most R&D intensive, where manufacturing and research efforts need to be integrated to safeguard the longer term success of both. Therefore, both the smaller share of high tech industry in the EU and its relatively smaller R&D intensity also explain the gap in the deployment of KETs between the EU and the US and Japan.[9] The EU however has strengths in some enabling high technologies due to its good research and industrial base. This is particularly true for the advanced materials that underpin the EU's competitiveness in the chemical, automotive, mechanical engineering, aeronautics and space industries. The EU also has significant research and industrial strengths in nano- and microelectronics, industrial biotech and photonics. In nanotechnology, still an emerging technology, the EU has similar levels of R&D spending to the US but with a much lower private sector share (see SEC (2009) 1257).

In fact the EU faces significant obstacles in achieving a wider deployment of these KETs. In particular, the EU has been less effective than the US and some Asian countries in terms of commercialisation and exploitation of nanotechnologies, some aspects of photonics, biotechnology or semiconductors. These are all areas where substantial public R&D efforts are undertaken, however they do not sufficiently translate into economic and societal gains. There are several reasons for this:

- The EU does not effectively capitalise on its own R&D results.[10] As a consequence very costly research, both from public and private sources undertaken in the EU leads to commercialisation in other regions. This is not in the European interest and such developments endanger the future research capabilities in the EU, because in the long run R&D activities are likely to follow production to third countries. It may be relatively easy for competitors or imitators to catch up and take many of the potential profits from the original developer, if intellectual property rights (IPR) are not effectively protected and enforced internationally.
- Public knowledge and understanding of key enabling technologies is often lacking. This can contribute to environmental or health and safety concerns about the development and use of

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of the SET-Plan will set up joint programmes, including basic energy science, enabling and breakthrough technologies.

9 http:// ec.europa.eu/research/era/pdf/key-figures-report2008-2009_en.pdf.

10 See also, Reviewing Community innovation policy in a changing world COM (2009) 442.

high technologies. This is not only true for applications particularly linked with public consumption or end use such as in healthcare and food, but also for other areas. There is often no proactive strategy bringing together stakeholders to address public concerns or fears to avoid delays in introduction of new technologies in the EU. In order to ensure wide user acceptance and the prompt deployment of high-technologies, public understanding and knowledge of enabling technologies needs to be improved and any ethical, environmental, health and safety concerns anticipated, assessed and addressed at an early stage.

- There is a shortage of skilled labour tailored to the multidisciplinary nature of key enabling technologies. While Europe has leading-edge research capabilities in key enabling technologies and can draw on a substantial knowledge base in science and engineering[11], it needs to continue to expand its science, technology, engineering and maths (STEM) graduate base and find ways to maximise their effective deployment across research and business. The knowledge transfer between researchers, entrepreneurs and financial intermediaries needs to be reinforced. Students and professors especially need stronger incentives to commercialise research results to increase spin-offs from university research.
- In the EU, the levels of venture capital funding and private investment available for KETs remain comparatively low. The situation has become even more problematic during the current financial and economic crisis. For example, over 80% of worldwide venture capital funding related to nanotech is raised in the US. High development costs and uncertainty make the availability of risk venture capital crucial. The short product life-cycles of many high-tech, e.g. semiconductor or photonic-based, products combined with high initial development costs, often make financing risky and difficult. In 2005, US total investment in venture capital in high-tech sectors was about three times the level invested in the EU.[12] US venture capitalists appear to be more successful at concentrating their investment on more advanced projects/technologies that are generating higher profits, while European research teams need to seek venture capital at too early a stage when the uncertainties are often still too high for both parties.[13]
- The fragmentation of EU policy efforts is often caused by a lack of a long-term vision and coordination. Better division of work is needed to improve conditions for industrial exploitation in the EU. Individual Member State technology policies, while similarly focused, often lack the synergies and benefits of economies of scale and scope that arise from more coordinated joint actions. The joint technology initiatives instrument could be further simplified and strengthened and the role of technology platforms[14] could be expanded and co-ordination among platforms enhanced to ensure the contribution of KETs to the solution of key societal challenges. Depending on the maturity level of KETs, a strong integration between experimental research, innovation and industrial exploitation is essential. An example

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[11] EU countries still have a greater share of science and technology graduates (27%) than Japan (24%) or the US (16%), despite smaller share of researchers in the workforce: Source: Eurostat (2006): “Science, technology and innovation in Europe”.

[12] OECD Science, Technology and Industry: Outlook 2008.

[13] Science, Technology and Innovation key figures report 2005 and “The shifting structure of private equity funding in Europe. What role for early stage investment?” ECFIN/L/6(2005)REP/51515.

[14] Examples of technology platforms related to enabling high technologies include the European Technology Platform on Sustainable Chemistry or the Technology Platform on future manufacturing technologies.

is the need to carry out very costly pre-production "proof of concept" and test fabrication projects to ensure the adoption of KETs. These demonstration projects could benefit from joint programming and EU-wide participation, to reach the minimum effective size for diffusion of these technologies. The fragmentation of the markets for innovations is a major weakness caused e.g. by different regulations, standardisation, certification and public procurement procedures across the Member States.

- In some third countries KETs may benefit from state support, which are often not transparent and therefore need to be analysed further. . In the Community, Member States may grant public support in accordance with existing state aid rules and encourage measures for KETs, which do not constitute state aid. It is of utmost importance to ensure that European companies can compete on a level playing field with their third country competitors. European state aid rules provide the framework and conditions for allowing Member States to match aid intensities provided by third countries in the field of state aid for research and development.

4. FOSTERING KEY ENABLING TECHNOLOGIES IN THE EU

Addressing the need to foster KETs in the EU requires a clear improvement in the EU's research and innovation performance in order to succeed in the EU's ambition to become a world class location for entrepreneurship and innovation, the latter addressed in the Commission's review of the innovation policy.[15] This review, inter alia, stressed the importance of setting up a Community patent and a unified patent litigation system. For an effective industrial deployment of KETs the following policy areas need to be addressed:

4.1. Increased focus on innovation for key enabling technologies

The economic downturn has affected investment in general and especially in technology-enabled sectors such as chemicals, automotive, construction and electronics. Lower industrial output and slower technology adoption reduces demand for basic technology providers. A key objective of public support for R&D and innovation in the EU Framework and Member State programmes should be to ensure that the flow of innovation is maintained and that technology adoption is facilitated.[16] Calls for proposals in the years ahead should be designed to assure the link between research output and industrial impact. Publicly supported programmes should be reinforced to help key industries to maintain their long term innovation plans for enabling technologies and thus ensure their competitiveness in the subsequent economic upturn.[17]

4.2. Increased focus on technology transfer and EU-wide supply chains

The process of technology transfer between research institutions and industry needs to be strengthened. The European Institute for Innovation and Technology (EIT) and the

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15 Reviewing Community innovation policy in a changing world COM (2009) 442. This Communication does not replicate general innovation instruments that are needed to foster KETs, but focuses on those actions that are specific to deploy KETs.

16 The Recovery Plan proposed by the Commission in 2008 includes public private partnerships for research and development related to "Factories of the Future", "Energy-efficient Buildings" and "Green Cars".

17 Efforts already made such as with the Framework Program and the JTIs on nanoelectronics and Embedded Systems should be reinforced.

Enterprise Europe Network can play an important role in this regard, but Member States may also need to increase their capacity for technology transfer through strengthening links between research-based contract institutions and SMEs.[18] Greater access for SMEs to enabling high technologies manufactured in Europe and the promotion of regional innovation clusters and networks are essential for creating and maintaining world-class innovation. They are key elements of a broad based European innovation strategy and of the Small Business Act. The potential for expanding EU-wide technology transfer and supply chains may also need to be strengthened, e.g. through making information on research expertise and SME supplier specialisation more widely available across the EU. Earlier involvement of potential customers in R&D activities could also improve technology transfer.

4.3. Increased focus on joint strategic programming and demonstration projects

The Community, but also Member States and regions should pursue a more strategic and coordinated approach to avoid uneconomical duplications and more effectively capitalise on R&D results related to KETs. This approach should encompass increasing innovation efforts and putting greater emphasis on the transfer of research results into marketable products. Joint calls, already carried out between different themes could focus more on the KETs with the greatest potential for synergies and for wide deployment in European industries. In parallel, the Commission and Member States could discuss the evaluation of KETs, establish best practices and set joint medium to long term priorities

In order to reach sufficient critical mass and overcome fragmentation, innovation programmes financed in Member States should provide stronger incentives for collaborative joint programming actions between Member States.[19] This would allow more ambitious technology policies to be developed, unlocking the benefits of economies of scale and scope and facilitating strategic alliances between European companies.

As the costs of demonstration projects are sometimes an order of magnitude greater than those of upstream R&D, greater collaboration across the EU with stronger industry and user involvement could allow projects to be realised efficiently and affordably. The Commission will work with Member States to identify and initiate a range of joint or common European research, demonstration or prototyping initiatives and infrastructures, such as in the case of the co-financing of CCS demonstration projects. Furthermore it will undertake a study to analyse the costs and benefits of establishing 450mm semiconductor wafer production in the EU and the subsequent impact on the competitiveness of the European economy.

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

19 For the research area see COM (2008) 468 "Towards Joint Programming in Research: Working together to tackle common challenges more effectively."

4.4. State aid policies

Well targeted state aid that addresses market failures is an appropriate instrument to increase R&D and foster innovation in the EU. The 2006 Community framework for state aid for research, development and innovation increased the allowed aid intensities and the number of categories of aid. The Commission intends to carry out a review of the framework in 2010 that will assess whether amendments are necessary including if the possibilities to spur innovation through State aid are adequate.

4.5. Combining the deployment of KETs and Climate change policy

While it is obvious that the knowledge-based economy will not be achieved without the capacity to develop and use KETs, it is still important to stress, that the leading role of the EU in the fight against climate change has to be based on the most modern technologies, in particular KETs. The combination of fostering KETs and fighting climate change would offer important economic and social opportunities and would also facilitate considerably the financing of the European share of the burden that will be the result of the international agreement which is under preparation.

4.6. Lead markets and public procurement

The EU needs a favourable environment for effective capitalisation of research results in products. It also needs to promote demand which requires a more targeted approach such as the one followed in innovation policy with the Lead Market Initiative. Public procurement may also play a role in stimulating enabling high technologies and innovative leading edge applications. Member States could use pre-commercial procurement and procurement for large-scale, close-to-market innovations to stimulate emerging enabling technology markets.

4.7. International comparison of high-tech policies and enhanced international cooperation

The exchange of experiences and best practices between Member States and with other regions should be intensified. The International space station symbolise not only a scientific achievement, but also reflects the industrial gains by joining forces. The Commission will therefore conduct an international comparison of high technology policies in other leading and emerging countries, such as the US, Japan, Russia, China and India and explore the scope for closer cooperation.

4.8. Trade Policy

Within the Commission’s ‘Global Europe strategy’ particular attention should be paid to ensure favourable trade conditions for KETs through bilateral and multilateral means, i.e. avoid international market distortions, facilitate market access and investment opportunities, improve IPR protection, and reduce the use of subsidies and tariff and non-tariff barriers at global level.

Trade policy must ensure that potential trade distortions triggered by direct or indirect subsidies in third countries are effectively screened and tackled, for instance through trade defence instruments or through the WTO dispute settlement procedure where violations to existing rules such as the WTO Agreement on Subsidies and

Countervailing Measures occur. Therefore, the Commission will actively monitor subsidies and other trade distortions by third countries.

The Commission will also assess how to best ensure that future bilateral and multilateral agreements effectively prohibit such subsidy practices and that bilateral dispute settlement clauses are enforced if necessary. Existing international fora, such as the "Governments/Authorities Meeting on Semiconductors (GAMS)", should be used to address the problems that have been identified.

4.9. EIB financing instrument and venture capital financing

The Commission will further stimulate increased financial investment in high technology industries for research, development, manufacturing and infrastructure and encourage the EIB to further develop its loan policy to give priority to high technology industry using appropriate instruments like risk sharing finance facility and the loan guarantee instrument or designing new instruments in order to facilitate investments, taking account of the current financial and economic crisis.

The financing of the commercialisation of technological innovation also needs a strengthening of venture capital funds specialised in early-stage investment. Such funds are supported under the financial instruments of the Competitiveness and Innovation Framework Programme (CIP)[20]. Sufficient availability of venture capital can be assured through public-private partnerships which play a critical role in the creation and expansion of R&D-intensive companies.[21]

4.10. Skills, higher education and training

Attention must be paid to the upgrading of skills and to developing adequate skills strategies to provide appropriate vocational training in response to labour market needs.[22] This can ensure that the full potential of new technologies is exploited. Natural sciences and engineering must achieve their deserved place in the education systems. The percentage of graduates in this area should be increased, also by attracting international talents.[23] Multidisciplinary experience and skills need to be improved. Additional efforts should also be spent in improving green and environmental skills and in introducing environmental studies into engineering and business curricula in line with the EU e-skills strategy.[24]

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[20] Decision 1639/2006/EC of 24 October 2006; OJ L 310/15.

[21] For alist of current EIB loans to projects with high technology components, see www.eib.org.

[22] New Skills for New Jobs COM (2008) 868.

[23] A possible indicator for biotechnology for instance is the number of PhD Graduates in Life Sciences, see for instance: European Techno-Economic Policy Support Network (2006): “Consequences, opportunities and challenges of Modern Biotechnology for Europe”; Europe’s overall higher education expenditure is 1.3% of GDP, which is lower than in the US (2.9%); see Bruegel (2009) memos to the new Commission: Europe’s economic priorities 2010-2015.

[24] “e-Skills for the 21st Century: Fostering Competitiveness, Growth and Jobs" COM (2007) 496.

5. THE WAY FORWARD

The design of an industrial policy framework for enabling high technologies needs to be founded upon a widely shared and broadly-based EU-wide strategic vision about the technologies that the EU wishes to master in research and production. This will be one important element for developing the EU into a breeding space of innovation. It will also be required to match the European ambition to become a key international player when it comes to facing global societal challenges and to translate its engagement in welfare gains at home and abroad.

To that end a shared long term vision and a strong partnership will be required between the EU, its Member States, businesses and key stakeholders. Therefore the Commission invites Member States to agree on the importance of deploying KETs in the EU and support the orientations set out in the present Communication.

In the short term the Community will foster the deployment of key enabling technologies within its current policy framework: (i) state aid rules (such as the temporary State aid framework) (ii) trade aspects (iii) access to finance notably within the forthcoming innovation act[25] and (iv) reinforcing existing initiatives and/or proposing direct actions in the field of specific enabling high technologies.

Moreover it suggests setting up a high-level expert group tasked with developing a shared longer term strategy for key enabling technologies, addressing particularly the areas identified in chapter 4. This high-level group will be composed of Members States' industrial and academic experts. This high level expert group should build on the results of the key technologies expert group findings in 2005. To create synergies this expert group should rely on and closely co-operate with other Commission expert groups on innovation and technology, the EIT, the European Technology Platforms and Joint Technology Initiatives and should:

(1) assess the competitive situation of the relevant technologies in the EU with a particular focus on industrial deployment and their contribution to address major societal challenges,

(2) analyse in depth the available public and private R&D capacities for KETs in the EU (on all levels) and

(3) propose specific policy recommendations for a more effective industrial deployment of KETs in the EU.

The Commission will report back to the Council and the European Parliament by the end of 2010.

[25] COM (2009) 442.