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SHAPING EUROPE'S INNOVATION POLICIES:

A FOCUS ON KEY ENABLING TECHNOLOGIES

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Table of contents

Chapter 3 Key Enabling Technologies

Chapter 4 Discussion andConclusions

Chapter 1.

Introduction - The growing importance of innovation and innovation policy

Today we are experiencing one of the most severe economic crisis's mankind ever encountered. We call it a financial crisis, but it is more than that. Food crises and energy crises are emerging world-wide, while major demographic changes are taking place. The global world population is expected to grow from the current 7 billion to more than 9 billion by the year 2050, while mankind is facing a very challenging situation of depletion of natural resources – from land and water - which are finite and subject to increasing pressure and competition for their use. We are experiencing a system crisis. Whereas until now economic theories are based on growth - and the politicians still encourage this idea, as do most economic specialists -- we can conclude that pure growth will not save us. Due to globalisation of the economy, more and more countries are expanding, and increasingly rare resources must be shared with more and more people. This becomes a challenge on world-level, since growth is only possible when there is space and resources to grow. We are limited by the fact that there is only one planet earth, and the limit is approaching fast. We need to produce more with less and in a better manner, while preserving our environment. There is a need for a paradigm shift, and to this extent innovation is expected to play a major role. Innovation is the keyword, as will be sustainability.

The challenge of demographic and environmental disproportions is challenging all existing economic theories, but it will challenge also our moral and ethical believes. How humanity will solve these questions is still unanswered. The ambition of always wanting more - which gave us the level of development of today - will possibly destroy us if no alternatives are available. Instead of growing economies (in quantitative terms) we will have to choose for sharing economies and growing in quality terms. This requires a consensus amongst all nations, which is not easy to achieve, as history has shown in so many occasions.

1.1. Why is innovation important? "Mission growth"

One of the drivers which will make the sharing economy a successful idea is innovation. In one sentence, we need not necessarily more, we need better. An economic shift can deliver better products and processes, more efficiency, etc. However, this needs to be steered and accompanied by responsible governance at international, national and local levels. Policy makers will have to decide on demographic parameters, environmental

challenges, resource efficiency, share the welfare in collaboration amongst nations, and promote a smooth, sustainable and equitable development.

The fact that innovation will be a key element for success implies the necessity to have performant innovation policies in place. This latter is a challenging objective to reach. Because of fast evolving markets, there is merely the time to think about concrete measures, and then we are not even discussing implementing them.

The European Union is aware of this. At the Lisbon Council in 2010, the European Commission has adopted a new Strategy for the next decade: Europe 2020 – a strategy for smart, sustainable and inclusive growth[1]. The main goal is once more growth – "mission growth" - to quote EC President Barroso – which is no more mission impossible but "mission unstoppable"[2]. More specifically, this Strategy is about addressing the shortcomings of our classical growth model and creating the conditions for a different type of growth that is smarter, more sustainable and more inclusive. A growth based on knowledge and innovation, on an inclusive high-employment society, on a competitive and sustainable economy. The Europe 2020 Strategy puts therefore innovation at the very heart of growth and social progress and proposes the flagship initiative "Innovation Union"[3].

As professors Benjamin and Rai write in their article 'Fixing Innovation Policy: a structural perspective' (2008), innovation is central to growth and human welfare. Innovation will be also the driver for a sharing economy. Innovation is the main answer to most of the questions. Vice-President Antonio Tajani**,** European Commissioner for Industry and Entrepreneurship stated recently that "we need to step up our efforts in making Europe more innovative in order to catch up with our main competitors and recover the path of robust and sustainable growth". Europe's GDP has grown by more than 30% in the last 15 years, with 23 million new jobs – and there is room for more. Stronger emphasis is needed on research, development and deployment, cutting red tape and facilitating access to credit for businesses. Manufacturing can still play a major role in driving the EU economy, especially in green technologies, where Europe is a world leader. Better education and a higher level of employment are also key factors, stressed President Barroso.

When analyzing the situation in the US, Benjamin and Rai argument the creation of a new agency with multi-agency focus to coordinate and make more efficient the implementation of innovation. This is a valid approach and starting country by country is a logical step to take. Furthermore, in each country everybody should be involved and awareness raising is a basic step towards sustainable growth. We see that in companies

[1] http://ec.europa.eu/europe2020/index_en.htm
[2] "Mission Growth" Conference, Brussels May 2012
http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/12/394
[3] http://ec.europa.eu/research/innovation-union/index_en.cfm

sustainability policies are common. But it may not remain a paper exercise. Action is needed and a mondial approach might be required in the end.

1.2.What do we understand when discussing 'innovation'?

The Merriam-Webster dictionary describes innovation as 'the introduction of something new, a new idea, method or device, a novelty'. The Michigan Council for Labor and Economic Growth defines innovation as: "Innovation is the conversion of knowledge and ideas into a benefit, which may be for commercial use or the public good; the benefit may be new or improved products, processes or services. Innovation is a process of continuously generating and applying new ideas[4]. In their book 'Innovation Law and Policy in the European Union', professors Granieri and Renda define innovation as "the process by which individuals and organizations generate new ideas and put them into practice"[5]. This definition has the advantage of not focussing on a specific angle (as do market-focused or customer-oriented definitions). All the definitions used have their truth. Innovation is in fact the introduction of new ideas, methods, believes, etc. Since we are living a system-crisis, innovation will be required in all parts of our thinking, acting, organizing, … in every day live of all world citizens and by consequence is all systems and organizations people use. Innovation will be as important as is oxygen for humans to live, to survive and to prosper. We adhere to the definition of Joseph Schumpeter, but only where he says that innovation should be considered more broadly. In fact, not only in our economic parameters, but in all elements of human life innovation should be a major driver. As mentioned above, a system crisis requires a broader answer than only an economic one. All of this is valid if innovation is linked to sustainability.

In the frame of this thesis, we will focus on the economic parameters. Narrowing down to the economic parameters does not make the challenge easier. Professors Granieri and Renda state that defining and capturing innovation becomes even more difficult today, as markets and forms of exchange change continuously, often departing from the traditional chain of innovative activities, which took place mostly in universities and large public or private research entities. Today, the most diverse forms of exchange are emerging on the planet, most often based on reciprocity, not on markets. In addition, innovation takes place inside and outside firms, through new mechanisms of collaboration such as 'open innovation' chains and innovation hubs. Moreover, users can be innovators just as easily as big entrepreneurs. Social innovation becomes an important component of innovation. The data boom we are experiencing today will open entirely new windows of opportunities for designing innovative products and processes and for anticipating societal needs. Some people conclude that innovation becomes impossible to define. You know it when you see it.

[4]Innovation indicators, report to the Michigan Council for Labor and Economic Growth. August 2007
[5]Innovation Law and Policy in the European Union. Towards Horizon 2020

If innovation is difficult to define, defining innovation policy becomes even more challenging. The definition given by Granieri and Renda is twofold: (a) the creation of new (or the efficient reallocation of existing) resources (in the broadest sense), (b) which contribute to progress (welfare in the long run, without depriving society of resources that could have been more usefully allocated elsewhere).

1.3.Innovation and entrepreneurs

Given the intimate link between innovation and dynamic efficiency, innovation policy heavily relies on the actors that commit themselves to the discovery of new ways of producing existing goods or services, or entirely new products to place on the marketplace or any other locus where exchange take place. These individuals, in economic theory, are called 'entrepreneurs'. Innovation policy aims at optimizing the conditions in which entrepreneurs can function and prosper.

Who are those entrepreneurs and are they the only actors in innovation?

The answer is no, entrepreneurs are an import category but they are not the only actors. Innovation requires entrepreneurs in the broadest sense of the word. The Austrian School economists state that entrepreneurship implies creativity and capacity to organize knowledge in a way that generates innovative commercialized products (implies vigilance and alertness). Entrepreneurship always generates new information, is fundamentally creative, transmits information, exerts a coordinating effect, is competitive and never stops or ends.

They function as an engine for the national innovation system. Their week point is that they have limited information. This means that the greater the contribution of other actors is, to the production and dissemination of knowledge and the creation of innovative skills, the easier it will be for them to perform their crucial task for the achievement of progress and prosperity within a national innovation system.

We notice today in the economic crisis we are living, that the engine of our economy is not necessarily the large corporations, but more the small and medium enterprises (SME's). These small, mostly family owned, companies show a larger capacity to respond to difficult and fast changing economic circumstances. They are recognized as the perfect candidates to assume the role of entrepreneurs. The fact that they are small makes that they are more flexible, however it is also a weakness. Indeed they do not always have the resources to access information, to digest this information and to implement it. It is the obligation of society to encourage these SME's by facilitating the access to funds, the establishment of valuable partnerships for the realization of their ideas and the creation of new products in a market and the creation of a stimulating legal framework. The concept of 'the valley of death' (= markets do not always believe in the initiatives and ideas of an entrepreneur and by consequence do not invest in it)

means that ideas cannot enter the concrete phase of development and production, and by consequence are lost or even ‘stolen’ by other parties. The latter is to be avoided.

Important actors of innovations are universities and research institutes. In science most of the fundamental research is done by universities (and financed by public means). The simple reason is that such research is costly and the possible use in commercial interesting products is far away. Companies intend only to invest in products which guarantee a profitable market. Strengthening public-private partnerships in the whole research and innovation chain, from discovery to market uptake, become a key element to foster true innovation based on new knowledge generation.

Universities and research centers have increasingly played the role of facilitators of knowledge transfers, open innovation and co-innovation. Often so-called spin-offs create the necessary boost and generate resources for the universities by entering themselves the faze of production and distribution. Universities main role is the creation of knowledge, the transfer and management of it. They become more and more involved in technology transfer (being one of the key engines of innovation in industrialized countries). In the Key Enabling Technologies (KET, see also chapter 3), such as photonics and nanotechnologies, where universities hold the core of the scientific knowledge, technology transfer is a must. European universities should realize their added value, their possibilities to generate income from the work they do.

Other actors are the venture capitalists and business angels. Since entrepreneurs do not always have the necessary funds venture capitalists can intervene, creating as such a leverage effect for the entrepreneurs. (Venture capitalists are companies providing cash in an early-stage, high-potential, high-risk, high-growth start-up companies. They intend to stay in those companies for a limited period. Since they assume large risks, they hope to realize within a reasonable delay a plus-value). In order to be successful, also these venture capitalists must be innovative. Together with venture capitalists, a key role is played by business angels (BA’s), defined as ‘individuals, acting alone or in a formal or informal syndicate, who invest their own money directly in an unquoted business in which there is no family connection, and who, after making the investment, take an active involvement in the business.

Non-neglectable actors are governments. It is clear that the theories of the perfect market as defined by economists 50 years ago (e.g. Keynes: a market is a place where buyers and sellers meet, where no-one can influence the price and all have equal access to information) do not correspond with reality. Markets are more and more imperfect. The result is that it is difficult to reach socially optimal levels of innovation. These include, among other things, transaction costs, imperfections in the dissemination and sharing of key information related to innovative products and ideas, general imperfections in the market-place ideas, imperfections in the financial markets and rational biases in consumer demand. All these frictions demand for government intervention. A serious concern of government intervention is that governments tend to

play the nationalistic card: they use legislation for protective measures, which is ofcourse contradictory to the idea on world-level to reach an optimal level of innovation. This is the reason that the European Commission often uses a 'Regulation' instead of a 'Directive'. A Regulation is after publication in the European Journal immediately applicable in all member states and does not need a translation in national law like a Directive does. This prevents national parliaments to give a 'personal' touch to the new law.

How governments can act to promote innovation?

- Direct intervention: this includes state aid and subsidies for innovation, and industrial policy to promote innovation in specific sectors of the economy (e.g. space policy);
- Regulation: a number of legal rules to facilitate private bargaining over collaborative innovations. (e.g. intellectual property laws);
- Supply-side policies in innovation: they include: (a) public expenditure to support Research & Development; (b) the development of research infrastructures and institutions, from patent offices to university funding; (c) information and brokerage services such as the production of data and the development of patent databases and portals for innovating firms; and (d) networking measures such as the creation of science parks in collaboration with universities, etc.
- Demand-side policies: they include the promotion of user-driven innovation, the use of pre-commercial procurement and green public procurement, support for private demand for innovative products, etc.
- Infrastructure policies and digital agendas. These facilitate the development of online collaborative partnerships for innovation as well as innovation hubs and platforms.

When thinking about the role of governments, one must not limit itself to the old idea on governments (parliament, ministries publishing laws and carrying out a certain number of tasks), intended as rather administrative, non-transparent institutions. As Barack Obama tries to implement in the USA, governments should become open. Governments should be transparent, participatory and collaborative. Hilgers and Piller in a recent article define this new type of government as the combined effect of four concomitant revolutions: a social revolution (social networking), an economic revolution (Wikinomics), a demographic revolution (the net generation) and a technology revolution (Web 2.0)[6].

The most prominent scientific paradigm to the organization of innovation strategies developed in the past years is certainly the 'triple helix' approach, which looks at possible ways to bridge the existing distance between industry, academia and

[6]Hilgers D, Piller FT (2011) A government 2.0: fostering public sector rethinking by open innovation

government to build successful public-private partnerships for innovation[7] . Today an additional layer of complexity is being added due to the need to study the interaction between producers and end users, with 'networked individual' becoming the fourth helix and, if possible, a fifth helix is added due to the need to ensure that the interaction between the actors of innovation is aimed at meeting the grand challenges of modern society, from sustainability to the needs of an ageing population. In their book the professors Granieri and Renda incite the 'next frontier', the concepts of 'smart specialization', Smart Cities and Regional Innovation ecosystems. The concept of 'smart specialization' is currently at the forefront of Europe's attempt to catch up with other economies, notably, the US and the Asian tigers in terms of productivity and innovation potential. The smart specialization relies on two core pillars:

- Knowledge ecology (context matters for the potential technological evolution of an innovation system), meaning the structures already existing and the existing dynamics condition the evolution.
- Identification of knowledge-intensive areas as those areas that feature the highest presence of key players in the innovation eco-system (e.g. researchers, service providers, entrepreneurs, users, …).

1.4.How can one measure innovation?

Measuring innovation is extremely complex. One key indicator is certainly not sufficient. In order to have a reliable indication on innovation a set of parameters needs to be combined.

The Michigan Council for Labor and Economic Growth conducted an extensive search of literature and studies to identify a broad set of measures for consideration as indicators of innovation. The five indicators selected met these criteria established by the team:

- Measure the capacity for technological innovation and the composition of the state work force;
- Published on a regular basis, at least annually, for all 50 states; and
- Produced by a reliable source with a consistent methodology.

This brought to the identification of the following 5 indicators:

- Education level of the workforce
- Percentage of scientists and engineers in the workforce
- Number of patents issued
- Industry investment in research and development
- Venture capital investment

[7]Etzkowitz and Leydesdorff (1997, Universities and the global knowledge economy: a triple helix of university-industry-government relations. Continuum, London

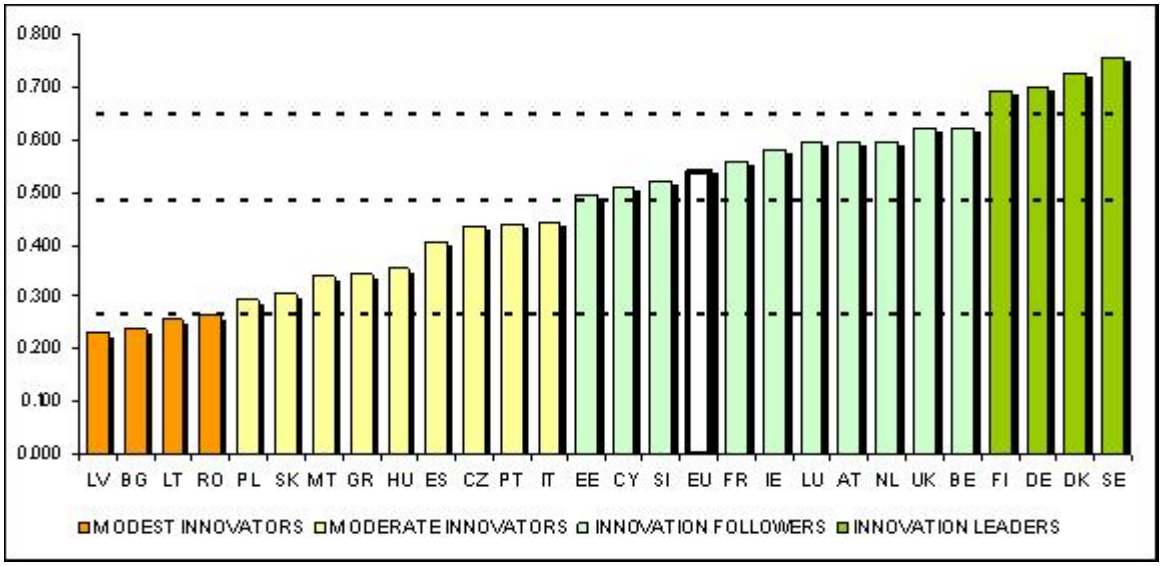
It is interesting to compare this selection to the actual selection used by the European Commission, which uses a well established and recognized tool for assessing innovation performance in EU Member States: the Innovation Union Scoreboard (IUS)[8]. This latter includes innovation indicators and trend analyses for the EU27 Member States, as well as for Croatia, Iceland, the Former Yugoslav Republic of Macedonia, Norway, Serbia, Switzerland and Turkey. It also includes comparisons based on a more reduced set of indicators between the EU27 and 10 global competitors. The IUS 2011 distinguishes between 3 main types of indicators and 8 innovation dimensions, capturing in total 25 different indicators.

The Scoreboard places **Member States** into the following four country groups (see figure below):

- **Innovation leaders**: Denmark, Finland, Germany, Sweden all show a performance well above that of the EU27 average.
- **Innovation followers**: Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all show a performance close to that of the EU27 average.
- **Moderate innovators**: The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below that of the EU27 average.
- **Modest innovators**: The performance of Bulgaria, Latvia, Lithuania and Romania is well below that of the EU27 average.

[8] http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/innovation-scoreboard/index_en.htm

EU Member States' innovation performance



Source: European Commission IUS 2011 - Note: Average performance is measured using a composite indicator building on data for 24 indicators going from a lowest possible performance of 0 to a maximum possible performance of 1. Average performance in 2010 reflects performance in 2008/2009 due to a lag in data availability.

The EU in its Innovation Union Scoreboard 2010 confirmed that the US and Japan are far ahead of EU Member States along several dimensions of innovation. At the same time, countries that used to lag behind, such as the BRIC economies, are quickly catching up and seem likely to overtake the EU in the next five years. (BRIC = Brazil, Russia, India and China).

This is an undesirable development in terms of sustainable development and, overall, of the progress and prosperity that will be enjoyed by European citizens and businesses in the years to come. It indicates the failure of the EU efforts in the direction of encouraging innovation, growth and productivity.

The index used by the Innovation Union Scoreboard is based on number of assumptions. The basic three enablers that capture the main drivers of innovation performance external to the firm, and then eight innovation dimensions, capturing in total twenty-five different indicators.

The three enablers are:

- Human resources, which in turn includes three sub-indicators and measures the availability of a highly skilled and educated workforce;
- Open, excellent and attractive research systems, covering three sub-indicators and measuring the international competitiveness of the science base;
- Finance and support, which includes two sub-indicators and measures the availability of finance for innovation projects and the support of governments for research and innovation activities.

Moreover, the 'Firm activities' component captures the innovation efforts at the level of the firm and differentiates between three innovation dimensions:

- The 'Firm investments' dimension includes two sub-indicators of both R&D and non-R&D investments that firms make in order to generate innovations;
- 'Linkages & entrepreneurship' includes three sub-indicators and measures entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector;
- 'Intellectual assets' captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process.

Finally the 'outputs' dimension captures the effects of firms' innovation activities and differentiates between three innovation dimensions:

- 'Innovators' includes three sub-indictors and measures the number of firms that have introduced innovations onto the market or within their organizations, covering both technological and non-technological innovations and the presence of high-growth firms;
- The indicator on 'innovative high-growth firms' corresponds to a new sub-indicator developed at the EU level, which will be completed by 2012;
- 'Economic effects' includes five sub-indicators and captures the economic success of innovation in employment, exports and sales due to innovation activities.

In their book, professors Granieri and Renda come to the conclusion (comparing the elements of the eco-system to this scoreboard) that the scoreboard indicators described above do not cover all the possible dimensions of innovation, and are still significantly related to the traditional concept of innovation as something that eminently takes place within the boundaries of a single firm. This was even truer for the Michigan document, but the Michigan document was the first report the Michigan Council drafted. Now we are five years further and considering the need of Europe to accelerate its efforts, the method to measure these efforts is not complete enough and did not evolve accordingly to the needs.

Another tool used by the EC to monitor innovation is the annual Research and Innovation Scoreboard[9]. This scoreboard compares countries based on research and development (R&D) investment levels – a key performance indicator – along with 23 other factors. The 2012 report shows, once more, that EU makes progress, but growth is slowing. Almost all EU countries have become better at fostering innovation, but the EU still has not closed its innovation gap with international leaders the US, Japan and South Korea. On top of that, emerging economies such as China, Brazil, and India have been catching up over the past 5 years. This trend makes clear that the EU will have to

[9] http://ec.europa.eu/news/science/120208_en.htm

increase efforts to stimulate and speed up innovation if it is to boost – let alone maintain – its competitiveness. That's why innovation – and removing bottlenecks that prevent good ideas from reaching the market – is at the heart of the EU's 2020 growth and jobs strategy.

This Scoreboard identifies **Ingredients for innovation**; The EU's innovation leaders are found to be Sweden, Denmark, Germany and Finland. The 4 countries tend to have:

- above-average R&D expenditure, especially in the business sector
- higher investment in skills and finance
- strong national research and innovation systems with a key role for partnerships between public and private sectors
- better results in turning technological knowledge into products and services.

The scoreboard compares countries' performances in these areas and others considered as key to stimulating innovation. The UK for example has above-average innovation levels. Its strengths rest on its workers' skills and on excellent research systems, among other factors.

In chapter 2 we will analyze more in detail the EU innovation policy. As a preamble, the complex case of the innovation indicators reflects the complexity of innovation itself, and by consequence the complexity of the techniques to measure innovation. Not only is it difficult to choose the reliable indicator (e.g. patents: the number of patents does not inform us over the quality of the patent, its profitability, etc.). This is the reason why innovation scholars have introduced various patent-related indicators as a measure of the 'quality' of the inventive output. Integrating these measures of inventive activity with other firm-level information, such as accounting and financial data, is another challenging task. A major problem in this field is represented by the difficulty of harmonizing information from different data sources. This is a relevant issue since inaccuracy in data merging and integration leads to measurement errors and biased results. An important source of measurement error arises from inaccuracies in matching data on innovators across different datasets.

If we want society to understand the importance of innovation solid indicators are necessary to shift public attention towards larger commitment and within Europe to make understand that only together Europe has a chance.

The number of scoreboards that cover innovation has increased since the mid 1990s in response to policy and media interest. DG Research's Key Indicators, DG Enterprises' Enterprise Policy Indicators, the OECD's Science, Technology and Industry

Scoreboard, the UK Competitiveness Index, etc. All of these indicators assume innovation is one of the key drivers of economic performance.

The increasing supply of innovation scoreboards and the apparent attractiveness to the policy community is not without controversy. Innovation Scoreboards can, when misused, provide misleading and simplistic summaries of national or regional innovation capacities. Conversely, when used correctly, they can quickly summarize complex data in a way that can identify problems or help build political support for government actions.

The effectiveness depends not on the number of indicators. The art is to choose the right number and the right detail of indicator. “Too” is always bad (too little, too much, too detailed, too high level, …).

1.5.Types of Innovation

Albert Einstein once said: ‘if I have 20 days to solve a problem, I would spend 19 to define it’. Good advice.

We already mentioned how difficult it is to define innovation and to measure it. Nevertheless several types are distinguished. New ideas make that there is a constant shift. A journey from open innovation to distributed co-creation, to social innovation.

Open innovation is a term promoted by Henry Chesbrough (professor and executive director at the Center for Open Innovation at the University of California, Berkeley), in his book Open Innovation: the new imperative for creating and profiting from technology.

Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology” or "Innovating with partners by sharing risk and sharing reward." The boundaries between a firm and its environment have become more permeable; innovations can easily transfer inward and outward. The central idea behind open innovation is that in a world of widely distributed knowledge, companies cannot afford to rely entirely on their own research, but should instead buy or license processes or inventions (i.e. patents) from other companies. In addition, internal inventions not being used in a firm's business should be taken outside the company (e.g. through licensing, joint ventures or "corporate spin-off" (http://en.wikipedia.org/wiki/Corporate_spin-off). Open innovation is linked to e.g. user innovation and know-how trading. Thanks to Wikipedia we learn that user innovation refers to innovation by intermediate users or consumer users, rather than suppliers. Eric von Hippel (MIT, 1986) and others observed that many products and services actually developed or at least refined, by users, at the site of implementation and use. These

ideas are then moved back into the supply network. This is because products are developed to meet the widest possible need; when individual users face problems that the majority of consumers do not, they have no choice but to develop their own modifications to existing products, or entirely new products, to solve their issues. Often, user innovators will share their ideas with manufacturers in hopes of having them produce the product, a process called free revealing.

Know-how trading is a web-based research and design phenomenon related to open innovation and crowdsourcing. It denotes fee-based knowledge markets that treat knowledge and expertise as commodities that can be traded for financial gain. Know-how trading sites differ from open innovation communities in that the entry level for solutions is much lower. Rather than seeking large research projects, know-how trading enables businessmen, researchers and individuals to save time by harnessing the skills and expertise of others to solve very specific, often quite difficult problems. Some individuals use know-how trading portals in an informal way to accumulate new knowledge about subjects which they are interested in.

Executives in a number of companies are implementing the next step in this trend toward more open innovation. For one thing they are looking at ways to delegate more of the management of innovation to networks of suppliers and independent specialists that interact with each other to co-create products and services. They also hope to get their customers into the act. If a company could use technology to link these outsiders into its development projects, could it come up with better ideas for new products and develop those ideas more quickly and cheaply than it can today? Suppose that a wireless carrier, say, were to orchestrate the design of a new generation of mobile devices through an open network of interested customers, software engineers, and component suppliers, all working interactively with one another.

This is the model of innovation as a convergence of like-minded parties. Increasing numbers of organizations are now taking that approach: distributed co-creation, to use it technical name. LEGO, for instance, famously invited customers to suggest new models interactively and then financially rewarded the people whose ideas proved marketable. (Jacques Bughin. The next step in open innovation. The McKinsey Quarterly. June 2008).

Innovation is however not limited to industrial or commercial companies. Indeed, society as a whole can benefit. The results of social innovation are all around us. Self-help health groups and self-building housing, telephone help lines and telethon fundraising, neighbourhood nurseries, Wikipedia, Open University, complementary medicine, holistic health and hospices, microcredit and consumer cooperatives, charity shops and the fair trade movement, zero carbon housing schemes and community wind farms, etc.

Social innovation[10] is innovative services and activities that are motivated by the goal of meeting a social need and that are predominantly developed and diffused through organizations whose primary purposes are social. This differentiates social innovation from business innovation where the primary goal is to generate profits. Social innovation has never been restricted to what we would now call social policy. Successful innovations have grown up in many fields. For example, Rabobank (Netherlands), a cooperative bank, has one of the world's highest credit ratings. The Mondiagon network of cooperatives in Spain now employs some 80.000 people, and has grown by 10.000 each decade since 1980. It operates with some 50 plants outside Spain making it probably the world's most successful social enterprise.

1.6.Governance models for Innovation.

Companies when having new ideas often lack the financial means, the technical knowledge to implement these ideas fast. This means that time is needed to organize. During this period, and even when the product is on the market, companies must be able to protect their ideas and innovations and to benefit also financially from them.

Innovation depends strongly on the creation of new information and its translation into new knowledge. This seems contradictory to the private use of new technologies.

However information can feature a wide variety of utility functions with respect to the degree of diffusion. The private value of a piece of information changes enormously depending on the type of information and the degree of diffusion. At the same time, certain types of information only produce value if shared with a controlled group of trusted partners. The policy consequence arising from the fact that not all information is created equal is that the optimal production of information is reached only when private information is actually kept private, collectively shared information is not retained by a single individual or publicly disclosed, and public information is made public. What is and what should be is not always the same story. This is the reason that legislation on intellectual property rights becomes needed, provided that it is designed in a way that makes the diffusion of each type of information optimal.

Important is to focus on the relationship between private property a common use of information. This is not without risk: if we want new, complex products, sustainable growth, a sharing economy, information must be shared in respect of the rights of the ones creating these new insides and products.

The tool used is patents. Within Europe there is no real efficient patent system. An internal market without a patent system that covers its entire territories is nonsense and a paradox per se. The European Commission is aware of this; however, a number of

[10]Geoff Mulgan*: Social Innovation: What it is, why it matters and how it can be accelerated.*. Oxford Said Business School

Member States are sabotaging the creation of such a unitary patent office. The obligation to pass by national systems is costly, slow, inadequate and risky.

In the 'Europe 2020' strategy, the creation of a European Patent Office (EPO) is foreseen. This latter already exists, but it needs to become much more performant and the goal is that the EPO would replace all National Patent Offices. Practical issues are for instance the language of the patents, costs of protection, etc. English is predominant, but can create burdens for non-English speaking entrepreneurs.

The availability (and the restriction of) information was defined by Garrett Hardin in 1968 as the tragedy of the commons[11]. A 'commons' is normally defined as a shared resource, which is subject to congestion, over-use and final depletion if no property rights are assigned to its users. To the contrary, an 'anticommons' exists whenever users of a collective resource hold too strong property rights, such that each of them has a veto power on the use of the whole resource. Finally a 'semicommons' is a system in which "both common and private uses are important and impact significantly on each other".

As stated, from the perspective of information and innovation policy, the sharing of information is very important to maximize the production of information and its optimal disclosure. For example:

- Patent pools are often considered as a perfect example of an anticommons
- The internet is a semicommons, since it 'mixes private property in individual computers and network links with a commons in the communications that flow through the network.
- In biomedical research, where patents have formed an almost inextricable thicket, innovation has become increasingly subject to uncertainty about potential patent infringement.
- Another voice in the discussion considers internet (and its global knowledge) as a 'commons without a tragedy'. (when we do not consider the spreading of non-relevant or false information)

A consideration is that we must be aware of these phenomena and that policymakers must reflect on whether traditional innovation policy, mostly based on assigning property rights should be converted into a more flexible policy which removes potential failures and obstacles to the free flow of information that are created by anticommons and strategic behaviour. This is mostly dependent on technology, more than law. As technology increasingly redefines the boundaries of what is possible, new collective sharing possibilities emerge and the prevention of third-party appropriation becomes increasingly difficult for certain types of information. Thus creating another problem: information should be shared if it boost the global interests, but people and companies

[11]Garrett Hardin, The tragedy of the commons. Science 162:1243-1248, 1968

should be rewarded for creating information in order to allow them to continue their innovation efforts.

An important element of the EU innovation policy is participative governance. The European Commission is regularly running an "Innobarometer", which is an annual opinion poll of businesses or general public on attitudes and activities related to innovation policy[12].

The Innobarometer survey provides policy relevant information direct from business or the general public which is not available from other sources. Launched in September 2000, it complements the statistical analysis in the European Innovation Scoreboard. The Innobarometer is conducted as part of the Eurobarometer series. The 2011 Innobarometer on Innovation in the Public Sector: its perception in and impact on businesses is a significant contribution by the Commission to better assess the economic impact of innovation in the public sector. The survey covered around 8 500 businesses employing one or more people in the manufacturing, retail, services and industry sectors in the EU and in some countries outside the EU.

From the business perspective, there seem to be considerable potential benefits to be gained from public sector innovation. For example, reducing the time needed for administrative procedures can save businesses valuable time that they can spend on their core business activities.

According to the survey, a majority of respondents who observed the introduction of measures to improve public services say that their experience of using those services has improved as a result between 75% and 64%, depending on the service in question). Likewise nearly two-thirds (63%) of respondents who observed a significant improvement in public services for business attribute that improvement to innovation.

The 2011 survey complements the 2010 Innobarometer issue which surveyed 4 000 public administrations and in which respondents from administrations had reported improved user satisfaction (71%), more targeted services (63%), faster delivery of services (61%) and new services to more or new types of users as a result of innovation (54%).

Nevertheless the 2011 Innobarometer evidences still a high demand for public sector innovation among businesses. A large majority of respondents (87%) agree – most of them strongly – that public services need to upscale their efforts to become more innovative in order to better match businesses' needs. Only a fifth of respondents, for example, think that the procedures for obtaining financial support are easy to use and only a quarter feel that government programmes are well targeted at supporting innovation.

[12] http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/innobarometer/index_en.htm

Finally, another important element in the governance of innovation is policy monitoring and assessment. Interesting tools are supported by the European Commission, such as the INNO Policy TrendChart which provides independent analyses of major innovation policy trends at national and regional levels across the EU-27 and other countries in the Mediterranean region, North America and Asia. The European TrendChart on Innovation is the longest running policy benchmarking tool at European level.It aims to contribute to policy assessment and to identify examples of good practices, thus improving the basis for decision making in innovation policy.

A policy monitoring network of country correspondents tracks developments in research and innovation policy measures in 48 countries. The information collected by this network is used to run and maintain the European Inventory of Research and Innovation Policy Measures and ERAWATCH, which is the European Commission's information platform on European, national and regional research systems and policies. Moreover it also feeds into analytical reports such as the 'Innovation Policy Trends', the 'Innovation Policy Funding' and other thematic reports[13].

[13] http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/trendchart/index_en.htm

Chapter 2.

Innovation policy: a comparative analysis

In this chapter we would like to compare the US approach to the European approach regarding innovation policies. While the main focus remains on European policy, a comparative analysis with the US approach is interesting, especially because, even though many publications are critical towards the actual US situation, their approach might be considered by some more successful than the EU one. The following chapters will analyze how the USA and EU are respectively facing the current economic crisis with maximum efforts in order to optimize the outcome of their innovation programs and policies.

2.1. **How is the US tackling this issue?**

Benjamin and Rai in their article on "Structuring US innovation policy"[14] write that *U.S. policymakers are understandably focused on prodding the economy out of the current recession". There is a robust debate about how to achieve this goal, but a fairly broad consensus about the longer term: both theory and empirical evidence support the primacy of technological innovation in advancing long term economic growth and, ultimately, human welfare. Innovation is also central to addressing the environmental and other challenges that can accompany economic growth. Thus questions of how to foster technological innovation are, quite properly, at the forefront of both scholarly analysis and policy debate.*

The different angles and main challenges linked to innovation - definition, key role, characteristics and bottlenecks of innovation - discussed in chapter 1 are also mentioned in this article and both professors recognize the importance and complexity of all these issues. In addition they observe that an important element is often missing: the analysis of how to optimize the structure and coherence of all government linked entities involved in innovation. One of the conclusions of Chapter 1 was the need for governments to act pro-actively. Also Benjamin and Rai come to this conclusion and they propose the creation of a White House Office of Innovation Policy (OIP) to review federal agencies' actions that affect innovation.

This implies an intervention by the President in order to give such an office the necessary striking power to really make the difference.
In their view, it is clear that even in the US there is no perfect governance for innovation. The relative absence of innovation from the agenda of Congress and many relevant federal agencies - as well as interagency processes such as the centralized cost-

[14] http://www.itif.org/files/WhiteHouse_Innovation.pdf S.M. Benjamin and A.K. Rai " Structuring U.S. Innovation Policies: Creating a White House Office of Innovation Policy" The Information Technology and Innovation Foundation, June 2009

benefit review performed by the Office of Information and Regulatory Affairs (OIRA) within the Office of Management and Budget (OMB) - manifests the confluence of two regulatory challenges: first, the tendency of political actors to focus on short-term goals and consequences; and second, political actors' reluctance to threaten powerful incumbent actors". Furthermore, courts lack sufficient expertise and the ability to conduct the type of forward-looking policy planning that should be a hallmark of innovation policy.

2.1.1. What current US government policy gets wrong?

First, almost by definition, innovation involves thinking about long-term outcomes, which is difficult to conceive by many. U.S. political actors have very little incentive to force themselves to think about long-term outcomes because they are unlikely to be around to reap credit (or blame). By consequence, the political pressures of dealing with day-to-day exigencies lead many political actors to give short shrift to long-term outcomes and the role of innovation.

Second, the theoretical and empirical literature indicates that start-up firms are particularly likely to be the sources of breakthrough or disruptive innovation.

As an empirical matter, the data indicate that significant innovations, particularly in fields like biotechnology, nanotechnology and information technology, have been driven by new entrants. However, incumbent firms are generally better organized and have more lobbying clout than upstarts.

Even US government institutions such as courts that are not constrained by political considerations are likely to systematically neglect innovation policy. The reason is that courts must act ex post, in the context of the limited information put forward in the particular dispute that is brought before them.

If US government agencies intend to handle innovation, they do this too much in a stand-alone approach, not aware what fellow agencies are doing. This leads to the inevitable conclusion that there is no efficient and coherent approach.

The lack of coordination among agencies is particularly challenging for innovations that represent technological convergence and have wide-ranging applications. For example, the so-called "minimal genome" that synthetic biologists seek to develop could be used by a wide variety of industries, ranging from clean energy to pharmaceuticals. Currently, innovation in energy and pharmaceuticals is regulated in the United States by a large number of different federal agencies— ranging from the National Institutes of Health and the Food and Drug Administration (pharmaceuticals) to the Department of Energy and the Environmental Protection Agency (energy).

With the abolition of the congressional Office of Technology Assessment in the mid-1990s, the ability of Congress to secure unbiased advice on questions of innovation policy is also quite limited. Moreover, innovation can not be related exclusively to technologies and even with unbiased advice, it is not clear that Congress would be capable of acting in a systematic manner with respect to innovation. Although the passage of the America COMPETES (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Act is a positive sign, Congress's failure to fund the act at authorized levels in the first year mitigates this success.

Given that different federal agencies have different missions, it is not surprising that there are both regulatory overlaps and regulatory lacunae, particularly on trade-off issues. Both phenomena can lead to lack of coordination and inefficiency, as federal agencies often take actions in tension with those of another agency (in the case of overlaps) or take actions that are outside their core area of expertise and in the process do a poor job. An example of regulatory overlaps is the jurisdiction of multiple federal agencies over U.S. telecommunications mergers.

Presidential efforts to exert greater centralized control have typically been promoted as attempts to counter the parochialism of federal agencies and to harmonize conflicts between such agencies, particularly in the area of risk regulation. The most systematic mechanism through which greater presidential control has been pursued is a series of executive orders imposing the somewhat controversial requirement that federal agencies conduct cost-benefit analyses of major regulations. Centralized review of these analyses is then conducted by OIRA. The reason OIRA has not maximized net regulatory benefits is because it has failed to think proactively about government-wide priorities, including innovation.

According to the article OIRA is not the agency needed to promote a more coherent approach since they are limited to the cost analysis of a number of agencies, but are not equipped or mandated to conduct a wider policy.

The Obama administration recently created via executive order a Chief Technology Officer (CTO) position. Under the executive order, the CTO serves as both an assistant to the President and as an associate director of the Office of Science and Technology Policy. Although the executive order does not specify the duties of the CTO one can imagine that a part of his duties include promoting technological innovation in the private sector. This is a useful step forward. However, the executive order creating the CTO position does not give it power to coordinate, rationalize, and spur agency action. An explicit grant of such power is necessary for an innovation policymaker to have real impact.

The creation of such a function seems to be a positive element. In large administrations (as in the US and in the EU), the strategic choice where a certain entity is situated is

very important to assure its good functioning. In the article of Benjamin and Rai, several options are examined, but end at the executive branch of the government.

Having proposed that OIP (Office of Innovation Policy) should be located in the executive branch, they discuss the specifics of OIP's operation: first, should OIP be centralized or decentralized; second, precisely how much legal authority should it have; third, what sort of analysis should it undertake; and fourth, how should it be created?

There is no expert entity in the United States that looks at innovation generally. The system is entirely piecemeal. Even for proponents of a decentralized approach, this is extreme.

What about the other extreme—complete centralization? For example, Congress could replace federal agencies that currently regulate innovation (whether by design or by default) with a new entity that would do their jobs and focus entirely on innovation. That is, Congress could eliminate agencies with a narrow focus on a particular industry or innovation incentive and replace them with a "Department of Innovation."

To shift from one system to another would be extremely costly which makes it not likely to happen. Moreover, there are considerable advantages in having federal agencies with specialized knowledge. Regulation of areas like the environment, telecommunications, and drug safety is enormously complex. Thus it is unlikely that a policymaker with expertise in innovation generally (as opposed to, say, environmental issues specifically) would ever understand the intricacies of environmental regulation with sufficient depth to make the very finely calibrated decisions that implementation of environmental statutes requires.

Another approach is the horizontal or vertical one. A horizontal regulator (i.e., a regulator in charge of innovation wherever it may arise) has a certain number of advantages, but so have also vertical (or sector-specific) regulators such as the Federal Communications Commission (FCC; which considers innovation alongside other goals as it regulates telecommunications) or the patent system (which considers innovation—to the extent it considers innovation at all—only in the context of patents). Purely vertical regulation allows for greater expertise but also for tunnel vision, without considering trade-offs and with a failure to encourage broad innovation.

In contrast, purely horizontal regulation encourages innovation but at the cost of sector-specific expertise and a focus on other goals.

2.1.2. <u>What is a sound mix?</u>

The new agency must have solid authority. What does this mean?

With respect to legal authority, this implies authority to create and promulgate regulations; to amend regulations proposed by existing agencies; to block proposed agency actions; to remand (but not permanently block) proposed actions for further consideration; to delay proposed actions for further review; and/or to review proposed actions with no authority to take any further action. OIP's authority could also be enhanced via standards of judicial review - for example, making its decisions unreviewable, placing a presumption behind its recommendations, forcing the substantive agency to justify its action if the innovation policymaker disapproved it, or asking whether the agency took a hard look at the innovation policymaker's contrary suggestions.

Giving an innovation policymaker the authority to unilaterally block or promulgate regulations or adjudications arguably places innovation above all other goals that administrative agencies have. Such concentration of power in one entity and the concomitant privileging of innovation above other goals are excessive. Innovation is tremendously important, and fostering innovation should be made an explicit goal of regulatory policy, although it should not be considered as an exclusive goal above all others

At the other end, an innovation policymaker making recommendations with no legal consequences whatsoever also seems unattractive because such recommendations would be too easy to ignore. There are many entities - governmental and others - that can and do make recommendations to Congress and to administrative agencies. Without the backing provided by some enforcement mechanism, those recommendations often have little weight.

The second axis addresses the same general concern with respect to the innovation policymaker: to what extent is the policymaker likely to be overeager, pushing broader regulatory solutions than would be ideal? As with the question regarding resistance from agency officials, this is a question about the likelihood of error compared with an ideal model that will never be obtained in reality. We know that there will be deviations from an ideal path, but in some cases the danger of overzealousness—whether in seeking to add regulations or to block them—will be greater than in others. Insofar as that danger increases, it serves as an argument for limiting the innovation policymaker's powers.

Giving OIP the power to block federal agencies' actions should be avoided. Once the possibility of OIP blocking agency action is off the table, the danger posed by an overeager regulator is greatly reduced. As a consequence, interest groups will have less incentive to influence OIP than they would if it could block regulations. This obviously means that OIP cannot altogether remake government policy in a fundamental way, but it also means that it cannot deliver regulatory gains to interest groups—and that means the danger of OIP overzealousness is minimized.

OIP should be authorized both to propose new agency action and respond to existing agency action. Federal agencies would be subject to a requirement that they consider and respond to OIP's analysis.

What sort of analysis should OIP undertake, and what procedures should it use?

The principles that OIP would use for its analysis would be quite parsimonious, which should also help to avoid undue delay. Again, the idea would be not so much that individual federal agencies could not use the principles, but that such agencies would not necessarily have the motivation and expertise to use the principles appropriately. The most important principle (which might, in certain cases, represent the entirety of OIP's analysis) would simply be whether, on balance, the proposed regulatory action maximized the sum of innovation incentives for all innovators, both current and future.

In considering the procedures OIP should use, we might ask whether administrative law requirements that are intended to secure public input—in particular, public comments—should apply to OIP. With respect to transparency, the answer is clear. At a minimum, transparency requirements similar to those imposed on OIRA during the Clinton administration should apply. And as we noted above, OIP's input would be part of the record before the agency and thus would be publicly disclosed. There is of course the question of compliance. Commentators have complained that OIRA's compliance with transparency obligations has been incomplete. OIP would presumably have a greater interest in transparency than does OIRA: unlike OIRA, OIP would not be able to block agency action, so OIP's authority would flow from the degree to which it could persuade others to accept its views.

Because it would have somewhat less inherent power than OIRA, OIP would need to make greater use of the "bully pulpit."

Implicit in the discussion above are basic elements of OIP's procedures—gathering information, conducting analysis, and communicating its ideas. These are the core aspects of almost any decision making process for any entity. The real question is whether OIP's processes would include the central distinctive element of the informal rulemaking process under the Administrative Procedure Act (APA): the requirement of a process pursuant to which members of the public can comment on proposed federal regulations. Neither agency decision making nor judicial review of agency actions requires a comment process, so its costs and benefits in the context of innovation regulation are worth careful consideration.

Creation of an innovation policymaker via executive order is the most attractive, and feasible, path.

The central cost of the comment process is straightforward: the relevant agency's time in reading, assessing, and, when appropriate, responding to the various comments. Even if comments turn out to add little, the agency has to read and assess them in order to

make that determination. This alone is a substantial use of agency resources. Then there is the time and energy required to demonstrate that the agency has taken a hard look at whichever arguments and data in the comments a court may later find significant and thus require an agency response.

Benjamin and Rai examined three FCC proceedings and they observed some negative trends. They found that comments were submitted disproportionately by well-organized groups. None of the comments was against the economic interests of the relevant commenters. And the vast majority of comments from private and public interest groups, and virtually all the comments from private citizens (which were mainly form letters), were duplicative of comments that had already been submitted. In contrast to the literal duplication entailed in form letters, the comments from organized interest groups used different words and different phrasing. But when we looked closely at the substance of the points that commenters made, we found a very high degree of duplication. The words differed, but the arguments did not.

The bottom line is that the comment process yielded little more than we might expect from a bare-bones lobbying process. The ideas and information that seemed important (both to us in reading the comments and to the FCC in responding to them) could be expected to be made by any given lobbyist on a particular side of the issue. All the other comments on the same side added little.

In sum, the results of the available theoretical and empirical work, including the one of Benjamin and Rai, strongly suggest that an APA-style public comment process is not essential, or even particularly helpful, for purposes of improving innovation regulation.

2.1.3. How should OIP be created?

One big advantage of the proposal over other possible mechanisms for improving U.S. innovation policy is that, while it can be implemented via legislation, it can also be implemented by executive order. The President can (and often does) create new offices via executive order, and giving a new office the authority to submit materials to agencies raise no constitutional issues.

The only constitutional concern raised by an OIP created by the President through executive order would involve the President's ability to authorize OIP to remand regulations back to independent agencies, as opposed to executive agencies. Some executive orders on federal regulation have refrained from giving entities like OIRA the ability to block regulations issued by independent agencies, authorizing such power only with respect to executive agency regulations. However, there is no case law holding that giving an entity created by executive order the power to block independent agencies' regulations would be unconstitutional.

In any event, they are not proposing a veto (which OIRA effectively has), but instead what amounts to a delay. OIP can remand only once and cannot force the agency to do anything, so an agency that refused even to read OIP's input would be subject only to a delay in promulgating its regulation. The weight of commentary indicates that such a procedure would not violate the separation of powers. So although Congress could eliminate any question by passing legislation giving this power to OIP, we do not believe that this would be necessary.

The advantage of having an OIP that can be created by executive order is quite significant. Indeed, creating OIP by executive order makes it much more likely that an effective OIP will in fact be created. There are several reasons. One is the simple fact that it is easier to persuade the President to promulgate a policy than to persuade veto-proof majorities in the House and Senate. Another reason is that there is widespread agreement that the President is more politically accountable to the national public than Congress. As a result, the President has greater reason to be concerned about the overall health of the national economy. And the innovation with which we are concerned may well negatively affect some regions of the country even as it helps others (the costs and benefits of innovation are sometimes geographically lumpy). Simply stated, the President's broader electoral constituency makes him more responsive to majoritarian preferences than Congress. As a result, creation of an innovation policymaker via executive order is the most attractive, and feasible, path.

It also bears noting both that the proposed OIP should face less danger of capture by powerful interests than other institutions do and that the absolute danger of such capture would be reasonably low. We have already noted two reasons for this: OIP will not be able to block regulations, and it will have both an obligation and an incentive to operate transparently. But another reason is significant as well: OIP's broad scope will make capture more difficult, and therefore less likely. The classic case of capture arises when an agency (or congressional committee) covers one or two industries. The major incumbents from those industries (or from advocacy groups with an interest in these industries) can band together and exert a huge amount of influence. That is the story, for instance, with respect to broadcasters' decades-long influence at the FCC. An entity that takes a cross-cutting approach to all regulation is less subject to the power of a few major stakeholders precisely because there will not be a few major stakeholders. Some of the entities affected by OIP will of course be powerful, but they will also be diffuse and they will not necessarily be repeat players, making it less likely that they will find it worth their time and energy to organize themselves much better than citizens groups are organized. Thus the logic of collective action should not produce the results that we see with more narrowly focused agencies.

2.1.4. Some conclusions

Promoting innovation is a critical goal of US public policy, and it can take many forms: direct investment, tax incentives, procurement, etc. One crucial element of U.S.

innovation policy that has been given short shrift, however, is structuring federal regulatory policy so that it promotes—or at least does not retard—innovation. Currently, there is no formal process within the executive branch to ensure that this happens.

There is no perfect mechanism for improving US innovation policy, but the article concludes that the best approach would be to establish an Office of Innovation Policy that could serve as an innovation policymaker within the US government with enough authority to be able to have a significant positive impact on innovation policy, but without giving it so much power that it can run roughshod over the other agencies. There would now be an entity speaking clearly and forthrightly on the centrality of innovation. Second, and more important, OIP would not merely have a voice: it would be able to remand agency actions that harm innovation. It would also have as part of its mission proposing regulation that benefits innovation. This is no small matter. Indeed, it would change the regulatory playing field overnight.

But today, agencies are already making predictions about the future (whether consciously or not) when they make laws that affect innovation. They are simply doing so in a manner that is unsystematic, haphazard, and subject to undue influence by well-funded incumbents. There is room for improvement!

The conclusion is that in the US several government players are active on innovation but there is no real coordination and interests of strong parties are better served than the public good.

Nevertheless studies show that the final result is not so bad. As stated in the first chapter the different entrepreneurs are also involved in innovation, the US has a large internal market and a strong sense for private initiative. The fact that government efforts are not always optimized lowers the possible positive effects, but does not neutralize them. The fact to have a strong central power (the President) can also strengthen the initiatives to optimize.

2.2. The EU context

The situation in Europe is quite different. The European Union is a unique economic and political partnership between 27 European countries that together cover much of the continent.

It was created in the aftermath of the Second World War. The first steps were to foster economic cooperation: the European Economic Community (EEC) was created in 1958 with the goal of increasing economic cooperation among six countries - Belgium, Germany, France, Italy, Luxembourg and the Netherlands. Since then, a huge single market has been created and continues to develop towards its full potential. What began

as a purely economic union has evolved into an organization spanning all policy areas, from development aid to environment. A name change from the EEC to the European Union (the EU) in 1993 reflected this change. The EU is based on the rule of law. This means that everything that it does is founded on treaties, voluntarily and democratically agreed by all member countries. These binding agreements set out the EU's goals in its many areas of activity. One of its main goals is to promote human rights both internally and around the world. Since the 2009 signing of the Treaty of Lisbon; the EU's Charter of Fundamental Rights brings all these rights together in a single document. The EU's institutions are legally bound to uphold them, as are EU governments whenever they apply EU law.

The single market is the EU's main economic engine, enabling most goods, services, money and people to move freely. Another key objective is to develop this huge resource to ensure that Europeans can draw the maximum benefit. As it continues to grow, the EU remains focused on making its governing institutions more transparent and democratic. More powers are being given to the directly elected European Parliament, while national parliaments are being given a greater role, working alongside the European institutions. In turn, European citizens have an ever-increasing number of channels for taking part in the political process.

There are 3 main institutions involved in EU legislation:

- The European Parliament , which represents the EU’s citizens and is directly elected by them;
- The Council of the European Union, which represents the governments of the individual member countries. The Presidency of the Council is shared by the member states on a rotating basis.
- The European Commission, which represents the interests of the Union as a whole.

Together, these three institutions produce through the “Ordinary Legislative Procedure” (ex "co-decision") the policies and laws that apply throughout the EU. In principle, the Commission proposes new laws, and the Parliament and Council adopt them. The Commission and the member countries then implement them, and the Commission ensures that the laws are properly applied and implemented.

In this framework, the European Union is regularly setting its strategy for economic development and growth. The Lisbon Strategy, also known as the Lisbon Agenda or Lisbon Process, was an action and development plan devised by the EU Heads of States at the European Council in Lisbon in 2010, for the economy of the European Union between 2000 and 2010. The Lisbon Strategy aimed specifically for economic as well as social and environmental renewal. The Strategy seeked to increase European competitiveness; not on the basis of social dumping but by investing in a knowledge-

based and highly productive society. Its aim was to make the EU "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion", by 2010. It was set out by the.

Building on the Lisbon Strategy, a new strategy for the next decade - **Europe 2020** – was announced in March 2010 by EC President Barroso[15]. The 2020 Strategy is expected to help kick-start recovery from the current economic downturn and create an ambitious new structural reform agenda at both national and EU levels.

The 2020 Strategy will continue with the Lisbon Strategy's process of creating growth in the context of sustainable development, making greater public investment in infrastructure, putting research and technology high on the economic agenda and investing in a greener economy.

2.2.1. What is Europe 2020?

Quoting the President of the European Commission J.M. Barroso: "Europe 2020 is the EU's growth strategy for the coming decade. In a changing world, we want the EU to become a smart, sustainable and inclusive economy. These three mutually reinforcing priorities should help the EU and the Member States deliver high levels of employment, productivity and social cohesion." [16]

Europe 2020 was designed as a strategy to "exit" from the crisis that severely hit Europe in 2009 – with spreading of unemployment and wiping out of long-term progress – and to build a lasting recovery, avoiding Europe's decline[17].

Growth based on knowledge and innovation, an inclusive high-employment society, and a competitive and sustainable economy: these are the priorities of Europe 2020, the Union's strategy for sustainable growth and jobs, which President Barroso presented to the informal European Council in March 2010.

Concretely, the Union has set five ambitious objectives - on employment, innovation, education, social inclusion and climate/energy - to be reached by 2020. Each Member State has adopted its own national targets in each of these areas. Concrete actions at EU and national levels underpin the strategy.

2.2.1.1. Which are the 5 targets?

1. **Employment**

[15] http://ec.europa.eu/europe2020/index_en.htm
[16] http://ec.europa.eu/europe2020/documents/president-barroso-on-europe2020/index_en.htm
[17] http://ec.europa.eu/commission_2010-2014/president/news/speeches-statements/pdf/president_barroso_europe2020_presentation_en.pdf

a. 75 % of the 20-64 years-olds to be employed

2. **R&D**
    a. 3% of the EU's GDP to be invested in R&D
3. **Climate change / energy**
    a. Greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than 1990
    b. 20% of energy from renewables
    c. 20% increase in energy efficiency
4. **Education**
    a. Reducing school drop-out below 10%
    b. At least 40% of 30-34-year-olds completing third level education
5. **Poverty / social exclusion**: at least 20 million people less in or at risk of poverty or social exclusion

2.2.1.2.How is Europe to realize its ambitions?

The Europe 2020 plan is founded on initiatives by the European Commission but includes also initiatives in each of the Member States. The idea is to focus around the objectives of the Europe 2020 strategy – smart, inclusive and sustainable growth - in order to boost each other's efforts.

2.2.1.2.1. Smart growth

It is all about improving the EU's performance in:

- Education (encouraging people to learn, study and update their skills)
- Research/innovation (creating new products/services that generate growth and jobs and help address social challenges)
- Digital society (using information and communication technologies)

EU targets for smart growth include:

1. Combined public and private investment levels to reach 3% of EU's GDP as well as better conditions for R&D and Innovation;
2. 75% employment rate for women and men aged 20-64 by 2020 – achieved by getting more people into work, especially women, the young, older and low-skilled people and legal migrants;
3. Better educational attainment – in particular:
    a. Reducing school drop-out rates below 10%
    b. At least 40% of 30-34-year-olds with third level education (or equivalent)

This programme is very challenging, but how politicians plan to boost smart growth?

To implement the Europe 2020 Strategy, three so-called flagship initiatives were created:

1. **Digital agenda for Europe** = creating a single digital market based on fast/ultrafast internet and interoperable applications:
    - By 2013: broadband access for all
    - By 2020: access for all to much higher internet speeds (30 Mbps or above)
    - By 2020: 50% or more of European households with internet connections above 100 Mbps.
2. **Innovation Union**
    - Refocusing R&D and Innovation policy on major challenges for our society like climate change, energy and resource efficiency, food security, health and demographic change
    - Strengthening every link in the innovation chain, from 'blue sky' research to commercialization
3. **Youth on the move**
    - Helping students and trainees study abroad
    - Equipping young people better for the job market
    - Enhancing the performance/international attractiveness of Europe's universities
    - Improving all levels of education and training (academic excellence, equal opportunities)

<u>The global context</u>

The needs are high in Europe and global competition is fierce. We are limping behind other major economies (US, Japan, but even the BRIC countries) under different aspects.

The European Commission in its report on 'The World in 2025' noticed that if recent trends continue, the United States and Europe will have lost their scientific and technological supremacy for the benefit of Asia. In particular, the US and EU will lose their primacy in terms of R&D investments, with India and China reaching 20% of the world's R&D. The European Commission in its report on 'The World in 2025' noticed that if recent trends continue, the United States and Europe will have lost their scientific and technological supremacy for the benefit of Asia. In particular, the US and EU will lose their primacy in terms of R&D investments, with India and China reaching 20% of the world's R&D. In the 90's and until beginning of the 21st century, we could see at

Belgian universities and research centers many Chinese and Indian scientists. They came to study and learn. Some of them remained here in those days. Since over 10 years we notice the return of all those scientists to the country of origin. China and India offer them good paid jobs and almost unlimited financial and structural means.

The European Commission indicates as an example that Europe only accounts for 25% of the market of information/communication technologies. European still have to coop with no or slow access to high-speed internet, which affects Europe's ability to innovate, spread knowledge and distribute goods and services, and which leaves rural areas isolated.

The results in the other two topics are not brighter. Analyzing Education and training shows that 25% of European school children have poor reading skills. Too many young people leave education/training without qualifications. Numbers attaining medium-level qualifications are better, but these qualifications often fail to match labour market needs. Furthermore under a third of Europeans aged 25-34 have an university degree (40% in the US and over 50% in Japan). In addition, European universities rank poorly in global terms (only 2 are in the world top 20 according to the Shanghai Index (ARWU)). By comparison, the motivation of students and scientists from countries such as China and India is overwhelming. There is an enormous number of high skilled scholars, selected through a very demanding and highly selective system, in these countries and the booming industry of these economies offers them many opportunities of highly paid and challenging jobs.

To some extent, the wellbeing in Europe made us lose the drive for innovation, hard work, collaboration, etc.

Another social issue is ageing populations. As Europeans live longer and have fewer children, fewer people in work have to support higher numbers of pensioners, as well as fund the rest of the welfare system. The number of -60s is now increasing twice as fast as it did before 2007 – by some 2 million a year instead of 1 million previously. A better knowledge economy with more opportunities will help people work longer and relieve the strain.

Europe's lower growth than it main competitors can only be solved by putting more focus on

- Investment in R&D and innovation
- Better use of information/communication technologies
- Improve access to innovation in some sections of society

In order to survive the problems mankind is facing today, growth is necessary. Not the growth anymore we knew, but sustainable growth for a resource efficient, greener and more competitive economy.

2.2.1.2.2. Sustainable growth

The idea is to build a more competitive low-carbon economy that makes efficient, sustainable use of the resources. This objective is only feasible in combination with the protection of the environment, reducing emissions and preventing biodiversity loss. The latter we can do because Europe is leader in developing new green technologies and production methods. We must support our EU-scale networks to give our businesses (especially the small and medium ones) an additional competitive advantage. Last but not least consumers should make well-informed choices in order to create the demand for adequate products and services.

Also in this domain, Europe proposes two flagship initiatives:

1. **Resource-efficient Europe**
    a. By reducing CO2 emissions
    b. By promoting greater energy security
    c. By reducing the resource intensity of what we use and consume

2. **An industrial policy for the globalization era**
    a. By supporting entrepreneurship – to make European business fitter and more competitive;
    b. By covering every part of the increasingly international value chain – from access to raw materials to after-sales services.

The only guarantee to success is the collaboration of all involved parties: business, trade unions, academics, NGO's and consumer organizations.

As already mentioned in the first chapter, growth must be sustainable. The European Commission in its publications confirms this. Also in Europe we over-depend on fossil fuels. Our dependence on oil, gas and coal leaves consumers and businesses vulnerable to harmful and costly price shocks, threatens our economic security and contributes to climate change.

Indeed, natural resources are by definition limited. Global competition will intensify and put pressures through its sustainable development policies.

Another important issue is Climate Change. To achieve the climate goals put forward in Europe 2020, there is the need to reduce emissions more quickly and harness new technologies such as wind and solar power and carbon capture and sequestration. Economies 'resilience to climate risks and the capacity for disaster prevention and response must be strengthening.

All of this must be realized respecting and improving productivity and competitiveness. Europe must maintain its early lead in green solutions, especially in view of growing competition from China and North America.

Meeting the energy goals could save up to 60 Billion Euro on Europe's bill for oil and gas imports by 2020 – essential for both energy security and economic reasons. Further integration of the European energy market can boost GDP by 0.6% to 0.8%. In addition 20% of Europe's energy needs from renewable sources could create over 600.000 jobs in the EU. An additional 400.000 jobs are possible if we meet the 20% energy-efficiency target. By optimizing emission-reduction commitments Europe maximizes benefits and minimizes cost, which is at the benefit of our all.

2.2.1.2.3. Inclusive growth

The Europe 2020 strategy foresees inclusive growth (a high-employment economy delivering economic, social and territorial cohesion). This implies:

- Raising Europe's employment rate – more and better jobs, especially for women, young people and older workers;
- Helping people of all ages anticipate and manage change through investment in skills & training;
- Modernizing labour markets and welfare systems;
- Ensuring the benefits of growth reach all parts of the EU.

Towards this goal, two flagship initiatives are defined.

1. **Agenda for new skills and jobs**
    a. For individuals: helping people acquire new skills, adapt to a changing labour market and making career shifts more successful
    b. Collectively: modernizing labour markets to raise employment levels, reduce unemployment, raise labour productivity and ensure the sustainability of our social models
2. **European platform against poverty**
    a. Ensuring economic, social and territorial cohesion
    b. Guaranteeing respect for the fundamental rights of people experiencing poverty and social exclusion, and enabling them to live in dignity and take an active part in society;
    c. Mobilizing support to help people integrate in the communities where they live, get training and help to find a job and have access to social benefits.

Regional development and investment also support inclusive growth by helping disparities among regions diminish and making sure that the benefits of growth reach all corners of the EU.

Why is inclusive growth so important?

Europe's workforce is shrinking as a result of demographic change – a smaller workforce is supporting a growing number of inactive people. By consequence, the EU

is constraint to increase its overall employment rate. Especially for women this rate is very low (63% against 76% for men aged 20-64) but also for older workers, aged 55-64 (46% against 62% in both US and Japan). In Europe less people work, but the ones working, work les hours than in the US or Japan (10% less). The economic crisis we are living today generates youth unemployment (21 %) and makes it harder for out-of-work people to find a job.

When discussing jobs, we need to verify if people have the right skills. Here too, in Europe there is a gap. Around 80 million people are with low or basic skills. By 2020, 16 million more jobs will require high qualifications, with 13 million fewer jobs requiring for low skill-levels. It is crystal clear that acquiring and building on new skills is ever more important.

Job creation is fighting poverty. Even before the crisis, there were 80 million people at risk of poverty, including 19 million children. 8% of working people do not earn enough to make it above the poverty line.

2.2.2 What is the difference between Europe 2020 and its predecessor the Lisbon Strategy?

Europe 2020, as states the EU Commission, builds on lessons learned from the earlier strategy, recognizing its strengths (the right goals of growth and job creation, 18 million new jobs created since 2000) but addressing its weaknesses (poor implementation, with big differences between EU countries in the speed and depth of reform). The new strategy also reflects changes in the EU's situation since 2000 – in particular the immediate need to recover from the economic crisis[18].

Europe 2020 stands for a new kind of growth (smart, sustainable and inclusive), mainly by:

- Improving skills levels and (life-long) education;
- Boosting research and innovation
- More use of smart networks and the digital economy
- Modernizing industry
- Greater energy and resource efficiency

This by stronger governance (regular and transparent monitoring; leadership at the highest political level = the European Council).

[18]D. Natali "The Lisbon Strategy, Europe 2020 and the crisis in between" , The European Social Observatory, May 2010,
http://www.ose.be/files/publication/2010/Natali_2010_Lisbon%20StrategyEU2020&Crisis.pdf

The Commission is steering the process and uses the new instruments introduced by the Lisbon treaty – recommendations, policy warnings where necessary, and, for serious delays, the possibility of penalties.

There will be also a tighter economic coordination. Under new arrangements for coordinating economic policy – the 'European semester' – national governments have to submit reports on economic reform, stability and convergence at the same time, so they need to ensure solid funding for their reform programmes.

Effective and timely delivery is also helped by strong monitoring during the European semester, clear and measurable targets (both at EU and national level) and robust surveillance.

2.2.3. Conclusions and way-forward

The crisis exposed fundamental problems and unsustainable trends in many European countries. It also made clear just how interdependent the EU's economies are. Greater economic policy coordination across the EU will help the EU Member States to address these problems and boost growth and job creation in future.

The European Commission is confident that their Europe 2020 plan is solid and, if executed well, it will give Europe the necessary boost. This is not the first attempt to boost innovation. Immediately before the Lisbon Council (in March 2000), the EC adopted its Communication Towards a European Research Area (January 2000). The aim was to reinvigorate Europe's leadership in research. The awareness was that Europe was less and less investing in research and development. In 2002, the Barcelona European Council set a target for EU R&D investment to approach 3%. In addition there was the appeal to strengthen the links between university research and industry. The 2006 'AHO report' on 'Creating an Innovative Europe' argued that the innovation potential of the EU was not being fully exploited and that the business climate should be made more innovation-friendly. Several other initiatives were taken (e.g. tax measures in 2007 and 2008).

Unfortunately, all these efforts did not lead to significant results, and the EC decided to re-launch the ERA in 2007[19]. A new Green Paper on ERA, coupled with a comprehensive stakeholder consultation, called for the end of the fragmentation of the European research landscape[20]. In autumn 2010 another flagship was presented: 'Innovation Union'.

[19] Granieri and Renda: *Innovation Law and Policy in the European Union – Towards Horizon 2020,* Springer Verlag 2012

[20] European Commission (2009). The World in 2025. Rising Asia and socio-ecological transition.

All these efforts indicate the importance of innovation, but also painfully show the weakness of the system in Europe. Governance with 27 Member States is not evident. Each Member State is mostly interested in its own strategy and national interests. However, the EU Strategy demonstrates the importance of interconnections and of a common approach for sustainable growth. Furthermore the European social context and mentality – including various social laws - makes that private initiative is not as aggressive as it is in the States and the education and training pushes underlying innovation are not as strong and motivated as we can observe in emerging economies such as China and India.

A major impediment in Europe is the fragmentation of efforts. Funds are available, but possibly too spread over a large number of programmes - at EU, national and regional level - and under a panoply of different management rules.

The European Commission is currently managing a series of main programmes supporting research and innovation: the EU **Seventh Framework Programme** for research, technological development and demonstration activities (FP7)[21] bundles all research-related EU initiatives together under a common roof playing a crucial role in reaching the goals of growth, competitiveness and employment; along with a new Competitiveness and Innovation Framework Programme (CIP)[22], Education and Training programmes, and Structural and Cohesion Funds for regional convergence and competitiveness.

The governance of the EU landscape is complex: four different executive agencies support the implementation of the centralized research and innovation programmes. In addition, the European Investment Fund and its financial intermediaries are active for the development and implementation of financial instruments within the Competitiveness and Innovation Programme and the Risk sharing Financing Facility. As many as 24 committees were dealing with the programming and monitoring of implementation to the centrally managed programmes directly targeting innovation. No fewer than 386 operational programmes under the European Regional Development Funds and European Science Foundation that contain an innovation policy.

It is obvious that a splinter bomb could not do more damage. Simplification is an issue. The potential beneficiaries found no single information or entry point to the different EU support programmes and a panoply of different application forms and management rules at EU, national and regional levels. This was clearly leading to a lack of clear political leadership and strategic orientation.

Europe 2020 aims at improving the governance. The situation and approach described by Benjamin and Rai for the US is also valid for Europe. Alone in Europe the different players have each a national sovereignty and can slow down the solution which is so

[21] http://cordis.europa.eu/fp7/home_en.html
[22] http://ec.europa.eu/cip/index_en.htm

urgently needed. This is why proposal such as Europe 2020 are so important. Countries must realize that they are already too linked to each other to neglect a common approach.

Horizon 2020, the EU's proposal for the new research and innovation programme to run from 2014 to 2020 with an €80 billion budget, follows this direction. Horizon 2020 is the financial instrument implementing the Europe 2020 flagship initiative "Innovation Union" "; using research and innovation as main drive; to create new growth and jobs in Europe. The new programme provides major simplification through a single set of rules. It will combine all research and innovation funding currently provided through the Framework Programmes for Research and Technical Development, the innovation related activities of the Competitiveness and Innovation Framework Programme (CIP) and the European Institute of Innovation and Technology (EIT).[23] Horizon 2020 will tackle societal challenges by helping to bridge the gap between research and the market by, for example, helping innovative enterprise to develop their technological breakthroughs into viable products with real commercial potential. This market-driven approach will include creating partnerships with the private sector and Member States to bring together the resources needed.

[23] http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020

Chapter 3.

Key Enabling Technologies

3.1. What are the Key Enabling Technologies and why are they so important for the future?

Key Enabling Technologies (KETs) are knowledge and capital-intensive technologies associated with high research and development (R&D) intensity, rapid and integrated innovation cycles, high capital expenditure and highly-skilled employment. Their influence is pervasive, enabling process, product and service innovation throughout the economy. They are of systemic relevance, multidisciplinary and trans-sectorial, cutting across many technology areas with a trend towards convergence, technology integration and the potential to induce structural change[24] .

KET's have two specific characteristics that separate them from other 'enabling technologies': they are embedded at the core of innovative products and they underpin strategic European value chains.

Combinations of KETs are embedded at the core of most advanced products. For example, an electric car is a combination of advanced materials for batteries, microelectronics components for power electronics, photonics for low consumption lighting, industrial biotechnologies for low friction tires and finally advanced manufacturing systems to produce electrical vehicles at a competitive cost. In addition they underpin strategic European value chains. (A value chain is a term used to describe the cooperation of the relevant business sectors from raw material to final product, to ensure delivery of products and processes).

3.2. Implementation in Europe

In 2009, the European Union identified Key Enabling Technologies (KET) for their potential impact in strengthening Europe's industrial and innovation capacities[25]. In July 2010, a High-Level Experts Group (HLG) on Key Enabling Technologies[26] was appointed by the European Commission to advise on the future of KET's.

The Europe 2020 strategy clearly signalled the importance of industrial competitiveness for growth and jobs as well as for Europe's ability to address grand societal challenges in the coming years. Mastering and deploying Key Enabling Technologies (KETs) in the European Union is central to strengthening Europe's capacity for industrial

[24] Commission Staff Working Document (SEC/2009/1257).
[25] Preparing for our future: Developing a common strategy for KET in the EU, Brussels, 30.09.2009. COM(2009) 512 final
[26] http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf

innovation and the development of new products and services needed to deliver smart, sustainable and inclusive European growth.

To eat or to be eaten

In the KET's domain, the EU is now facing growing and overwhelming global competition from both developed and emerging economies in particular in North America and East Asia. Although the EU remains resilient, in a position of relative strength, it must now reinforce and rapidly develop its KETs industry to compete for the future. From research and industrial perspectives, these assets include a strong technological research base, leveraging in particular Europe's leading Research Technology Organisations, as well as world leadership in several KET application sectors (automotive, aeronautics, health, and energy) relying, for most of them, on strong technological and manufacturing competences in large and small companies, and in production and competence networks along established and highly diverse new value chains. The KET's HLG therefore strongly believes that the EU and its policy makers should urgently engage in a radical rebalancing of resources and objectives in order to retain critical capability and capacity in these domains of vital European importance. Signs that Europe is risking to miss the train are the filings of patents: Europe has 32% of filings, Asia 38% and the US 27%.

The HLG has identified the major difficulties Europe has in translating its ideas into marketable products – in crossing the internationally recognized "valley of death" (A similar initiative is taken by president Obama: PCAST = Advisory panel on science and technology).

To cross this 'valley', the HLG recommends a strategy comprising three pillars:

- A pillar focused on technological research. Consists on taking best advantage of European scientific excellence in transforming the ideas arising for fundamental research into technologies competitive at world level.

- A product demonstration pillar focused on product development. Allows the use and exploitation of these KET's to make innovative and performing European process and product prototyping facilities to enable the fabrication of a significant quantity of innovative products.

- A production pillar focused on world-class, advanced manufacturing. Starting from the prototypes duly validated during the demonstration phase, crate and maintain in Europe attractive economic environments in EU regions based on strong eco-systems and globally competitive industries.

By focusing on these key stages of the innovation chain, the HLG proposals can trigger a virtuous cycle, from knowledge generation to market flow with feedback from the

market to knowledge generation support, thereby strengthening economic development in Europe.

3.2.1 Recommendations by the High Level Group on KET's

Based on the three pillar bridge model, the HLG has made a series of specific policy recommendations for a more effective industrial development and deployment of KET's.

- A single KET's and fully-fledged innovation policy at EU level

Firstly, the HLG recommends a single KETs label and fully-fledged KETs innovation policy, to exploit their cross-fertilizing impact and their pervasive enabling nature. The HLG considers that the success of such a policy requires KETs to be positioned as a technological priority for Europe and for this to be demonstrably translated into the EU's main political and financial instruments in the next financial perspective 2014-2020.

In particular this priority must be reflected in the upcoming Horizon 2020 – the forthcoming EU Framework Programme for Research and Innovation (2014-2020) - the instruments related to the EU's Regional Policy and the policies of the European Investment Bank group. In this regard, the EU should recognize the need for the full and simultaneous implementation of the three pillar bridge model along the innovation chain, from basic research, through technological research, product development and prototyping up to globally competitive manufacturing. This notably requires the application of appropriate R&D definition aligned on the industrially-recognized Technology Readiness Level (TRL) scale in accordance with OECD practice and a radical rebalancing of RDI funding in KETs-related programmes towards innovation activities in the future Horizon 2020 programme.

- *A comprehensive strategic approach to a KET's policy at EU level*

In addition, the HLG agreed on the need for a comprehensive strategic approach to a KETs policy at EU level to be implemented. The EU KETs policy should be forward-looking and driven in a long-term perspective since it concerns the innovation capabilities of EU industries in the next decade and beyond. Such a policy needs a full strategy involving all stakeholders - private and public - at European, national and regional level, and must encompass all relevant policy instruments. In particular, the HLG calls for the selection criteria and implementation rules in the CSF programme to be adapted to maximize its impact on the value and innovation chains.

- *Combined financing to promote RDI investments in KET's*

Given the high costs of many KETs RDI projects, the HLG recommends a tripartite approach to financing where required, based on combined funding mechanisms to

promote RDI investments in KETs involving industry, the EU and the Member States (at national and local level). It also calls for mechanisms to allow the combination of different types of EU funding to enable the optimum investment in significant KET pilot line and manufacturing facilities across Europe while respecting state aid rules. In this regard, the HLG calls for state aid provisions to be adapted to facilitate RDI activities and large-scale investment in KETs, in particular through the generalized introduction of a matching clause in the EU state aid framework, increased thresholds for notifications, faster procedures and greater use of provisions covering projects of common European interest.

- *Globally competitive IP Policy*

The HLG considers that the rules for participation in Horizon 2020 should be strengthened in order to generate greater economic value in Europe by better protecting the technological knowledge created. Generally, the EU should clearly promote a globally competitive Intellectual Property (IP) policy based on "in Europe first" principles. Before the start of any project, consortium partners should have to demonstrate that they have a clear IP plan for both the ownership of and first exploitation of IP resulting from the project within the EU.

- *Education and Skills*

In the long term, strengthening the technological and industrial base of Europe requires the development of new KETs' skills and competencies in Europe. The exploitation of KETs synergies and crossing the boundaries towards KETs trans-disciplinarily requires competencies that current linear training and education cannot provide. In particular, the HLG recommends that KETs skills should be promoted within the framework of the regional policy (European Social Fund) and calls for the creation of a European Technology Research Council (ETRC) to promote individual excellence in technologically-focused engineering research and innovation mirroring the European Research Council's (ERC) promotion of fundamental science. To be competitive; Europe needs a world-class cadre of scientists, engineers and technologists.

- *Follow up (monitoring)*

Finally, the HLG has noted through its work an ongoing and urgent need for stakeholders to have relevant information on KETs to inform strategy and decision making. More hard data is needed on KETs to provide EU, national and regional policy makers with information to better develop and implement policies influencing the development and deployment of KETs. The HLG recommends the establishment a European KETs Observatory, Monitoring Mechanism, tasked with the mission of performing analyses and a "KETs Consultative Body" comprising stakeholders across the entire innovation chain to advise and monitor the progress achieved towards the development and deployment of KETs for a competitive industry in Europe.

Overview of the recommendations by the High Level Group on Key Enabling Technologies

1. The HLG recommends that an integrated KETS policy should be implemented, that KETs should be visibly prioritized in EU policies and financial instruments and that the European Investment Bank group should pro-actively support KETs initiatives in Europe.
2. The HLG recommends the EU to align its RDI activities on the TRL (technical readiness levels) scale in line with the OECD definition. The Commission should also systematically apply this definition in order to include technological research, product development and demonstration activities within its RDI portfolio.
3. The HLG recommends that the EU should apply R&D definitions in its programmes which support the full and simultaneous implementation of the three pillar bridge model along the innovation chain, from basic research, through technological research, product development and prototyping up to globally competitive manufacturing.
4. The HLG recommends that the EU and Member States firmly rebalance their RDI funding in KETs related programmes towards technological research, product development (including pilot lines, prototypes, first-in-kind equipment and facilities and demonstrator activities). In particular in the future CSF, the EU should set indicative targets for the percentage of funding dedicated to basic research, technological research and development activities.
5. The HLG recommends that the European Commission defines and implements a strategic, industry driven and coordinated approach to KETs programmes and related policies across EC RDI funding programmes and instruments (CSF, ERDF).
6. The HLG recommends that the European Commission adapts its selection criteria and implementation rules in the CSF programme to maximize its impact on the value and innovation chains. In particular, a "value chain correctness" criterion should be added.
7. The HLG recommends that the EU should introduce a tripartite financing approach based on combined funding mechanisms involving industry, Commission, and national authorities (Member States and local government), when required by the high costs of the KETs RDI projects, and put in place the appropriate program management and mechanisms to allow the combination of EU funding (CSF, structural funds), to enable the optimum investment in significant KET pilot line and manufacturing facilities across Europe.
8. The HLG recommends that the EU adapts state aid provisions to facilitate RDI activities and large-scale investment in KETs, in particular through the introduction of a matching clause in the EU state aid framework across the board, review of the scaling-down mechanism for larger investments increased thresholds for notifications, faster procedures and the use of projects of common European interest.
9. The HLG recommends that the selection criteria and terms of the consortium agreements of EU RDI funding programmes should be amended to ensure that participating consortia have a clear and explicit plan for both the ownership of and first exploitation of IP resulting from the project within the EU. It should explicitly include provisions similar to those of the "Bayh-Dole act" and "Exception Circumstances"-like provisions to encourage the first exploitation and manufacturing of products based on this IP within the EU.
10. The HLG recommends that the EU should create a European Technology Research Council (ETRC) to promote individual excellence in technologically focused engineering research and innovation and establish the appropriate framework conditions through the ESF regulation in order to support KETs skills capacity building at national and regional level.
11. The HLG recommends that the European Commission establishes a European KETs Observatory Monitoring Mechanism tasked with the mission of performing analysis and a "KETs Consultative Body" comprised of stakeholders across the entire innovation chain to advise and monitor the progress in Europe of the HLG KET recommendations towards the development and deployment of KETs for a competitive Europe this should include all relevant data regarding policies and strategies evolution outside EU.

3.2.2. The AHO report

It is worth noting that prior to the report by the EU High-Level Group on KET's, which provides indeed a rather complete analysis of the needs and a solid proposal for change, another interesting report tackled the issue of KET's and formulated a number of recommendations. Indeed in 2006 the so-called AHO report - named after a former premier of Finland, Esko Aho – was published[27].

The intention of the EU (as written down in the Lisbon Strategy) to spend 3% of the GDP (Gross Domestic Product) for research in order to defend and consolidate the position of the European Union in the domain of innovation, may not be seen as an end in itself. The 3% are an indicator of an Innovative Europe. Measures are needed to increase our efforts for an excellent science, industrial R&D and the science-industry.

The proportion of structural funds spent on research and innovation should be trebled.

Special attention is required at three levels:

1. Human resources need a step change in mobility across boundaries; Financial mobility requires an effective venture capital sector and new financial instruments for the knowledge-based economy;
2. Mobility in organization and knowledge means cutting across established structures to allow new linkages to be made through the instruments of European technology platforms and clusters.
3. More resources for R&D and innovation are a necessity but they are an insufficient means to achieve the goal of an Innovative Europe. A paradigm change is needed in which European values are preserved but in a new social structure.

An independent monitoring panel with support from the Commission should report annually on progress in relation to the Pact. Europe and its citizens should realize that their way of life is under threat but also that the path to prosperity through research and innovation is open if large scale action is taken now by their leaders before it is too late.

The AHO report presents a strategy to create an Innovative Europe. Achieving this requires a combination of a market for innovative goods and services, focused resources, new financial structures and mobility of people, money and organizations.

Together these constitute a paradigm shift going well beyond the narrow domain of R&D and innovation policy.

The central recommendation is that a Pact for Research and Innovation is needed to drive the agenda for an Innovative Europe. This requires a huge act of will and

[27] Aho Group Report: " Creating an Innovative Europe" http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm

commitment from political, business and social leaders. Current efforts towards the revised Lisbon Agenda should be continued and reinforced but are not enough. In addition, simultaneous and synchronous efforts are needed in the three areas which constitute the Pact and which we use to structure this report:

At the core of their recommendations is the need for Europe to provide an innovation-friendly market for its businesses, the lack of which is the main barrier to investment in research and innovation. This needs actions on regulation, standards, public procurement, intellectual property and fostering a culture which celebrates innovation. A combination of supply and these measures to create demand should be focused in large scale strategic actions. The commission identifies several examples: e-Health, Pharmaceuticals, Energy, Environment, Transport and Logistics, Security, and Digital Content. An independent High Level Coordinator should be appointed to orchestrate European action in each area.

The AHO report identifies a number of areas considered strategic for innovation. The reasoning is that some areas are more sensitive for change and where a market for innovation can work because of a significant role for public policy.

The sectors listed account for a large portion of GDP and impact upon the daily lives of citizens. These are not the only areas for concerted action but nonetheless focus and concentration of resources is necessary. They are e-Health, Pharmaceuticals, Transport and Logistics, Environment, Digital Content, Energy, and Security.

Each of these areas is of critical importance. The degree of coordination necessary requires the appointment of a senior individual of high standing and demonstrated independence with the remit to create a platform and orchestrate European action in the area across DGs, Member States and regions and to liaise between R&D performers, regulators, users and sectorial stakeholders.

Example of strategic areas for innovation identified by the Aho Group Report

E-HEALTH:

The healthcare sector combines great need with many possibilities for revolutionary innovation. It already accounts for 9% of GDP in Europe and the share is growing at 6% pa as costly new treatments and an ageing population exerts pressures. However, in an increasingly service intensive sector 7% of costs are consumed by administration (more than the cost of general practitioners), a situation ripe for ICT-led innovation to reduce costs. Opportunities lie
in eHealth, a term which describes the application of information and communications technologies (ICTs) across the whole range of functions that affect the health sector. e-Health, it is estimated, will account for 5% of the total Member States' health budget by 2010.
Specific challenges include the cost of duplication in non-standardized medical files, the high administrative costs and coping with an ageing population requiring prolonged medical care. Massive savings could be made by digitizing all diagnostic tests and images so that results are available to clinicians immediately. The cost of access to such records created and delivered manually is huge and causes unacceptable delays in processing patients. Patient supervision at a distance using communications and analysis/sensor technologies is another major opportunity for saving. Health services also have massive purchasing power yet can be late and slow adopters of new technology with negative

consequences for both health and expenditure. Organizational and operational changes are needed. A recent foresight report noted the opportunities European collaboration brings for standardization, shared assessment of technologies and hence market creation.

PHARMACEUTICALS:

Europe's position as the world's leading manufacturing location for pharmaceuticals, is under long-term threat despite being the only high technology sector to consistently show a growing positive trade balance. It employs 588,000 people including 100,000 in R&D, with an R&D investment of €20,500 million.
Huge opportunities remain to be exploited in genomics and their combination with other technologies. Better regulation can also help innovation to reduce healthcare costs. Nonetheless there is cause for concern. In 1990, major European research-based companiesspent 73% of their worldwide R&D expenditure in EU territory. In 1999, they spent only 59% in EU territory. The USA was the main beneficiary of this transfer of R&D Expenditure. Furthermore, in 1992 six out of the ten top selling pharmaceuticals were produced by European companies. In 2002, this figure had fallen down to two out of ten.
The European Technology Platform is this area is addressing key barriers to development of new drugs in Europe:
• Safety, addressing the bottlenecks predictive toxicology and risk assessment with authority
• Efficacy, addressing the bottlenecks predictive pharmacology, biomarkers identification and validation, patient recruitment and risk assessment with authority
• Knowledge Management, leveraging the potential of new technologies to analyse a huge amount of information in an integrative and predictive way
• Education and Training, addressing certain gaps in expertise which need to be resolved in order to change and support the biopharmaceutical research and development process
This approach involves bringing together a wide range of stakeholders in the manner we envisage including large and small firms, academics, patients and their representatives, clinicians, regulatory agencies, government at several levels, health providers and charities. Beyond this, achievement of a single market in pharmaceuticals requires continuing efforts insimplification of legislation and regulation at EU and national levels and speeding up national negotiations on reimbursement and pricing.

3.2.3. Horizon 2020 and KET's

Key Enabling Technologies are recognized to play a fundamental role in the proposal for the next EU Framework Programme for Research and Innovation, Horizon 2020. Following on from recommendations made by the High Level Group on KET's, the Horizon 2020 part dedicated to 'Leadership in enabling and industrial technologies' identifies KET's as a key priority of Horizon 2020, highlighting their importance for growth and jobs. This includes a dedicated budget of EUR 6663 million for the KETs of *photonics, micro- and nanoelectronics, nanotechnologies, advanced materials, biotechnology and advanced manufacturing and processing*[28].

Horizon 2020 proposes *an integrated approach to Key Enabling Technologies.* 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

[28]COM(2011)808/3 Horizon 2020 – The Framework Programme for Research and Innovation

will therefore be exploited. As part of this integrated approach to KETs, dedicated support will be provided for activities exploiting the accumulated benefits from combining a number of KETs, in particular through support for larger-scale pilot line and demonstrator projects. 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. 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. Finally, strong private sector involvement in such activities will be a prerequisite and implementation will therefore notably be through public private partnerships[29]. In this prospect, the European Commission has recently launched a public consultation for the establishment of a *public-private partnership* on research and innovation for bio-based industries[30].

3.3. Focus on Biotechnology

Biotechnology is by far one of the most important KET and powerful driver of innovation and economic growth. Though it is for many citizen still rather unknown, it influences the daily life of everybody. The United Nations Convention on Biological Diversity defines biotechnology as: "Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." The word biotechnology is a cross between the Greek words 'bios' (everything to do with life) and 'technikos' (involving human knowledge and skills). The OECD (the Organisation of Economic Co-operation and Development) defines biotechnology as "the application of scientific and engineering principles to the processing of materials by biological agents". More simply, biotechnology is using living organisms to make useful products[31].

[29] Proposal for a COUNCIL DECISION establishing the Specific Programme Implementing Horizon 2020 - The Framework Programme for Research and Innovation (2014-2020) - COM(2011) 811/3

[30] http://ec.europa.eu/research/consultations/bio_based_h2020/consultation_en.htm

[31] EuropaBio – Association of European Bio-based Industries http://www.europabio.org/what-biotechnology

In Europe, four main sectors of biotech are commonly distinguished: red or healthcare biotech, green or agricultural biotech, white or industrial biotech and blue or marine biotech.
Key biotechnology indicators (e.g. firms, R&D, expenditures, applications, patents…) and world-wide statistics are regularly produced by the OECD[32]. They show that the large majority of biotechnology firms are SMEs. Over 2.000 SME's are active in this sector within Europe. EU is a global leader in some biotechnology sectors, such as enzymes production, while the USA leads in biofuels.[33]

World-wide, biotechnology is an increasing main focus also in the national agenda's of major emerging economies. Just to mention one example, on April 2012 the Russian government adopted "The Comprehensive Program for Development of Biotechnology in the Russian Federation through 2020". The programme – which acknowledges that Russia is lagging behind both developed and developing countries in the development and use of biotechnology (including agricultural biotechnology) and sets targets to create a biotech-oriented economy by 2020 - envisages 1.2 trillion rubbles ($39 billion) financing from 2012 through 2020, including 200 billion rubbles ($6.7 billion) for development of agricultural biotechnology.[34] India and China are also heavily investing in biotechnology research and innovation programmes.

Interests for the area of biotechnology are not new. A forecast study dating back to 2005 predicted that Europe will have made substantial progress towards a bio-based society by 2025[35]. Biotechnology will be used for the conversion of agricultural feedstocks into a wide variety of fine and bulk chemicals, bioplastics, biofuels, pharmaceuticals, etc. At the same time, these biological processes will result in significant cost reductions, lower waste and energy use, and a major reduction in our dependence on increasingly expensive imported petrochemical feedstocks. Biotechnology will allow for an increasing eco-efficient use of renewable resources as raw materials for the industry. Agriculture in the hinterland will be supported, and the rural economy developed.

Today, in 2012 and in light of the recent crises that have hit our society - not only financial but also food and energy crises – such forecasts might seem to have been over-optimistic. Changing climate and growing populations are endangering agriculture and food prices are rising. A month ago the European Commission had to indicate that using products which are also useful in the food chain for e.g. the production of bio-oil is no longer an unlimited option. While biotechnology cannot be simply considered by itself

[32] http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/keybiotechnologyindicators.htm
[33] http://www.oecd.org/sti/biotechnologypolicies/44777130.pdf
[34]

http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Program%20on%20Development%20of%20Biotechnology%20in%20Russia%20through%202020_Moscow_Russian%20Federation_6-7-2012.pdf
[35]Looking ahead in Europe: White Biotech by 2025 - Gen Publishing Inc. vol. 1, nr2, summer 2005 – Industrial Biotechnology

as “the miracle solution” to all problems our society is facing, it holds great potential to contribute to sustainable growth.

The economic contribution of biotechnology could be greatest in industrial applications: the estimated potential share of industrial biotechnology to the total biotechnology gross added value is 39% in the OECD area by 2030[36]. The OECD has published several studies highlighting the potential of industrial biotechnology (IB)[37]. For example towards the challenge of climate change, industrial biotechnology, based on renewable resources, can save energy and significantly reduce CO2 emissions. It is an embryonic industry, but has already proven its worth in climate change mitigation. It holds much greater promise for the future by avoiding the use of fossil raw materials. It involves the use of enzymes and microorganisms to make biobased products in a diverse variety of industry sectors. The feedstocks are agricultural biomass and organic waste materials, even wastewaters. The new industrial biotechnology arose from international interest in the production of biofuels from a variety of feedstocks. Many countries now have bioenergy strategies and targets. In first instance, many supportive policies were developed for the production and utilization of biofuels, particularly bioethanol. However, very quickly the biofuels boom faced controversy, especially the food versus fuel debate. Now there is a shift in policy towards second generation biofuels using non-food crops as feedstocks.[38]The field of industrial biotechnology has moved rapidly in recent years as a combined result of international political desire – especially in the case of biofuels – and unprecedented progress in molecular biology research that has supplied the enabling technologies. Different geographical regions have different priorities, but common drivers are climate change mitigation and the desire for energy independence. Now, industrial biotechnology has reached the centre of scientific and political attention. At no time in the past has there been a more pressing need for coherent, evidence-based, proportionate regulations and policy measures; they are at the heart of responsible development of industrial biotechnology.

3.3.1 Challenges, bottlenecks and opportunities

Biotechnology is a key enabling technology which bears great potential to contribute to sustainable growth and jobs creation, but it needs to be considered in a broader context. Several factors have to be taken into account, as shown by various analyses which pinpointed bottlenecks and opportunities to fully exploit the potential of biotechnological advances.

[36]OECD (2009): *The Bioeconomy to 2030: Designing a Policy Agenda, p.201; htt*p://www.oecd.org/sti/biotechnologypolicies/44777130.pdf
[37]http://www.oecd.org/sti/biotechnologypolicies/
[38] Industrial Biotechnology and climate Change – Opportunities and Challenges – OECD Report http://www.oecd.org/sti/biotechnologypolicies/49024032.pdf

Coordination and co-operation

While most research activities, programmes and policies take place at regional and national levels, no single country has sufficient resources to be competitive on a world scale. Nor is it likely to have the resources or capacity to adequately address all the research necessary to support new transboundary issues. For example, obligations as a result of international agreements, such as WTO activities, the Kyoto Protocol and the Convention on Biological Diversity lead to activities and policies that should be increasingly designed and operated from a transnational perspective including, where relevant, cross-border cooperation.

Coordination is a must. To achieve the maximum return on research funds and not duplicate efforts, EU national programs should benefit from more co-ordination, within an overarching European research agenda. Enhanced coordination among policies and initiatives, including research and innovation programmes, at EU and national level is a key element To this extent, the European Commission supports via its Framework Programme (FP) for Research and Innovation the so called **ERA-Nets**, which are networks for co-ordination and co-operation among national and regional EU R&D programmes in given areas of strategic interest, including those relevant to biotechnology (examples in the areas of food safety, industrial biotechnology, plant health and genomics, agricultural research, maritime and fisheries research, biodiversity, bioenergy, systems biology, etc[39]).

Recently, global challenges, in particular the global demand for food which is expected to increase by 50% by 2030, are driving research agendas in EU Member States. Food supply must increase sustainably to meet this demand, and efforts have been complicated by climate change. Due to the urgency of these problems, EU Member States are also undertaking **Joint Programming Initiatives (JPI)**in a coordinated and coherent manner.

Demand driven agendas

Considerable benefits will accrue across the whole EU as industrial biotechnology begins to be introduced in a coordinated way. Currently; only technologically advanced Member States with some history of using biotechnology in manufacturing have begun to reap the benefits of innovation and environmental improvements. The EC has established in 2005 a helpful mechanism for fostering important areas where research, technology, and development are key to addressing major economic, technological, or societal challenges: the **European Technology Platforms** (ETPs)[40].

These technology platforms should:

[39]ftp://ftp.cordis.europa.eu/pub/fp7/kbbe/docs/fafb-eranet-2010_en.pdf
[40] Cordis Technology Platforms. www.cordis.lu/technology-platforms

- Provide a common vision that contributes to coherent policy making
- Overcome obstacles at all levels to accelerate market penetration of new technologies;
- Stimulate knowledge and innovation, thereby increasing productivity and competitiveness and making the investment climate more attractive;
- Encourage public debate on risks and benefits to facilitate technology acceptance

Several ETPs are established in areas related to biotechnology, such as the one addressing sustainable chemistry (SusChem, http://www.suschem.org/).

Knowledge transfer and deployment: turning ideas into market

In the study "What Europe has to offer biotechnology companies", [41] the authors observe that: "National governments have done much to encourage innovation, often through a web of tax incentives for research. Yet, by and large, they have done too little to ensure that these ideas are translated into new businesses, new products, additional jobs and so, in time, a faster rate of economic growth." This is painful especially if we read the AHO report and the article "Looking ahead in Europe: white biotech by 2025". Both indicate the need for collaboration and warn for the danger not to translate the efforts in job creation, in new products and services, etc. Apparently lessons were not always clear and understood. Lessons learned should be part of every new policy-evaluation.

The study of E&Y focuses on the blocking factors for job creation, new products and services from a business point of view. Their conclusion is similar to one drawn in the first chapter of this thesis: at a time when large biotechnology companies are looking for inspiration, governments need to encourage small and medium-sized enterprises to take steps that may help them one day to become large firms in their own right. There is however more to creating a successful industry than putting in place the right standard of regulation. What is needed is a "climate of innovation", coupled with the bricks and mortar with which to build industries around it.

Policy coherence and regulations

A further level of complexity is the policy landscape affecting biotechnology. Biotechnology is situated at the intersection of a wide range of different policies, including fiscal policies, industrial policies and major sectorial policies such as agriculture, environment, energy and health[42]. Policy instruments – both short terms such as tax incentives, subsides, demand-led programmes or procurements and long term support strategies – as well as regulations play an important role.

[41] E&Y, EuropaBio, April 2012

[42] D. Batten, CSIRO Australia: "International Policy Approaches and Challenges in Industrial Biotechnology", OECD Workshop, Jan 2010 ;
http://www.oecd.org/sti/biotechnologypolicies/44777130.pdf

As an example, there is still a challenge in terms of product approval legislation in Europe. A simplified and efficient regulatory framework could make Europe a more attractive place for research and the creation of products and services. Such a framework reduces the administrative burden and costs for public and private sector researchers, as well as for Member States, by allowing faster access to innovative products and services. However, citizens' wellbeing, consumer's protection and environment preservation need to remain a main concern and priority for policy making. An example is the case of biotechnology and health systems. The links between innovation, productivity, health and wealth are recognized by many countries and the need to encourage innovation is also apparent. Investing in and encouraging innovation is a priority for many jurisdictions as is the affordability, quality and sustainability of healthcare systems. There is an apparent tension between these goals that can be mitigated with timely policy development work. International organizations such as the OECD are looking into how to encourage and foster innovation which addresses health needs and priorities, maximizes access to the benefits, and manages the challenges and risks in a way that is beneficial both to innovators and health systems.

A tool for boosting innovation, which is not discussed in this thesis yet, is the rate of corporation tax. Another is the use of tax credits for R&D. Similar measures were adopted by some countries for investors in start-up companies by offering access to reduced rates or indeed exemptions for capital gains tax once certain conditions are met, which can be key to attracting finance for these high risk activities. In the case of industrial biotechnology, the following bottleneck was reported: the use of fossil-based raw materials are often exempted from environmental taxes, which implies weaker incentive for using renewables[18].

Another domain, already discussed in chapter 1, is the filing of patents. Industrial biotechnology patents face rigorous disclosure requirements, heavy cost and time constraints.

D. Batten reports the following future policy challenges and mismatches for industrial biotechnology: Availability of capital and affordable biomass feedstock (including considering the *Food* versus *fibre* versus *fuel debate);* R&D mismatches (only 2% of biotech R&D went to IB in 2003, yet OECD expects IB to contribute up to 39% of biotech's future GVA); Patents and other IP rights; Demand-led innovation (Lead market initiative and Technology Platforms); Demand-side policies linked directly to sustainability; Sustainability indicators/assessments as policy tools; Policy coherence between different sectors (Biorefinery model: chemicals, materials, fuels, heat & power) [18]

Public awareness and participative governance

A Eurobarometer survey carried out in 2010 on life sciences and biotechnology shows that Europeans are optimistic about biotechnology. 53% of respondents believe

biotechnology will have a positive effect in the future, and only 20% a negative effect. The survey also reveals important knowledge gaps, pointing to a need for more communication: a majority of respondents had never heard of some of the areas covered by the survey, such as nanotechnology (55% unaware), biobanks (67% unaware) and synthetic biology (83% unaware) while skepticism and concern persist in some areas such as genetically modified foods[43].

The EU Research, Innovation and Science Commissioner Máire Geoghegan-Quinn said in a press release concerning this Eurobarometer: *"This survey tells us three things. First, Europeans are mostly rather positive about biotechnology although they remain uneasy about some particular aspects. Second, many people feel that they lack basic information on important aspects of biotechnology, so there is a major communication challenge. I intend to take it up and I urge all stakeholders to do the same. Third, all decisions on biotechnology should be rooted in sound science and take due account of ethical, health and environmental factors: we cannot be led either by emotional reactions or by short-term commercial considerations".*

In conclusion, strength in biotechnology is one of Europe's most valuable industrial assets. The sector is at the core of the knowledge-based economy that is central to future European growth. Many of the innovations that have made biotechnology one of the world's most important growth sectors originated in Europe, and the biotechnology sector involves a large number of SMEs in Europe. Public awareness, expectations and concerns are also an important issue. Biotechnology is likely to continue to play a leading role in the growth agenda of the next decade and beyond, provided that it will be accompanied by appropriate policy contexts and responsible governance.

In this respect, EU strategies and initiatives - such as Horizon 2020 and the recently launched Bioeconomy Strategy and Action Plan for Europe - as described further - are expected to play an important role to contribute towards bridging the gap between good ideas and the investment opportunities to make them a reality, for the benefit of mankind.

3.4. The EU policy context and initiatives – From life sciences and biotechnologies to a Bioeconomy for Europe

Historically, the EU Framework Programmes for Research and Development recognized the potential and supported the development of biotechnologies since the 80's. A pioneering example was the baker's yeast genome sequencing project, which unravelled for the first time the entire genome of an eukaryotic cell, through a

[43]The Eurobarometer survey on life sciences and biotechnology carried out in February 2010 is the seventh in a series since 1991 and is based on representative samples from 32 European countries http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/1499&format=HTML&aged=0&language=EN&guiLanguage=en

collaborative effort of a network of hundreds of laboratories in Europe and world-wide, and with the support of the EU progamme (FP3/4 Biotech) .

In 2002, the European Commission adopted the "**Life Sciences and Biotechnology – A strategy for Europe"**[44]. With applications in a broad variety of sectors, life sciences and biotechnology have been the main innovation drivers of the knowledge-based bio-economy (KBBE), leading to new growth and competitiveness in traditional sectors, such as food and agriculture, forestry, fisheries and aquaculture and the creation of emerging sectors, such as bio-based products and bioenergy.

The concept of a Knowledge-Based-Bioeconomy (KBBE) for Europe became a main driver for EU research and innovation during the past decade[45]. **"**We may live in the high-tech information age, but our prosperity is still very much derived from the fat of the land. In fact, the bio-economy – all those sectors which derive their products from biomass – is worth an estimated €1.5 trillion a year. Given this, it is not surprising that the KBBE is set to become one of the most important components of the EU's efforts to forge the world's most competitive knowledge-based economy. It will take the bud of promising life science and biotech ideas and nurture them to full blossom. **"**

The current **7th Framework Programme for Research and Technological Development** dedicates one Co-operation Theme to research and innovation in "Food, Agriculture and Fisheries and Biotechnology" in order to support the development of a Knowledge-Based Bioeconomy in Europe, with a budget of for the years 2007-2013.[46]

Within this FP7 Theme, the European Commission aims to create a strong and competitive Knowledge Based bio-economy and to offer solutions to challenges facing Europe and the world, such as feeding a growing world population and fighting climate change while mitigating its effects. The research activities funded bring together science, industry and other stakeholders to exploit new and emerging research opportunities in the following areas:

- *Food*research looks into maintaining an affordable, safe, healthy and nutritious food supply in the face of changing demographics: a growing world population and increasing urbanization.

- *Agriculture and Fisheries*addresses the pressures on natural resources, such as the decline in fossil fuels, depletion of fish stocks, as well as combating climate change through reducing greenhouse gas emissions and the adaptation of the agricultural sector accordingly. Another global challenge is animal health and the control of infectious diseases and zoonoses (infectious diseases that can be transmitted from

[44] COM 52002)27 http://ec.europa.eu/biotechnology/pdf/com2002-27_en.pdf
[45] http://ec.europa.eu/research/biosociety/kbbe/kbbe_en.htm
[46] http://cordis.europa.eu/fp7/kbbe/home_en.html

animals to humans). Furthermore, research into plant health, and sustainable, competitive, multifunctional agriculture and rural development, including forestry, provides support for a number of EU policies.

- *Biotechnology***,** life sciencesand biochemistry to contribute to sustainable non-food products and processes. The research deals with renewable energy demands, waste reduction and bio-based products and processes for the 'greening' of our industries. It also looks into emerging trends in biotechnology, such as synthetic biology.[47]

All these research supports EU policies in agriculture, fisheries, development, environment, health and other sectors and, in particular, policies involved in the European economic recovery. It therefore forms an integral part of the Europe 2020 strategy.

On 13 February 2012, the EC adopted a Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions, entitled : "**Innovating for Sustainable Growth: A Bioeconomy for Europe"**[48]. The Bioeconomy Strategy has the ambitious goal of leading the transition to an economic model which uses more renewable resources. The proposal will help to drive the transition from a fossil-based economy to a sustainable bioeconomy in Europe, with research and innovation at its core[49].

[47]One area of FP7 Theme 2 activities is dedicated to mission-oriented research towards life sciences, biotechnology and biochemistry for sustainable non-food products and processes. It has been divided into six interlinked areas: 1) *Novel sources of biomass and bio-products* optimisation of non-food plants for the production of biomaterials (plant factory) and as biomass source for industrial processes (e.g. biorefinery), as well as on the screening of terrestrial biodiversity for new organisms and new biochemical pathways for use in the production of bioproducts) 2) *Marine and fresh-water biotechnology (blue biotechnology):* screening of aquatic biodiversity for new organisms and new biochemical pathways to enhance the current knowledge-base and to contribute to the development of novel processes and products for industrial applications. 3) *Industrial biotechnology:* added value bio-products and bio-processes (white biotechnology, expanding the use of micro-organisms and bio-catalysts as a green and efficient alternative to conventional industrial processes, e.g. production of fine and specialty chemicals. The use of biochemical processes can significantly improve resource efficiency, for example by reducing energy and water intensity.4) *Bio-refinery* industrial biotechnology to convert renewable raw materials into sustainable and cost-effective bioproducts, bioenergy and second-generation biofuels. Its goal is to replace fossil carbon sources by renewable resources in a more sustainable bio-refinery.) 5) *Environmental biotechnology* plants, microorganisms and enzymes are investigated for environmental and industrial applications, such as the cleaning-up of polluted environments or the greening of industrial processes. Genetically modified organisms are also covered by this area, in particular research on their environmental risks and benefits and their economic performance. 6) *Emerging trends in biotechnology* This area explores and develops the potential of cutting-edge research taking place in this domain. It is the source for many new tools and solutions that will contribute to improving the knowledge base and driving innovation in other areas of biotechnology.

[48]COM(2012) 60final;
http://ec.europa.eu/research/bioeconomy/pdf/bioeconomycommunicationstrategy_b5_brochure_web.pdf

[49] http://ec.europa.eu/research/bioeconomy/pdf/bioeconomy_citizen_summary_en.pdf

What is the Bioeconomy and how does it impact on our society?

The term "Bioeconomy" means an economy using biological resources from the land and sea, as well as waste, as inputs to food and feed, industrial and energy production**.** It also covers the use of bio-based processes for sustainable industries. Bio-waste for example has considerable potential as an alternative to chemical fertilizers or for conversion into bio-energy, and can meet 2% of the EU renewable energy target. "Europe needs to make the transition to a post-petroleum economy. Greater use of renewable resources is no longer just an option, it is a necessity. We must drive the transition from a fossil-based to a bio-based society with research and innovation as the motor. This is good for our environment, our food and energy security, and for Europe's competitiveness for the future," said Commissioner for Research, Innovation and Science Máire Geoghegan-Quinn when presenting the new Commission strategy for a sustainable Bioeconomy in Europe[50].

The bioeconomy encompasses the production of renewable biological resources and their conversion, as well as that of waste streams, into food, feed, bio-based products and bioenergy via innovative and efficient technologies. It is already a reality and one that offers great opportunities and solutions to a growing number of major societal, environmental and economic challenges, including climate change mitigation, energy and food security and resource efficiency.

The EU bioeconomy already has a turnover of nearly €2 trillion and employs more than 22 million people - often in rural or coastal areas and in Small and Medium Sized Enterprises (SMEs) - accounting for 9% of total employment in the EU,. It includes agriculture, forestry, fisheries, food production, as well as parts of chemical, biotechnological and energy industries. The diverse bioeconomy sectors have a strong innovation potential due to their use of a wide range of sciences (life sciences, agronomy, ecology, food science and social sciences), enabling industrial technologies (biotechnology, nanotechnology, information and communication technologies (ICT), and engineering), as well as local and tacit knowledge.

The Bioeconomy Strategy

With the world population moving towards 9 billion by 2050 – with food demand expected to increase by 70% by 2050 - and fossil resources dwindling, Europe needs to review its management and use of renewable biological resources. The depletion of fossil resources, on which the European economy heavily depends, calls for a shift towards a new, post-petroleum society. With its cross-cutting nature, the bioeconomy

[50] http://ec.europa.eu/research/bioeconomy/pdf/201202_press_release.pdf

offers a unique opportunity to address complex and inter-connected challenges, while achieving economic growth. It can assist Europe in making the transition to a more resource efficient society that relies more strongly on renewable biological resources to satisfy consumers' needs, industry demand and tackle major challenges such as food and energy security and climate change.

The ultimate aim of the bioeconomy is to help keep Europe competitive, innovative and prosperous by providing sustainable, smart and inclusive economic growth and jobs, and by meeting the needs of a growing population whilst protecting our environment and resources. This means an economy based on an enhanced sustainable and more efficient use of our biological and renewable resources, as an alternative to our heavy reliance on finite fossil fuel resources. The bioeconomy alone is not a silver bullet for all of society's needs, but it is an important piece of the puzzle in creating a more sustainable future where resources are used in the most efficient way[51].

How to get there? The EU Action Plan for a Bioeconomy

The European Commission proposed an Action Plan for the implementation of the Bioeconomy Strategy, building on research and innovation as a major engine for growth, as well as reinforced policy coherence.

This Action Plan identifies three main pillars for actions:

1)Investments in research, innovation and skills;

2) Reinforced policy interactions and stakeholders engagement;

3) Enhancement of markets and competitiveness in the bioeconomy.

This Action Plan is not only a commitment for EU institutions, but it also invites Member States, regions and stakeholders from both public and private sectors to engage.

[51] Boosting the EU Bioeconomy – EuropaBio Policy Paper 2012
http://www.europabio.org/industrial/positions/boosting-eu-bioeconomy

The Bioeconomy Action Plan

1. Investments in research, innovation and skills

1. Ensure substantial EU and national funding as well as private investment and partnering for bioeconomy research and innovation. Develop further JPI and ERA-Net activities in order to strengthen coherence and synergies between public programmes. Support bioclusters and KICs under the EIT for partnering with the private sector. Outline the main research and innovation concepts and priorities for food, sustainable agri culture and forestry and for marine and maritime activities under Horizon 2020.

2. Increase the share of multi-disciplinary and cross-sectoral research and innovation in order to address the complexity and inter-connectedness of societal challenges by improving the existing knowledge-base and developing new technologies. Provide scientific advice for informed policy decisions on benefits and trade-offs of bioeconomy solutions.

3. Promote the uptake and diffusion of innovation in bioeconomy sectors and create further feedback mechanisms on regulations and policy measures where necessary. Expand support to knowledge networks, advisory and business support services, notably through EIPs and bioclusters.

4. Build the human capacity required to support the growth and further integration of bioeconomy sectors by organising university fora for the development of new bioeconomy curricula and vocational training schemes.

2. Reinforced policy interaction and stakeholder engagement

5. Create a Bioeconomy Panel that will contribute to enhancing synergies and coherence between policies, initiatives and economic sectors related to the bioeconomy at EU level, linking with existing mechanisms (by 2012). Encourage the creation of similar panels at Member State and regional level. Foster participation of researchers, end-users, policy-makers and civil society in an open and informed dialogue throughout the research and innovation process of the bioeconomy. Organise regular Bioeconomy Stakeholder Conferences.

6. Establish a Bioeconomy Observatory in close collaboration with existing information systems that allows the Commission to regularly assess the progress and impact of the bioeconomy and develop forward-looking and modelling tools (by 2012). Review progress and update the Strategy at mid-term.

7. Support the development of regional and national bioeconomy strategies by providing a mapping of existing research and innovation activities, competence centres and infrastructures in the EU (by 2015). Support strategic discussions with authorities responsible for rural and coastal development and Cohesion Policy[9] at local, regional and national level to maximise the impact of existing funding mechanisms.

8. Develop international cooperation on bioeconomy research and innovation to jointly address global challenges, such as food security and climate change, as well as the issue of sustainable biomass supply (from 2012). Seek further synergies between the international cooperation efforts of the EU and Member States and reach out to international organisations.

3. Enhancement of markets and competitiveness in bioeconomy

9. Provide the knowledge-base for sustainable intensification of primary production. Improve the understan ding of current, potential and future availability and demand of biomass (including agricultural and forestry residues and waste) across sectors, taking into account added value, sustainability, soil fertility and climate mitigation potential. Make these findings available for the development and review of relevant policies. Support the future development of an agreed methodology for the calculation of environ mental footprints, e.g. using life cycle assessments (LCAs).

10. Promote the setting up of networks with the required logistics for integrated and diversified biorefineries, demonstration and pilot plants across Europe, including the necessary logistics and supply chains for a cascading use of biomass and waste streams. Start negotiations to establish a research and innovation PPP for bio-based industries at European level (by 2013).

11. Support the expansion of new markets by developing standards and standardised sustainability assessment methodologies for bio-based products and food production systems and supporting scale-up activities. Facilitate green procurement for bio-based products by developing labels, an initial European product information list and specific trainings for public procurers. Contribute to the long-term competitiveness of bioeconomy sectors by putting in place incentives and mutual learning mechanisms for improved resource efficiency.

12. Develop science-based approaches to inform consumers about product properties (e.g. nutritional benefits, production methods and environment sustainability) and to promote a healthy and sustainable lifestyle.

Interesting discussions can be found on the website of EuropaBio – the European bio-industries association - which confronts the initiatives of the Commission with the interests of industry[52]. Interesting are the Frequently Asked Questions and a short video showing the "invisible revolution of biotechnologies", which describes how biotechnology can be applied to our everyday lives (www.europabio.org).

In conclusion, research and innovation are recognized to be a main engine to drive progress and sustainable growth in the Bioeconomy, and the Action Plan encourages initiatives in this direction. In this respect, **Horizon 2020** proposes to dedicate 4,7 bn € for research and innovation to the societal challenge "Food Security, Sustainable Agriculture, Marine and Maritime Research and the Bioeconomy". Moreover, it proposes to support Biotechnology as one the KETs under the Leading Enabling and Industrial Technologies, mainly for: 1) *boosting cutting-edge biotechnologies as future innovation drivers; 2) biotechnology based industrial processes and 3) Innovative and competitive platform technologies*[53] .

Reinforced policy interactions and stakeholders engagement for a responsible governance of the bioeconomy are also a main principle and objective of the Strategy and Action Plan

[52]http://www.europabio.org/industrial/positions/boosting-eu-bioeconomy

[53]Proposal for aCOUNCIL DECISIONestablishing the Specific Programme Implementing Horizon 2020 - The FrameworkProgramme for Research and Innovation (2014-2020) - COM(2011) 811/3

Extract from LEIT/ 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 ofinnovation, also in the medium and long term. It encompasses the development of emergingtools such as synthetic biology, bioinformatics, systems biology and exploiting theconvergence with other enabling technologies such as nanotechnology (e.g.bionanotechnology) and ICT (e.g. bioelectronics). These and other cutting-edge fields deserveappropriate measures in terms of research and development to facilitate effective transfer andimplementation 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 newproducts and processes meeting industrial and societal demands; and competitive andenhanced biotechnology-based alternatives to replace established ones; on the other hand,harnessing the potential of biotechnology for detecting, monitoring, preventing and removingpollution. It includes R&I on enzymatic and metabolic pathways, bio-processes design,advanced fermentation, up- and down-stream processing, gaining insight on the dynamics ofmicrobial communities. It will also encompass the development of prototypes for assessingthe 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 ofeconomic sectors. It includes aspects, such as underpinning the development of bio-resourceswith optimized properties and applications beyond conventional alternatives; enablingexploration, understanding and exploitation in a sustainable manner of terrestrial and marinebiodiversity for novel applications; and sustaining the development of biotechnology-basedhealthcare solutions (e.g. diagnostics, biologicals, bio-medical devices).

An impact assessment carried out for the preparation of the Bioeconomy Strategy predicted that the increased research funding for the bioeconomy under Horizon 2020, combined with the stronger innovation drive and reinforced policy interaction prescribed by the Bioeconomy Strategy, is estimated to generate an added value of about €45 billion and create new jobs in bioeconomy sectors by 2025. This implies that every euro invested in bioeconomy research and innovation under Horizon 2020 is expected to generate about €10 in value added[54]. Overall, the Bioeconomy Strategy will also contribute to the Commission's Europe 2020 goal on moving to a low-carbon economy by 2050 and to the flagship initiatives "Innovation Union" and "A Resource Efficient Europe".

[54] Bioeconomy COM(2012) 60final; and related Commission Staff Working Document reporting on Impact Assessment;
http://ec.europa.eu/research/bioeconomy/pdf/201202_commision_staff_working.pdf

Chapter 4.

Discussion and Conclusions

4.1 Putting innovation policy under the spotlight

In this thesis we analysed the issue of innovation, by making a survey of the situation in the US and a more detailed analysis of the European situation. Since our thesis focuses on the shaping of Europe's innovation policies the conclusions I want to put to the attention of the reader are by consequence related to the future of Europe's innovation efforts.

Despite the recognized scientific excellence and leadership in various technological areas that distinguish Europe, the EU appears to be limping behind in innovation due to the fragmentation of its policies and related initiatives, as well as governance models. The only way out seems to be a more efficient common approach. Europe decided to focus on a strong partnership between public and private sectors. A particular focus was given to SMEs and indeed, as we mentioned in this analysis, the efforts done by small and medium enterprises are by far the engine of any progress we saw in the past and which we will see in the future. The decision to work with and stimulate the relations between government and the private sector appears to be an intelligent and logical move.

However, the situation is complex. The actual economic crisis is putting a lot of pressure on governments, moreover because we are not living a pure financial crisis but a system crisis. This is new and answers are not to be easily found. In the past, system crises also happened, but the parameters of the current crisis are much more complex due to the global economic interactions, the demographic and environmental disproportions which require a mondial answer and consensus.

The arguments underlying the Europe policy making launching the Europe 2020 Strategy and the Horizon 2020 program do consider these global challenges. However, they might run the risk of focusing too narrowly the solutions to a European level, and to somehow simplify the solutions given to proposals we are able to understand and accept …and that politicians are able to sell. History shows that it is indeed rare that politicians would promote long term visions, since by definition they tend to propose short term solutions to accompany their own mandates and gain votes. The future will make it clear whether these answers were not too soft.

4.2.The Lisbon Strategy

All started with the Lisbon strategy, its political and economic rationale and its main advancements and limits. This is instrumental for asking some analytical and political questions on the post-Lisbon phase and the launch and implementation of the Europe 2020 strategy.[55]

The Lisbon strategy launched in 2000 has represented a twofold ambitious goal for the European Union (EU): to transform the European economy of the 21st century (and make it the most competitive knowledge-based economy in the world) and to innovate EU governance through new forms of interaction between national practices and European objectives. Since then, a lively multi-disciplinary debate has developed.

When the Lisbon strategy came into existence many academic and political commentators viewed the Lisbon agenda and its related governance tools as a promising step to improve EU socio-economic performance while also legitimizing European integration[56] . The strategy was widely interpreted to be a 'fundamental transformation' of the EU project in economic, social and environmental dimensions[57].

The Lisbon strategy represented a comprehensive attempt to transform European economies and increase their competitiveness in a global economic environment. In other words, it represented the (proposed) answer to long-lasting EU socio-economic problems (unemployment, productivity stagnation and weak macroeconomic performance) as well as to the new emerging challenges at the end of the last century (population ageing, fast technological innovation, and growing financial and economic globalisation)[58] .

The conclusions of the Lisbon Summit of 2000 were based on the assumption that EU economic models needed to change to be competitive in the global economy. Such an assumption was based on a critical understanding of the EU development trajectory since the 1970s: European problems in productivity and innovation (and the increased gap with US dynamism) were largely interpreted to be the result of economic and social rigidities. In the words of Begg[59], a systematic lack of competitiveness was made evident by the deteriorating economic performances, persistent unemployment and

[55] Natali, D.: *European Social Observatory. The Lisbon Strategy, Europe 2020 and the crisis between* (www.ose.be)

[56]Natali, D. (2009), The Lisbon Strategy ten years on, A critical review of a multi-disciplinary literature, Transfer:European Review of Labour and Research, Vol. 15, No. 1, 111-137

[57] Tucker, C. (2003) 'The Lisbon Strategy and the Open Method of Coordination: A New Vision and the Revolutionary Potential of Soft Governance in the European Union', paper presented at the Annual Meeting of the American Political Science Association, 28-31 August

[58] Sapir, A. (ed.) (2004) An Agenda for Growing Europe. The Sapir Report, Oxford: Oxford University Press

[59]Begg, I. (2008) 'Is there a convincing rationale for the Lisbon Strategy?', Journal of Common Market Studies, 2 (46), 427-435

delay in developing knowledge-intensive sectors. To remedy the European shortcomings some key reforms had to be implemented. From a micro-economic perspective, structural reforms had to be introduced to boost productivity and employment rates. More investment on information technologies, fewer obstacles to the freedom of services provision and the liberalization of transport and energy markets were some of the innovations to be introduced.

Economic reasoning was also at the basis of the perceived need for more economic coordination. Two types of reasoning justify embarking on EU economic coordination. Firstly, interdependence may render independent decision making undesirable. Spillover effects of national decisions may be active in the policy areas where benefits are not confined to the country where decisions are taken (e.g. research and development), and in policy domains where complementarities exist (as is the case of product market and employment policies). Secondly, policy-makers may learn from each other. Policy learning may be improved through cross-country comparison and benchmarking. And common programmes may represent a reform lever for national policy-makers through a shared understanding of the needed reforms[60] .

The recent debate on the economic rationale of the Lisbon Strategy and the definition of the 'new' Europe 2020 Strategy has been largely shaped by the huge financial, economic and then budgetary crisis affecting most advanced western economies.

Many researchers identified major institutional shortcomings related to EU governance and to the OMC (open method of coordination) in particular. Such a research effort has been based on extensive empirical evidence of the economic performance of EU countries since 2000, the political functioning of the process at national and EU level and the key 'deliverables' of the process. Scholars have firstly analyzed the 'disappointing' economic and social performance of the EU since 2000. Comparing the post-Lisbon period with the previous decade an extensive literature has stressed that Europe has not become the 'most dynamic economy in the world': GDP growth in EU-15 and the euro area has been much lower than in the US; long-term productivity has been higher in the US than in the Europe; and while employment rates have improved, the labour market has become more flexible at the lower end[61] ().

The poor performance of the EU proves that the EU has not developed the coherent economic policy institutions to foster its potential growth. The EU thus lacks 'the real means of a proactive macro-structural policy mix, and implementing structural reforms

[60] Dyson, K. (2000) The politics of the Euro-zone: stability or breakdown?, Oxford: Oxford University Press

[61] Collignon, S., R. Dehousse, J. Gabolde, M. Jouen, P. Pochet, R. Salais, R.-U. Sprenger, and H. Zsolt De Sousa (2005) 'The Lisbon strategy and the Open Method of Co-ordination. 12 Recommendations for an Effective Multi-level Strategy', Policy Paper No 12, March 2005, Paris: Notre Europe

without coherent macro-economic governance' appears to be an 'impossible task'. Another critical point is the problematic balance between the ministers of finance and social policy ministers. And the issue is even more evident in the governance of the new EU 2020 Strategy.

We can conclude that the Lisbon agenda has represented in many respects a decisive step in the EU approach to social and economic development. Yet, substantive and analytical questions still need to be dealt with to shed light on the present and on the future of European integration. And the recent financial and economic crisis has contributed to put them at the core of the scientific and political debate. There are open tensions (or trade-offs) that EU integration protagonists (and scholars) have to face in the near future.

Firstly, the tensions have to do with the political and economic foundation of the EU project, and the reform of the European social model in the global economy. The Lisbon agenda has represented a first attempt to find a new compromise through a broad strategy. Limits have been evident in its ability to adjust social cohesion and economic competitiveness; environmental policy and productive growth; fiscal stability and structural reforms. In that respect, the Lisbon strategy appears as a mechanical addition of different aims and goals rather than the solution to such trade-offs. Specific issues are related to the broad policy agenda; the tensions between budget, economic, employment and welfare reforms; and the need to focus more on social and labour market policy.

Secondly, the governance introduced through the Lisbon strategy is still in need for improvements. The aim of increasing participation and transparency seems far from being solved. EU democratic legitimacy has not significantly improved through the strategy, even if improvements in facilitating new forms of meaningful participation of civil society at the domestic level have been discerned.

Individual parts of the process have shown different dynamics, with the social policy OMCs being the most successful. It is widely recognized that there have been advances in deliberation, sharing of information, benchmarking and learning. But they seem far from having had major outcomes on national policies.

4.3. Europe 2020

The European Commission realized that the Lisbon Strategy had clearly its limits. Lessons learned were taken serious and a new strategy was launched: Europe 2020.

The crisis was not unnoticed by the Commission and they set forward a set of triggers why a new strategy was needed.

Europe's growth was severely hit. Unemployment has spread, and what is more worrying, the unemployment of young people (up to 21 % - European average). Industrial production is in sharp decline and companies are going bankrupt at a raising speed. The crisis in the financial institutions is not at all under control. Private investments were never so low (even negative) and public finances are severely affected by this crisis (the recent case of Greece as well as of different Spanish regions asking for support are an example.

A common answer is required. One of the elements to tackle this crisis - at least the financial part of it - is a fiscal consolidation (even a consolidation of 1 % will not bring back the level of public debt to the 60% level).

As an additional level of complexity in the EU, the 27 Member States are each at a different level. For instance in Lithuania, 25 % of the population left the country in the last decade, leaving a poor economy and an aging population. Public debt in Italy and Spain impacts the interest rates at which government can finance. Furthermore, the statistically unreliable and per country too divers reporting on the actual situation is preventing a transparent view on the real situation and is fuel for the uncertainty of the markets and the eager of speculation.
The bill will be high and more and more governments realize that the correct statement is "too high".

Which are the challenges?

Global competition is fierce. Intra-EU trade might be a catalyst for growth, though Asia will remain the fastest growing market. Because of mondialisation of the economy, the future of all countries are linked (the reason why the Chinese support the Euro and finance public debt in the US and in Europe).

A difficult challenge is demographic disequilibria, ageing accelerates. This leads to old-age dependencies and fast rising social costs.

Climate and environmental challenges require fast and efficient measures, again at high costs. Over the coming decades Europe will be challenged by dwindling natural resources, the effects of climate change and the need to provide a sustainable, safe and secure food and energy supply for a growing global population. Member States and also the EU realize that alone they are not able to solve such challenges.

The Europe 2020 strategy aims at boosting employment based on the productivity levers (strong points of European economy) and GDP (Gross Domestic Product) must be restored by sustainable growth.

Growth must be based on knowledge and innovation. Europe must nurturing high-tech, high-growth sectors, spreading innovation across firms and raising the levels of R&D investment. Coordination of R&D efforts will boost results. To put things in perspective: the EU Framework Programme for Research (FP7) invests about 1.3 billion Euro in ICT R&D every year. In 2009, "Google" alone invested 2.8 billion USD (about 2 billion Euro) in R&D. However, the EU FP only represents about 6% of the total investment in R&D of the EU Member States altogether. For this reason, co-ordination and synergies among programmes through public-public partnership, as well as private-public partnership are key to leverage the effects of R&D investments and trigger innovation.

An important part of the efforts will be by investing in skills, education and vocational training, students and universities, broadening access to tertiary education. Today in the EU, less than one person in three aged 25-34 has completed a university degree, compared to more than 50% in Japan and 40% in the US. The EU formulates it as "taking up the global fight for knowledge" and "catching up with high-capacity broadband"; the latter because fast access to the internet is a basic condition of having access to information.

Basic goal of Europe 2020 is keeping all citizens at work. This will combat risks of poverty. To do so we must tackle early school-leaving and meeting future skills needed. The so-called PISA survey rang the alarm bell. Indeed the reading capacities of the population is worse in Europe. Immigrants are better supported in countries like Canada and Australia. The aging population requires promoting active ageing and lifelong learning. Investing in human capital pays off and societal change creates new opportunities. All of this supported by job-friendly tax systems.

The changing demographic situation where more and more people want (and need) a piece of the cake makes that growth will only be possible under a number of conditions Some indicative examples are mentioned hereunder.

Reducing CO2 emissions and our dependence from fossil resources. Decarbonising the electricity supply and the transport facilities is a need. The transport sector represents 7% of EU GDP and emits one quarter of total CO2 emissions. 97% of the sector depends on oil and is by consequence vulnerable to price shocks. Congestion costs more than 100 billion Euro every year. The move towards decarbonisation will open up opportunities for new vehicles, standards and infrastructures, in the EU and abroad.

Growing via resource efficiency. Natural resources are dwilling and subject to an unprecedented level of pressure and competition for their use. We need to secure food and energy supplies for an increasing world population; shifting to an economy based on biological and renewable resources is a necessity. Materials are a cost to industry.

Europe is improving but Japan – for example – is already more efficient and improving even faster. If Europe could improve its resource efficiency by 20 % this could boost growth by around 1 per cent.
Greening the industry. Europe is leading in bio-sciences and -technologies and in green sectors. These green sectors create growth and new jobs (provisions indicate that this market will triple by 2030). Jobs in the eco-industry have increased by 7% every year on average since 2000 to reach 3.4 million. Achieving the 2020 renewable target could deliver 2.8 million jobs in the renewable energy sector in total.

Furthermore, Europe should become *more united in its energy market*. Tackling the missing energy links will reduce prices for firms and consumers and may add 0.6%-0.8% to GDP. It will reduce considerably the European dependency and diversify imports for all Member States.

The *single market* has borne fruit in terms of higher economic integration: intra-EU exports (67% of total exports) and intra-EU FDI (62% of total FDI) have increased markedly. This resulted in significant economic gains: 2.1 % of EU GDP over the period 1992-2006 (€ 500
per head) and 2.75 million jobs.

The EU is a significant market for cross-border trade in services - but the intra-EU dimension for services (58% of total) is weaker than for goods (67% of total). The full implementation of the Services Directive could increase trade in commercial services by 45% and Foreign Direct
Investment (FDI) by 25%. It can bring 0.5 to 1.5% increase in GDP.

The total estimated value of online transactions is around 150 billion € in 2009. About 40% consumers have used internet to purchase goods and services, but only 8% have done so from abroad. Too many users have doubts about safety and financial transaction on the net.

As the reader can see, the challenge is complex and many targets need to be met.

4.4. Does Europe have an innovation policy?

Innovation is at the very heart of Europe's policy making. The recent Europe 2020 Strategy for sustainable, smart and inclusive growth, and its flagships initiatives such as the Innovation Union, clearly pinpoints innovation as a major engine for growth, jobs creation, competitiveness and stability. The EU Framework programmes for research and technological development support a large number of innovation driven activities, to turn ideas into markets applications. Enhanced efforts are taking place in Europe towards reducing fragmentation, increasing synergies and leveraging effects among

different funding instruments at EU, national and regional levels, with increasing public-private partnerships as well as public-public partnerships for research and innovation. The EU supports a participative governance model for innovation, providing a wide range of tools (such as the European Innovation Scoreboard, the Innobarometer, the INNO Policy TrendChart...) to measure, benchmark, monitor and assess trends and impacts of innovation, as well as of innovation policies[62][63].

Today, the most obvious and greatest challenge for research and innovation policies across all the countries is to maintain funding levels in the face of the worst global crisis since the Great Depression coupled with its consequences in terms of public austerity measures and the extraordinary turmoil on the financial markets.

The panorama in Europe is diverse and complex, as reported by an interesting analysis on *Funding Innovation in the EU and Beyond* [64]. Different EU countries responded differently to the crisis. In some, mainly innovation leaders and followers (such as Sweden, Denmark, Finland, Germany and Austria), funding for research and innovation has been increased. In others (such as Portugal, the Netherlands and the UK) it has remained balanced. In both instances this is because policy-makers see innovation as being one way to respond to the dramatic downturns in GDP and to the increase in unemployment. This reflects the fact that innovation is becoming more rooted in policy thinking.

However, there are EU Member States where decreases occurred due to the exceptional economic downturn and related public austerity measures (Latvia, Bulgaria and Romania responded with unprecedented cuts and funding were also reduced in Belgium and in Spain. In Italy, the economic crisis put on hold the large publicly-funded programmes; in Hungary, there was a disruption in funding, as in 2010 approximately 37% of the Research and Technological Innovation Fund budget was frozen). In a number of countries, funding provided to innovation agencies and departments has been maintained whilst in others, institutional budgets have been cut. Reallocations and consolidations between different government departments or agencies can also be observed.

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[62] Innovation Policy Trends in the EU and Beyond - Analytical Report 2011*http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/files/inno-trends-report-2011_en.pdf*

[63] Trends and Challenges in Demand-Side Innovation Policies in Europe - Thematic Report 2011 http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/files/trendchart-demand-side-innovation-policies-2011_en.pdf

[64] *Funding Innovation in the EU and Beyond* – Analytical Report 2011 http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/files/innovation-funding-trends-2011_en.pdf

By comparison, it is interesting to note that innovation funding in BRICs countries has generally been strengthened. China continues to promote science, technology and innovation activities, and R&D expenditure rose by 23% compared with 2009. In the USA, a reduction of policy budgets can be observed, except for R&D funding, which remained stable.

A trend of consolidation or concentration of funding to increase effectiveness and impact can be observed in several EU countries. Efforts are being made to streamline policy support channels and to simplify the national innovation systems, which results in smaller initiatives being bundled into programmes with larger budgets. A recurring theme in the funding of innovation policy is the search for increased effectiveness and impact of the measures. For instance, one clear impact of the deep crisis in Ireland is a strong focus on ensuring the effectiveness of investments, particularly in high-expenditure areas such as basic research in biotechnology and ICT.

There is a notable shift in several countries (UK, Ireland, Denmark, and France) towards the application of tax credit schemes rather than the provision of grants. A stronger use of reimbursable loans instead of grants has appeared (for example in Belgium and the Netherlands) and this is reflected in the new policy measures launched during the course of 2010-2011. The Austrian research, development and innovation strategy also puts more emphasis on guarantees, liabilities and credit based instruments.

In terms of priorities, Member States allocated the majority of funding firstly, to "support measures within research and technologies", secondly to "promoting and sustaining the creation and growth of innovative enterprises", and thirdly to "human resources".

Recent trends reflect an increasing emphasis on the commercialisation of research results and getting ideas to market. Along this trend, finance for innovation is a priority across the countries, particularly when it is used to support young innovative companies. Several new start-up funds and support schemes were launched in 2010-2011. New measures related to societal challenges and green innovation have been introduced and funding has been allocated to new research programmes, particularly in the areas of environment, health and energy.

In France, the UK and Ireland, public-private partnerships are becoming more significant, particularly in the mobilisation of risk and venture financing and growth capital. It is now more important than ever for public budgets to trigger a leveraging effect for private investments in research and innovation. Also countries should introduce incentives to keep the research, development and innovation activities of multinationals in place and to attract new R&D units of large companies.

The dependence of national research and innovation policy budgets on the EU Structural Funds has meant that in certain countries, there is stability in funding. A future challenge for these countries is to decrease their reliance on European assistance and to create national, easy-to-access support schemes for innovation.

It is evident that in the near future these Member States will have to find the right balance between the requirement to consolidate public budgets and the need to improve the impact and effectiveness of the existing policy

As we can read many initiatives are ongoing. Scholars and governments acknowledge the need to combine public and private initiatives. How successful is Europe in doing so? If we read in many publications that the gap with the US and with the emerging economies is becoming larger, there is reason to be pessimistic.

For sure many initiatives are taken to create a more united approach in governance. The European Commission launches EU strategies and framework programmes where innovation plays a key role.
In their article "Does Europe have an innovation policy?", the authors Lauren Battaglia, Pierre Larouche and Matteo Negrinotti (Tilburg University) analyze the economic law in Europe and its interaction with innovation (competition policy, intellectual property law, sector regulation).

The authors come to the finding that it is remarkable that, in major policy initiatives where innovation plays a central role, such as the Lisbon Agenda and its successor Europe 2020, little attention is paid to those areas of the law which influence the incentives to innovate, namely competition law, intellectual property law, sector-specific regulation (especially electronic communications regulation) and standardization (hereinafter 'EU economic law').

For instance, in the recent Communication 'Innovation Union'; it is stated that 'the EU Patent has become a symbol for Europe's failure on innovation". Similarly, one reads that 'standards play an important role for innovation' so that standard-setting must be improved 'to enable interoperability and foster innovation in fast-moving global markets. As far as competition policy is concerned; the Commission acknowledges that its relationship with intellectual property 'requires in-depth consideration' while giving competition policy a role in 'safeguarding against the use of intellectual property rights for anti-competitive purposes'.

These statements all seem obvious, but they reflect tradeoffs which have not been explicited, much less discussed. Furthermore, they are not all consistent with one another. What is more, as the saying goes, the proof of the pudding is in the eating: we

do not know if and how the actual practice at EU level, as reflected in enactments, decisions, notices, etc. measures up to these statements.

In their paper they analyze the situation on the field in the pharmaceutical industry, concluding that declarations are one thing, the situation on the field a different one. Unfortunately, the situation on the field is the one which will impact our future.

The pharmaceutical industry is by definition driven by innovation. However, if new products are not sufficiently protected by patents (enabling industry to recover R&D costs and gets sufficient profit), this innovation efforts might encounter scepticism and reluctance because governments tend to promote generics products. One of the cases presented in the article suggests that actions which interfere with the standard model of upfront patent protection for novel medicines followed by vigorous competition by generics post-patent lapse to drive prices down will be viewed with a healthy dose of scepticism.

The authors conclude that the study of recent competition law developments in the pharmaceutical sector is intended as an illustration and because of that, their study is in no way exhaustive. However, it does provide some insights as to how the Commission and European courts are approaching innovation in this industry.

By using the pharmaceutical industry as an example, the authors promote the idea that innovation policies must be aware of the differences in the markets they want to regulate and that certain options taken might give a considerable impact on the R&D efforts (and by consequences on the product and services derived from these R&D efforts).

The European Union promotes strategies like Europe 2020. Via the Framework Programmes specific actions are possible. However one must realize that next to the burdens mentioned in this thesis, and taking into account the arguments and examples given by the above mentioned case study, a fine tuning is required depending on the economic domain. This makes policy making an extremely complex exercise.

When reading this article one realizes the difficulty of policy making. General principles are needed, but one may not forget that a policy's value is seen on the field. The importance of their study is not necessarily the fact of clarifying the situation of the pharmaceutical industry, but to point the attention of policy makers to the fact that a general approach might damage.
There is by consequence a dual conflict: on one side we need more unified approach and coordination, on the other side the specific requirements on the field must be taken into account too.

4.5. The European Commission Impact Assessment System

Innovation policies are a complex issue, as shown by the analyses carried out in this thesis. Preparing innovation policies, and in general the process of policy making is also a complex and delicate issue, which requires a solid system in place. The European Commission realizes the complexity of shaping new policies initiatives and regulations. Therefore, it has put in place, since a decade, a standard procedure of Impact Assessment to help policymakers when new policy initiatives and regulations are to be drafted.

Before the European Commission proposes new initiatives it assesses the potential economic, social and environmental consequences that they may have. Impact assessment is a process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options by assessing their potential impact. Impact assessment also helps to explain why an action is necessary at the EU level and why the proposed response is an appropriate choice. It may of course also demonstrate why no action at the EU level should be taken.

Impact assessments are prepared for legislative proposals which have significant economic, social and environmental impacts; for non-legislative initiatives (white papers, action plans, expenditure programmes, and negotiating guidelines for international agreements) which define future policies; and for certain implementing measures which are likely to have significant impacts.

In brief, the Commission has rolled out a wide-ranging impact assessment system. It is based on an integrated approach which analyses both benefits and costs, and addresses all significant economic, social and environmental impacts of possible new initiatives. This approach ensures that all relevant expertise within the Commission is used, together with inputs from stakeholders, via public consultations. In doing so, it also enhances the coherence of initiatives across policy areas. The Commission's system is both accountable and transparent. All impact assessments and all opinions of the Impact Assessment Board on their quality are published online once the Commission has adopted the relevant proposal[65].

The steps applied for the EC Impact Assessments are outlined in the following guidelines:

1. Planning of impact assessment (IA): Roadmap, integration in the Commission's strategic planning and programming (SPP) cycle and timetable.
2. Work closely with your IA support unit throughout all steps of the IA process.
3. Set up an impact assessment steering group and involve it in all IA work phases.

[65] http://ec.europa.eu/governance/impact/which_com_init/which_com_init_en.htm

4. Consult interested parties, collect expertise and analyze the results.
5. Carry out the IA analysis.
6. Present the findings in the IA report.
7. Present the draft IA report together with the executive summary to the Impact Assessment Board (IAB) and take into account the possible time needed to resubmit a revised version.
8. Finalize the IA report in the light of the IAB's recommendations.
9. IA report and IAB opinion(s) go into inter-service consultation alongside the proposal.
10. Submission of IA report, executive summary, IAB opinion(s) and proposal to the College of Commissioners.
11. Transmission of the IA report and the executive summary with the proposal to the other EU institutions.
12. Final IA report and IAB opinion(s) published on dedicated Europa website.
13. In the light of new information or on request from the EP or the Council, the Commission may decide to update the IA report.

Such ex-ante Impact Assessment is an important tool to provide with a reasonable assurance that the new policy initiatives will have an impact, thus justifying the EU intervention. Such IA has been carried out for all main EC proposed initiatives, such as Horizon 2020, providing justification for an EU financial intervention. The IA will be an important tool for preparing new or adapted innovation policies in the future. The EU IA methodology also provides a best practice and interesting model which could be followed for preparing policy initiatives at national and regional levels.

4.6. Final Conclusions

In this work we analysed and discussed the state of the art of innovation and related policies, with a detailed focus on the European Union and a comparative analysis with other countries such as the USA.

The conclusions are for sure no surprise. I take the liberty to provide a non-exhaustive list of the main findings that I learned, while reading the different authors, and that I consider to be important for nurturing and boosting innovation, together with responsible policies.

1. A coordinated governance of innovation is needed.

2. Enhanced coherence among policies, initiatives and sectors related to innovation at both EU and national levels is necessary.

3. Collaboration amongst countries is fundamental.

4. Resources must be allocated in a sustainable, efficient and transparent way in order to maximize the outcome.

5. Support must be given to the collaboration between the public and private sector, where in the private sector the role of small and medium enterprises must be encouraged.

6. Access to information is crucial, as is access to funding.

7. Regulators need to realize that their policies must take into account the specific needs of the different sectors.

8. Regulators need to take into account that innovators must be able to profit from their efforts: a fair rewarding must be possible

9. Regulators must think long term and direct companies, public authorities and the public towards sustainable solutions.

10. The general interest must prevail on the individual short term winnings.

11. Responsible policies and participative governance are needed.

12. Impact assessments are an important tool to shape future policies and regulations.

13. Europe is part of the world and collaboration with all countries is a must.

14. The challenges for the future are immense: we are in a so-called system crisis. Solutions cannot be limited to financial problems; attention is needed for environment, resource management, demographic challenges, etc. This will require out-of-the box thinking and might even impact our future moral and ethical values. We have to move from an economic model rewarding the most successful one in financial terms, to a model rewarding the most successful one in sustainable values, in innovation.

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