Research, technology and innovation in Belgium: The missing links

High Level Group 3% Belgium

R&D and innovation in Belgium
Research Series

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Preamble

The importance of the Barcelona objective, known as the "3 % Objective" in the Lisbon agenda, is more than ever a topical issue. Indeed, it represents an essential element of Europe's future, as well as of its Member States, as it was confirmed during the last European Summit in spring 2005.

Aware of the need to undergo a major analysis at the Belgian level, the former Minister of Science Policy at the federal level, Mrs. F. Moerman, has taken a fortunate initiative in putting afoot since 1st June 2004 a High Level Group 3 % Belgium. Independent experts from all research spheres have been contacted, whether they belong to public or private sector, academic world, R&D-management, multinationals, spin-offs… Nominated upon proposal of the whole federate or federal entities of our country, these experts have gone far beyond language boundaries.

Under the sound presidency of Professor Luc Soete of the Maastricht University (MERIT), this think tank has delivered his so expected final report. My great pleasure is now to transmit it to you as a whole.

This report is twofold with a diagnostic section followed by a set of recommendations. It is conceived as a tool aimed at a better organization of Belgium's road map towards the completion of the 3 % Objective. This report favors the emergence of a true knowledge economy, competitive and efficient, in Belgium.

It is of course intended for the Federal Government and the whole public authorities of our country, which bear the responsibility of making this action plan operational. But, in a broader view, it must also question all research and innovation policy actors as well as all the relevant Belgian administrative bodies at the federal level and in the Communities and Regions too.

Therefore I express the wish that all these actors and all these institutions may be informed of this report in a thorough way. This report should be more than a topical flash in the pan or "one more" study that will end on a shelf. The major lines of this report must be applied in a coherent and concerted way, in the perspective of a real brain gain through more quality knowledge investments.

Last but not least, I would like to stress again in this foreword how thankful I am to all the experts of the High Level Group 3 % Belgium and in particular to his President, for their efficient contribution to this decisive move for our future. Referring to the Government's Agreement, I would point out a key idea : "breath for knowledge and the will to undertake" !

Marc Verwilghen
Federal Minister of Science Policy

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Introductory words

This report in your hands represents the achievement of a true high level group composed of men and women of science and industry coming from very diverse horizons. Far from the usual statements, which are well-known of the scientific Community and of the persons in charge for science, this document puts forth a whole set of practical recommendations.

We would all greatly benefit from a quick application of these recommendations.

Amongst all these propositions, one is particularly dear to me. And I wish to bring it out as it outlines the "would-be" landscape of the scientific Community of our country: a "Belgian Research Area". This area should be to Belgium and its components, what the "European Research Area" is to the Member States of the European Union.

Nevertheless the idea is certainly not to impose anything to the relevant Belgian entities but rather to create, together, a framework and offer them tools. These will allow an optimal use of the huge scientific potential concealed in our universities and enterprises. On this respect, it should not be forgotten that one of the weaknesses pointed out by this report is the high degree of fragmentation of the Belgian innovation system. The same holds for Europe. And this is precisely what has led European Commissary Philippe Busquin to promote this concept at such a level.

The "Belgian Research Area" will also contribute to improve the integration of Belgian teams in the European dynamics of research.

The Belgian Science Policy should, in this context and at the national level, play a role very close to that of the Commission in Europe: gather the energies through various tools among which we find the framework R&D-programs. Already, such programs do exist in Belgium. They cover a broad range of research themes, either basic or applied, and take the form of networks at the national level. The infrastructures of domestic dimension are present at the Belgian level too and are conform to those developed at the European level: namely we have the Federal Scientific Institutions.

More broadly, at last, we have some priority objectives: the intensification of the research effort, public as well as private, a stronger integration of our researchers in the European research networks or the multiplication of scientific vocations among youth. These objectives could not be achieved unless Belgium puts afoot one and only one action plan. The following report represents an excellent starting point to implement this plan.

I would like to conclude by thanking all the persons who have contributed to this tremendous and remarkable piece of work. I want to pay a special tribute to the colleagues of the Belgian Science Policy Office not only for their contribution to this reflection but also for the flawless coordination in the working-out of this report.

Dr Philippe Mettens
President of the Direction Committee

Executive summary

The High Level Group 3 % Belgium was established in the Summer of 2004 and composed of independent Belgian personalities with high level responsibilities in the Belgian research area. Its aim is to **define a global action plan and recommendations** to encourage investments in R&D in line with the European Barcelona objective, the so-called "3 % Objective". The position adopted by the High Level Group 3 % is independent of institutional settings, though respectful of the sharing of competencies, and is intended to give an impulse for reflection and action. It is chaired by Professor Luc Soete from the University of Maastricht.

Therefore, the present report provides useful input for a rapid implementation and follow-up of the required policies in the area of investments in knowledge and innovation. **Strengthening Europe's R&D and innovation systems** appeared absolutely essential in realizing the Lisbon strategic goal. The assumption behind this is that domestic private and public R&D is a crucial driving force for a competitive and dynamic knowledge-based economy. For what concerns Belgium, however, it is clear that most of the effort will rely on public authorities.

But, in the mind of the HLG3 %, the 3 % objective **cannot be reduced to an investment cost target**. The question must be considered of the potential results of such investments, of their efficiency. Private R&D has become by and large a mobile production factor, with firms locating such activities where the local conditions appear optimal. Not surprisingly, it is to each of these "attractor" factors that most of our policy recommendations will be directed. Two keywords characterise these recommendations: **attractiveness** and **synergies**, crystallised in a small number of major areas of urgent policy action.

First, there is a need for a **major public funding injection in Belgium's public research infrastructure**. That infrastructure has traditionally represented one of the core comparative strengths of Belgian society but is in danger of loosing its attractor's role. Reinforcing governments' credits for R&D should be a priority. The High Level Group considers that there is substantial room for manoeuvre in investing more public funds in research and innovation. In essence, the Barcelona target conveys the message that governments should invest at least 1 % of their domestic resources in R&D so as to create the optimal knowledge creation, knowledge attraction and knowledge diffusion conditions for private knowledge investments to flourish and contribute to maintain competitiveness. The High Level Group calls for the creation of an innovation capital fund for these investments.

Second, **financial conditions for private R&D investments** should be radically improved. The analysis of labour costs of R&D indicated the major discrepancy between the net income earned by researchers and the gross labour costs for R&D personnel incurred by firms in Belgium. This discrepancy undermines Belgium's long standing competitive advantage in business R&D intensive activities. The High Level Group's position favours a competitive tax deductibility in order to facilitate the hiring of additional researchers and reduce the total salary cost of research departments vis-à-vis neighbouring countries.

However, we must achieve a **better match between research executed in the public and in the private sectors**. This goes through giving more chances for an adequate financing to innovative projects and through the creation of a status for young innovative companies. Next, ways should be found to enforce those mechanisms and institutions actually acting as a bridge between both sectors, namely the collective centers and the technological attraction poles.

Right now, mobility of the R&D personnel goes only in one direction, away from the public sector to the private sector or even abroad. This is a thread to the long term viability of the public sector research. Careers in the public sector need to become more attractive through qualitative, as well as quantitative, measures. This is being addressed in our fourth set of recommendations. One key aspect of this challenge lies in the **poor career opportunities of researchers** and more generally speaking, high-skilled technology talent in Belgium. Shifting the current **brain drain into a brain gain** trend is the major policy challenge. Close to the concerns of the High Level Group, the European charter for researchers as well the Canadian Chair program can serve as inspiration sources.

This report is also a plea for the establishment of a "**Belgian research area**", motivated by the European research area. There is a strong need, for example, for diminishing the redundancy of research efforts, while reinforcing the requirement for world class research by merging forces, while keeping in mind that companies are active on either side of the regional borders.

In short the weaknesses are manifold. They concern high labour costs of research, lack of diffusion of knowledge and weak industry-science linkages, under-funding of public research, deficits of innovation performance and in the framework conditions for innovation, human resources availability for research in the medium term and problems in the careers of researchers, the insufficient knowledge on the NIS itself and, last but not least, the fragmentation of the policy setting.

Many of these **systemic failures** are partly addressed by the various Belgian relevant policy entities: fostering entrepreneurship, establishing excellence centres with critical masses, facilitating the attraction of public researchers, establishing intermediaries between science and technology providers and enterprises, sharing the financial risk of innovation, etc. Advisory Councils and various associations are also in place to advise the governments on what is needed in the STI policy area. What is missing, though, can be basically summarised as:

- A **sense of urgency**: Flanders, Wallonia, Brussels and the federal state have all endorsed the 3 % objective in their policy declarations. This is a good basis, but higher priority should be given to STI in all concrete governmental programmes across Belgium, within the STI area but also in economic policies and in the establishment of rules and administrative regulations;
- A willingness to **look beyond institutional borders** and to search for synergies and better coordination between the actions developed by various governments in Belgium, in order to avoid unnecessary overlaps and fill gaps, and to build up mutually reinforcing strategies.

These recommendations, with the use of the excellence achieved in "concertation-overleg" practices, could well help Belgium to address the major challenge for its future.

Composition of the High Level Group 3 % Belgium

Name of members	Affiliation
Chairman: Mr. Luc Soete	**MERIT – Université de Maastricht**
Mrs. Claire Bosch	Fevia
Mr. Jacques Brotchi	World Federation of Neurosurgical Societies
Mr. Jo Bury	VIB
Mr. Francis Cambier	INISMA
Mr. Eric Carnoy	Samtech
Mr. Dirk Carrez	Europabio
Mr. Jo Cornu	Alcatel
Mrs. Ann De Clercq	De Clercq, Brants & Partners
Mr. Martin De Prycker	Barco
Mr. Koenraad Debackere	KUL
Mr. Jean-François Denef	UCL
Mr. Paul Lagasse	RUG
Mr. Philippe Lambin	FUNDP
Mr. Joseph Lemineur	Materia Nova
Mr. Michel Milecan	Sonaca
Mrs. Claire Nauwelaers	MERIT - Maastricht University
Mr. Jacques Pèlerin	Cockerill-Sambre
Mr. Bernard Rentier	ULg
Mr. Ajit Shetty	Janssen Pharmaceutica
Mr. Jean Stephenne	GSK
Mrs. Anne-Marie Straus	AWT
Mrs. Christine Tahon	Solvay
Mrs. Françoise Thys-Clément	ULB
Mrs. Annie Van Broeckhoven	Innogenetics
Mrs. Christine Van Broeckhoven	UA
Mr. Johan Van Helleputte	IMEC
Mr. Paul Verdurme	Belgian Venture Capital Association
Mrs. Irina Verentenicoff	VUB
Mr. Rudy Verheyen	UA – VITO

Name of substitute	Affiliation
Mr. Paul Baekelmans	Solvay
Mr. Johan Brants	DCB & Partners
Mrs. Véronique Cabiaux	ULB
Mr. Paul Depuydt	Alcatel
Mr. Luc Desimpelaere	Barco
Mrs. Michèle Fontaine	FUNDP
Mr. Dirk Fransaer	VITO
Mr. Stefan Gijssels	Janssen Pharmaceutica
Mr. Didier Granville	Samtech
Mr. Pierre Hauser	GSKBIO
Mr. Roland Keunings	UCL
Mr. André Lemaître	ULg
Mrs. Lydie Meheus	Innogenetics
Mr. Stefaan Nicolay	BVCA
Mrs. Lieve Ongena	VIB
Mr. Eric Spruyt	UA
Mr. Michel Theys	Honorarium ordinary professor ULB
Mrs. Marie-Claire Van de Velde	IBBT
Mr. Jean-Louis Vanherweghem	ULB
Mr. Lode Wyns	VUB

Introduction

The High Level Group 3 % Belgium was established in the Summer of 2004 at the initiative of the then federal Minister in charge of Science Policy, Mrs. F. Moerman. It has no institutional position and is composed of independent Belgian personalities with high level research responsibilities in both the Belgian academic and public research sector as well as in industry. It is chaired by Professor dr. Luc Soete from the University of Maastricht (and MERIT) in the Netherlands.

The aim of the Group is to define a global action plan and recommendations to encourage more and better investments in research and innovation in Belgium, in line with the European Barcelona objective, the so-called "3 % Objective". The Group's final report will be formally presented to the responsible Belgian policy makers in April 2005.

Contrary to similar groups which have been set up in other European countries, the Belgian High Level Group 3 % (HLG3 %) has opted for a role, limited in time, providing relevant policy makers with a "one shot" policy advice on ways and methods to achieve the 3 % norm. There are already a number of formal advisory science, technology and innovation councils at the federal, regional and community levels who provide a permanent policy advice structure in the area of science, technology and innovation in Belgium. The present HLG3 % representing a temporary strategic think-thank of researchers from the academic world, the private as well as the public research sector from the various Regions and Communities, provides a view which is independent of institutional settings, and will hopefully give an impulse for reflection and further action.

With the suggested revision of the Lisbon agenda and the specific recommendations of the Kok High Level Group[1] and the European Commission[2] to establish at the national member country level a policy coordinating agency or person (a “Mr. or Ms. Lisbon”) responsible for the follow up at the national level of the various policy measures in the area of research, development and innovation, it is hoped that the present report provides useful input for the policy debate in Belgium and the rapid implementation and follow-up of the required policies in the area of knowledge investments and innovation.

As the recommendations of the Group are mostly kept at a relatively general level, it will be up to the official bodies and administrations to examine them in more detail and make them operational. In a number of cases, more detailed examples have been gathered to illustrate the points made, but they should not be considered as exhaustive, and will need to be worked out by the competent bodies. The recommendations of the Group cross over the competences of all Belgian entities, federal state, Regions and Communities, though a specific accent has been placed on federal level responsibilities since the initiative to establish this Group was taken by the Minister in charge of federal science policy. But the Group has deliberately taken a broad perspective, starting from the need of research actors and the overall position of Belgium, rather than from the institutional definition of competencies. The report addresses hence all competent administrations across the full spectrum of the relevant Belgian entities.

A first step in the work of the Group was to agree on a common diagnosis of the situation, with regard to R&D investment, innovation and knowledge investments more broadly in Belgium today. A second step was the adoption of policy recommendations, with the view of responding to the challenges identified in the diagnosis.

The present report draws on the numerous contributions received from the members of the HLG3 % during plenary meetings, and on the work of five working groups established by the Group, which met at various moments over the period October 2004 - January 2005.

It also relies on two introductory written contributions:

- Achieving the 3 % target within the context of a small open economy: the Belgian challenge (May 2004), prepared for this High Level Group by Luc Soete, Chairman (MERIT - University of Maastricht),
- Benchmarking National R&D policies in Europe: lessons for Belgium (October 2003) by Claire Nauwelaers (MERIT - University of Maastricht), Reinhilde Veugelers (Katholieke Universiteit Leuven and CEPR London) and Bart Van Looy (Katholieke Universiteit Leuven).

The work of the Group was supported by several individuals who acted as rapporteurs of the working groups: two officials from the Belgian Federal Science Policy Office (Bernard Delhausse and Ward Ziarko), a member of the cabinet of the Minister in charge of Science Policy (Patrick Lamot), and two members of the Group (Claire Nauwelaers and Dirk Carrez). Hugo Hollanders from MERIT has provided data gathering support[3].

[1] European Commission (2004).

[2] European Commission (2005).

[3] The chairman of the Group, Professor Soete, was also invited by the Canadian Embassy in Brussels for a mission field trip to Canada to visit various Canadian institutions and to have discussions with a number of policy makers both at the national and provincial level dealing with Science, Technology and Innovation policy in Canada.

Chapter 1
The 3 % Objective

Whereas the recent European spring summit (March 2005) of Heads of State and Government has put the so-called Lisbon goal for the Union to become by 2010 "the most competitive and dynamic knowledge-based economy in the world" into a longer term and less formal objective, the knowledge investment targets set at the Barcelona European Council meeting in 2002, remain a major policy priority for EU member countries. Thus as agreed in Barcelona research and technological development (R&D) investment in the EU will have to be increased to amount to 3 % of GDP by 2010, up from the 1.9 % of GDP in 2000. To achieve this, an increase in the level of business R&D funding has been called upon rising from its current level of 56 % to two-thirds of total R&D investment, a proportion currently achieved in the US and in some European countries. Public investment in R&D should amount by 2010 1 % of GDP.

The Barcelona R&D investment objectives arose from the recognition that strengthening Europe's private R&D and innovation systems appeared absolutely essential in realising the Lisbon strategic goal. The assumption behind this was that domestic private R&D would be a crucial driving force for a competitive and dynamic knowledge-based economy. Recognizing the political importance of setting such long term knowledge investment targets, the starting view of the HLG3 % is nevertheless that, as a meaningful long term policy target, the 3 % objective is somewhat of an odd target.

First and foremost it is an investment **cost** target. Equally important, if not more so, is the question what the results – in terms of efficiency and effectiveness – of such investments will be. Firms are not interested in increasing R&D expenditures just for the sake of it but because they expect that the new or improved production processes, technology concepts, or new products responding to market needs emerging from these activities, will improve their efficiency and hence their long term competitiveness. But these same basic economic rules apply of course also to the increasingly costly R&D process itself: if at all possible, firms will try to license such technologies or alternatively outsource at least part of the most expensive knowledge investments to suppliers of machinery. In the current international environment, firms are continuingly being pressed to increase the efficiency of their internal R&D by rationalising, reducing the risks by outsourcing R&D to separate small high-tech companies which operate at arms length but can be taken over, once successful. All these features, which from an economic growth and competitiveness perspective appear essential, are not captured in the 3 % R&D objective.

Second, as a policy target decomposed in a dominant private industry target (2 %) and a relatively weak public sector target (1 %), the 3 % objective does not appear a very credible policy target: the main investment efforts needed to achieve it are with the private sector, something most governments have at best some indirect influence over, whereas the weaker public sector target is itself subject to the other 3 % *Growth and Stability Pact* restrictions. Conceptually too, the decomposition of the 3 % Barcelona objective in a double R&D effort of the private sector for every single R&D effort of the public sector appears not based on a careful reflection of the role of each of those sectors in knowledge investments. Rather it is based on the current US private versus public decomposition of R&D expenditures, hence ignoring the differences between the US and Belgium in the taxing regime within the country (neutral versus progressive) and the implications thereof for private and public parties in the funding of research and development (and higher education and training). In countries with much stronger and progressive taxing regimes such as Belgium and many other continental European countries, there is a natural expectation with private investors (businesses or individuals) to assume that governments will take on a stronger role with respect to investments in public research infrastructure and higher education in particular[4].

Third, and from the Belgian small open economy perspective in an increasingly global knowledge economy framework, the question must be raised whether a **national** domestic knowledge investment target, has any real economic significance. With increased globalisation, the relevant R&D which will act as driving force in a country might well come from abroad; at the same time domestic R&D activities might have little impact on the domestic economy in which such R&D activities happen to be located[5]. Although many enterprises recognise the increased importance of investing in R&D, they do so only to the extent that they can exploit results effectively within their (often international) organizational borders and expect sufficient returns to

4 This explains amongst others why the "tuition debate" is strongly resisted by the population at large in most continental European countries with progressive income tax regimes, even if it is widely accepted that most of the current systems of free or cheap higher education are effectively resulting in subsidies from the poor to the rich.

5 To highlight that such argument isn't purely theoretical, an example: Flanders with IMEC has a top research facility in semiconductors, including clean room facilities. However, it has no national production anymore. Flemish policy makers are of course requesting from private partners with IMEC proof of national/regional spill-over effects when applying for public R&D support. Yet, for most of the private partners of IMEC the spillovers (at least in terms of blue-collar labor) are likely to accrue elsewhere in the world where they have their production facilities.

balance the risks inherent in such investment. Here too, the same argument holds: firms will do so no longer from a domestic but from a global perspective.

In short, private R&D has become by and large a mobile production factor, with firms locating such activities where the local conditions appear optimal. Among the most important factors in this regard are a sufficient supply of highly qualified human resources and in particular in science and engineering, a strong public research base flexible and open to interactions with the private sector, and a local environment characterized by a dynamic entrepreneurship culture particularly with respect to potential suppliers and users. Not surprisingly, it is to each of these "attractor" factors that most of our policy recommendations will be directed.

Before doing so we turn in the next section to the main underlying conceptual framework which we will use to present both the diagnosis as well as the recommendations of the HLG3%.

Chapter 2
The "National Innovation System" concept and the approach taken by the HLG 3%

The basic conceptual notion that underlies the work of the HLG3 % Belgium is that of the analysis and the workings of the "**National Innovation System**" (NIS). Economists use this concept as a framework to better understand the complexity of innovation processes within a country, and in particular the way they are shaped by the national environment. The key idea at the root of the NIS concept is that innovation does not occur in isolation or as a direct result of R&D investments, but rather as the product of various interactions between elements of a system that for simplicity is being looked at within the national borders of a country. In short, a system of innovation is much more than a formal R&D system: it encompasses a wide array of other elements: from the private, business world, from the public research world, from education, from training systems, from the national institutional set-up and "external" environment, from national rules and regulations. The National Innovation Systems approach strongly advocates that the performance of an economy in terms of innovation and productivity is not only the result of public and private investments in tangibles and intangibles (such as R&D), but is also strongly influenced by the character and intensity of the interactions between the key elements of the system. The notion of "national" can of course increasingly become questioned. Many of the systemic interactions within a NIS have taken on an international dimension. Certainly within the context of further European integration and the many European policy initiatives in the area of research (the concept of the European Research Area and the various new instruments introduced in the

Framework Programmes), many linkages between the various components of the Belgian innovation system have become European. But to talk about a European or an "International Innovation System" appears analytically at this stage not really helpful (Caracostas and Soete, 1997): the national (and regional) geographical framework, certainly from a policy perspective, appears by and large dominant. But obviously in the Belgian case, the international (as well as the regional) aspects will warrant particular attention when using the NIS concept.

The **creation** of new knowledge (mainly through R&D) is at the centre of the Group's concerns, but the **diffusion** and combined **use** of various forms of knowledge throughout the economy is equally crucial. This view, also central in the NIS notion, departs of course from earlier "pipeline" ideas, in which inputs (basic or fundamental R&D activities) are injected at the beginning of the pipeline and, with a certain probability, coming out at the end of the pipeline in the form of new innovation and other research output. The popularity, particularly with policy makers, of this pipeline model is of course the easiness to formulate policy goals and the apparent straightforward outcomes of such supply-side led policies. More realistic, complex representations of the innovation process such as the NIS one, put much more emphasis on the dual nature of supply and demand (Schmookler, 1966) in bringing about both more research investments and new innovations. Thus, the creation of new knowledge depends itself also on the feedback from (potential) users. The diffusion of innovations, the problems encountered in using the technology, provide themselves often invaluable information upstream to research establishments allowing them to further improve upon the technology. At every stage of this complex chain-linked process (Landau and Rosenberg, 1986), different policy challenges will emerge. In short, the complexity of the innovation process will be reflected in a similar complexity of policy goals and instruments. Simple normative policy goals can often be misleading in this area. Thus, whereas innovation and technological developments need often a strong R&D production system (both public and private) and sophisticated human skills, they also depend on the national or local ability to utilize new knowledge produced elsewhere and to combine it with the available domestic stock of knowledge.

This approach poses some questions with regard to **the European and national 3 % R&D target**, at the core of the formal mandate of the Group. This target, as was already discussed in the previous section, is nothing but an investment cost target. Equally important, if not more so, is the underlying question what the results – in terms of efficiency and effectiveness – of such R&D investments will be. The highly efficient or extremely costly way knowledge is being produced, exploited, diffused and/or can be appropriated is at least as important as the question of how much efforts are being devoted to R&D activities. Furthermore and again as already touched upon in the previous section, from a small open economy perspective, the question must be raised whether such a national target, has any economic meaning within the international competitive world within which firms operate. Small countries are not just much more dependent on foreign R&D activities, they are also unlikely to be able to capture all the benefits of their R&D investments domestically. Thus, the absorptive capacity of Belgian actors with regard to new knowledge, produced in the country or elsewhere, their capacity to create linkages with foreign R&D actors, should be equally key elements of attention in addition to the "3 % target" as an expense target.

Given these general considerations, the High Level Group 3 % and contrary to its formal name, has focused its attention on the various ways to increase the efficiency, exploitation and diffusion of R&D[6], including the reduction in the costs of carrying out private R&D, the barriers to the spreading of innovation and knowledge more generally, developed domestically or abroad, rather than just on ways and methods to reach a 3 % volume target of R&D.

Furthermore, and in accordance with the NIS approach, briefly described above, the High Level Group 3 % Belgium has included in its analysis a wide variety of actors involved in all types of R&D, innovation, and knowledge diffusion and absorption. Its work was organized so as to maximize the various interactions between these categories of actors and take into account their different positions in the National Innovation System of Belgium.

As a first step in its work, the Group identified a number of key topics, which are, in the Group's vision, at the heart of the Research and Innovation challenge in Belgium. These are:

- **The costs of research:** a first aspect relates to the costs of carrying out research in Belgium, in the public as well as in the private sector. Making research in Belgium more attractive from a financial point of view (for both individual researchers and for companies) is an important part of the debate. Fiscal options are on the table currently, but other options such as subsidies, grants or other cost-lowering initiatives might also be relevant;
- **Human capital for R&D:** human capital is the primary asset in the knowledge-based economy. How to raise the quantity and quality of the skilled labour force, attract or retain the best brains in the country, are crucial questions for the efficiency and long-term sustainability of any National Innovation System. Mobility, status and career perspectives, life-long learning, entrepreneurship education, etc. are amongst the main critical points here;
- **Knowledge exploitation and diffusion:** both the broad economic framework conditions, as well as very specific bottlenecks and mismatches are at the core here of explaining various failures: in the creation of new innovative ventures, the uptake of new knowledge, the access to capital, etc. The focal point for policy attention is the success and efficacy of various stimuli in favour of innovation. From spin-offs promotion, the availability of venture capital, public-private research partnerships, etc.;

[6] On that topic, see the report "Assessing R&D effectiveness" of the European Industrial Research Management Association (2004).

- **Quality and organization of research:** given the complexity of the Belgian institutional set-up, the natural question to be raised is whether the historically grown division of labour between the various layers of policy responsibility between the federal state, the Regions and the Communities in the area of S, T and I, is innovation-enhancing or rather creating institutional policy fragmentation. Furthermore and from a more immediate policy perspective, are there ways and means to improve the functioning of the research base: interregional and international openness, collaborations, infrastructures, evaluations, search for synergies, etc.;
- **Regulations, rules and legal settings:** the overall climate for science and innovation is essential to encourage education and industry in their scientific endeavours. Efforts done by the ministries responsible for science policy and innovation should be accompanied by positive attitude and policy in other areas of politics and regulation. The legal and regulatory framework plays an important, if not crucial role in providing incentives or on the contrary having detrimental effects on knowledge creation, diffusion and absorption. This vast question covers not only R&D-specific administrative rules or regulations (e.g. for medical research), but also more general rules impacting on new technology-based firms creation, working conditions for researchers, innovative activities and their linkages with environmental rules, etc.

In the next section, presenting the summary diagnosis of the Group, each of these 5 key dimensions is integrated into a general analysis of the strengths and weaknesses of the Belgian Innovation System. This diagnosis, kept, given the voluminous literature on the subject (see references), to a minimum, forms the basis of the Groups' recommendations aimed at improving the functioning of this system, taking the "3 % objective" as stimulus for debate and mobilization of all research actors.

Chapter 3
Diagnosis of the Belgian Innovation System

Looking at the figures...

Using a bold quantitative and EU comparative approach, Table 1 below provides a picture of the position of Belgium within Europe, as measured by the main science and technology indicators. The Group recognizes that these quantitative indicators fail to measure all relevant aspects of the National Innovation System of Belgium, and tell only little about the functioning of the system. Furthermore, the relevant comparison should ideally not be confined to Europe, but should extend to the world competitors and most notably some of the emerging Asian economies. Despite these limitations, the data presented in Table 1 hopefully help to give a first broad and objective impression of the main characteristic features of the Belgian Innovation System.

The very first line of Table 1 indicates that the share of R&D expenditures in Belgium reached 2.17 % of GDP in 2001, substantially below the 3 % Barcelona objective. Econometric projections show that, if current trends are maintained, it will be practically impossible for the country to reach a figure of 3 % by 2010. Leaving aside the relevance of achieving this target as discussed above, the current position of Belgium with respect to R&D investments and the unlikelihood to achieve the 3 % Barcelona norm by 2010 provide the rationale for the setting up of the Group and its work.

Looking at the very nature of R&D investments, it appears that public investments in R&D are clearly and significantly lagging behind mean investment efforts in other

EU countries. Some catching-up signs are visible (line 4), but they remain poor compared to the challenge ahead. The figures suggest that R&D is still insufficiently high on the policy agenda in Belgium.

On the other hand, business R&D expenditures are remarkably important (line 5), though not growing as fast as in competitor countries. More specifically, the total number of R&D-active firms in Belgium can be estimated to amount to 1385.[7] While important in aggregate quantitative terms, the largest volume of business R&D expenditures is concentrated in a dozen of larger firms. Thus in 2001, R&D-active firms of more than 250 employees represented 66 % of total R&D investments. The narrow firm basis of business R&D investments in Belgium represents a significant point of vulnerability. A decrease in R&D efforts in Belgium of one of these companies is likely to reduce significantly the formally measured aggregate R&D intensity level of the Belgian economy. This is even more so the case for R&D intensity levels measured at the level of regions. Thus the Flemish level of R&D intensity, often claimed to be currently in line with the 3 % target, is particularly sensitive to individual firm's R&D investment decision. Over the last two years, the business R&D expenditure figure declined in the case of Flanders (reaching a 2.14 % of R&D intensity in 2003 from 2.43 % in 2001, AWI, 2005).

A strong relative performance can be observed for Belgium with respect to human resources (lines 9 to 15): the population is generally well educated, investments in higher education are superior to EU average, and the number of researchers[8] is relatively high and growing. Belgium typically scores well with respect to pharmaceuticals (in 1999, 5 % of all pharmaceutical products in the world had a Belgian origin). However, new science and engineering graduates are less numerous, though high growth rates for these graduates in the last years are more reassuring. Clearly, human research capital is a main asset of Belgium, to such an extent that there is a significant brain drain. There are increasingly insufficient positions for young academic researchers to pursue a career in Belgium given the relatively low levels of public research funding (see above).

Measured in academic terms, public research is quite productive (lines 16 and 17)[9], however exploitation of research through patents (lines 18 to 22) shows Belgium has difficulty to use scientific advances for possible commercial exploitation. Figures on high-tech patents are mediocre and contrast with the good results obtained for public research productivity[10].

Belgium is at a disadvantage with respect to its industrial structure and international competitiveness, which appears strongly oriented towards medium-and low-tech industries (line 23). Their absorptive capacity for new knowledge is likely to be much

7 This is the size of the so-called "repertoire", i.e. the catalog containing all the firms pursuing R&D activities in Belgium and used for the permanent inventory of the Belgian research potential.

8 In the Frascati Manual, the researcher is poorly defined as someone doing R&D, it is a "professional engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned".

9 The Website, SCI-BYTES, linked to the ISI Essential Science Indicators, reports that Belgium's world share of science and social science papers (all fields) over the last 5 years is 1.36 %. Belgium ranked 14th for citations, 18th for papers and 19th for citations per paper. Depending on the way we look at figures, microbiology, clinical medicine and physics seem to be leading domains considering citations. Cf. http://www.in-cites.com/countries/belgium.html & http://www.in-cites.com/research/2004/.

10 See however the discussion in the next section on the strategy of patenting in multinational companies.

lower than in the case of high-tech industries. It would appear that the small number of large, heavily R&D investing, firms, explaining the relatively high, aggregate business R&D intensity figure for Belgium (referred to above) appear like "islands" of high-tech activity in Belgium's industrial landscape. Furthermore, Belgium is like many other European countries increasingly becoming a service economy whereas much of its R&D pertains to manufacturing. R&D in service (insurance, banking systems, transport...) is small, despite some high-skilled labs, universities and high schools departments. The low figure for high-tech exports (line 25) illustrates the problem of having failed so far to translate relative business R&D strength in international competitiveness. There are some signs of catching-up here when looking at the trend indicator for this variable (line 26). Such structural changes take time though.

The figures presented in Table 1 give a sense of urgency to the work of the High Level Group. They also justify the orientation of the Group to questions of increasing the efficiency of R&D investments.

To sum up:

Belgium is clearly not amongst the leaders in the knowledge-based economy. The weakest links in its innovation system appear to be related to public research inputs and its capacity to translate resource endowments into technological performance. Furthermore, focusing policy attention in the case of Belgium on the 3 % target, and in particular the 2 % private R&D investment target as major challenge, appears to miss the point of the real policy challenges in the area of R&D: the dramatic dependence on a small number of large R&D performing firms.

Looking behind the figures...

In order to examine in more detail the various aspects of the Belgian NIS and to identify its weak and strong spots, one needs to complement quantitative indicators with qualitative analyses. These qualitative analyses shed more light on several important aspects of the Belgian Innovation System, such as: the costs of doing research, the quality and intensity of knowledge flows, the organizational aspects of innovation, the efficiency of the policy system, etc.

The figures in Table 1 tell us little about the costs of doing research in Belgium. Such figures are difficult to calculate, aggregate or compare. Some comparable figures, though, on wages, social contributions, taxes, etc. do inform us on the **high level of labour costs in Belgium** compared to its neighbours. Figure 1 presents costs in the private sector amongst a number of countries. While, in Figure 1, net salaries to researchers in the case of Belgium appear at the lower end, slightly higher than France and Italy, and substantially below the US and the UK, the total employer costs for researchers are highest in Belgium, even higher than in the US. In short, this is more or less the worst of both worlds. Researchers are being paid less, nearly half of what they get in the US and substantially less than what they could get in the UK or even the Netherlands, while private businesses have to pay salaries at even higher costs levels than in the US.

There are obviously good reasons why there is such a large discrepancy between net salaries and total employment costs in Belgium as compared e.g. to the US which are directly related to the much more extensive social welfare model Belgian employees are enjoying as compared to American ones. At the same time though such an extreme difference between net wages and gross labour costs in R&D is probably also one of the central explanations why there could be a structural trend towards a brain drain from Belgian researchers to foreign countries on the one hand, and a reduction of private R&D investment in Belgium[11] on the other hand.

It should be noted that labour is currently the main component of R&D expenditures (more than 60 % in Belgium in 2001). An analysis of the total cost of R&D in the chemical and pharmaceutical industries showed that between 30 and 40 % of total R&D costs could be directly linked to the researchers (wages, social security costs), another 30 to 40 % to support services (IP, documentation, analysis) where labour costs are also particularly important, between 10 and 15 % to administrative costs, and finally around 20 % to investments in equipment. The dominance of labour costs in ICT industries is also patent.

[11] The most recent figures for the amount of business financed R&D in Belgium and its different Regions actually do point to a reduction of private R&D investments, even though such statistically observed reductions in R&D might well reflect effects of a further harmonization and sharpening of the definition of R&D carried out within firms.

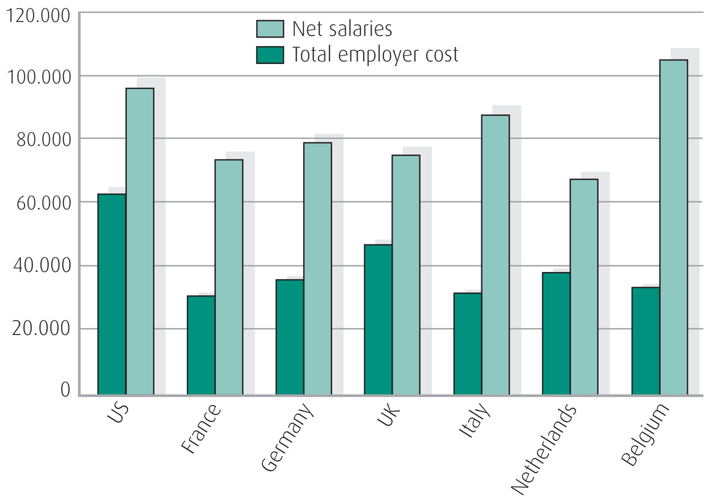
Table 1 Selection of Main Innovation Indicators EU-15 and EU-25 comparison (Latest available years)

		Belgium	EU25	EU15
	R&D investments			
1	Total R&D expenditures (% of GDP) – 2001	2.17	1.93	1.98
2	Public R&D expenditures (% of GDP) – 2001	0.57	0.67	0.69
3	Government budget allocated to R&D (% GDP) - 2003	0.61	0.76	0.77
4	Government budget allocated to R&D – average annual growth rate (%) 1997- 2003	3.4	3.2	3.2
5	Business expenditures on R&D (% of GDP) – 2002	1.64	1.27	1.30
6	Industry financed R&D - average annual real growth rate (%) 1997 to 2001	4.0	1.7	5.6
7	R&D investment – average annual growth rate (%) 1997-2001	6.3	4.5	4.5
8	R&D Intensity - average growth rate (%) 1997-2001	3.8	1.3	1.5
	Human resources for the knowledge-based economy			
9	New S&E Graduates (per thousand of 25-34 years age class) – 2001	0.49	0.49	0.55
10	New S&E Graduates (per thousand of 25-34 years age class) – average annual growth rate (%) 1998- 2001	11.2	–	2.4
11	Expenditure per student in tertiary public education, in US$PPS – 2001	9,897	–	8,334
12	Working population with third level education (% of 25-64 years age class) – 2002	29.0	21.2	21.8
13	Population involved in lifelong learning activities (% of 25-64 years age class) – 2002	6.5	–	8.5
14	Total R&D Personnel (FTE) per 1,000 workforce – 2001	6.95	–	5.68
15	Total R&D Personnel (FTE) per 1,000 workforce – average annual growth rate (%) 1996- 2001	4.3	–	2.6
	Research Productivity			
16	Scientific Publications per million population – 2002	929	–	673
17	Scientific Publications per million population - average annual growth rate (%) 1995- 2002	1.6	–	2.1
18	EPO patent applications (per million population) – 2000	124.1	107.7	128.4
19	USPTO patent applications (per million population) – 2002	70.4	59.9	71.3
20	USPTO high-tech patent applications (per million population)	8.8	9.4	11.2
21	EPO high-tech patent application (per million population)	27.7	26.0	30.9
22	Triad Patents per million population – 1998	37.2	-	36.0

R&D orientation of production			
23 Employment in high-tech manufacturing sectors (share of total employment)	6.4	6.6	7.1
24 Employment in high-tech services (share of total employment)	3.9	3.2	3.5
25 High-Tech exports as % of total exports – 2001	9	–	19.8
26 Share of world market High Tech Products - % Growth 1996-2001	5.22	–	0.62
Financing of innovation			
27 Seed and start-up venture capital – investment per 1000 GDP – 2002	0.42	0.28	0.28
28 Share of seed and start-up venture capital in total venture capital investments - 2001	33	–	34
29 Share of High-tech sectors in venture capital investments (%) – 2001	58	–	32

Sources: Eurostat, European Commission (2003a, 2003b)

Figure 1 Net Salaries & Total Employer Cost for R&D Manager at equal job description (PhD level, 5 - 10 years experience, low range, in USD))



Source: Invest in Sweden Agency, Johnson & Johnson

The second feature worthwhile noting, is the apparent contradiction in Belgium between, on the one hand, relatively good levels of scientific performance and level of business R&D investments, and on the other hand, the mediocre levels in patenting and in the share of manufacturing value added in high-tech sectors or the proportion of high-tech exports.

Recent studies help to complete our assessment of the Belgian NIS, and more particularly, the nature of private R&D activities (see, in particular OSTC, 2002, Capron and Meeusen, 2000, Capron and Duelz, 2004). First of all, it is fair to characterize the private R&D expenditures by the Belgian enterprise sector as being more oriented towards the rapid adoption of new (process) technologies, rather than towards the genesis of new technology breakthroughs. This orientation could explain the relative disconnect between research carried out at enterprises and universities (or research centres).

Furthermore, as already highlighted above, R&D expenditures and patenting activities are concentrated in a limited number of large companies. The diffusion of new knowledge across the whole economy is not ensured if there are no strong linkages between these companies and the rest of the economic fabric. Spatially disaggregated data show imbalances of the R&D efforts across Belgium: **R&D activities are concentrated in a limited number of firms and high-tech districts, with polarization effects around universities and high-tech corridors but few evidence of spillovers outside these poles** (Spithoven and Teirlinck, 2002), (Nicolini, 2002). A further analysis of knowledge spillovers on the basis of patent citations results in a similar conclusion on the relative absence of inter-firm linkages and hence limited diffusion of know-how. There are no truly "open" industrial sectors in terms of the propensity to co-operate at inter-firm and, even more, at inter-industry levels. Most industrial sectors (except pharmaceuticals and chemicals) are orientated towards **intra-firm knowledge flows** (Lukach and Plasmans, 2002). Further available evidence suggests that intra-national collaboration links in RTD are weak, especially between Flanders and Wallonia, and that complementarities might therefore be under-exploited (Capron and Cincera, 2002) presumably as a consequence of the small size of the clusters in Belgium[12].

Nevertheless, Belgium benefits from the presence of the so-called "collective research institutes", such as the De Groote centres[13] established in 1947, which represent effectively sectorial RTD clusters involving alongside the industrial, often small and medium sized, firms also universities and other scientific research institutes. Such collective centres funded and directed by the industrial firms come nearest to the industry boards described by Paul Romer (1986) as the most appropriate innovation support institutional set-up. Furthermore, until recently, such centres operate at the trans-regional level. In the specific Belgian case they might well be considered as model for the institutional structure needed to deal with the problem of insufficient cluster creation in high tech sectors. The question remains if they will be able to maintain their trans-regional perspective with the new funding arrangements in force since 2004, when

[12] Though several intra-regional good practices can be observed (VIB, IBBT...) interregional best practices are still to be found.

[13] The research centres, in Flanders and Wallonia are gathered respectively under the VLOOT and ACCORD-Wallonie associations (www.vloot.be and www.accord-wallonie.be)

the multilateral agreement between the federal state and the three Regions has been suppressed. More recent centres, such as VITO, VIB, IBBT or IMEC in Flanders or Multitel, Giga or the Space Centre in Wallonia, do share with the collective research centres (and to some extent also with High Schools) the mission to diffuse technology within the wider industrial fabric. On the Walloon side, a recent position of the Science Policy Council (N° 757, February 2005)[14] indicates a number of important weaknesses in the S&T intermediary system: much needs to be done to improve the effectiveness of these centres and intermediaries in terms of their diffusion power.

The **extremely high degree of openness** of the Belgian economy has a crucial impact on the Belgian NIS. Belgium is particularly characterized by the large presence of subsidiaries of multinational companies, whose R&D and innovation activities are less easily translated fully into domestic economic impact indicators (Veugelers and Cassiman 2002), while patenting of inventions originated in Belgium can occur elsewhere through parents of multinational companies (Capron and Cincera, 2000). Recent studies (Veugelers, 2002) have shown that the benefits of the presence of subsidiaries of multinational corporations in the country depend on the quality of the host environment, and most notably, on the technological competence of indigenous firms. Belgium benefits from its openness, through access to international technology markets, but the appearance of a virtuous circle of technology and innovation spillovers between foreign subsidiaries and domestic firms is far from automatic: it will only be present if the subsidiaries are integrated both into their international corporate network as well as into the domestic economy. A further prerequisite for spillovers from foreign subsidiaries to the domestic economy is an adequate technological and innovative potential in the local economy, ensuring the necessary absorptive capacity. Thus, weak innovation performance in domestic firms impacts negatively on the development of spillovers from multinational corporations.[15]

This high degree of openness represents hence a strength as well as a threat. For pharmaceutical research (which constitutes a large part of the business R&D in Belgium) and for the R&D-active firms dealing with foreign suppliers or customers, it is important to obtain good money rewards for the products that are developed in Belgium. And as Belgium is the home market, the price for the world market will be based on the price in Belgium. If this price is low, firms might well decide that this is not worth it, and R&D investments in Belgium will decrease. The rationale behind this is that if the innovation is not valued on the domestic market, there are few chances that it will be valued abroad. In effect higher prices abroad might be considered in the international trading arena as disguised forms of transfer pricing. In short, policies in very different areas such as health or competition policy are likely to have a direct impact on the incentives for firms to invest in R&D in Belgium. A coherent innovation policy in a small open economy will have to take into account such impacts if only to maintain current competitive innovation strengths, let alone strengthen them.

[14] See www.cesrw.be.

[15] Let us notice that several public research bodies, like IMEC, VITO have pursued a policy of contracting with business companies, mainly residing abroad. Though this increases the chances of positive spillovers and of technology and knowledge transfer, this also increases the dependency towards foreign R&D actors.

Therefore, linkages between R&D, technology and innovation policies, and notably competition and health policies need to be created and reinforced.

The very high degree of the internationalization of the Belgian R&D system is also visible in the high level of participation of Belgian actors (both research organizations and firms) in the European RTD Framework Programs. However, the position of Belgian *firms* as partners in international strategic alliances is much weaker: an **imbalance appears thus between the position of the country in pre-competitive research and internationally competitive research activities** (Capron and Meeusen, 2000).

To further investigate the weak diffusion capacity of the Belgian NIS, we need to consider not only the inter-firm linkages, but also to take a closer look at the performance of Belgium in terms of **Industry-Science Links**. How are the various institutions, such as Business Angels, the Business Innovation Centres, or the technological incubators helping to improve such links? As in other EU member countries, universities and public research institutes are not important sources of information for the innovation activities of Belgian firms (Debackere and Veugelers, 2003). And as in other EU countries, universities or research centres are not important in terms of patenting activities (Debackere, Luwel and Veugelers, 1999), although the number of such patents is growing in recent years[16]. In terms of research-based start-ups though, Belgium is performing relatively well according to EU standards, but still well below US levels (Degroof et alii, 2001)[17].

Overall, the qualitative evidence on the Belgian NIS presented so far, illustrates the weak point in the system already spelled out from the reading of the aggregate figures in Table 1, namely **the weak diffusion power of the system to combine R&D capacity with innovative performance**. The hampering factors for the development of a well-performing innovation system lie primarily in elements outside the R&D system stricto sensu. From the evidence brought together in numerous analyses, the following appear of particular importance:

- **Low entrepreneurship dynamics** in the country is one barrier to the transformation of new knowledge in economic gains. This phenomenon is documented in many studies of the Belgian situation. Regulations and bureaucracy are consistently reported as effective barriers, but the generous social protection system plays also a role here (General Entrepreneurship Monitor, 2002)[18].
- While Belgium is quite successful in producing academic spin-offs, there is however a **weakness in intrapreneurship**: Belgian enterprises have no tradition to stimulate industrial spin-offs.
- Another barrier consists of **firms' deficiencies in commercial management**: using trademark statistics, Capron and Cincera found that Belgium performs significantly less well than its main competitors in terms of commercial innovations

[16] It has nevertheless to be acknowledged that patents are a rather unequal indicator of evaluating industry performance in R&D. ICT firms, due to the fact that they can patent processes and sub-processes, are a lot more active than, for example, pharmaceutical companies.

[17] In that respect one might be willing to assess the efficiency of the IMEC or of the ULB biology pole in Couillet, as well as the impact and role of the SPOWs in Wallonia and their Flemish counterparts.

[18] This problem stems in fact from a whole cultural environment and as such entrepreneurship should in some way be addressed in school, where students would receive an education to entrepreneurship and innovation.

(Capron and Cincera, 2000). To ensure innovation and growth, companies need researchers, entrepreneurs and managers.[19].

- The various functions of the firms cannot be disconnected, and **innovation management** is multi-faceted. Too many Belgian SMEs lack absorption capacities to profit from external knowledge, and a change of mentality from "owning" a firm towards "managing" it and taking risks for innovation is needed. Large domestic firms are hesitant to engage in strategic partnerships, which create impediments to their developments.
- **Financing of innovative ventures is problematic**: at the level of the Belgian institutional funding bodies there is a structural shortage of funds to be allocated to the venture capital and private equity asset class. At the level of the funds themselves, there are problems of fragmentation and sub-critical fund size. Some investments, typically in the range of 3Mio € do not meet the interest of investors. At the level of the SME itself, there appear to be few if any local investors willing to pick up the sometimes hefty capital investments required to transform precious local intellectual capital into economic value on an international scale.

To summarize: conducting research is ultimately all about taking risks. The only way to reduce those risks is by creating the proper framework conditions for R&D, innovation and entrepreneurship. In Europe and more specifically in Belgium, for most firms these framework conditions are rather stringent: recruitment of high skilled researchers, wage costs, innovation climate and cumbersome administrative constraints[20] in order to gather funds... Start-ups and spin-offs in that respect tend to cumulate risks: putting a company afoot and doing nearly 100 % of R&D, represent two risky tasks, sometimes referred to as "the explosive cocktail".

Not only is the link from research capacity to technological and innovative performance an area of concern, also examining the link from innovative performance to **economic growth and competitiveness** is revealing in this respect. Linking the strengths and weaknesses in technological areas (as measured by shares in patenting activities) to economic activity (as measured by shares in export markets) reveals an important 'mismatch' in Belgium and Flanders in particular (Debackere, Luwel and Veugelers, 1999, Debackere and Veugelers, 2003). Most of the Belgian/Flemish patent activity is situated within industries where no comparative economic advantage is to be observed, while most of the sectors where Belgium/Flanders does hold a comparative advantage in economic terms (exports), are not characterized by strong technological advantages (as measured by patents). This tends to suggest that **Belgium's economic competitive position is not fully built on its comparative technological strength**.

[19] In the typology of Reich (1991), the symbolic analyzers can be divided in three groups: problem finders, problem solvers, problem brokers. The question is then: do we have the optimal mix of these experts.

[20] The OECD has recently pointed out the amelioration of the legal and administrative burden put on firms and has acclaimed the process of the administrative simplification in Belgium as one of the most successful.

This is consistent with the above observation that Belgium is not specializing in high-tech sectors, but in the more traditional medium tech industries, such as engineering and machinery, chemicals, vehicles, electrical machinery, metals and base materials (the same remark holds for the low development of R&D in services). In these industries, Belgium derives its strong performance through high capital intensity and labour productivity, hence from operational efficiency. But also in these sectors, knowledge and innovation is important. Undisclosed figures computed under the European Innovation Trend Chart project show that Belgian innovative performance is higher in branches with lower knowledge intensity. Belgium's gap in innovative performance with the EU leaders is more important in the high-tech and medium-high tech industries than in the medium-low or low-tech industries. In the last category, Belgium is even amongst the best innovation performers in Europe. Hence, although Belgium is building on innovation to sustain its competitive position, this is not in high-tech sectors where innovation is built on new scientific and technological developments, and where most of the high growth potential is.

In most EU countries, **R&D human resources availability is considered as one of the main of the bottlenecks** that one is about to face at the 2010 horizon. This, however, does not come out from Table 1. As a matter of fact, Belgium does appear to have a high-skilled labour force, with a high proportion of workers with a university degree. As far as the 3 % objective is concerned, estimations are that Belgium needs to bring an additional 11,150 researchers (in full-time equivalents) to the R&D sector between 2002 and 2010. Among those, approximately 6,140 will have to enter the business sector. Thus the recruitment of those researchers is but one of the many problems to be tackled. Another one concerns the frequent mismatch between expectations of firms and the training received by students. Therefore, as firms can't find the particular skilled workers in Belgium, fitting their R&D plans, they might be forced either to move their R&D facilities abroad or find this labour force in foreign countries. Belgium, on that level, displays one of the highest percentage of foreign PhD students (36.1 %) among OECD countries. Some shortages also are likely to appear, as e.g. in engineering the number of graduates has significantly dropped over the last ten years (Table 2). It also appears that Belgium has a low female participation rate (and for all human resources indicators too). Activating more female participation in research might hence well be one of the most direct ways of achieving the 3 % objective at the level of human resources. At the same time, it should be noted that research and research careers appear ill-perceived in some areas. This is to be considered in relation with the often proclaimed loss of interest for sciences among the young students.

Table 2 Shares and evolution of scientific graduates in Belgium – 1995-2003

Number of new graduates by field of science in Belgium	Graduates - share in 2003	Graduates - annual average growth 1995-2003
Natural sciences	8,7	2,9
Engineering	7,3	– 2,6
Medical sciences	19,8	2,6
Agricultural sciences	3,8	1,0
Social sciences	46,3	1,7
Humanities	14,1	**4,6**
Total number 16,694	**100,0**	**1,9**

Sources: Vlaams Min. van Onderwijs, 1996, 2004; CReF, 1996, 2004.
Belgian Science Policy calculations.

Looking at policies...

Belgium shows a unique feature amongst all EU Member States, namely that it is the only country where Science, Technology and Innovation policies are completely decentralized across several governments enjoying full autonomy of decision power in such matters. This decentralized structure holds both promises and threats. Thus while decentralization allows for more direct policy interest, flexibility and support, it also is likely to lead to **a fragmentation of STI policy governance across the various governing entities**. Though some co-operation mechanisms exist to favour linkages between the areas of action of autonomous governments across the country, in practice these are quite limited as regards core areas of the STI policy, such as industry-science links, establishment of technology centres, provision of innovation support structures, etc. There is a tendency to accentuate the delimitation of competencies rather than the creation of nation-wide synergies or shared initiatives. From an industry point of view, the presence of different schemes and rules in the different Communities and Regions in Belgium increases significantly the efforts required by firms, often active across regions, to access knowledge and the support of relevant policies.

The federal organization of Belgium allows each Region and Community to take decisions according to its own specific challenges. This is well in line with the specificity of each regional innovation system. It helps fine-tuning policy instruments to real needs and to pursue voluntaristic objectives with a greater degree of social consensus. However, this organization is much less suited to deal with activities and spillover effects that span across borders. Moreover, the separations between the Federal

State's responsibilities with respect to tax advantages to R&D, the Community responsibilities with respect to the funding of academic research and higher education and the Regions' responsibilities for technology and innovation in the productive sector are likely to constitute **difficulties for the development of "bridging" policies**: policies falling in between the responsibilities of the different entities. Such "bridging policies" are precisely the most needed ones, in a system of innovation's perspective, such as the one depicted in the above sections. The institutional structure for STI policy can also be judged at odds with the industrial structure, as it does not lead to the natural promotion of linkages across regional borders, while this would sound obvious to businessmen. For example, the promotion of technological clusters in the two main regions does not take into account the tendency of businesses to deal with partners from other regions. Another example is the difficulty to build a balance in the portfolio of instruments in support for RTD since fiscal incentives for RTD are a responsibility of the federal level, while subsidies and loans are a regional responsibility.

The different entities are also at play when it comes to fostering research careers. Communities, Regions and the Federal State can all intervene to make careers more attractive or increase the mobility of researchers. The same applies for policies aimed at reducing brain drain or policies directed towards brain gain attempting to (re-)attract researchers who left the country. Communities can play a role in developing research careers and training courses in high schools or universities. Intersectoral or intrasectoral mobility can be addressed by the Federal State and Regions too, through general or more elaborate programs. And since applied and basic research are often not that easy to separate, the interconnections between the two call for some coordination at higher levels.

The fragmentation of policy responsibilities has not only to do with the specific Belgian institutional context. Like in many other countries, the separation between generic policies aimed at improving the environment in which businesses operate and more specific, technology focused development policies, results in a fragmented support system, in which broad macro- and micro-economic policies (e.g. competition policy) do not pay particular attention to the conditions for innovation, while the more specific STI policies tend to ignore business dynamics outside of their relationship with science and technology development. As innovation does not only call for technological competencies, but also for managerial and organizational ones, the range of policy instruments should go well beyond the traditional STI toolkit.

From this perspective, **STI policy-making in Belgium is likely to suffer from a double fragmentation**: institutional fragmentation and fragmentation between traditional policy intervention fields. This poses a particular challenge since the weakness in the Belgian Innovation System lies precisely in its capacity, or rather the lack thereof, to ensure flows and linkages between its various parts.

Conclusions on the Belgian National Innovation System...

Overall, the most significant aspects of the Belgian NIS can be summarized as follows:

1. In terms of RTD inputs, Belgium can rely on a highly educated labour force. The availability of human resources seems appropriate, even though some mismatches occur in the short and medium term for specific research fields important for R&D. From a somewhat longer perspective, i.e. beyond 2015 when the retirement of large numbers of "research baby boomers" will take place, the question must be raised whether shortages in highly qualified R&D personnel will not start to take their toll on Belgium's innovation system.
2. There are major efforts needed in making the career of academic researcher less precarious and more attractive: in particular to women and to young researchers giving them more prospects for long term career prospects. Mobility between R&D institutions, public or private, is hampered by the lack of career prospects and opportunities. Furthermore the career life cycle of the large amount of research baby boomers has hampered the career opportunities of more recent cohorts of researchers.
3. Scientific output production appears good, but is increasingly threatened by low public R&D expenditures[21]. There is a significant under-funding of university and public research more generally. While this weakness is currently being addressed by increases in public R&D expenses, there is a need for a stronger commitment.
4. There are major bottlenecks in the use of knowledge in the private sector, due to various mismatches: between areas of scientific excellence and economic specialization; in innovative performance, often stronger in the medium to low-tech sectors, and between foreign-linked large firms and domestic SMEs. Other areas of concern relate to the uneven presence of entrepreneurial, strategic and commercial skills, in order to turn new knowledge into commercial opportunities.
5. The dual problem of low wages for researchers and high R&D labour costs for employers represents a time bomb under Belgium's innovation system. It undermines the career attractiveness of research, reinforces the brain drain, and is likely in the long term to lead to major shortages in research human capital; at the same time the high labour costs are likely to further induce the large R&D intensive firms to offshore or relocate their R&D activities to other countries.
6. Belgium's good performance in terms of labour productivity is not related to a strong RTD position in high tech sectors. Productivity gains appear more related to so-called imitation strategies (Sapir et al., 2003) than to industrial renewal. The country does not have a competitive advantage in high- and medium-tech industrial sectors. The situation with regard to high-tech services is better.

[21] If defense-related public R&D expenses are excluded from the comparison, Belgium shows a better, though still average, position on this variable.

7. Finance for innovation seems at first to be less problematic than in other EU countries, though Belgium remains far from the leading countries. Some failures and bottlenecks do appear[22]. The rise in venture capital in recent years is mainly due to management buyouts and to non high-tech expansion/development funds[23]. The structure of venture capital is highly changing from year to year and average figures do hide this lack of stability, which should be remedied.
8. At the institutional level, STI policy is more fragmented in Belgium than in other countries, posing specific challenges when trying to improve the dynamics and in particular the linkages and synergies between the various components of the innovation system.
9. Lack of relevant data on several key aspects (i.e. incidence of policies, vintage charts, relations between the needed knowledge for subsidized research programs and the knowledge taught in universities, relation between basic research and new industrial activities) of the Belgian NIS is not without consequence on the assessment one can make of it. Key aspects of the NIS are insufficiently documented.

Overall, it could be argued that **the Belgian national innovation system is characterized by 'atomization'.** Weaknesses of knowledge flows between the public science sector and businesses, moderate degrees of co-operation amongst businesses, insufficient integration of foreign subsidiaries into the domestic innovation system (with the danger of repatriation of R&D benefits out of the country), spatial concentrations with limited diffusion effects, fragmentation of STI policy setting, are all points of attention.

The above diagnosis points to the urgency of the problems with which the Belgian innovation system is being confronted. Rather than addressing ways and means to achieve the 3 % Barcelona target, there is currently a more immediate need to address the many systemic failures in the Belgian NIS, which are likely to reduce in the years to come not just R&D efforts, but also the overall innovative performance of the Belgian economy. There is in other words, a dramatic need to increase the priority for Science, Technology and Innovation in Belgium, both within the public debate on the need for more public resources to be devoted to knowledge investments –the 1 % public target– and for novel fiscal budget allocations to research in the private sector. Public efforts in RDT have been lagging behind for a long time, and the catching-up process has barely started. It means that Belgium will increasingly have difficulties to compete with other regions where a stronger support in developing large public-private interactions is present. At the same time, Belgium faces a structural disconnect between its science and technology activities and its economic fabric, which calls not just for more funds but also for a set of more specific policies addressing such major "connection" failures.

[22] Private equity investments represent only 0.114 % of GDP in Belgium in 2003. Belgium lags behind most European countries with respect to this indicator (Netherlands 0.241, EU-15 0.288, Finland 0.307, Sweden 0.380, UK 0.852...).

[23] Seed, start-up and expansion investments declined in 2003. Parallel to this, a noticeable decrease can be seen in high-tech investments (from 35.7 % in 2002 to 16.3 % of a smaller total amount in 2003).

Chapter 4
Recommendations

Time for action…

On the basis of the diagnosis presented above, the HLG3 % draws a number of what it considers to be essential recommendations. These recommendations are made in the spirit of the creation of the HLG3 % last year to involve fully all relevant research actors in Belgium, beyond institutional considerations. This being said, the task of the HLG3 % is clearly not to substitute for existing decision and advising councils, but rather to carry out an in-depth strategic reflection going beyond existing institutional borders, respecting the allocations of competences across Belgian entities.

Furthermore, we do not wish to provide here a long extended list of recommendations, neither do we wish to discuss here the specific implementation details of what we propose. The devil is undoubtedly in the detail, but it will be up to the appropriate policy-making bodies to work out the specifics of what we propose. Our role is first and foremost one of a strategic think-thank, recommending some crucial areas for urgent policy action in the area of science, technology, innovation and knowledge diffusion.

The urgency of the problems which confront the Belgian research and innovation system are, in the view of the HLG3 %, still insufficiently recognized. In the increasingly international competitive framework of the 21st Century, maintaining and where possible strengthening the welfare basis of the Belgian economy will crucially depend on improving the conditions for investment in knowledge-based activities. Those conditions depend heavily on the willingness of policy makers to grant knowledge activities in the broadest sense of the term, including knowledge creation, development and adaptation and diffusion, full priority. The diagnosis presented above suggests that granting that priority is more needed than ever. The Belgian economy has some specific structural weaknesses which put it at risks of falling behind in the decennia to come in the knowledge based economy. Today, it is no longer time for talking but for action.

Six major areas of urgent policy action for the Belgian Innovation System…

Two keywords characterise the recommendations proposed by the HLG3 %: **attractiveness** and **synergies**, to be found in the National Innovation System. The work of the HLG3 % has crystallised in six major areas of urgent policy action.

First and foremost, there is a need for a **major public funding injection in Belgium's public research infrastructure**. That infrastructure which has traditionally represented one of the core comparative strengths of Belgian society is, after years of being under-funded, in danger of loosing its attractor's role with respect to both domestic and international private knowledge investments. Reinforcing governments' credits for R&D should be a priority.

Second, there is a need to improve radically the **financial conditions for private R&D investments**. The analysis of labour costs in R&D presented in the previous section indicated the major discrepancy between the net income earned by researchers and the gross labour costs for R&D personnel incurred by firms in Belgium. This discrepancy undermines Belgium's long standing competitive advantage in business R&D intensive activities. If it is not addressed as a matter of urgency, the whole Belgian Innovation System will be severely weakened even be put in jeopardy. The challenges are multiple: attracting new R&D investors in the country, promote further investments from existing R&D-active firms, induce companies not yet involved in R&D activities to follow this route. Public authorities have some levers at their disposal to support these goals: through notably fiscal incentives, they can act on research costs, of which the main components are salary costs.

Third, given Belgium's international competitive strength in low to medium high-tech products and sectors, there is a particular need to ensure that the high-tech sectors often dominated by foreign multinationals do not remain islands of research and technological expertise but are rather sources for **innovation and knowledge diffusion**.

Fourth, there is a need to **reinforce Belgian attractiveness for knowledge workers**, as an utmost priority. One key aspect of this challenge lies in the poor career opportunities of researchers and more generally speaking, high-skilled technology talent in Belgium. How to shift the current brain drain into a brain gain trend is the major policy challenge. Facilitating mobility, be it inter-sectoral (between public and private) or international, is also part of the issue. There is a need to broaden the possibilities so that the creativity potential is released and founds its way in commercialisation of research results.

Fifth, the institutional complexity and fragmentation of Belgian's national system of innovation call for a major policy initiative in this area, which we like to refer to as creating something like a ***Belgian research area*** in aims and purpose inspired by the European research area and fully integrated into it. This should be done in full respect of the competences of the various Belgian entities, but needs to start from the recognition that there is a need to **search for synergies in this STI policy area**. There is a need to "de-fragment" policies at multiple levels: to define a long term coherent strategy, to develop the image of Belgium and its regions as hot spots for R&D, to reinforce research efficiency, improve bridges and mobility between private and public sectors, etc. Each policy move needs to be considered with a view to its impact on the broader innovation system. This search for synergy and "de-fragmentation" can best be done using the "concertation-overleg" method.

Sixth, there is a need to reinforce Belgium's attractiveness for R&D thanks to a **legal and regulatory framework** which is best adapted to innovation. This framework needs to be revised in the light of innovation imperatives, in order to alleviate useless or ineffective barriers and facilitate the conduct of R&D activities, and support the growth of innovative activities and firms. A coherent and adapted framework has a strong impact on the image and visibility of a territory for R&D investors and innovative entrepreneurs.

We now turn to each of these areas in more detail.

4.1. Investing in public R&D infrastructure

The available figures on current investment in the government and higher education research infrastructure in Belgium compared to the amount of money spent by the private sector in business research and development reveal a clear, but striking pattern. Belgium is currently near the bottom in Europe in the relative amounts of money (% of total GERD), it invests in government and higher education research.

Furthermore, the trend of Belgian R&D investments in the higher education sector declined over the last twenty years: this contrasts with other European countries which have made the public strengthening of university research infrastructure an absolute priority. Outside of the EU, the Canadian example is probably most illustrative here. In the mid 90's, after a major crisis in Canada's long term growth performance and a long-term decline in government investment in university research, the government decided to allocate "unused" expenditures at the end of each fiscal year to a newly established Canadian Foundation for Innovation. That Foundation has invested heavily in strengthening Canada's scientific university research infrastructure over the last ten years: currently a total volume of some € 2 billions.

In comparative terms, it would imply that Belgium would need to invest an additional amount of some € 600 millions in its scientific university research infrastructure over the next ten years. Creating such a capital fund for investment in public higher education research infrastructure leaving out the specifics of size and funding implementation, is probably the best guarantee to secure Belgium's long term knowledge future. The creation of such a fund might be compared with a "*Goudfonds*", more valuable and ultimately more likely to provide long term growth enhancing returns than the "*Zilverfonds*"[24].

R1 - Strengthening Belgium's scientific research infrastructure

The HLG recommends the creation of a Belgian research infrastructure capital fund. There is an urgent need for more active investment in our future based on the strengthening of the current research infrastructure, the best guarantee as to preserving our long term future welfare, competitiveness and access to knowledge. In times of tight budgetary constraints, this involves voluntary choices from our governments, to shift resources from other areas, where investments are perhaps more visible, but which are not sufficient to address long term needs to invest in knowledge.

The crucial importance of sufficient funding for fundamental research is not just acknowledged by the public research actors, but also by private companies, who in the more mobile international knowledge environment of the 21st Century are looking for long-term access to fundamental research and human capital.

It is important to realize from this perspective that companies are connected to fundamental research through several mechanisms, notably:

- Specific research programmes which are also open to industry;
- The provision of mechanisms through which the business world can express its needs in terms of fundamental research;
- The establishment of meeting places for researchers from companies and from public research institutions.

A lot of such mechanisms exist in Regions, Communities and at federal level, but they need to be mapped, possible synergies need to become more visible and the way they operate need to become subject to evaluation[25]. We turn to this issue below under 4.5.

In general, there must be a concern in improving access to research infrastructure (both for public and private researchers) and in applying mechanisms to evaluate the need and optimal use of this infrastructure.

[24] For correctness, it should of course be pointed out that the current "Zilverfonds" is less of a capital fund but rather a method of redirecting interest payments on government bonds rendered superfluous through further reductions in public debt towards payments for ageing

[25] We also insist that lessons should be learned here from mistakes in the past as in the case of the relatively fragmented materials technology research infrastructure.

4.2. Strengthening the financial incentives for private R&D investments

The idea here is to investigate the means and amounts of fiscal incentives aimed at providing a leverage effect on private R&D investments. The aim is to reinforce the competitiveness of R&D-active enterprises located (or to be located) in Belgium, through an improved attractiveness of investment conditions. Such an objective is also in line with the more general goal of the federal government, to foster the creation of high-quality jobs in Belgium. While it cannot be guaranteed that more R&D investments will necessary lead to successful innovation and new jobs, the view of the HLG3 % is that facilitating R&D investments through fiscal incentives is an essential "enabling" factor.

One key element here is to act on the salary costs for doing research in Belgium. To this end, the federal government can use to a much greater extent the fiscal incentives instrument. The HLG3 % proposes that the government makes extensive use of this instrument with a view to improve significantly the conditions for doing R&D in Belgium, in dialogue with the main research stakeholders. The differing conditions of large enterprises, SMEs and Spin-off companies need to be taken into account in this process. The argument holds obviously also for public research institutes.

R2 - Higher and more efficient tax incentives for R&D investments and employment

Fiscal incentives exist to support both capital investments in R&D and the hiring of R&D personnel in companies. The existing mechanisms should be maintained, but they also need to be adapted and reinforced in several respects. At the same time there is a need for the simplification of fiscal measures for R&D.

Fiscal incentives for capital investments in R&D are a particular useful policy tool in the area of R&D investments. They do not suffer from too much discretionary political power through e.g. the direct subsidy of particular R&D programs or pro-jects, at the same time they are not so generic, such as in the case of reductions in the level of enterprise profit taxation, that the costs become prohibitive. At the same time, they address the activity within enterprises, which is subject most directly to spill-overs and knowledge leakages, hence most likely to be subject to a tendency towards under-investment. Finally, the ease with which fiscal incentives can be implemented in a simplified manner, imply that such policies are likely to suffer least from various forms of implementation failures.

Fiscal measures should work on three levels: A. encouragement of R&D investments by offering a competitive tax deductibility; B. facilitating the hiring of additional researchers; C. reducing the biggest competitive hurdle, i.e. total salary cost of research departments vis-à-vis neighbouring countries.

The HLG3 % therefore proposes the following:

A ***With regard to R&D investments***

- Extend the coverage of existing measures both in the private and public sector;
- Heighten the rate of deduction to 25 %, to put this in line with the situation of the most attractive EU Members States;
- For SMEs in particular, envisage the possibility to convert the investment deduction in reimbursable tax credit, and for sub-contracted R&D expenses too;
- The same fiscal measures/incentives as developed for R&D investments should hold for patents. As well, the possibility for business companies to transfer the ownership of patents to institutions of higher education and research should also be examined (with an ad hoc tax exemption).

B ***With regard to the hiring of R&D personnel***

The so-called "Article 67 - Tax exemption for additional R&D personnel" ensures that taxable benefits will be diminished by a fixed amount for the hiring year and raised by that amount when the worker quits the firm or is no longer employed as a researcher. While this measure is well in line with the need to lower research costs in the private sector, it has not received an adequate attention by companies because of internal weaknesses. There is a need to make this measure administratively simpler and easier, through ensuring:

- less constraints on eligibility conditions for highly qualified researchers such as PhDs as well as for all R&D personnel;
- a period after which the company does not need to reimburse the amount;
- a general simplification of the administrative procedures could add to the success of this measure.

C ***Total salary cost of research departments***

Finally, the fiscal instrument allows the federal government to act on research costs in the private sector, by allowing deductions in withholding taxes (which are responsible for the large discrepancy between net and gross salaries as depicted earlier in this report) in the same manner as it has been adopted for researchers in public institutions. Simulations involving budgetary implications and possibly a variety of scenarios would need to be carried out in order to determine the optimal application of the measure. The HLEG 3 % recommends a progressive implementation of such a measure, whereby care should be taken to define precisely the categories of personnel concerned and to keep a good balance between such categories in the public and private sectors[26].

[26] We do not want to enter the specific details here of such a measure but one line of thinking could be to extend the current deduction of the withholding tax of 50 % to all research staff working in R&D departments, based on either collaboration with universities or based on the percentage of R&D staff in the organisation, or based on the percentage of company turnover invested in R&D. These qualifying parameters are easy to calculate, easy to control within the budget and simple administratively.

R3 - Allowing a partial exemption of withholding tax for R&D personnel in enterprises

It would be appropriate to progressively extend to private-sector R&D employees, the measure of reduction of withholding tax that has been adopted for higher education (universities and high schools) and public sector research institutions[27].

By emphasizing the need for and the particular role of such fiscal and para-fiscal measures, the Group wishes to emphasize that the proposed set of enlarged and new fiscal measures should not be considered as undermining in any sense the general notions of solidarity behind national taxation. Rather the Group is arguing that in order to maintain long term solidarity and tax incomes, it is essential to create today the appropriate fiscal climate for those knowledge investments such as R&D activities, which are essential to our long term competitive future.

It will of course be important that all new or modified fiscal and para-fiscal measures in support of RDT in both the private and public sector are subject to evaluations and that the results of such evaluations are systematically used to fine-tune the instrument over time.

4.3 Strengthening the diffusion of knowledge

As argued in the diagnosis, a central problem the Belgian economy is the growing divide between an emerging core of high-tech activities and the broader pattern of export specialisation in medium and low tech industrial activities. This divide calls for a set of policies aimed at the diffusion of knowledge between these two sectors. A number of policy measures seem needed here.

First and foremost, there is the **issue of funding new innovative ventures**. The venture capital and private equity pipeline is a complex supply chain involving multiple types of players: institutional funding bodies, both local and foreign, venture capital and private equity funds and finally the SMEs. The shortage of capital witnessed at the SME-end of this pipeline is the result of multiple upstream issues in this chain. Both the federal and regional governments need to develop a long-term view on the entire venture capital and private equity chain.

[27] This measure actually concerns the category of researcher-assistants in higher education and research institutions and certainly calls for enlargement.

R4 - Putting more priority to funding mechanisms for new innovative ventures

Several mechanisms do exist at various institutional levels to incite patient money to be directed to innovative starters. These need to be given more financial resources, and incentives should be put in place so that all promising ventures can find matching capital. "Early venture capital" needs a specific attention. Tax incentives, appropriate status, and a simplified administrative framework are also important to reach such an objective.

For starters, the capital available to local venture capital and private equity funds from local institutional funding bodies will need to increase by a factor 3 to 4 over the coming years, to even remotely reach the European average. In this perspective the 'Arkimedes'-rule of the Flemish Government as well as the efforts to reinforce risk capital activities in 'Wallonia invests' will probably be helpful. The Federal Government could think of a similar rule or a major clean-up of the legislation of the Private Privak, or the introduction of a local variant of a Prudent Man Rule to incite institutional investors to allocate a bigger slice of their assets to local VC-funds.

At the level of the funds, policy makers should recognize and institutionalize the valuable role played by venture capitalists and private equity operators. Tax incentives and a new transparent VAT status will need to be available to all sector players.

At the level of the entrepreneurs and their companies a long-term strategy is needed, aiming to strengthen the intellectual capital of our future start-up companies. We need more incentives both to industry and the universities and research centres to spin-off valuable chunks of IP. Equally the mechanism of VAT co-contractor (as in construction sector) could be made available to young SMEs until these are profitable.

R5 - Develop a Young and Innovative Company Status (YIC)

There is no specific status in Belgium, to account for the specific situation of young innovative companies. This could provide a good incentive to help such companies to move from the situation of young start-up towards permanent R&D-intensive innovative actor.

The benefits attached to such a status could be very diverse. We could have fiscal incentives (or rather social security incentives) as well as a public recognition of the value added of such firms. On the fiscal level, one could for example envisage the following:

- Exemption from social charges for all employees involved in R&D projects for a number of years. Indeed, since such companies do rarely make profits for a number of years, the social security taxes are probably the most relevant levers to act on;

- Exemption from corporate taxation for a number of years;
- Income tax exemption for the first three profitable years and 50 % relief for the following two years up to €100,000 (for example)

An example to learn from is the status of YIC in France, where an SME (Small and Medium-size Enterprise) that spends at least 15 per cent of its expenditures on R&D, and is less than 15 years old is categorized as a YIC.

Second, there is a need **for broad diffusion-oriented policy actions** addressing the gap between publicly supported "excellence" research and the uptake of new technologies in SMEs. SMEs are an important source of flexibility in European and in particular Belgian supply and value chains - absorbing cost pressures, re-organising work processes, and introducing new technologies more rapidly than large firms could do on their own. The vast majority of SMEs do, however, not engage in research in a formal sense. By contrast, the vast majority of SMEs do innovate. They improve their existing products and services, usually in small step-by-step ways. More rarely, they take a major risk and introduce new products and services.

As discussed in the diagnosis section, an appropriate institutional framework to help and assist SMEs in their innovation trajectory, consists of some sort of industry board. In Belgium the so-called collective RTD centers, established in the 50s, come close to such form of institutional need: the collective research institutes in Belgium cover indeed mostly the so called mid-tech en low-tech sectors (construction, metal-assembly, wood, textile, etc...), which happen to be the sectors in which Belgium has a strong competitive strength and which belong to the best innovation performers in Europe. Over time, they have evolved to cover new technologies across the whole industry.

The strong points of these collective RTD-institutes are:

- They are very close to their members (SME's) on a nearly day to day basis;
- The RTD activities are often defined in a bottom-up approach, by the sector itself (represented in technical committees for each sub-sector of the industry);
- The financing and steering occurs through the member companies (e.g. 70 000 SME's from the construction sector are member of BBRI, Belgian Building Research Institute);
- There is often good collaboration with other centers of knowledge (universities, other scientific research institutes at both national and international level);
- There is a strong focus on the diffusion of knowledge and pro-active stimulation of innovation through internet web-sites, publications, seminars, Technological Assistance;
- And finally there is often close integration of the complete knowledge-chain in one institute.

However, these centres are also faced with a number of challenges, notably: the need to broaden their client base in order to reach new companies, the reinforcement of a user-driven management, and the development of stronger linkages with other centers (collective research centers, other research centers and university laboratories). On the latter point, there is a need in all Belgian regions, and from a country-wide perspective, to organize better synergies with these centers and others more recent centers, such as the "excellence centers" in Wallonia and IMEC or VIB in Flanders. All centers located on the Belgian territory constitute a very rich environment for companies, which need to be able to access their knowledge independently of their institutional position or origin.

There is an urgent need to both strengthen the operation of those research centres and to create new financial methods linking the scientific research infrastructure closer to such sectoral collective research institutes. The "technological attraction poles" is an example of such attempt, and there is certainly a need to draw conclusions on the working of this instrument and for more ideas in this vein. Competence centers, gathering companies as well as public research institutes are becoming widespread in several countries and should be studied for their relevance to the Belgian context. Some novel ideas are being launched in various countries in Europe aimed at improving such linkages. One may think here of the recent policy introduced in The Netherlands with respect to the granting of so-called "Innovation Vouchers" or cheques to SMEs which can then be "cashed in" in the form of specific technology support and advice from such collective research institutes. At the same time one might also think of ways to assist SMEs in their participation in international, cross-European Technology Platforms.

R6 - Strengthening the research infrastructure through additional and new tools to link research, technology, development and innovation

All types of research centers should be encouraged to establish more public-private partnerships. Funding needs to be performance-based, with due consideration of the specific mission of research centers; these may vary according to the sectors and technologies they cover. Furthermore one may consider introducing new additional funding methods such as "innovation cheques".

4.4. Foster attractiveness of R&D for Human Resources

Research careers in the public sector need to become more attractive and lead to more permanent research positions if Belgium wants to meet its challenge of becoming a well-functioning knowledge-based economy. If this were not the case, efforts in other parts of the system would become hampered by a deficit in adequate human resources. Numerous issues are at stake here, pertaining to career, training, and financing of public researchers. The reinforcement of fundamental research also plays an important role towards this objective, in giving a more stable framework for conducting research in the public sector.

R7 - Develop and foster the research status and career in a European perspective

There is an urgent need to restore the image of the researchers through career plans, mobility incentives, better status for researchers, career perspectives, social security plans. The overall goal should be to put the conditions for inducing better creativity and developing a risk-taking behaviour.
The researcher status needs to be reformed taking into account the European dimension. The European Charter for Researcher needs to be signed as soon as possible and implemented a.o. by all the funding agencies (FWO, FNRS...).

Research attractiveness is supported by the possibility for researchers to obtain a clear vision on possible scientific trajectories and careers. Possibilities and opportunities need to be presented and made accessible. To this end, a Development Plan for each researcher needs to be spelled out, on the basis of a deep reflection on career trajectory. This needs to be carried out in the form of a dialogue, and be formalised in a fiche mentioning the rights of all parties. This fiche would then be included in research projects financed by the federal authority and added to the documents requested for funding. All this needs to be integrated into the human resources management procedures in the research institutions. An "R&D guarantee Fund" could also be used, so as to ensure continuity in financing for researchers under contracts.

The European Charter for Researchers, as well as the code of conduct for recruitment procedures, needs to be signed by the Minister. The Minister would also need to ensure that his colleagues in other Members States sign the charter too. It would then be necessary to integrate the recommendations from this Charter into Belgian law (and in structures and mentalities).

Moreover several directions for **career plans** could also be taken, examples follow:

- Break down barriers between public and private spheres, and between national and international environment;

- Ensure more flexibility and mobility for R&D workers;
- Foster Gender mainstreaming;
- Reduce pressure on researchers to allow their creativity to flourish;
- Give more recognition to PhD, both financially and in terms of research environment (acknowledge their value added, especially in public sector jobs, including in research administration jobs);
- Ensure pension rights and financial recognition;
- Develop the concept of collective insurance in research contracts, for Belgian and foreign researchers as well;
- Ensure the portability of rights across countries (notably pension rights);
- Guarantee the recognition of years in service for researchers moving between public and private sectors.

Efforts should also be paid in terms of researchers **training,** for example:
- Research projects and programmes involving public and private partners in long term perspective and on equal footing (with a specific focus on SMEs) ;
- Possibility for young researchers (from scientific institutions and higher and research organizations) to get involved in pedagogical responsibilities, in order to broaden the options and available knowledge bases for students;
- Innovation training: confront researchers and students to innovation and entrepreneurship.

R8 - From brain drain to brain gain: A Belgian chairs programme

The lack of career perspectives in Belgian academic or public research is forcing a large number of young as well as internationally recognized Belgian researchers to pursue their careers abroad. While part of a natural international mobility trend and an illustration of Belgium's excellence in university education, this phenomenon is also an illustration of the lack of career perspectives and of the low net wages in Belgium in public research institutions. There is an urgent need to broaden policy measures aimed at actively attracting foreigners and Belgian expatriates to Belgian research establishments. Given their quality and international reputation this should be no problem if an appropriate funding mechanism can be found. It is therefore proposed to establish a Belgian chair programme, similar in structure to the Canadian chair programme. Compared to the Canadian initiative this would imply the creation of some 500 chairs over the next ten years.

With this recommendation, the HLEG proposes:

- A total budget for a Belgian Chairs programme of 150 Mio € over 10 years. This federal action should be complementary to similar programmes financed by the Regions and by private money;
- A doubling of current grant programmes;
- Opening all sources of funding to researchers from all geographic areas ;
- Extending the experience from the Florence European Institute to other institutes (through co-financing for example);
- To open new PhD financing sources (pre and post docs), as well as for established researchers;
- To generalise the formula of "sending grants" to ensure that Belgian researchers acquire top competences in other countries, and is further incited to come back to Belgium with good perspectives of stability;
- To extend this measure for post-docs in order to nurture their high degree of qualification;
- To raise the funding sources for pre- and post-docs stays.

In addition, funding sources could be established in order to support acquaintance with R&D (in administration scientific establishments, etc.) for students in higher education. Fiscal incentives could be put in place to this end.

4.5. The search for better synergies in R&D and R&D policy systems

A core recommendation from the HLEG, concerns the need for R&D policies in Belgium, to be conceived and implemented in a more systemic perspective, so that they are better able to respond to the challenges identified for the Belgian Innovation System. Two lines should be followed here:

1. the opening up of programmes across Belgium: in line with the ERA perspective, everywhere in Europe, policy-makers are trying to modify their programmes in order to make them accessible for EU participants. This has been done, notably, with the federal research programmes, in which a part is earmarked for foreign participants. However, it is for example impossible for a company from one region to be financed for a research project by another region. This stands in contrast with the natural playing field of companies, which extends well beyond the regional borders;
2. the search for synergies between policies of the various Belgian entities: there is a need for improvement of the coordination mechanisms between the various governmental bodies, ministries and agencies, dealing with various aspects of the Belgian Innovation System; and for new strategies to foster synergies between all instruments put in place by the various Belgian policy-makers, looking beyond

the institutional borders. This relates primarily to science, research and technology policies, but extends also to areas of economic policy. The conformity to the subsidiarity principle, and the respect of areas of competences as defined by the law, must obviously form the starting point of these efforts.

R9 - Towards a "Belgian Research Area": reinforce political and strategic "concertation-overleg" in R&D policy

The HLG3 % recommends reinforcing "concertation-overleg" mechanisms between the various entities in charge of STI matters. This is necessary for the development of a shared vision of objectives to which all the policies need to contribute, in a coherent fashion, respecting the definition of STI competence fields across all jurisdictions, as defined by the law.
This "concertation-overleg" needs to be supported by analyses and tools, and also evaluation practices, that cross over institutional frontiers. The HLG3 % recommends to foster mutual information, dialogue and coordinated actions, between R&D actors, and between the public sector entities across the whole country. The overall aim is to improve effectiveness, reap common benefits and access critical masses needed to compete on the global scale.

Along this path, there is a crucial need to obtain much better information of the effectiveness and efficiency of policies, individually and collectively (following a systemic approach). Evaluation of policies (and policy instruments), and benchmarking of policies in an international perspective are therefore absolutely crucial. Detailed indicators are needed to support these practices.

To reach this goal, the following more specific measures are being proposed:
- the establishment of a platform to allow the Regions, Communities and Federal Governments to focus more on the potential complementarities in STI policy (using CFS-Commission for Federal Cooperation and the various Councils);
- to organise regular joint meetings for the various advisory bodies for STI policy in Belgium;
- to optimise joint national procedures for the realisation of broad policy objectives (such as the 3 % norm or the Kyoto objectives);
- to improve the contacts between the various bodies in charge of the management of scientific research, technology and innovation, thus incorporating also economic departments of the various administrations;
- to upgrade "policy intelligence" by a periodic SWOT analysis of the Belgian National Innovation System, cutting across several competencies, a more widespread evaluation practice at all levels, incorporating cross-entities learning and an international benchmarking, participation to and exploitation of international

- learning platforms (OECD STI/TIP group, EU initiatives such as Trendchart or ERAWATCH);
- to promote S&T culture in society through more coordinated action and the search for synergies between actions carried out by Communities, Regions and the Federal state.

Though we must distinguish between a "concertation-overleg" at the institutional level and a "concertation-overleg" between R&D actors, these two types of "concertation-overleg" are complementary and intimately linked.

This search for collaboration and synergies can be achieved through various means. What follows is a non-exhaustive list of examples of areas where the HLG3 % suspects that there are lost opportunities because of fragmentation. They illustrate the general point and might serve as starting points for the enhanced "concertation-overleg". These are all areas where joint actions are possible for several authorities.

Support to academic spin-offs

- Establish open information systems on competencies of centers or institutes of higher education and research
- Broaden the interfaces contacts of institutes for higher education and research across regional borders

Cross-regional partnership

- Placement and mobility schemes allowing cross-regional activities
- Coordinated funding for fundamental and applied research in institutes for higher education and research, opening of programs to non regional participants
- Encourage collaborative R&D projects involving centers and institutes for higher education and research across the whole country, by drawing lessons from the IUAP or from the TAP program - Technology Attraction Poles, moreover the inclusion of business companies in research programs should be encouraged

Role of S&T intermediaries

- Investigate need and possibilities for inter-regional linkages between (networks of) intermediaries

Public-Private excellence centers

- Investigate need and possibilities for inter-regional linkages between excellence centers, allowing access/participation from companies from other regions, in view of reaching critical mass needed in the ERA
- Joint cross-regional participation in Technology Platforms at EU level

Innovation Clusters

- Investigate need and possibilities for inter-regional linkages and exchanges (cfr. informal exchange group Wallonia-Flanders on cluster policy)

Enhanced coherence of RDT aid support systems across Belgium

- Ensure easier access to aids systems for "multi-region" companies
- Introduce knowledge vouchers (valid across regions) to support more SME-driven research in research centers

Support to entrepreneurship and intrapreneurship

- Setting-up of an instrument to promote intrapreneurship across regional borders: exploiting innovative ideas coming out of companies

Improving international collaborations

- Install a joint lobbying system for Belgian partners to participate in international research programmes

4.6. Improving regulatory framework for research and innovation

Research, technological development and innovation activities, in public research centres, universities and companies, need a favourable regulatory context. This is a major factor of attractiveness for Belgium in a knowledge economy.

R10 - Improve regulatory framework and application of European rules

Research cannot flourish in a context of undue administrative and regulatory barriers. Many rules and regulations need to be improved with the view to encouraging, or at least not hindering R&D and innovation activities.
It is notably necessary to implement European rules into Belgian law, without delays, without over passing the minimum rules to be respected, and ensuring the highest juridical stability and security.

Even if this is indirectly related to R&D activities, simplification of procedures to obtain administrative documents, notably for foreign researchers, and for enterprises, would represent an important contribution to the situation of Belgium in R&D matters.

In addition to the speedy and well-thought implementation of European directives in Belgian Law, there is a need to support the creation of a European patent. In the meantime, as indicated above, an increased fiscal intervention for patenting activities would be welcome.

It goes beyond the task of the HLG3 % to review in detail the impact of various rules and regulations on R&D and innovation, and propose specific changes. But the HLG3 % wants to emphasize this need and recommends such critical examination by the concerned bodies.

Conclusions

The key message of the HLG3 % is that more priority should be given to Research, Technology and Innovation in policy, at all levels of government, in a more synergetic fashion, and with enhanced strategic intelligence. Weaknesses of knowledge flows between the public science sector and businesses, moderate degrees of co-operation amongst businesses, insufficient integration of foreign subsidiaries into the domestic innovation system, spatial concentrations with limited diffusion effects, fragmentation of STI policy settings – the list is non exhaustive – are all major points of concern.

Our diagnosis points to the urgency of the problems with which the Belgian innovation system is being confronted. Rather than addressing ways and means to achieve the 3 % Barcelona target, there is, in the Group's view, currently a more immediate need to address the many systemic failures in the Belgian NIS, which are likely to reduce in the years to come not just R&D efforts, but also the overall innovative performance of the Belgian economy.

First and foremost, there is a dramatic need to increase the priority for Science, Technology and Innovation in Belgium, both within the public debate on the need for more public resources to be devoted to knowledge investments – the 1 % public target – and for novel fiscal budget allocations to research in the private sector. Our first three recommendations address directly this need. Public efforts in RDT in Belgium have now been lagging behind for a long time, and the catching-up process has barely started. It means that Belgium will increasingly have difficulties to compete with other regions where a much stronger support in developing large public-private interactions is present.

There is, it should be remembered, a substantial room for manoeuvre in investing more public funds in research and innovation if Belgium wants to attain the 1 % public R&D target, the only target governments are directly responsible for. In essence that target – part of the Barcelona target and Lisbon strategy – conveys the message that highly developed countries such as Belgium, if they want to sustain their economic richness in the long term, will need to invest publicly at least 1 % of their domestic resources so as to create the optimal knowledge creation, knowledge attraction and knowledge diffusion conditions for private knowledge investments to flourish and contribute to maintain competitiveness. A quick back of the envelope calculation would indicate that there is scope for an ***additional*** packet of financial support measures such as fiscal incentives for investments in R&D, and new funding schemes, such as the creation of a "golden" innovation capital fund, of the order of some 200 to 250 Million € annually[28]. Our first sets of recommendations dealing with the need for a major public funding injection in Belgium's public research infrastructure and for a radically improvement in the financial conditions for private R&D investments are likely to involve a substantial part of these additional financial public means.

Within current budgetary constraints, this might well and inevitably mean the reorientation of other public expenditures towards such knowledge investment. But this has precisely been the choice made in Lisbon and subsequently translated in the Barcelona knowledge investment targets. The time has come to draw the consequences of that decision and ambition, even if this involves difficult choices particularly given the fact that such investments in research do not bear their fruits immediately and are not very visible. It is, however, the responsibility of policy-makers to make such difficult choices. The HLG3 % is convinced that there is no other option to secure our long term future. It is time to act now.

But second, and as our report makes painfully clear, spending more public money for R&D purposes is far from sufficient: much more crucial is the way this money is spent and will address the numerous weaknesses in the Belgian innovation system. Belgium's economy and international competitiveness is still characterized by the relative dominance of low to medium high-tech products and sectors. The high-tech sectors, often dominated by foreign multinationals, appear more like islands of research and technological expertise rather than being a source for continuous innovation and knowledge diffusion throughout the country. At the same time, the core competitive strength of the Belgian economy and more broadly Belgian society, its high quality university and higher education training system is in danger of remaining underexploited because of poor career opportunities of researchers and more generally speaking, high-skilled technology talent in Belgium.

Our third set of recommendations addressed all these questions. Proposals were made to better match the research in the public sector with the one executed in the

[28] For sake of comparison, the total amount of public R&D funding in both the public and higher education sector amounted in 2001 to some € 1.3 billions.

private sector. Innovative projects need to get more chances for an adequate financing from the private sector; and the creation of the status of a young innovative company (proposals are made) will assure these innovative projects a better support from the government with better growth prospects. In the second place ways should be found to enforce those mechanisms and institutions that act as a bridge between both sectors, e.g. the collective centers, the so-called "technological attraction projects" by means of new ideas and new instruments. One of these new ideas to be explored could be the "innovation cheques".

Right now, mobility goes only in one direction, away from the public sector to the private sector or even abroad. This is a thread to the long term viability of the public sector research. Careers in the public sector need to become more attractive through a number of qualitative and other measures. This is being addressed in our fourth set of recommendations. Inspiration was found in the European charter for researchers as well in the Canadian Chair program. With this program Canada developed a policy that goes much further then just trying to get the migrated researchers back home: excellence from all over the world is invited, making Canada a real international center for excellent research.

Last but not least the report favors the establishment of a true "Belgian research area". The European Commission promotes the establishment of a European research area aiming the opening-up of programs of different European countries for foreign researchers; or the collaboration between programs from different countries to offer a combined financing to excellent researchers, etc. This European research area should be an inspiration to Belgium as the same analysis can be made: research efforts should not be duplicated; world class research should be created by merging forces; companies are active on either side of the regional borders; etc.

In short the weaknesses are manifold. They concern: high labour costs of research, lack of diffusion of knowledge and weak industry-science linkages, under-funding of public research, deficits of innovation performance and in the framework conditions for innovation, human resources availability for research in the medium term and problems in the careers of researchers, the insufficient knowledge on the NIS itself, and last but not least the fragmentation of the policy setting.

Many of these "systemic failures" are partly addressed by the various Belgian relevant policy entities: fostering entrepreneurship, establishing excellence centres with critical masses, facilitating the attraction of public researchers, establishing intermediaries between science and technology providers and enterprises, sharing the financial risk of innovation, etc. Advisory Councils and various associations are also in place to advise the governments on what is needed in the STI policy area. What is missing, though, can be basically summarised as:

- A sense of urgency: Flanders, Wallonia, Brussels and the federal state have all endorsed the 3 % objective in their policy declarations. This is a good basis, but higher priority should be given to STI in all concrete governmental programmes across Belgium, within the STI area but also in economic policies and in the establishment of rules and administrative regulations;

- A willingness to look beyond institutional borders and to search for synergies and better coordination between the actions developed by various governments in Belgium, in order to avoid unnecessary overlaps and fill gaps, and to build up mutually reinforcing strategies.

The HLEG3 % has produced ten recommendations, designed to address the Belgian NIS failures and to reinforce its attractiveness. These range from an enhanced use of fiscal and para-fiscal tools to improve financial conditions for conducting R&D in Belgium; the reinforcement of public R&D infrastructure; greater efforts to meet the needs of new innovative ventures and to address the problems in research careers; more attention to the adaptation of the legal and regulatory framework for innovative activities; and a strong plea for more synergies and effectiveness in STI policy-making across institutional borders.

These recommendations, if taken up seriously by all the competent entities, and with the use of the excellence achieved in "concertation-overleg" practices, could well help Belgium to address the major challenge for its future.

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