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Peer Review of the Bulgarian Research and Innovation system

Horizon 2020 Policy Support Facility

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Contact (H2020 PSF peer review of Bulgaria):
Roman.ARJONA-GRACIA@ec.europa.eu
Diana.IVANOVA-VAN-BEERS@ec.europa.eu

Contact (H2020 PSF coordination team):
Roman.ARJONA-GRACIA@ec.europa.eu
Diana.SENCZYSZYN@ec.europa.eu

RTD-PUBLICATIONS@ec.europa.eu

European Commission
B-1049 Brussels

Peer Review of the Bulgarian Research and Innovation system

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Written by the independent panel of experts:

National Peers

Mateusz Gaczynski (Ministry of Science and Higher Education, Poland)
Clara E. Garcia (Ministry of Economy and Competitiveness, Spain)
Luisa Henriques (Foundation for Science and Technology, Portugal)
Armin Mahr (Federal Ministry of Science, Research and Economy, Austria)
Stojan Sorčan (Ministry of Education, Science and Sport, Slovenia)

Independent Experts

Luc Soete (Chair, Maastricht University, The Netherlands)
Lisa Cowey (Rapporteur, independent consultant, United Kingdom)
Liv Langfeldt (Expert for institution assessment and evaluation, Norway)
Conor O'Carroll (Expert for funding agencies, human resources and mobility, Ireland)
Steffen Preissler (Expert for innovative transfer systems, Germany)

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List of acronyms

AA	Agricultural Academy
BAS	Bulgarian Academy of Sciences
BESMEPA	Bulgarian Small and Medium Enterprises Promotion Agency
CoC	Centre of Competence
CoE	Centre of Excellence
CoM	Council of Ministers
CSG	Council for Smart Growth
EAFRD	European Agricultural Fund for Rural Development
ERAB	European Research Area Board
EC	European Commission
EHEA	European Higher Education Area
ERA	European Research Area
ESF	European Science Foundation
ESIF	European Structural and Investment Funds
EU	European Union
EUA	European University Association
FRINDOC	Framework For The Internationalisation Of Doctoral Education
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
HE	Higher Education
HEI	Higher Education Institute
HR	Human Resources
HRS4R	Human Resources in Research Award
HRST	Human Resources in Science and Technology
IPR	Intellectual Property Rights
IDTP	Innovative Doctoral Training Principles
ISSS/IS3/S3	Innovation Strategy for Smart Specialisation/ Smart Specialisation Strategy
KPI	Key Performance Indicator
MS	Member State
MSCF	Marie Skłodowska-Curie Fund
MoAF	Ministry of Agriculture and Food
MoE	Ministry of Economy
MoES	Ministry of Education and Science
MORE	Mobility Patterns and Career Paths of EU Researchers
NIF	National Innovation Fund
NIS	National Innovation System
NPOs	Non Profit Organisations
NSF	National Science Fund
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PoC	Proof of Concept
PRO	Public Research Organisation
PSF	Horizon 2020 Policy Support Facility
RIS3	R&I Strategy for Smart Specialisation (alternative for Smart Specialisation Strategy)
R&D	Research and Development
R&I/ RI	Research and Innovation
S&T	Science and Technology
S3	Smart Specialisation Strategy
SESG	Science and Education for Smart Growth
SMEs	Small and Medium Enterprises
TTO	Technology Transfer Office
TRL	Technology Readiness Level
WIPO	World Intellectual Property Organisation

POLICY MESSAGES

The PSF expert panel arrived at the following **ten Policy Messages**, each one supported by a number of detailed recommendations presented in the report of the PSF peer review panel. The present document explains the rationale supporting each of those ten policy statements.

1. Bulgaria has a historic opportunity to strengthen its economic potential by increasing science and innovation funding to at least 1% of GDP in 2020. Achieving sustainable impact from such increased funding will require major structural reforms of the research and innovation system to boost efficiency and quality. More and better funding will also need coordinated and effective planning and use of the European Structural Funds.

Bulgaria has to:

2. Establish long-lasting support for science and innovation investments and reforms by seeking broad political consensus in matters of science and innovation, and launch a structured, committed and sustained dialogue with the Bulgarian science and innovation community. This dialogue should lead to a 'National Science Agenda' capable of rebuilding trust in the system. The Council for Smart Growth is best placed to take leadership in this process.

3. Set up a professional, independent and robust national research agency to design and manage research and innovation funding programmes and support the successful implementation of the RI structural reforms package.

4. Improve the processes for the evaluation and funding of project proposals, and bring those processes to international standards.

5. Increasingly concentrate funding for institutions that perform research, so as to reward high performance.

6. Encourage the participation of Bulgarian scientists and innovation entrepreneurs in European programmes.

7. Take rapid action to rebuild incentives for research careers at all stages and to retain and attract young talent from Bulgaria and from abroad into science and innovation.

8. Incentivise the opening up of Bulgaria's science base to businesses and step up the schemes to support public-private cooperation.

9. Create the conditions for specific regional and local innovation ecosystems to develop in Bulgaria using the Sofia Tech Park as a strategic innovation testbed.

10. ще се върнем… (We'll be back...) The Bulgarian government should favour an assessment of the implementation of those recommendations within a three-year time span.

1. Bulgaria has a historic opportunity to strengthen its economic potential by increasing science and innovation funding to at least 1% of GDP in 2020. Achieving sustainable impact from such increased funding will require major structural reforms of the research and innovation system to boost efficiency and quality. More and better funding will also need coordinated and effective planning and use of the European Structural Funds

Historically heavily committed towards science and technology, Bulgaria's accession to the EU in 2007, at the eve of the global financial recession, restricted the economic (GDP contracted with more than 5% in 2009) and political room for manoeuvre of the country to support its socio-economic development through research and innovation, despite their critical role as sources of growth.

The first message from the panel is thus that for Bulgaria to recover from the crisis faster and to circumvent a vicious circle of declining public funds, lack of trust in the system and underuse of EU funding, the current low level in the public funding of research and innovation in Bulgaria is not sustainable. If not reversed, it might lead to a downward adjustment in the structure of the Bulgarian economy.

Nowadays, with the stable political and economic situation of Bulgaria, **the panel recommends that the government makes a renewed and realistic commitment to a significant increase in the public funding of R&D**. Bulgaria should move upwards in the R&D intensity rankings at least from the current level of 0.65% of GDP in 2013, one of the lowest in the EU, to 1% in 2020. This would bring the current national R&D intensity target of 1.5 to a more realistic and achievable one. **Public funding should play a decisive role in achieving this target**, well beyond the current public R&D intensity level of 0.24% of GDP.

However, for those **increased RI investments to be successful they must be accompanied by major structural reforms** to:

1. Improve the country's RI funding instruments, bring project evaluation practices to international standards, improve the management and governance of public organisations that perform research, as well as the functioning of national funding bodies, and link science funding closer to performance. These reforms are discussed in Chapter 2 of the report.

2. Strengthen the country's highly skilled and educated human resources in RI, address the issue of the very low salaries of PhD researchers, build critical mass in the public and private sector, support top research performing organisations in moving up the stairway to excellence, incentivise international and higher quality PhDs programmes and higher mobility of researchers, recruit and retain established and leading researchers and bring young talent into the system, and develop a supportive research environment and working culture. See Chapter 3 of the report.

3. Incentivise the opening up of Bulgaria's science base to businesses and step up the schemes to support public-private cooperation, and create the conditions for innovation ecosystems to emerge and develop. This entails efforts to encourage smart specialisation and support its priority areas, stimulate regional and local test-beds, foster entrepreneurship in organisations that do public research, nurture successful clusters, address research infrastructure gaps and leverage shared infrastructure capacity. These issues are discussed in Chapter 4 of the report.

Underpinning those structural reforms, there is a clear need for Bulgaria to ensure **effective synergies and planning, as well as efficient use, of all funding sources across Ministries and notably the EU structural and investment funds** in order to maximise impact from all available resources.

The implementation of these reforms requires political courage. The panel is convinced that within the current economic and political environment, those reforms have a real chance to be successfully implemented. The willingness of the Bulgarian authorities to request and support this first country PSF peer review is to some extent witness to this conviction.

2. Establish long-lasting support for science and innovation investments and reforms by seeking broad political consensus in matters of science and innovation, and launch of a structured, committed and sustained dialogue with the Bulgarian science and innovation community. This dialogue should lead to a 'National Science Agenda' capable of rebuilding trust in the system. The Council for Smart Growth is best placed to take leadership in this process

The public perception of the role of RI in Bulgaria is low. This appears in many ways a more general problem in many European countries. However, interesting examples exist in which **an all-party parliamentary consensus can be developed with both academia and business to secure widespread support for a major national effort on RI**. As a common vision is key, the PSF panel recommends authorities to launch a ***Bulgarian 'National Science Agenda'*** in collaboration with national and regional media, leading academic and business leaders, stakeholders and civil society.

The Council for Smart Growth was recently created (May 12th 2015) and is headed by the Prime Minister. In view of the panel, **the Council for Smart Growth is uniquely placed to lead on such a trust-building exercise from the government's side and integrate views** around the science and innovation spectrum, put R&D investments and reforms on top of the policy agenda, encourage the development of a consensual National Science Agenda, urge the implementation of structural reforms and the Smart Specialisation agenda, and concentrate efforts on removing barriers that prevent the eco-system from welcoming creative and innovative people in Bulgaria. The Council should regularly involve academia and business leaders and representatives in its discussions, open up co-operation with international experts and the Bulgarian diaspora, have a public policy orientation and count on a strong communication agenda.

3. Set up a professional, independent and robust national research agency to design and manage research and innovation funding programmes and support the successful implementation of the RI structural reforms package

At present the Bulgarian RI system appears characterized by silo thinking, often uncoordinated priorities and on-going concerns with regard to alleged malpractice. There is thus a clear need to redesign the RI Funding Agencies. This need can best be met by **establishing an independent, robust agency, capable of designing and implementing multi-annual research programmes with impartial, transparent and efficient grant review procedures**. The panel supports that the agency is built with an implementation-driven mission and that **it should take a leading role in connecting the funding for the relevant policy fields both horizontally and vertically**.

As such, the Promotion Agency for RI ('PARI'), already proposed by the government, might partly satisfy those needs. However, in the view of the panel, the agency as presently defined appears less of a research funding agency than a European Promotion Agency. Moreover, it excludes the allocation of European Structural and Investment Funds linked to the country's strategy for smart specialisation. Therefore **the PARI proposal should be upgraded to cover for such a professional, independent and robust national research agency**.

The government has also started to set up an inter-ministerial structure under the Council of Ministers (an 'administrative network') mirroring the Smart Growth Council which should act as regional network for the place-based implementation of the Smart Specialisation strategy. The proposed national research agency should have an appropriate operational relationship to this inter-ministerial structure, so that **the implementation of the smart specialisation strategy and of the national funding programmes is synergetic, and the priorities aligned**.

4. Improve the processes for the evaluation and funding of project proposals, and bring those processes to international standards

Bulgaria should strongly improve the processes for the selection of scientific and scholarly proposals for funding based on peer-review of project proposals. These are processes where international standards typically involve a panel-based system, in which panels of recognised scientists and/ or scholars make recommendations for funding either autonomously or based on the feedback of specialists external to the panel acting as remote referees.

In particular, **Bulgaria should ensure that it comes as rapidly as possible in-line with international standards for expert assessments and transparency. Funding mechanisms for RI activity should be based on predictability, transparency and the involvement of relevant/ high-level expertise, including international expertise.** At present, the national

research community in Bulgaria suffers from a lack of confidence in the fairness of funding allocations and in the established peer review system for the evaluation of projects. Solid processes to peer review project proposals are critical to restore confidence and trust among researchers. Adequate and transparent conflict of interest regulations, proficient enforcement of these regulations as well as adequate feedback to the researchers is crucial and should be built into the system as a necessary pre-condition for any competitive allocation of funding.

The panel is of the opinion that, **while the independent and autonomous research agency (see point 3 above) is established, outsourcing part or all of the process to an external agency such as the European Commission or the European Science Foundation would contribute to building trust in the evaluation system**. Regular independent ex post evaluations of the Bulgarian RI funding programmes are also recommended by the panel.

5. Increasingly concentrate funding for institutions that perform research, so as to reward high performance

Bulgaria with a population of 7.5 million has over 50 public universities and only a handful of them are able to undertake excellent research. Traditionally research has been the remit of the Bulgarian Academy of Science which does not engage in direct teaching. Despite this binary system, funding for research is distributed widely across the public universities. Spreading the research budget thinly and enabling its use for non-core research activities brings little scope for quality research of any significance at a public university. **The fragmented and dispersed Bulgarian higher education and research system would profit from a progressively higher concentration of resources based on the allocation of public funding to institutions using measures rewarding high quality such as performance-based funding schemes or performance contracts**. The present model for funding Bulgarian higher education and research organisations that perform research is clearly inadequate when it comes to encouraging the building-up of high-level research environments.

The panel also recommends that the binary nature of the education system is recognised by having also a binary research support policy. One pillar focusing on top research performing organisations supporting them towards the stairway to excellence including access to European research funding. A second pillar should focus on higher education teaching establishments. Bulgaria needs to introduce performance-based funding in order to facilitate the transparent, fair and competitive allocation of resources, and enhance performance incentives. However, developing performance-based funding is a long-term and complex process, requiring next to stakeholder involvement, expertise in research metrics and research evaluation. **The panel therefore recommends that Bulgaria considers specific support under the Policy Support Facility to provide concrete recommendations as to how to address this issue.**

More generally, public research organisations in Bulgaria appear unable to deal with many of the challenges facing a modern university or research institution. Most universities and research institutes are still impeded by old bureaucratic practices and a lack of professional management for their daily effective and efficient administration. **It is recommended that Bulgarian public research organisations professionalise their management, and develop and implement (their own) research strategies, including priority-setting**. Such strategy development should take place only against the background of their funding according to proven performance. **Integration and synergies between the various public research institutes should also be encouraged** to build critical mass and avoid overlaps and duplications of resources.

6. Encourage the participation of Bulgarian scientists and innovation entrepreneurs in European programmes

Up to now, Bulgarian funding schemes do neither complement nor prepare for the effective participation of Bulgarian scientists and innovation entrepreneurs in EU research and innovation programmes or in activities funded through the European structural and investment funds. **The panel recommends that Bulgaria strengthens its EU funding capacities by establishing a Sciences/ EU Funding Liaison Office in Brussels and a full-time professional National Contact Point (NCP) Network**. Both actions will contribute to reinforcing the capacities of national researchers and teams to successfully take part in EU funding programmes.

Equally, **the panel recommends the setting up of a matching-funds scheme that provides national funding to Bulgarian RI proposals that have been submitted for funding in Horizon 2020 and that have been positively evaluated, but that were finally below the**

necessary threshold to be granted funding. Targeted support should also be foreseen in order for potential participants in European programmes to acquire and/ or reinforce their abilities in preparing and managing European RI projects, including the preparation and coordination of proposals and promotion of projects or the hiring of experts for punctual advisory tasks.

Finally, the forthcoming introduction by the European Commission of **the 'Seal of Excellence' for Horizon 2020 projects proposals evaluated as excellent but not funded enables regions and countries willing to support excellent 'ready to fund' projects in their Smart Specialisation priority areas (via Structural funds) to identify them easily**. Bulgaria should set up the adequate mechanisms to capitalise on such opportunity.

7. Take rapid action to rebuild incentives for research careers at all stages and to retain and attract young talent from Bulgaria and from abroad into science and innovation

Bulgaria suffers from an extreme pattern of demographic decline. It has fewer researchers in all main research categories compared with the EU average. Nearly half of its professors are over 65 years of age and migration of younger researchers to other EU countries or to jobs outside R&D is the rule. Increasing the number of researchers is a challenge, not just in raising public funding for RI but also in developing and maintaining the necessary quality of any additional human resources. It is recommended that **both the Bulgarian authorities and all public research organisations ensure that the recruitment, promotion and funding of new researchers is performed in an open, transparent and merit-based manner and on the basis of research excellence** using the necessary metrics and international peer review practices. It is also recommended that Bulgarian **universities and institutes of the Bulgarian Academy of Sciences adopt the European Charter for Researchers and the European Code of Conduct for Recruitment** to build a working environment leading to successful performance and career development and to ensure open, efficient and transparent recruitment practices.

In this context, it should be considered that the next generation of researchers should be well-equipped to take up jobs in the academic and business sectors. The dual education system in Bulgaria does not stimulate sufficient interest in research as a career (see point 5). PhD candidates in Bulgaria suffer from very low salaries. This makes doctoral studies abroad more attractive, contributing to brain drain and making it hard to recruit international researchers to come to Bulgaria. In addition, PhD candidates receive a very traditional research education that lacks modern elements -including the use of English language- and training in the so-called 'transferable' skills which enable them to access well paid positions in the business sector. To address these shortcomings **the Bulgarian authorities are urged to find ways to ensure that doctoral programmes become more international, incentivise the mobility of PhD students, establish better connections to market needs, and ensure higher quality in different disciplines**. Combining the strengths of the Bulgarian research universities with that of the top BAS institutions, such PhD programmes could become attractors of foreign PhD students and provide a sustainable source for new talent in the academic and business worlds. The so-called European Principles of Innovative Doctoral Training should be applied by all institutions performing research in Bulgaria.

Unlike in other EU Member States, the Bulgarian RI system does not recognise 'Postdoctoral Researcher' positions, the nearest equivalent being the 'Assistant Professor' figure with a fixed term contract usually greater than 4 years. Postdoctoral researchers in EU Member States have the experience to work independently under the supervision of an academic, and can act as mentors to PhD students. **The Bulgarian authorities should commit to support postdoctoral researchers. Dedicated individual fellowship programmes for attracting international researchers to Bulgaria and reintegration schemes for Bulgarian postdocs working abroad should prove useful tools**. The public universities, BAS and Agrarian Institutes should ensure that postdoctoral researchers get accommodated and absorbed into their institutional academic structures.

In addition, the Bulgarian government needs to address the issue of the very low PhD salaries with urgency. Adequate funding should be made available to public universities in order to offer adequate salaries. **The Bulgarian government, in coordination with public research organisations which have a large degree of autonomy to set up salary levels, should introduce initiatives based on individual research performance in order to fix and/ or adjust researcher salary levels. A study should be undertaken by the Bulgarian authorities to determine the competitive salary levels for these schemes.** The current practice of allowing researchers to top up their salary using national research grants should be phased out and replaced with a new merit-based system. Research funding should be a means to carry out high quality research and should not be misused as a salary policy.

8. Incentivise the opening up of Bulgaria's science base to businesses and step up the schemes to support public-private cooperation

The Bulgarian innovation landscape is fragmented and characterized by a strong separation between the public and private sector activities. Current policy instruments are primarily supply-oriented in the sense that they focus on traditional research funding and not on building human capacity around knowledge transfer activities neither on creating the necessary framework conditions for business R&D activities or innovation to flourish. Most public organisations that perform research activities lack a mission-oriented 'entrepreneurial' character, are not geared towards cooperation with businesses/ SMEs, and do not count on the tools nor on the skills to deal with key issues such as the management of intellectual property rights or the possibility for researchers to move temporarily to the business sector while keeping their career stable. The business absorption capacity for publicly generated R&D appears poor while at the same time public policy does not provide the business sector with the set of incentives it requires so that firms embrace innovation more often as a strategy for their competitive development. Tax incentives are one of the few existing measures designed to encourage private R&D but awareness and use appears to be low, most probably linked to the low and flat rates of corporate taxation in the country.

Therefore, a better 'policy mix' for innovation is needed, and one that supports both the funding and the development of Bulgaria's science base and the emergence of demand-led innovation. Striking an appropriate mix of policy tools to reinforce public-private cooperation requires strong dialogue and coordination between the relevant Ministries, as well as a clear effort to raise societal awareness and engagement in relation to the country's innovation agenda. **It is strongly recommended that Bulgaria develops a much wider portfolio of instruments to target those companies performing R&D and innovation activities**, in order to facilitate the creation of public-private research consortia and foster collaborative research projects. These instruments should include for example **'proof of concept' funds, innovation vouchers that can be 'spent' with a public sector R&D partner, pathways for researchers and technologists to move between the public and business sectors, and matching-grant schemes** for firms tailored to the needs of differences in sector, age and growth potential.

In addition, the RI system of Bulgaria does not incentivise public research organisations in becoming more entrepreneurial. **The Bulgarian authorities need to urgently tackle existing barriers which impede public-private cooperation in RI linked notably to the not-for-profit status of public research organisations and to the fact that knowledge transfer is not part of the mission and core strategy of public universities**. Institutional models to encourage more mission-oriented research in Bulgaria such as Centres of Competency are only just beginning to appear and in very limited functional form. Instead, **public research organisations should be allowed to professionalise technology transfer activities, the creation of intellectual property and its transfer to the business sector**. Funding for management of innovation in R&D projects, as well as for patenting should be possible in funding calls.

9. Create the conditions for specific regional and local innovation ecosystems to develop in Bulgaria using the Sofia Tech Park as a strategic innovation test-bed

Despite a number of early stage innovation initiatives in Bulgaria, many appear yet not well connected to public universities and public organisations which perform research in the country. New and emerging ecosystems, such as the SofiaTech Park depend for their long-term sustainability on adequate use of public funding, including from the structural funds, to support the development of business R&D and innovation activities. Public research organisations need to become increasingly oriented towards public-private cooperation. The emergence of strong local demand for innovation from the business sector, including from SMEs and new start-ups, is also a key factor. Most of these conditions are at present not fulfilled and certainly not all simultaneously.

SofiaTech and other regional initiatives are often equally hampered by a systemic lack of shared research infrastructures. Although Bulgaria struggles to invest in modern research infrastructure, and in view of concerns voiced with the panel regarding the feasibility of implementing the national research infrastructures roadmap and even Bulgaria's participation in the ESFRI Roadmap, there is arguably scope for better use of existing facilities and for more strategic investment into future ones, in line with the smart specialisation strategy. In addition, the lack of a critical mass in skilled human capital to support business R&D and innovation activities in regional and local ecosystems needs to be addressed. Such deficit is exacerbated by the fact that public universities usually follow traditional curricula which do not respond to emerging business needs, and in addition they are curtailed by the lack of proper pathways for researchers who wish to operate in the public and in the business sector.

The Bulgarian authorities are encouraged to strongly reinforce the public-private cooperation dimension of the Sofia Tech Park and to use it as a strategic innovation test-bed, identifying and addressing barriers to its effective functioning as a true innovation ecosystem, and ensuring that these lessons are learned and transmitted to other initiatives. Bulgaria must ensure that further RI investments via the European structural funds encourage smart specialisation while supporting public-private cooperation. Synergies and planning of funding sources across Ministries are crucial in helping to stimulate and grow regional and local innovation ecosystems.

10. ще се върнем… (We'll be back…) The Bulgarian government should favour an assessment of the implementation of those recommendations within a three-year time span

There are, as highlighted in the many country and case boxes which fill the different chapters of this PSF peer review report, numerous good examples of 'good practices' from other European Member States or from neighbouring countries in the Western Balkans, to learn from. Designing appropriate RI policy instruments is a complex undertaking which is heavily dependent on local circumstances.

The current Bulgarian government has started to put many of the reforms discussed and proposed here on the right track, clearly entering an implementation-driven approach of connecting relevant policy fields both horizontally and vertically. In view of the PSF panel this should now be integrated in a national roadmap underpinned by a financial envelope with an horizon of 5 to 8 years.

We hope that combined with the more detailed policy recommendations put forward in the various chapters of this PSF report, such national roadmap will help Bulgarian authorities to set in motion and implement the many necessary reforms on which we felt broad agreement with the broad range of stakeholders that we met during our missions to Bulgaria.

Where under the direct control of the Bulgarian government authorities, **we suggest that further funding for RI becomes directly linked to compliance with change and the necessary reforms.**

To make our point even stronger, **we propose to the Bulgarian government that in three years from now a broadly similar PSF panel comes to assess the implementation of those recommendations which can count on the support of the Bulgarian authorities.**

In short, **ще се върнем…**

THE PSF PEER REVIEW

The Directorate-General for Research & Innovation of the European Commission set up a 'Policy Support Facility' (PSF) under the European Framework Programme for Research & Innovation 'Horizon 2020' to support Member States in reforming their national science, technology and innovation systems.

The first activity requested from the PSF is a Peer Review to support wide-ranging reforms in **Bulgaria**. The Bulgarian national authorities expressed a **strong political commitment** to this exercise. More concretely, the aim of the peer review is to provide external advice to the Bulgarian authorities in the process of evaluating their R&I system and assist where necessary in implementing the recently updated National Strategy for Development of Research 2020 and the upcoming Smart Specialisation Strategy (referred to in Bulgaria as Innovation Strategy for Smart Specialisation ISSS or IS3).

At the request of the Bulgarian authorities, the peer review has set a focus on three main areas:

I. **Assessment of R&I funding and performing bodies and instruments**. Improving the quality and efficiency of the public research organisations and tailoring the normative base for effective monitoring of R&I programmes and project results. Re-design and implementation of structural changes within the Scientific Research Promotion Act and the National Science Fund Regulation.

II. **R&I Human resources capacity development**. Improving the academic career path through in-depth assessment of the current legislation (Academic Career Development Act) and recommendations for overcoming the challenges of brain-drain and aging of the research staff in a long-term prospective. Also introducing stimulus for the public research organisations (PROs) and the universities for adopting the Charter and the Code as well as specific reintegration measures.

III. **Tackling the gap between research and business**. Building-up and enhancing knowledge transfer policies and instruments, including evaluation of current legislation and introducing tailored measures for attracting industry and in particular the SMEs to collaborate with the public research organisations.

The peer review undertaken stands in the tradition of previous mutual learning models under the auspices of the CREST and ERAC groups by offering a slim structure based on one or two short field visits with stakeholder group interviews and a number of documents, including both qualitative and quantitative analyses, received beforehand. Findings thereby also reflect the degree of pre-information and insight provided by the reviewed country. The advantage of this design lies in a relatively short-termed availability of systemic expert impressions and timely commitment of external feedback to practical policy issues rather than an in-depth evaluation of single players, instruments and their functionalities.

The **Horizon 2020 PSF panel** (hereafter the "**PSF panel**") comprised senior officials from Austria, Poland, Portugal, Slovenia, and Spain working in policy-making at the national level and acting in a personal capacity, and high-level independent experts from Germany, Ireland, Norway, the Netherlands and the UK with expertise in relevant research and innovation fields.

The PSF panel met for a first field visit in Sofia from April 22nd till 24th 2015. Preliminary findings were presented to various Bulgarian stakeholders during a second field visit in Sofia on June 25th and 26th, 2015.

On the basis of the various documents received and analysed[1], responses to an online survey as well as in-depth discussions with various experts and the many comments received during the two field visit, the PSF panel drew up the present report.

[1] Annex 1 provides a full list of documents received and studied.

1. INTRODUCTION

Before addressing the three areas at the centre of the structural reforms which the Bulgarian national research and development system needs to push forward, this first Chapter briefly addresses the overall macro-economic framework of Bulgaria. Considered in the 80's as the Silicon Valley of Eastern Europe[2], Bulgaria's economy witnessed a long "transition" period, which culminated in 2007 in the accession to the European Union. Unfortunately, the accession took place on the eve of the global "great recession" financial crisis which affected the Bulgarian economy severely: not so much directly but rather indirectly through a collapse in European exports with as a result a severe contraction in Bulgaria's GDP (- 5.5% in 2009).

Many of the proposed reform measures, including those in research and innovation were not implemented. Political uncertainty and instability started to dominate, basically leaving the R&I system in an ailing limbo.

Today a more stable economic and political situation appears to have emerged in which the necessary reforms as discussed in more detail in the subsequent Chapters, have a real chance to be successfully implemented.

1.1. The Bulgarian research system: lost in transition?

The Bulgarian research system has been characterized by a significant underfunding of public research and innovation over a long period: effectively since the transition from a centrally planned economy to a free market economy. As in other transition countries this process was accompanied by an "implosion"[3] of the country's national R&D system[4]. The previously primary public funding of R&D being carried out in a segmented (sectoral) way through the allocation of resources from within the relevant ministries, was drastically cut and new incentives were created for private firms, both domestic and foreign, to invest in research and innovation using private resources or alternatively to acquire the most profitable parts from the public sector.

In Bulgaria this "implosion" process was more pronounced, and took longer than in most other transition economies in Europe. One of the somewhat paradoxical reasons for this more painful adjustment was the relatively sophisticated scientific level at which the centrally planned R&D system had been operating and which was subsequently lost. The country had internationally scientifically acknowledged expertise in areas such as physics (e.g. the institute of Physics founded by Nadzhakov in 1946), chemistry (such as Kaishev and Stranski's work on crystal growth which laid the foundations of the Bulgarian school on physical chemistry), and mathematics and informatics (Bulgaria was one of the first to develop a binary system based electronic computing machine named Vitosha (1964)[5], exporting to the COMECON[6] states computing technology exports such as the Pravetz personal computer in the early 80's). This sophisticated scientific research base lost not just its privileged public funding, the private interests appeared more dominated by Development than by Research, and often governed by international network advantages and the creation of global value chains.

It was to be hoped of course that joining the EU would enable a number of existing and new emerging high-tech companies to exploit fully the access to European markets; that universities and other PROs including the institutes of the Bulgarian Academy of Sciences (BAS) and the Agricultural Academy (AA) would benefit disproportionately from the new possibilities for participation in European research programs, and that the government would be able to use fully the new opportunities for structural investments in infrastructure thanks to access to European cohesion funds. But after a first wave of optimism and new energy based on Bulgaria's earlier scientific and technological strength, the country saw itself becoming "drowned" as it were in the new European funding and investment opportunities for which it was neither prepared administratively, nor capable of organizing a transparent distribution system. Combined with the unfolding European financial crisis affecting Bulgaria's economy indirectly, the large inflow of

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2 Due to its strong electronics hardware industry.

3 The term of "implosion" is used in contrast to the "explosion" of R&D expenditures as it occurred in many of the OECD countries following the first surveys along the lines of the Frascati Manual. In the latter case, many ongoing activities which had not previously been considered as 'R&D' were included in this class. This re-classification led to an artificial, exaggerated growth in the measured R&D expenditures in most OECD countries. In the case of "implosion" exactly the opposite occurred. While R&D activities were formally dramatically reduced, the underlying human capital of scientists and engineers continued to exist but were often no longer involved in formal R&D activities.

4 See amongst others Freeman, C. and L. Soete (1997), The Economics of Industrial Innovation, MIT Press and also Freeman, C. and Soete, L. (2009), Research Policy.

5 IT Services: Rila Establishes Bulgarian Beachhead in UK, findarticles.com, June 24, 1999.

6 Council for Mutual Economic Assistance.

conditional European funds[7] did neither compensate for the severe downturn in European demand and as a result domestic economic activity, nor strengthen the Bulgarian research and innovation system.

Due to the inefficient use of EU funding including pre-accession funds a vicious circle developed: important stakeholders questioned the country's capacity for supporting and administering both European and national research and innovation. As a result a lack of trust developed between the different partners in the research and innovation community, not least the young generation of new creative entrepreneurial researchers and public authorities, both national and European. This distrust led to further declining expectations in the available opportunities for further strengthening Bulgaria's research and innovation system with the support of European funding. As a result, the Bulgarian "public" research part did not take a "stairway to excellence", it rather found itself on a descending moving stairway or escalator, with most stakeholders putting their efforts in trying to maintain their level. By contrast, and as discussed in the next section in more detail, the international private sector increasingly discovered the islands of excellence in the Bulgarian research system combined with the overall advantages of the country's low taxation of private business.

Breaking the vicious circle of declining public funds, lack of trust and underutilization of European funding is critical today when Bulgaria is again confronted with substantial amounts of European Structural Funds. Conditional on receiving those funds is, however, the implementation of structural reforms which must provide better guarantees as to the way those funds can indeed exploit the numerous research and innovation opportunities as sketched out in the recently updated National Strategy for Development of Research 2020 and the Innovation Strategy for Smart Specialisation (ISSS). The diagnosis and analysis of what has to be done and can be achieved by such reforms, has in many ways already been done several times by different international, independent agencies such as the World Bank, the OECD and different directorates of the EC.

The main purpose of this Horizon 2020 PSF peer review is to contribute to the way those can be implemented quickly and efficiently.

1.2. Bulgaria's research and innovation performance: facts and figures

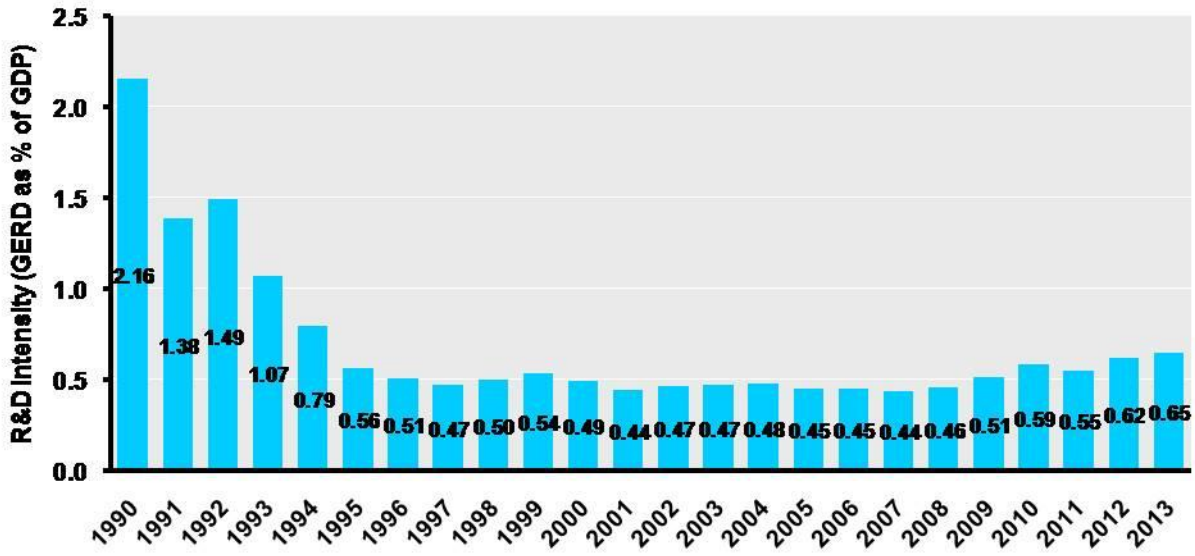
The declining trend in the overall, but primarily public funding of research in Bulgaria stabilized in the mid-nineties as it did in most other transition countries (Figure 1). However, in the Bulgarian case, unlike that of other countries, it remained at this low level of R&D intensity of 0.5% GDP rising only slightly over the last couple of years. In 2013 it stood at 0.65% with a public funding contribution of 0.24% of GDP, less than a quarter of a percentage.

One of the central questions is how realistic it is that Bulgaria will reach its self-chosen national target of 1.5 % R&D intensity in 2020. This national target implies a dramatic increase in R&D over the next five years. What is the commitment on the public side to realize such a target? What will be the implications for trust in the Bulgarian R&D policy system, also from its European partners, when such a target will not be achieved?

In short, should not a more realistic target be chosen, based on a carefully planned strategy aimed at raising both private and public R&D, paying particular attention to the complementary nature and possible spill-over effects of such investments, which can be systematically evaluated over time?

[7] Today total EU investment represents some 5.5% of Bulgaria's gross national income.

Figure 1: Bulgaria R&D intensity, 1990-2012 (1)

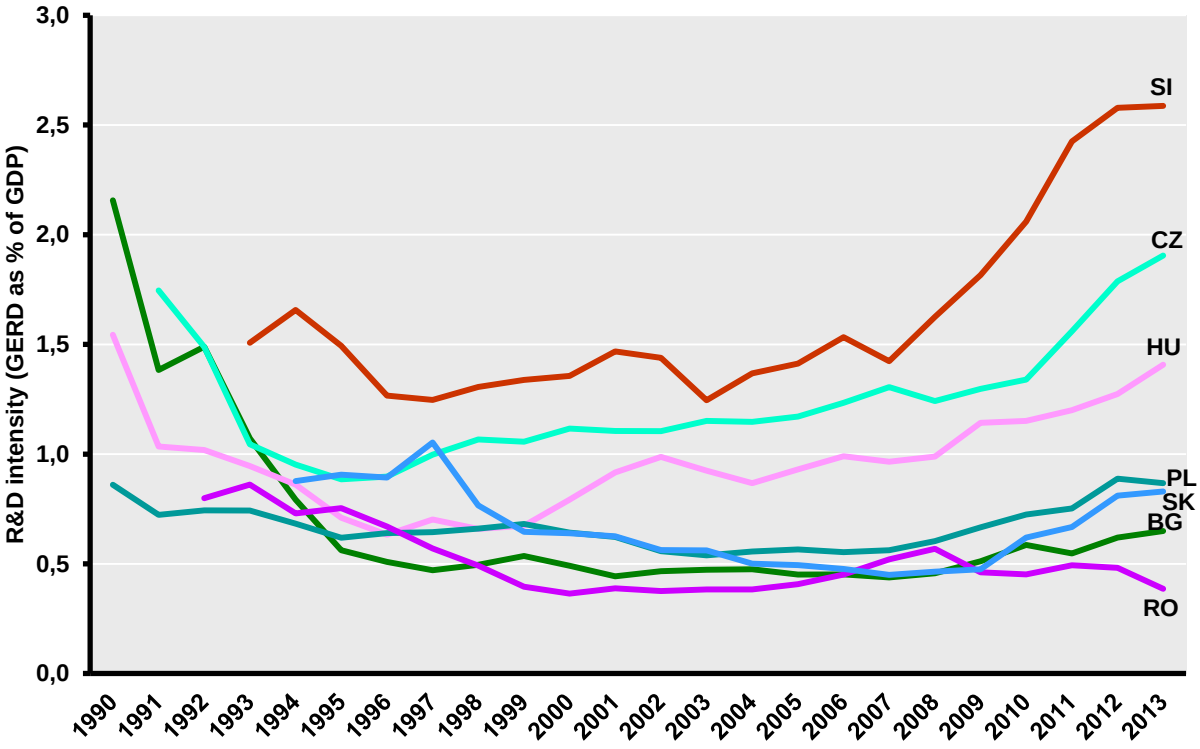


Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG ECFIN

Note: (1) Breaks in series between 1999 and the previous years and between 1996 and the previous years.

The contrast between the research investment in Bulgaria and other economies in transition is illustrated in Figure 2. Countries such as Slovenia, the Czech Republic, Hungary or even Poland saw their research system more or less completely recover and have now public (and private) research investments at similar levels to what they were in the early 90's under the centrally planned economic system. Bulgaria finds itself by contrast today overtaken by all those countries, with the exception of Romania which had always a much lower research intensity economic structure.

Figure 2: Comparative R&D intensity, 1990-2013

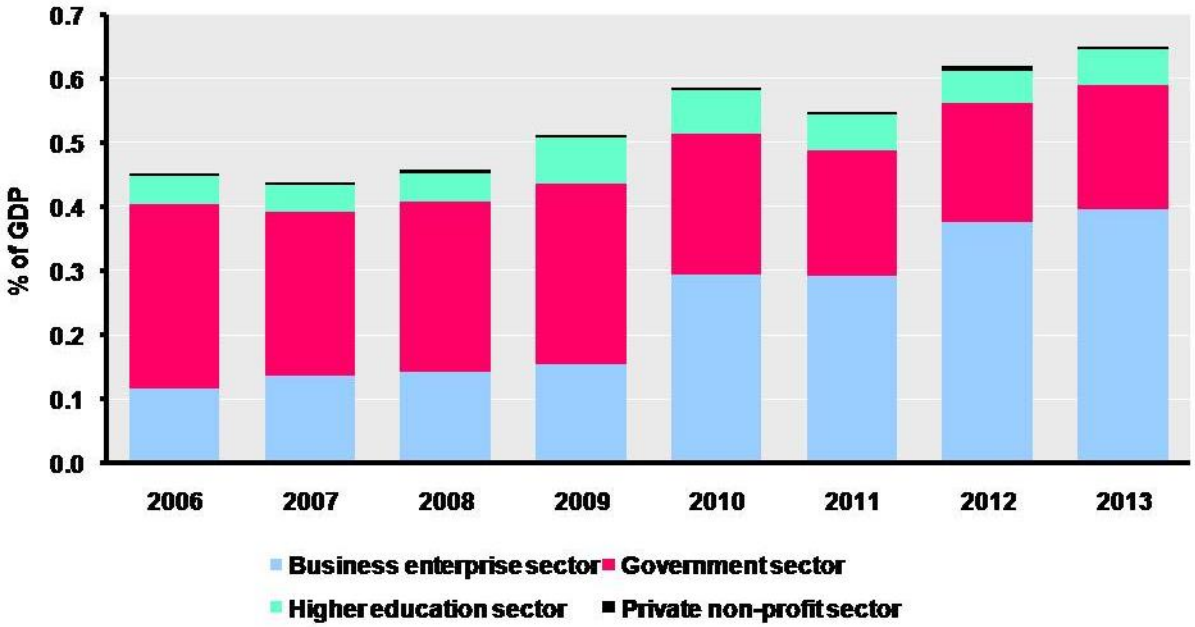


Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG ECFIN

On a more positive note, unlike the situation in Romania, Bulgaria's formal membership of the EU in 2007 did actually result in a small but sustained positive trend in overall research investment.

This latter "new" trend, illustrated in Figure 3, is primarily the result of the increased R&D performed by the private sector. As illustrated in the Figure, the public sector, including higher education, saw, by contrast, its R&D intensity further decline from 0.36% in 2009 to 0.24% in 2013. That is a figure lower than in any other European MS.

Figure 3 Bulgaria - GERD by sector of performance (as a % of GDP), 2006-2013



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat

In Table 1, the amounts of R&D spend by business, government and higher education are given both as a percentage of GDP and in absolute terms. Total public spending on R&D (GOV + HE) in Bulgaria was in 2013: 79 + 23 = 102 million Euro.

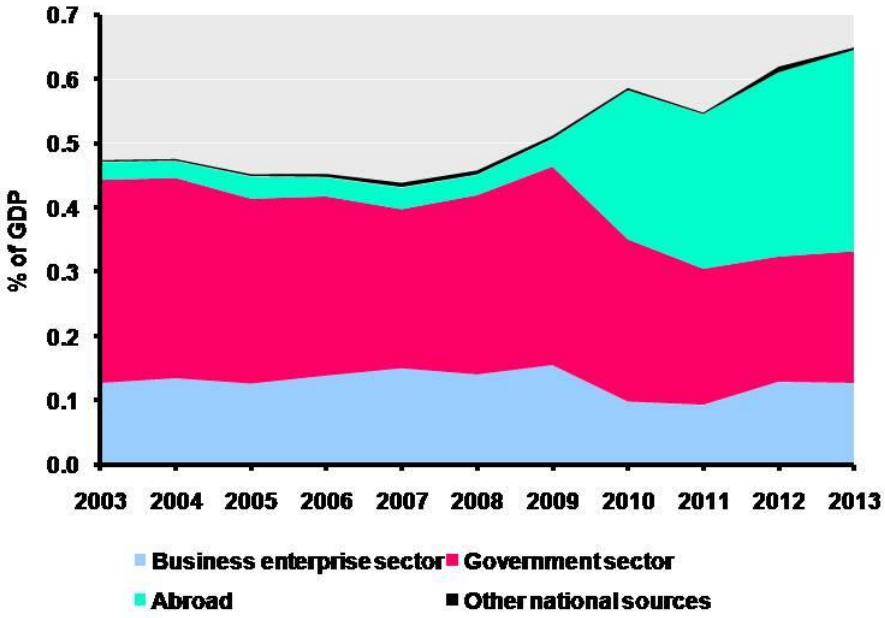
Table 1: Total spending on R&D in Bulgaria (2010-2013, as percentage of GDP and in absolute terms)

	2010	2011	2012	2013
GERD (% of GDP)	0.59	0.55	0.62	0.65
GERD (mln €)	216	220	254	267
Business (% of GDP)	0.30	0.29	0.38	0.40
Business (mln €)	108	117	154	163
Government (% of GDP)	0.22	0.20	0.19	0.19
Government (mln €)	80	79	76	79
Higher Education (% of GDP)	0.07	0.06	0.05	0.06
Higher Education (mln €)	25	22	20	23
Private non-profit sector (% of GDP)	0	0	0.01	0
Private non-profit sector (mln €)	1	2	4	2

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat

The decline in public R&D intensity contrasts sharply with the rapidly growing private R&D as illustrated in Figure 3 and in particular foreign R&D investments in Bulgaria, as illustrated in Figure 4.

Figure 4: GERD by source of funds as % of GDP, 2003-2013



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat

In the early period, before accession, BERD rose rapidly. Between 1998 and 2007, total BERD rose steadily from initially 12 million EUR to 43.5 million EUR. This trend was primarily due to a rise in domestic BERD, while foreign BERD (without the services sector) remained fairly stagnant. Restricted data availability due to confidentiality limits any detailed analysis of the degree of internationalisation or inward R&D penetration over that period. Whatever little information is available, highlights that i) in 2006, chemicals (incl. pharmaceuticals) had the highest share of foreign-owned affiliates in BERD (with only around 5%) and that ii) this particular industry accounted for 20% of total inward BERD in Bulgaria, rendering it a rather attractive industry for R&D activities of foreign-owned firms. Moreover, the analysis also highlighted that the majority of inward BERD in Bulgaria came from outside the European Union[8].

However, focusing on the more recent period in which BERD effectively exploded from 43.5 million in 2007 to 163 million euro in 2013, the growth in BERD concentrated practically solely in R&D services. As Table 2 illustrates, today Bulgarian BERD appears concentrated for more than 70% in just one sector, the "Professional, scientific and technical activities; administrative and support service activities" and in particular M72 *Scientific Research and Development*. That category includes unfortunately many things: clinical trials performed by foreign multinationals in Bulgaria, EC-funded research projects (in 2012 some 8.1 million euro) as well as numerous other R&D support investments for private, often foreign firms. From the available statistical evidence, as presented in Table 2, one may just observe that the contribution of such R&D service activities has been particularly substantial in Bulgaria.

Table 2: Business enterprise expenditure on R&D (BERD) by economic activity (Bulgaria, NACE Rev. 2) millions of euro.

NACE 2 Code	Sector	2006	2007	2008	2009	2010	2011	2012	2013
	Total - All NACE activities	30.883	43.494	51.699	55.309	108.450	116.930	153.546	162.921
C	Manufacturing	12.801	14.806	21.265	12.805	16.917	13.783	24.284	na
G-N	Services of the business economy	17.900	28.149	30.214	40.461	90.793	102.325	128.657	na
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	0.373	0.337	0.739	2.394	2.707	0.680	1.225	na
J	Information and communication	*Confidential*	15.384	11.684	6.515	4.536	2.777	5.778	na
J61	Telecommunications	*Confidential*	*Confidential*	*Confidential*	*Confidential*	0.000	0.000	0.052	na
J62	Computer programming, consultancy and related activities	4.109	*Confidential*	4.340	3.328	4.458	2.773	5.666	na
M	Professional, scientific and technical activities	5.189	*Confidential*	*Confidential*	*Confidential*	*Confidential*	*Confidential*	117.220	na
M72	Scientific research and development	2.362	3.223	12.789	27.525	82.001	96.487	110.420	na

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat

na = not available

8 See Leitner, S., G. Hunya and D. Hanzl- Weiß, "Internationalisation of business investments in R&D and analysis of their economic impact", Contract Nr. RTD/DirC/C3/2010/SI2.563818, May 2011.

Whatever the evidence on the possible "new" role of the business sector, domestic or foreign, in increasing overall investment in R&D in Bulgaria, for it to be sustainable in the long term, it will be essential for public funding in research and innovation to become more in line with what other countries of the level of development of Bulgaria spend as a percentage of R&D. Relying only on foreign investments will, and already creates, huge discrepancies in the use and functions of BAS (Bulgarian Academy of Sciences), AA (Agricultural Academy[9]) and HEIs (Higher Education Institutes) for the economy and quality of life in Bulgaria, as discussed below.

In short, the current low level in public funding of research and innovation in Bulgaria is in the view of the PSF panel not sustainable. If not reversed, it might lead to a further downward adjustment in the structure of the Bulgarian economy, the lack of public investment negatively shaping the training and skill acquisition of the human capital needed to perform R&D activities, so that the country becomes actually less attractive to foreign R&D investments, and at the same time negatively affecting the existing pool of knowledge available within the system so that companies benefit less from spill-over effects and positive externalities. Effectively it could mean a process of "submerging" as opposed to emerging development; Bulgaria not being capable of maintaining its historically high level of human capital and gradually adjusting its economic structure downwards once the older population with its relatively high human capital retires and cannot be replaced due to a lack of young human capital. The fact that the Bulgarian population is declining at the fastest pace in the world till 2050[10], is of course another factor which should be borne in mind within this context. It explains why the issue of human capital is a central part of our analysis, as discussed at greater length in Chapter 3.

1.3. Global and public/ societal environment

As argued above, without a substantial, renewed commitment to the public funding of research and innovation, Bulgaria risks losing the interest of both national and foreign firms in its national research and innovation capabilities. With the further globalisation of scientific research (open science or science 2.0)[11], higher education (Massive Open Online Courses MOOCs[12]) and business (global value chains), Bulgaria is in danger of losing its most dynamic endogenous actors in each of these fields.

Therefore it is **essential that the Bulgarian public authorities re-popularize the commitment to science within Bulgarian public opinion**. **It is vital that public funding raised is being spent in a prioritised way/based on clear priorities – making choices for *and* with society (specific or grand challenges) beneficial for the country's development**. The peer review panel suggests a broad national dialogue with stakeholders and the public at large to establish a national road-map along e.g. the EU research priorities including financial milestones. Evidence from other, successful catching-up processes such as Austria show that an all-party parliamentary consensus with academia and business can secure support for a national effort for research and innovation, and foster lasting impact through systemic trust. In short, a Bulgarian consensus for innovation as a national priority seems a pre-requisite to avoid fragmentation and disconnection of all other measures and should, by all means, outlast future elections.

The panel believes that a commonly shared vision and policy story line of how science and innovation should change Bulgaria in the next five to ten years is key. Various components can contribute to anchoring a national consensus for a science agenda:

- An all-party informal agreement to prioritise national investments in the knowledge triangle of education, research and innovation, to set them apart from political battles, and to seek all-party consensus for legislation in that field. The latter might help to reduce the number of small legal amendments, shift the focus to longer-term implementation cycles and thereby increase stability.

- Formal and symbolic acts like a national innovation summit, involving the presidency and government, parliamentary opposition, industry and academia, and the public signing of an 'innovation contract' could kick-off a national dialogue on redefining Bulgaria as a society and economy based on science and innovation. Media communication seems key to creating visibility for a political innovation agenda, to win taxpayers' support for investments and to make change sustainable.

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9 Formerly named National Centre of Agrarian Sciences.

10 http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf.

11 Science 2.0 is a suggested new approach to science that uses information-sharing and collaboration made possible by network technologies.

12 Massive Open Online Courses.

Case study 1: Forschungsdialog / Austrian Research Dialogue 2007/08[13]

From the late 1990s onwards, Austria experienced a decade of remarkable growth in public and private R&D investment, based on a broad consensus in the government, academic and business sectors, and the opinion leaders in society. In 2007, however, the need was felt to analyse the system for efficiency and growth potentials, and a new vision for the next decade. Government initiated two parallel initiatives: an in-depth analysis of the funding system and the Austrian Research Dialogue. Minister (the later Commissioner) Hahn invited all stakeholders for a year of structured discourse on the upcoming topics and challenges in science, research and innovation. 21 dialogue fora, focus groups and thematic workshops were held in all nine regions and online, opened by a minister and attracting several thousands of participants, and the media, to a wide range of topics from universities and the humanities, basic research and grand challenges to funding structures, women researchers and future research demands from industry and SME. The process was organised by a small team, yet in constant dialogue with all ministries, parliament and social partners, events were hosted by regions, universities and economic interest groups, and supported by scientific background documentation. The project results outlasted the dissolution of a coalition government, and were integrated into an STI strategy by the next government.

This case highlights various elements that could inspire politics in Bulgaria:

There are two features that should be acknowledged separately but need political connection, as they are highly inter-dependent: (1) an all-party political consensus, uniting politics, academia and business for growth through innovation as a 'national goal', and (2) a public agenda that wins civic support for that national goal, and communicates in both directions by fishing for ideas, and by using available media channels.

Processes do not need to be expensive when co-operation is sought with many players and institutions throughout the country. Repeated connection and mutual reassurance between the public agenda and the political stakeholder consensus maximise process legitimacy. Involving stakeholders and the public at large raises expectations, as many players feel ownership for a goal. Broad ownership supports new framework conditions to endure political swings, which again enhances systemic trust.

Combining public communication with consensus-building might be the right mobilising instrument for a system that needs to create longer termed planning conditions and trust among the key stakeholders, private investors and the public at large. The Austrian case seemed the right choice for a similar challenge. However, there are different phases in a country's policy cycle, and consensus then needs a periodical update of its guiding story to maintain its driving momentum.

Finally, introducing a stakeholder dialogue about the strategic goals is not only an instrument to foster change at a national level. It might also mobilise for higher acceptance of institutional change in PROs.

Actually, several countries introduced an innovation diplomacy initiative to communicate credibility for their domestic science agenda among investors and researchers, also outside the country. Various components could contribute to rebranding a country as an attractive place to work and invest in science and innovation-related activities:

- The appointment of science attachés at strategic posts (e.g. in the US, Canada, Germany, UK, Brazil…) to connect with high profile institutions and companies and to liaise with Bulgarian academic and business leaders living abroad (part of structured *diaspora relations*);
- The establishment of a Science/EU Funding Liaison Office in Brussels outside of the official premises of the Permanent Delegation with participation of representatives of the BAS, the Rectors Conference, the Bulgarian Chamber of Commerce and Industry and other stakeholders[14].

Also demanding innovative solutions to public needs from industry can help to communicate politics' commitment to the innovation-based change agenda (see below section 4.5. on public procurement).

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13 www.bmwfw.gv.at/forschungsdialog.

14 Experience from a number of EU member countries shows that a stakeholders liaison office can acquire first-hand information that would not be available through diplomatic channels.

1.4. Summary and conclusions

It is essential for Bulgarian public funding in research and innovation to become more in line with what countries of the level of development of Bulgaria spend as a percentage of GDP on R&D. The current low level in public funding of research in Bulgaria is not sustainable. The present government is committed to raise the total percentage of GDP to be spent on R&D from its current level of 0.65% to 1.5% in 2020.

Given the fact that public funding of R&D has been declining over the last three or five years such target seems at first sight not very realistic. However, the strategic meaning of setting targets, even if they appear at first sight unrealistic, is an "ex-ante conditionality" condition: the Bulgarian government will need to reach a realistic target in order to keep European structural funding flowing[15]. Such target will force authorities to pay more attention on how to raise further public R&D investment in the long term outlasting future elections and changes in governments.

However, for those **increased RI investments to be successful they must be accompanied by major structural reforms** to:

1. Improve the country's RI funding instruments, bring project evaluation practices to international standards, improve the management and governance of public organisations that perform research, as well as the functioning of national funding bodies, and link science funding closer to performance. These reforms are discussed in Chapter 2 of this report.

2. Strengthen the country's highly skilled and educated human resources in RI, address the issue of the very low salaries of PhD researchers, build critical mass in the public and private sector, support top research performing organisations in moving up the stairway to excellence, incentivise international and higher quality PhDs programmes and higher mobility of researchers, recruit and retain established and leading researchers and bring young talent into the system, and develop a supportive research environment and working culture. See Chapter 3 of this report.

3. Incentivise the opening up of Bulgaria's science base to businesses and step up the schemes to support public-private cooperation, and create the conditions for innovation ecosystems to create and develop. This entails efforts to encourage smart specialisation and support its priority areas, stimulate regional and local test-beds, foster entrepreneurship in organisations that do public research, nurture successful clusters, address research infrastructure gaps and leverage shared infrastructure capacity. These issues are discussed in Chapter 4 of this report.

Recommendation #1.1

The current very low level in public funding of research in Bulgaria is not sustainable for the necessary economic development and the social welfare of the country. Bulgaria has a historic opportunity to strengthen its economic potential by making a renewed, realistic, long term commitment to a ***clear increase in its R&D intensity to at least 1% of GDP by 2020*** *(Europe 2020) from the current level of 0.65% of GDP.* ***Public funding should play a decisive role in achieving this target****, well beyond the current public R&D intensity level of 0.24% of GDP.*

Such a long term commitment to investments and structural reforms will have to be based, in view of the Peer Review on a broad public policy and communication agenda with lasting all-party parliamentarian consensus and a pact with the relevant forces of society at large, including the science and innovation community, to prioritise research and innovation over the next five to ten years. Otherwise governments will find it difficult to sustain their reforms and build trust in the science system and among investors. Such a Bulgarian consensus for innovation as national priority seems also a pre-requisite to avoid fragmentation and disconnection with other structural change measures.

As we highlighted above, short term volatility, within a framework of restrictive public means, contributes to an atmosphere of mistrust between stakeholders. The lesser the resources, the more there is likely to be discussion, dispute and criticism against those who have received some of those limited resources, the more so when there are no clear and transparent rules for allocation.

[15] Structural Funds are based on co-funding mechanisms and not on private investments.

The lesser the resources, the more there will be a continuous push for changes: in focus, for different rules; for additional regulations, etc. Many such cases were highlighted to the PSF panel by various interlocutors during our field visits.

As a common vision is key, the PSF panel recommends authorities to launch a Bulgarian 'National Science Agenda' in collaboration with national and regional media, leading academic and business leaders, stakeholders and civil society.

Recommendation #1.2

To maximize impact of public investment, clear priority setting in science, research and innovation funding is a must at the political level, stakeholders' level and with the involvement of civil society. Bulgarian authorities are urged to launch a broad-based long-lasting and committed national dialogue inviting also the media, regional authorities, citizens to raise questions they consider crucial for the future of Bulgaria[16]. This dialogue should lead to a 'National Science Agenda' capable of rebuilding trust in the system. The Council for Smart Growth is best placed to take leadership in this process.

In the short term, increases in public funding will have to be accompanied by a new and more effective implementation, evaluation and coordination structure as we discuss in greater detail in the next Chapter. The Council for Smart Growth created on May 12th 2015 and now headed by the Prime Minister, is a good step in the right direction and towards implementation. Particularly its involvement of both academia and business leaders, and designed openness to co-operation with international experts and high profile representatives of the Bulgarian diaspora would foster a lasting impact, also on the public policy and communication agenda. Aimed at coordinating policy in the field of science and innovation, the Council should be in a position to integrate all activities in this field, urge the implementation of the IS3, and concentrate on efforts to remove barriers that prevent the eco-system from welcoming creative and innovative people in Bulgaria. A relatively small state, Bulgaria cannot head for excellence in every field. However, re-launching its research and innovation ecosystem should also be seen as an opportunity where Bulgaria can win reputation by consequently choosing quality when tailoring domestic and international inspiration.

On the technical side, the government has started to put things on the right track by setting up an inter-ministerial structure under the Council of Ministers (administrative network), mirroring the Smart Growth Council, by a regional network for a place-based implementation of the IS3 and by planning an independent agency with a professional multi-level funding competence (PARI). All of this needs to be integrated in a national roadmap underpinned by a financial back-up for 5-8 years. The panel supports this implementation-driven approach of connecting the relevant policy fields both horizontally and vertically. The implementation of the smart specialisation strategy and of the national funding programmes should ensure synergies and alignment of priorities.

A stakeholders' consensus, including political actors requiring strong policy leadership, is needed. That leadership should be prepared to put R&D investments on top of the policy agenda. The policy cycle is a critical variable. A coalition government provides actually a window of opportunity for conducting such an exercise.

In view of the panel, the Council for Smart Growth is uniquely placed to lead on such a trust-building exercise from the government's side and integrate views around the science and innovation spectrum, put R&D investments and reforms on top of the policy agenda, encourage the development of a consensual National Science Agenda, urge the implementation of structural reforms and the Smart Specialisation agenda, and concentrate efforts on removing barriers that prevent the eco-system from welcoming creative and innovative people in Bulgaria. The Council should regularly involve academia and business leaders and representatives in its discussions, open up co-operation with international experts and the Bulgarian diaspora, have a public policy orientation and count on a strong communication agenda.

[16] An example could be the current Dutch National Science Agenda in which more than 10,000 questions were assembled from scientists, organizations and individuals which will now become the subject of validation, debate and agenda setting for future research in The Netherlands.

Recommendation #1.3

Now that the process of the Smart Specialization Strategy and the several other strategies have been put in place, the focus of policy consensus should be on a roadmap for implementation of these strategies and on fostering their alignment throughout this implementation, and consequently for the design of specific actions and instruments to roll them out in synergy. There is, in the view of PSF panel, no reason why this process should be postponed. Accountability is a major issue but without political commitment it will not lead to a positive transformation. We urge the Bulgarian authorities to take strong policy leadership on putting those strategies fully in place.

Underpinning those structural reforms, there is a clear need for Bulgaria to ensure effective synergies and planning, as well as efficient use, of all funding sources across Ministries and notably the EU structural and investment funds in order to maximise impact from all available resources.

The implementation of these reforms requires political courage. The panel is convinced that within the current economic and political environment, those reforms have a real chance to be successfully implemented. The willingness of the Bulgarian authorities to request and support this first country PSF peer review is to some extent witness to this conviction.

2. ASSESSMENT OF R&I FUNDING AND PERFORMING BODIES AND INSTRUMENTS

The low level of public funding of research and innovation is of course the most striking feature of the Bulgarian R&I system, and one which warrants immediate attention, but the quality and efficiency of such public funding is also of central concern. The first priority area, as detailed in the request from the Bulgarian authorities in their appeal to the EC for using the Policy Support Facility was for: *"advice on the "Assessment of R&I funding and performing bodies and instruments".* In short - for assisting in improving the quality and efficiency of the public research organisations and tailoring the normative base for effective monitoring of R&I programmes and project results.

2.1. The Bulgarian policy challenge: enabling systemic synergies in research and innovation

2.1.1 The Bulgarian policy challenge

At present and despite the high potential of the Bulgarian research and innovation system in terms of science, human resources and innovative capacity, the national system appears to be characterized by silo thinking, uncoordinated priorities and on-going concerns with regard to alleged malpractice. There seems to be no obvious horizontal coordination in the system. In addition, despite the political willingness to push for reforms, research and innovation decision-making processes in Bulgaria appear dispersed, working administratively in silos according to old sectoral policy structures, without much operational horizontal coordination mechanism, or common strategy or vision. Yet, and as all stakeholders the PSF panel discussed with, agree, Bulgaria needs a coherent research and innovation system where the HE system plays the essential integrative role.

On the one hand it is the role of the Ministry of Education and Science (MoES) to take responsibility for the public research performing organisations whose contributions to innovation through well performing science and critical mass, are seen as increasingly critical for the country's Smart Specialisation Strategy (referred to in Bulgaria as ISSS or IS3). On the other hand there is the intention of the Ministry of Economy to strengthen the economy through the promotion of innovation within SMEs, the creation of at least one high-tech park (SofiaTech) and to attract the research activities of foreign firms. **Coordination between research and innovation and overall economic policy is crucial in today's dynamics of knowledge whereby bridging the gap between the two is absolutely essential as well as communication of their roles to the main PRO stakeholders, as highlighted in Chapter 1.** Mechanisms to enable coordination have been created, e.g. the Council for Innovation and Council for Science and more recently the Council for Smart Growth. In theory, such a plethora of coordination mechanisms and the existence of a high-level council led by the Prime Minister should create the conditions for optimised policy-making.

Historically, the Bulgarian policy-making system for R&D has appeared somewhat at the opposite of this ideal picture, characterised by vertical coordination with few linkages or real coordination mechanisms that could promote a systemic approach. An overall mission-oriented approach or problem-solving one would foster cooperation among different ministries and would in addition give scale to public funding through the pooling of resources. Furthermore, and in line with was already highlighted in Chapter 1, there is also a strong need to rebuild long-term trust in the country's scientific achievements and to rebrand Bulgaria as a business and working place based on knowledge and innovation, going beyond the narrow scope of research policy.

Beyond those more fundamental and structural problems, the review panel was particularly struck by the way the existing policy framework was, in the discussion with civil servants, primarily presented as a collection of strategic documents sometimes disconnected from policy action and often lacking effective tools for implementation.

Not only is the relationship between Ministries, agencies and research and innovation funds insufficient, a real planning of public investments for research and innovation appears also to be absent. This is not only a matter of funding levels but also of the choice and evaluation of specific tools and instruments to direct R&I public spending. Such instruments should be stable over a period of time to provide the right set of incentives and produce the medium and long term effects on the Bulgarian system for research and innovation. There is clearly a need here for a portfolio of instruments. The development of such a portfolio will have to be, in our view, one of the first tasks for the new Council for Smart Growth (CSG).

On the basis of available empirical evidence, already presented in Chapter 1, it may be concluded that the Bulgarian Research and Innovation System is not sufficiently engaged in the Bulgarian economic development policy and is not strongly integrated into governmental structural reforms. Institutions of the research and innovation system are fragmented without appropriate governmental coordination and do not operate in line with normative documents as well as with adopted R&I strategies and official announced policies. Existing public research potential is underfunded and not substantially involved in the transformation processes of the Bulgarian society

and industry. In fact, as a long term transitional processes Bulgaria is confronted with divergent development trajectories of public and private sectors in the field of R&D, as noted in Chapter 1.

2.1.2 Improving policy coordination and implementation

There is an urgent need to enhance the **coordination mechanisms and implementation capacity** in Bulgarian research and innovation policy. The recent establishment of the Council for Smart Growth (CSG) and the planned Promotion Agency for Research and Innovations (PARI, see Section 2.2.3 below) are important steps to address these challenges. The PSF panel concludes that the CSG initiative offers a new opportunity for the Bulgarian authorities to revitalize research and innovation policies as well as to reorganize the fragmented landscape of R&I and related sectoral policies – such as higher education and industrial policies including ICT. However, the current definition of the council and its functions (article 2) presents some drawbacks that may limit its effectiveness. In particular given the current definition and composition of the Council for Smart Growth and in order to reinforce the role of the Council to promote effective policy management and policy coordination across different departments it will be relevant to define the working of the Council at two different levels:

> (1) as a government body for inter-ministerial policy coordination concerning smart growth based on research and innovation including decisions on government budget allocation and
>
> (2) as a national advisory body to the government for the setting of national priorities to foster economic growth.

In view of the panel, as presented in Chapter 1, the CSG is uniquely placed to lead on the necessary trust-building exercise from the government's side and integrate views around the science and innovation spectrum, put R&D investments and reforms on top of the policy agenda, encourage the development of a consensual National Science Agenda, urge the implementation of structural reforms and the Smart Specialisation agenda, and concentrate efforts on removing barriers that prevent the eco-system from welcoming creative and innovative people in Bulgaria.

Since the Decree and regulations on the CSG are already in place, the number of options to overcome the current definition and composition of the CSG are limited; given the constrains the main instrument available may be the adoption of pluri-annual actions plans reflecting governmental coordinated actions and priorities. Finally, the Council for Smart Growth should focus more on the set of specific actions (and implementation) and "priorities" that never lead to actions. More detailed comments on the Council have been included as Annex 2.1.

2.2. Improving funding instruments and their evaluation

2.2.1. National funding schemes and bodies

The current system of competitive allocation of resources is relatively recent and funding for Research and Innovation remains fragmented at various levels and unpredictable. Two funds were created in 2004, one for science and another for innovation. The National Science Fund (NSF) sponsored basic and applied research activity and training of the public sector. The National Innovation Fund (NIF) financed applied research, development and innovation activities, including technology transfer.

The two funds have relatively limited resources[17], but are managed independently and have autonomous objectives and targets, without any mechanism in place for coordination. The very limited resources are dispersed in a large number of projects without clear reference to impact for society and the economy. The amount of funding available does not enable Bulgaria to contribute to the grand and social challenges and to create synergies with European programmes and enhance integration in international networks.

The characteristics of the two funds in terms of their management models are diverse. While the NIF is a programme under BSMEPA (Bulgarian SME Promotion Agency), the NSF has a complex structure, almost similar to a funding agency, but without the capacity, procedures and competences of that type of organisations, typical for other more developed Member States.

The NSF has an Executive Committee composed of active scientists and an executive director that manages a small staff, and currently lacks transparency, professional management and access to independent international reviewers. Informants from the research organisations emphasised that calls were irregular, funding level and transparency low and the procedures unnecessary bureaucratic. The system functions on an irregular basis, with unpredictable budgets and irregular calls for proposals. Hence, researchers cannot predict when they would be able to submit an application for funding. This reduces their ability to plan and coordinate their research activity. Reimbursements and payment mechanisms are similarly irregular with long time lags occurring

[17] In 2013, the NSF had a total budget of 5 million lev, the NIF of 10 million lev.

between approval to expenditure and reimbursement. There is no multi-annual planning capacity. In addition, accusations of corrupt practice against the fund including funding weak grant applications, and unfairly favouring those with close ties to the Fund[18] have seriously damaged trust in both the national and international communities.

The NIF on the other hand appears only a financial dimension within the SME Promotion Agency, which seems to have a clearer picture of its scope of action. But the NIF has also had sustained gaps in funding calls making funding very hard to predict for SMEs and it also lacks a multi-annual planning capacity. Once again, the elements that would help build trust and stability in the target R&I community are absent.

Neither the NIF nor the NSF appears to have designed synergy with the EU Framework Programme for Research and Innovation Horizon 2020 (H2020) into their programmes and calls.

There is a clear need to develop an independent agency capable of designing and implementing multi-annual research programmes. A simple merging of the two funds will not solve the problem. On the contrary, removing e.g. the NIF from the BSEMPA may have strong disadvantages as it would then be distanced from other funding instruments and activities e.g. cluster support and the OPs (in particular the OP Science and Education for Smart Growth and OP Innovation and Competitiveness). Similarly, putting science into the SME promotion agency would not work well. It is by any standard a different environment. A comparison with Poland with its PARP and NCBiR might be useful (see Case study below). There exist many other examples of such funding agencies elsewhere in Europe, with relatively limited resources which work well and are similarly in a process today of integrating more applied research and innovation[19].

Case study 2: Science, research and innovation supporting agencies in Poland[20]

The Polish system is relatively young. It was created in 2010 (last changes constituting the system). Agencies in those areas have a clear mission, that allows beneficiaries to use the services and support mechanisms without the risk of addressing the wrong body.

Polish Agency of Entrepreneurship Development (PARP) – responsible for pro-innovation services and environment in Poland (technology parks, National System of Services for SMS (including running the Innovation Portal)) and instruments for SMS willing to implement innovative solutions (uptake of innovative solutions, not R&D based innovation). Main beneficiaries – SMS, instruments in TRL[21] 9.

National Centre for Research and Development (NCBiR) – responsible for applied research and R&D based innovation. Calls based on National Research Program (adopted by the government as a result of dialogue with stakeholders from business and academia) but open for a new areas (i.e. sectoral programmes based on research agenda and financial contribution from the business – usually 50/50 model), what allows for supporting new, innovative ideas coming from business. Projects evaluated by experts from business and research (Polish and international), including interviews with applicants. Main beneficiaries – enterprises and consortia of entrepreneurs and researchers. Instruments in TRL 4-9, with the possibility to finance research in TRL 2-3 in a specific circumstances.

National Science Center (NCN) – responsible for basic research. Bottom-up calls (topics of projects defined by scientists) directed to the different groups of researchers (young, experienced, wishing to develop international cooperation or doing research in interdisciplinary way). At least 20% of funds should go to young scientists. Projects evaluated in peer review, according to ERC standards. Main beneficiaries – scientists.

Main features of the system:

- Support for beneficiaries – info lines, web pages, information days and workshops on project preparation, etc.
- Information to the beneficiaries (PARP and NCBiR) – beginning of each year the indicative calendar of calls is published on web sites of agencies.

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18 See for example http://www.nature.com/news/funding-protest-hits-bulgarian-research-agency-1.11902.

19 A good example is the Flemish FWO which will now integrate a large part of the research funds distributed in Flanders through IWT. FWO as national research fund has an excellent reputation and works well in collaboration with the ERC.

20 A similar model can be found in Austria: The Research Promotion Agency FFG (www.ffg.at) has an international reputation for professional support, combining national funding for applied research with EU and international competence; the Science Fund FWF (www.fwf.ac.at) offers funding for basic and blue-sky research based on exclusively international peer review – hence proposals need to be submitted in English; and AWS (www.awsg.at) provides financial solutions to companies.

21 TRL: Technology Readiness Level.

- Certainty of calls – NCN publish calls every year in the same way (every year call for young researchers, experienced, etc).
- Possibility of finding financing for developing ideas – common call of NCN and NCBiR allowing best projects from NCN to apply for financing from NCBiR (proof of concept kind of instrument).
- Support for full circle of innovation – possibility to find financing both for TRL 2-9 project, as well as only for TRL 9 or TRL 2-4.
- Support for IPR management – every agency has instruments supporting IPR managements, IPR elements as an eligible cost in NCBiR and PARP instruments.

What Bulgaria can learn from this:

- Need for a clear and communicated mission and objectives.
- Openness for innovative areas – possibility for stakeholders to co-create the calls agenda in NCBiR.
- Securing the financing for full circle of innovation and proof of concept projects.

To conclude, the Bulgarian design of research and innovation funding agencies has not yet resulted in the desired quality of governance and grant selection procedures. In particular, NSF is perceived to underperform, and previous reports have pointed to weaknesses in its governance, and the lack of an adequate framework for monitoring and evaluation[22]. In particular, there seems to have been a lack of competent and independent reviewers and of adequate conflict of interest regulations and/or enforcement of such regulations. Trust in the peer review processes and in the NSF in both the national and international community has been strongly tested, and will not be restored until the Bulgarian authorities are seen to be acting efficiently and promptly to address documented concerns and to take clear steps through reforms to ensure that trust is restored and maintained. Over the last months, some measures have been taken to reform NSF. We would urge the Bulgarian authorities to ensure that these reforms address the weaknesses pointed out in this and previous reports.

Recommendation #2.1

The PSF panel strongly recommends that the Bulgarian authorities pursue further efficient and transparent actions to address, respond and act on the concerns that have been raised related to the operation of the NSF, including the lack of competent and independent reviewers, adequate conflict of interest regulations and their reinforcement.

2.2.2. Restoring trust in grant review processes

To addressing some of the perceived deficiencies of the NSF, the Bulgarian government has drafted regulations on the monitoring and evaluation of the activities of the NSF. In short, the proposed system includes annual evaluations of the NSF's performance by a commission of seven independent experts appointed by the Minister of Education and Science. The evaluation will be based on submitted information such as lists of calls, programmes, reviewers/experts, call documents and decisions, complaints filed against NSF decisions, reports on the implementation of projects, lists of research infrastructures and patents. **The PSF panel welcomes this move and further suggests that in the process of designing and implementing such monitoring and evaluation systems, it may be useful for the Bulgarian government to consider some additional issues**:

- In order to restore trust in the peer review procedures, monitoring the enforcement of conflict of interest regulations should be a key task of the commission, and the independent experts would need specific expertise in this field and be trusted and regarded as independent by all stakeholders.
- The evaluators need to be given some leeway in what information they request and how they will perform their task, e.g. interviews/site visits, and observation of board and panel meetings may be considered necessary.
- The possibility of having one commission for monitoring both NSF and NIF (or one unit responsible for the evaluations of both funds), as it may help coordinating expertise and experiences across the funds as well as their ministries.

[22] Inputs for Bulgaria's Research and Innovation Strategies for Smart Specialization, The World Bank. February 2013 page 113.

Moreover, experiences from other countries may help as input to building a more robust funding body with impartial, transparent and efficient grant review procedures. Relevant input from Slovenia is provided below.

Case study 3: The Slovenian Research Agency and its grant selection processes

The Slovenian Research Agency, as by far the largest investor in basic science in Slovenia, was established by the Government of the Republic of Slovenia in 2004 and is by status a legal person of public law and indirect user of the National Budget of the Republic of Slovenia. The Agency has a wide range of funding instruments tailored for specific purposes which are designed mainly bottom up. The majority of the Agency's budget is distributed by public calls for research proposals. The main evaluation criteria are quality of the research outputs (scientific excellence), quality of a research programme proposed (peer review) and relevance for socio-economic development in Slovenia as well as established connections with the potential users of knowledge (business companies).

Slovenia has a centralised system of researchers' bibliographies and well elaborated system of bibliometric data monitoring. The national bibliographic system (COBISS) is connected with ISI Thomson Reuters and Scopus databases and therefore it provides reliable data about productivity of science which helps as an additional tool in evaluation process and especially in a pre-filtering phase (in case of a call for project proposals), in a stage of eligibility screening, when deciding who can be possible applicants for funding[23].

To be eligible for a particular call for proposals an applicant should obtain the minimum score which is set as an entry condition. Researchers who applied for the position of project leader, with the exception of postdoctoral project candidates, are required to have achieved a set of targets in number and quality of publications, number of citations and volume of cooperation with the business sector (or with other public funders). One of characteristics of the Slovenian Research Agency's evaluation system is two stage proposing and evaluation procedure in case of call for project proposals. Call for proposals for research projects is implemented in a two-phase manner, with approx. 1/3 to ½ of applicants entering phase II by invitation directly (best in their research fields based on an analysis of their five-year track record). And ½ to 2/3 of applicants entering phase II on the basis of peer review assessment done by foreign reviewers. Grant seekers that have reached second phase are then asked to resubmit their project proposals in more detailed for further peer review evaluation. Each proposal is sent to three foreign reviewers. The peer review system is the same as in the first phase (research qualification of grant seeker, project quality and social relevance). The mean score of three reviews is the basis for final decision about funding. Final priority list of projects is done by temporary expert body of the Agency for projects evaluation and international peers on panel session on the basis of the external peer review recommendations (remote reviews), comments and arguments of applicants on external reviews, and discussion on a panel session. Final decision is taken by the Scientific Council of the Agency which makes its decision on the basis of priority list proposed by a review panel.

The Slovenian Research Agency also provides monitoring and evaluation of the research programmes and projects implementation during every phase on the basis of annual and final research reports.

The head of the research programme or project is responsible for regularly reporting on the implementation of the research activities in accordance with the project contract. In the case of co-financed projects, the co-financer's written annual and final reports, including explanations of the potential effects of the project results, must be included in the assessment of the project realisation and the Agency may also request that the contractor submit a report on the economic and other social effects of project result application for five years after the end of the project.

The final research report on the results of completed research work mainly contain issues regarding to realisation of the proposed work programme and objectives, application of results, scientific (bibliometrics) and other research results, potential impacts of results and international cooperation.

The expert bodies of the Agency assess annual and final reports. The external (international) evaluations of the research programmes and projects are not part of the ex-post evaluation procedures but through their results strongly influence the grant selection processes[24].

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[23] For further information consult the Slovenian Current Research Information System (http://www.sicris.si/public/jqm/cris.aspx?lang=eng&opdescr=home).

[24] More on negative effects: Franc Mali, Why an Unbiased External R&D Evaluation System is Important for the Progress of Social Sciences-the Case of a Small Social Science Community, Social Sciences, 2013, 2, 284-297.

The Agency must inform the public and users about the results of completed programmes and projects via the Agency website, in internal communications, public media, and at public panel discussions and conferences organised by the Agency. The final research report is accessible online in the Slovenian and English languages – SICRIS database[25]. There are presented full information's on researchers bibliometric profile, description of significance for science and for socio-economic development of Slovenia, and most important scientific and socio-economic and culture relevant results for each of the research programmes and projects financed by public funds.

If the Bulgarian authorities feel that trust cannot be rapidly resorted in the present system of project proposal evaluations then they could consider outsourcing some or all of their evaluations to an external independent body e.g. the European Science Foundation ESF (See case study below) or the EC H2020 peer review system. However, this approach would not be without significant cost and has generated controversies when used in Portugal. The PSF panel would only recommend this approach for more than very short term usage if it can be combined with internal capacity building e.g. by agreeing with EC for national funding agency staff to be seconded to Brussels to learn the business of independent, transparent and merit based review.

Case study 4: ESF peer review service

ESF have developed three main services to support organisations undertake peer review from call preparation to selection and feedback to applicants.

1. **Basic Package**: provision of written expert reviews in the frame of an already defined call. Under this package, call management, final selection and funding decisions are conducted by the client organisation.
2. **Intermediate Package:** full scale elaboration, management and implementation of the scientific assessment process, resulting in prioritised list(s) and funding recommendations.
3. **Full Package:** end-to-end peer review process elaboration and implementation, from call management (gathering and handling of proposals) to final funding recommendation**s.**

In addition to these three packages, ESF can also provide tailored ad hoc services to meet specific requests from client organisations.

For more information see:
http://www.esf.org/fileadmin/Public_documents/Publications/peer_rewiew.pdf

In summary, tools and instruments for RTI policy and research funding should be based on predictability and transparency. At present, Bulgarian RTI policy and funding schemes seem to suffer from lack of both, and the research community from a lack of confidence in the fairness of funding allocations and in the peer review system. Transparency, predictability and the involvement of high-level expertise/international peer review will be critical for restoring confidence and trust among researchers. Predictability and transparency represent the basic building blocks in the implementation of new rules and practices including fair evaluation exercises according to international practices. This should include adequate and transparent conflicts of interest regulations, proficient enforcement of these regulations as well as adequate feedback to the researchers. Professional management and learning from the experiences in other countries will be needed in order to develop a reliable review system in line with international standards for expert assessments and transparency, and securing trust in the project selection procedures.

[25] http://www.sicris.si/public/jqm/cris.aspx?lang=eng&opdescr=home&opt=1.

Recommendation #2.2: National funding schemes and review processes

Bulgaria should strongly improve the process of peer review and in particular ensure it comes as rapidly as possible in-line with international standards for expert assessments and transparency. At present, the national research community in Bulgaria suffers from a lack of confidence in the fairness of funding allocations and in the established peer review system for the evaluation of projects. Solid processes to peer review project proposals are critical to restore confidence and trust among researchers. This may mean outsourcing part or all of the process to an external agency such as the EC or ESF while simultaneously building internal capacity and national trust. Independent international Ex post evaluations of programs are also recommended alongside the use of Policy and Programme Evaluation groups to help build trust and impact of existing or new Agencies.

2.2.3. The creation of the Promotion Agency for Research and Innovation (PARI)

The proposal of the Ministry of Education and Science to establish a new state agency (PARI) to help implement policies and coordinate funding sources for research is broadly welcomed by the PSF panel. Given the lack of management capacities and the limited size of the present funds, both a close collaboration and coordination between funds and the creation of professional support facilities, which would also manage the structural funds, seems needed. It should create critical mass, professionalism in management and also bring more credibility and trust in the peer-review mechanism. However, the panel raises the following concerns with respect to the present proposal for PARI:

- The new Agency only concerns the National Science Fund (NSF) and it excludes the allocation of ESIF funds linked to ISSS.
- As it has been defined it is not a truly research funding agency but mainly a European Promotion Agency.
- It should be the counterpart of the Bulgarian Agency for the promotion of SMEs (under the Ministry of Economy) and define their areas of action/intervention based on the funding instruments available.

More detailed comments on the Agency have been included as Annex 2.2.

Bulgaria may also consider regular international evaluation of activities run by the Agency to help build trust in its correct functioning and also to enhance its performance. Such an exercise might take the form of regular ex-post evaluation of programmes, as have been undertaken in Croatia[26], or more continuous monitoring of activities. In both cases, Bulgarian membership in the Working group on Research Policy and Programme Evaluation should be helpful (see text box below).

Example: Working group on Research Policy and Programme Evaluation

Research Policy and Programme Evaluation refers to the analyses and assessments carried out by research organisations to inform their strategies and help with their management and funding decisions. Such analyses can also be performed for the purposes of accountability to policymakers and the public. Evaluation activities support the efficiency, quality and impact of a research organisation's operation. Potential objects of evaluation are: research funding agencies, research institutes, funding policies, research fields or scientific disciplines, funding schemes and research grants.

The Working Group brings together a large number of evaluation experts from Science Europe's Member Organisations to work on the evaluation objectives laid out by the Science Europe Roadmap. Ultimately, the ambition of such work is to foster enhanced research evaluation activities within Member Organisations.

In particular, Member Organisations use the Working Group as a platform for the continued development of evaluation activities, to explore the alignment of evaluation methodologies and to contribute to the development and implementation of standards for the definition, acquisition, storage, analysis and sharing of evaluation-related data. Moreover, the Working Group is the voice of policy evaluation experts within Science Europe.

[26] Ex Post Evaluation of BICRO's Technology Programmes (PPA-CS-XX) Final Report to the Ministry of Science, Education and Sports of the Republic of Croatia Fritz Ohler, Technopolis Group Austria 2014 02 17.

The improvement of research evaluation activities within Member Organisations serves two main strategic objectives of Science Europe:

Facilitating science – by improving the evidence base at the disposal of policy makers, and by supporting the production of more effective strategies; and

Communicating science – by increasing transparency regarding the contributions of research and the research system to scientific, socio-economic, cultural and other progress, and by supporting Science Europe in framing its policy message.

For more information see: http://www.scienceeurope.org/policy/working-groups/research-policy-and-programme-evaluation

Recommendation #2.3

The panel supports establishing an independent, robust agency, capable of designing and implementing multi-annual research programmes with impartial, transparent and efficient grant review procedures. The panel supports that the agency is built with an implementation-driven mission and that it should take a leading role in connecting the funding for the relevant policy fields both horizontally and vertically. The Agency should also manage the structural funds, create critical mass, achieve professionalism in management and bring credibility and trust in the allocation and management of funds. However, the Bulgarian authorities are urged to address the concerns raised by the PSF panel regarding the proposed PARI (as outlined in Annex 2.2). The PARI proposal should be upgraded to cover for such a professional, independent and robust national research agency.

2.2.4. European funding instruments and coordination across Bulgarian funds

Bulgaria's performance in the Framework Programmes has been poor especially in relation to other "new" Member States of similar size. The total income since the beginning of Horizon 2020 has been €8.6m. In comparison, countries with smaller populations have been capable of attracting more H2020 funding: Croatia (€9m), Slovakia (€9m), Latvia (€9m)[27]. Participation in ERA-net joint calls is also lower than in comparable countries (e.g. Romania), and there is a general view that Bulgaria has been pulling out of co-operations (e.g. an ERIC infrastructure) rather than engaging in new European scale co-operations, due to a lack of national funding priority.[28]

Proposals to Horizon 2020 are judged on three evaluation criteria: Excellence, Impact and Implementation. There is no doubt that excellent science is a prerequisite for success however this is not sufficient. Scientists often do not appreciate fully the other criteria nor understand properly how to address them. This can be addressed by encouraging more scientists to register as Experts in the H2020 database that will give them the opportunity to be part of the evaluation process.

A national support structure for Horizon 2020, advising research institutions and companies on how to apply successfully has not been established. Other countries that are making clear preparation for supporting stronger participation in H2020 include Poland (see case study below on the 'Pact for H2020'). This may be a useful example for Bulgaria to examine, particularly as it may offer a way to reinforce other recommended reforms e.g. the European Charter and Code for Researchers.

[27] Data from Austrian Research Promotion Agency (FFG): http://eupm-portal.ffg.at/.

[28] The panel uses participation in EU funding schemes, networks and joint calls, and co-operation with companies and intermediaries as a proxy to identify the internationally competitive sectors of the Bulgarian research system.

Case study 5: Pact for Horizon 2020 – PPP intended to increase Polish participation in Horizon 2020

In order to increase Polish participation in Horizon 2020 the MSHE (Ministry for Science and Higher Education) prepared a "Pact for Horizon 2020". This document is an example of public-public partnership intended to create favourable conditions for researchers and PRO's to participate in Horizon 2020 calls.

By signing this document, higher education institutions, the institutes of the Polish Academy of Sciences and other research institutions formally recognise that fostering the widest possible participation in Horizon 2020 framework programme calls is a priority in their development strategies.

They particularly commit themselves to:

- building an effective organisational and administrative infrastructure, providing support to researchers and research teams which apply for and receive funding from the Horizon 2020 programme;
- awarding and including Horizon 2020 activity in evaluation and academic promotion procedures—particularly for European Research Council grantees and European research project co-ordinators; furthermore, it is also key to encourage Polish experts to work as evaluators in European calls, become members of European academic bodies, and participate in the most important academic conferences;
- initiating and supporting partnerships between entities from science and economic sectors to bolster participation in Horizon 2020;
- creating optimal conditions for Polish higher education institutions and institutes to engage in research projects funded through Horizon 2020, but acquired abroad – in particular such projects in which Polish researchers and entrepreneurs work in foreign research centres;
- accepting and abiding by the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, which is an important formal requirement in many European grant calls.

In order to strengthen the efforts made by PRO's, the MSHE will implement a system to identify, provide effective support and rewards for scientists, research teams and consortia which apply for research funding within Horizon 2020. The Ministry particularly commits itself to:

- ensuring the crucial role of research and innovation in operational programmes funded through the European Union's cohesion policy;
- ensuring the synergy of initiatives carried out within Horizon 2020, as well as national and regional operational programmes;
- supporting the participation of Polish experts in European initiatives advisory, working-group, and policy bodies, including Horizon 2020 bodies
- working on changing the mechanisms of parametric evaluation of higher education institutions, conducted by the Scientific Unit Evaluation Committee (KEJN), to more widely include participation and achievements of higher education institutions in Horizon 2020 calls;
- introducing direct Horizon 2020 support mechanisms for Polish researchers —"Grants for Grants" programme which funds the preparation and pre-evaluation of applications co-ordinated by Polish participants and a financial rewarding mechanism for researchers who carry out projects in Horizon 2020;
- improving the model of services provided by the National Contact Point (KPK) and Regional Contact Points, by putting stronger emphasis on identifying potential applicants and on their direct support through mentoring;
- obligating research-funding agencies supervised by the Ministry of Science and Higher Education—National Centre for Research and Development (NCBR) and National Science Centre (NCN)—to identify research projects with the biggest potential and to ensure individual support for prospective applicants;
- obligating NCBR, NCN and KPK to promote best practices in applying for Horizon 2020 funds, and to support building interdisciplinary research teams;
- carrying out an extensive information and promotion strategy focused on the participation of Polish project creators in Horizon 2020.

The "Pact for Horizon 2020" was signed so far by more than 350 PRO's and their organizations. In Spring 2015 MSHE carried out the evaluation of the Pact, its results will be made public during September's conference on Polish participation in Horizon 2020.

For more information see: https://www.nauka.gov.pl/en/polish-science-news/ministry-of-science-encourages-to-sign-the-pact-for-horizon-2020,akcja,pdf.html

And http://horizon2020projects.com/policy-research/polish-science-ministry-encourages-pact-for-h2020-signing/

The PSF panel also suggest that Bulgaria find ways to strengthen their participation in other EU initiatives. Actions that Bulgaria should consider include providing funding for travel grants to meet collaborators; providing dedicated funding for coordinators to prepare proposals; establishing an Science/ EU Funding Liaison Office in Brussels and establishing a professional fulltime National Contact Point Network.

The National Contact Point (NCP) Network for each country is there to provide information and support to applicants. In Bulgaria, the NCP's are part time and this restricts their ability to provide in depth support to prospective applicants. In other countries the NCP's are fulltime and usually hired by one of the national funding agencies. The impact of having fulltime NCP's can be significant and make a real difference to success. An approach to improving the impact of the NCPs in Portugal is outlined below as well as one from Ireland.

Case study 6: Professionalization of the NCPs in Portugal

Until 2007, Portuguese National Contact Points (NCPs) and delegates to the committees in the Framework Programmes (FP) were mostly members of the research community with a loose coordination from responsible Ministry and funding agency. In 2007, the Ministry took the decision to create an office with fully professional NCPs, working full time in exclusivity as NCPs to avoid conflicts of interest. The office "GPPQ" was created with 12 staff and since then it has been increased to 19 NCPs and a national coordinator. The office also closely coordinates the delegates to the FP committees, keeping them informed and aligning common positions on horizontal issues. Some of the senior NCPs have gradually become national delegates to most of the committees, ensuring a seamless flow of information between committees and national stakeholders.

The mission of GPPQ is to create awareness in the research and business communities on the Framework Programmes activities, through mutual coordination of national delegates to the committees, the network of NCPs and the representatives to the European joint Initiatives. NCPs also support the preparation of research proposals, provide training on how to submit good quality proposals, etc. The aim is to increase the share of Portuguese participation in the European calls and the corresponding financial return, while encompassing excellence in research and innovation.

Although the creation of the GPPQ, the professionalization and the work of the NCPs cannot be scientifically proven to have a causal relationship regarding the increase in the success rates, it is observed that the success rates of the Portuguese participation are approaching EU 28 average, and in Horizon 2020 they are already above the average (see: http://www.gppq.fct.pt/h2020/participacao_pt.php). The same positive trend is observed on the share of Portuguese participation in the total available EU funds. The share has increased from 1,03% in 2007, to 1,26% in 2013 and in 2015 it has already reached 1,76%.

Case study 7: Ireland's National Contact Points network

During FP6 the NCP's were part time but there was one exception. In 2003 a fulltime NCP was hired to support access to the Marie Curie Actions. The result was that the funding for Marie Curie in FP6 was €55 m, double that of the funding for that programme in FP5. The total income to Ireland from FP6 was €200 m (from the total of €17.5bn over 4 years) meaning that Marie Curie accounted for more than 25% and was more than the ICT and all other programmes. The evaluation of Ireland's performance[29] in FP6 made a number of recommendations that included:

- *Encourage increased levels of participation by Irish researchers within the FP evaluation process, in order to enable an improved understanding of how it operates and how to maximise chances of success*
- *Increase the use of dedicated (professional) management support, to assist in the development of proposals, drawing up of contracts, and management of large-scale projects*
- *Provide more flexible forms of financial assistance, including the option to claim travel grants retrospectively and selective provision of matched funding in strategically important areas to support FP participation*

A fulltime NCP network was established within Enterprise Ireland that set clear targets for each programme and an overall target of €600m for FP7 (from the total of €55bn over 7 years). The result was that Ireland's annual take rose from €50m in FP6 to €86m in FP7. This was during the 2007-2013 period when Ireland went through reductions in the number of academics and researchers. There is no doubt that the introduction of the professional NCP network along with funding support and the Brussels Liaison Office was responsible for this increased success.

[29] Evaluation of Framework Six Programme in Ireland, Forfas 2010, http://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/national_impact_studies/forfas_evaluation_of_fp6_in_ireland_condensed_report_2009.pdf.

National funding schemes do not seem to be complementing or preparing for the use of EU instruments. This evidence applies also for the use of the European Structural and Investment Funds (ESIF)[30] that allow for co-financing of regional investments, particularly in infrastructure, in a financial capacity far beyond the scope of the two national funds.

A major criticism from the research community that is probably shared in many EU countries relates to the preference of EU instruments[31] for green field investments and the growing difficulties in finding support for the valorisation and regular upgrade of existing infrastructure investments.

In the short term, one idea could be to include within the overall Bulgarian research infrastructure plan a sort of *Action Plan for Horizon 2020* to encourage effective participation of Bulgarian researchers into European networks and increase their success probabilities. In the medium and long term such public investments in research and innovation should be sustainable over a period of time to be effective and so as to fully take into account the maintenance costs of research infrastructure. That includes the definition of specific instruments to capture the opportunities of ESIF on research and innovation.

Coordination across Bulgarian Funds may provide opportunities through the design of specific instruments including collaborative and research oriented projects within the national priorities identified through the Smart Specialization Strategy (commonly referred to as S3 or RIS3 and also known in BG as ISSS or IS3). However, in the absence of effective mechanisms and tools, with clear rules of participation and evaluation and clear targets and expected outcomes, the Bulgarian research and innovation system will unfortunately neither benefit nor contribute to the country's Smart Specialisation Strategy. Certainly stakeholder evidence raises doubts as to the absorptive capacity of what the ESIF could leverage in Bulgaria, in the case that national funds are placed in line with the thematic investment priority areas stated in the Bulgarian ISSS. Yet, if communicated sufficiently broadly to all various R&I stakeholders, the ISSS could match both public and private national R&I investments with EU co-financing.

In short and covering both the opportunities for better using European funds as well addressing the infrastructure gap, there are several options to increase the impact of those instruments in the short term: (1) ***matching funds*** to those proposals that have been highly rated within different EU programs but did not reach the required level for EU funding[32]; and (2) ***co funding*** schemes and specific instruments linked to ESIF[33].

On the PRO side, a clear funding portfolio with a division of basic and competitive funding shares would be needed, while on the funding agency side, there is a strong need to establish a strategic overview of all funding instruments available to companies and PROs in Bulgaria. Competent and multi-level funding support is key to give Bulgarian researchers access to maximise the leverage.

As outlined in section 2.2.3, there is a current initiative to establish a new state research agency (PARI). One intention is to facilitate and support Bulgarian participation in EU and international research programmes, and the plans seem an important step to the PSF panel in addressing the Bulgarian challenges in preparing for and enhancing the use of EU instruments.

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[30] In 2014-20, research and innovation is a top funding priority particularly in the European Regional Development Fund (ERDF), but also in the Agricultural Fund for Rural Development (EAFRD). Also the European Social Fund (ESF) would provide funding opportunities for employability measures and higher education.

[31] Neither the ESIF (European Structural and Investment Funds) nor the new EFSI (European Fund for Strategic Investments) allow for the valorisation of existing investments.

[32] In Spain one has recently introduced similar schemes and noticed their positive returns as well as behavioural incentives provided.

[33] While national funding can always follow-up on positively evaluated but unfunded H2020 proposals, ESIF can only match or co-fund those research and innovation projects that are in line with the IS3 priorities. It is therefore essential for an independent BG funding agency to build the capacity to match and combine available funds from sources at all levels.

Recommendation #2.4: Europeanising funding capacities and matching-funds

The panel recommends that Bulgaria establishes a Science/ EU Funding Liaison Office in Brussels and a professional fulltime National Contact Point (NCP) Network. Both actions will contribute to reinforcing the capacities of national researchers and teams to successfully take part in EU funding programmes. The government should support the new Agency in setting up a matching-funds scheme that provides national funding to Bulgarian proposals that have been positively evaluated but that were below the threshold to receive funding from the EU and other similar sources. The forthcoming introduction by the European Commission of the 'Seal of Excellence' for Horizon 2020 proposals evaluated as excellent but not funded enables regions and countries willing to support excellent 'ready to fund' projects in their Smart Specialisation priority areas (via Structural funds). Bulgaria should set up the adequate mechanisms to capitalise on such opportunity. Finally, targeted support should be foreseen for potential participants in European programmes to acquire and/ or reinforce their abilities in preparing and managing European RI projects, including the preparation and coordination of proposals and promotion of projects or the hiring of experts for punctual advisory tasks.

2.3. Funding and evaluation of PROs

The Bulgarian university system is funded partially like many others in Europe. That is, block funding on the basis of the number of students rather than on the basis of performance. The current system for funding *research* has two components. The first is a fixed amount allocated to each institution based on academic headcount. This is given regardless of the research activity of the staff member or university. The second is a limited competitive fund from the NSF (see section 2.2.1). In total, taking the University of Sofia as an example, the total annually research funding from the government is about €1.5m. This is clearly inadequate for supporting research. Moreover, as far as the institutions receive funding from the NSF, this covers only direct costs, meaning that there is no funding foreseen to cover for indirect costs. This is borne out by the lack of research management and administrative capacity of the universities (as discussed in Section 2.4). Among the 50+ universities and HEIs[34], there are only a small number that have significant research activity.

In several reports on Bulgaria, there are recommendations to change and introduce legislation to control the development of the Higher Education sector.[35] One of the topics high on the agenda is performance-based funding. A World Bank report from 2013 recommends that 'funding would be allocated on the basis of regular, independent monitoring and evaluation of each PRO's performance'[36]. As a first step towards a performance-based system, the Bulgarian government has drafted regulations for monitoring and evaluating the research performance of higher education institutions and research institutes (and as referred to above on the NSF). According to these regulations, there will be an annual evaluation of all institutions. According to the plan, a commission of 13 independent experts appointed by the Minister of Education and Science will be responsible for evaluating the research performance of all institutions, based on fixed metrics.

The Bulgarian higher education and research system would undoubtedly profit from the higher concentration of resources that performance-based funding schemes, performance contracts or other measures to reward high performance are likely to generate. Competitive funding may be an important stimulus for change. However, in designing such measures, it is vital to obtain both a broad and long-term consensus, so that the institutions are offered relatively stable and predictable funding conditions in which they can develop long-term strategies, and also to ensure that the new system and associated performance indicators are implemented. Bulgaria seems to have achieved consensus on the need to introduce performance-based funding. The challenge is now developing the funding model and effectively implementing it. Nuanced/sensitive indicators and adequate management systems and databases (for the performance metrics) are essential for the trust in and transparency of performance-based funding. Hence, stakeholder participation in the development of review criteria and parameters for funding needs to be assured, and the implications of alternative models need to be properly analysed, including testing/simulation of implications of alternative funding models before implementation.

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[34] According to the Registry of Accredited Higher Educational Institutions in Bulgaria, maintained by the Ministry of Education and Science, the total number of higher schools is 52. A total of 42 of them are universities, of which 37 are public universities.

[35] The World Bank. February 2013: Input for Bulgaria's Research and Innovation Strategies for Smart Specialization; HEInnovate Reviews. Universities, Entrepreneurship and local Development. Bulgaria 2014 (http://info.technopolis-group.com/HEInnovate_Bulgaria/HEInnovate_Bulgaria_final_report.pdf).

[36] The World Bank. February 2013: Input for Bulgaria's Research and Innovation Strategies for Smart Specialization, page 18.

Taking the 10 principles in the Leiden Manifesto[37] for research metrics as a guideline, the present Bulgarian draft of criteria and indicators for evaluating the research organisations are clearly inadequate. As an example, indicators based on simple citation counts or h-index do not account for variation by field of research. Field or journal normalised indicators would be needed. Notably, in the survey performed for the PSF panel, respondents commented on the need for criteria and evaluation systems adjusted to the specific field of research. Moreover, there is a need for common, open, updated and quality ensured databases providing the information for the evaluation to ensure transparent and efficient monitoring, rather than requiring all institutions submitting hardcopies of data.

So far, there is no model for how the metrics or the conclusions of the experts could be converted to funding, which is reasonable, as any model should be tested and adjusted before linked to funding implications. As input to the further development of the model, the PSF panel would like to point to a number of challenges in the present draft regulations.

- The units and periods of evaluation will need to be defined. Metrics-based models are most often annual and the evaluation unit may be the university or an independent research institute. Peer review based models may be performed every 4-6 year, and the evaluation unit may be the individual departments or fields of research. In order to ensure predictability in funding and avoid large fluctuations, a multi-year data period may need to be taken into account (even if annual assessments as in metrics based models). It should be noted that whereas many countries have annual reporting and monitoring of research performance (with or without funding implications), few, if any, have an annual comprehensive/full scale evaluation including expert panels. Such an annual activity would be too time-consuming and expensive.
- The role and level of discretion of the experts will need to be clarified. If the model is intended to be based on peer review (not only metrics), there will be a need for international reviewers to ensure impartiality and trust in the assessments. There will be a need for more than one committee to handle assessments of research within all different fields of research. In as far as the model is intended to be based on metrics only, the expertise involved should be science metrics and bibliometrics.
- Transforming criteria to metrics for funding in a way that provides fair competition between different kinds of PROs and between different fields of research, is a major challenge in any model for performance based funding. One main issue in the Bulgarian model would be how to include publications not covered in international databases (including effective classification and quality assurance of data), and so to provide fair assessments of research within e.g. the various fields of social sciences and humanities. And as already mentioned, if citation indicators are included, they need to be field-normalised. Moreover, one may introduce different weights for different sets of indicators for the various kinds of PROs depending on their mission.

Different ways of dealing with these issues, and some discussion of pros and cons, can be seen in the recent reports presenting models for performance based funding develop for e.g. Sweden[38] and the Czech Republic[39].

It should be emphasised that designing a good model for performance-based funding is a demanding and complex task, and there are multiple aims to take into account: Models should enable strong research environments to develop, help in developing institutional accountability as well as autonomy, foster research-based education, and meet the needs of industry, and of course avoid unintended/negative consequences. Hence, developing performance based funding is a long-term complicated process, and in addition to stakeholder involvement, expertise in research metrics and research evaluation is needed.

In designing their model, Bulgarian authorities should profit from the experiences of the many countries which have already introduced performance-based funding, adjusted to their national contexts, policy aims and needs. Some of these are based on quantitative indicators, others on peer review or a combination of quantitative indicators and peer review, and finally, some on dialogue and performance contracts. The options range from the UK Research Excellence Framework (REF)[40] based on peer review (every 6th year), to the formulaic approach of the Australian Research Block Grant (annual calculations)[41]. The former is less relevant as it relies on

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[37] The principles are outline at http://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.17351.

[38] https://publikationer.vr.se/en/product/research-quality-evaluation-in-sweden-fokus-2/.

[39] http://metodika.reformy-msmt.cz/souhrnna-zprava.

[40] http://www.ref.ac.uk/.

[41] https://education.gov.au/research-block-grants.

an already highly developed and functioning research system. The latter does provide a straightforward method for distributing funding based on clear and measurable criteria, such as research income, research publications and student completion. A starting point for input from the experiences in other countries could be the evaluation and monitoring approach in the Slovenian Research and Innovation Strategy, presented below. This is a general evaluation and monitoring system, which so far is not linked to funding, and hence avoids the complexities and potential negative impacts of performance based funding.

Case study 8: Evaluation and monitoring in the Slovenian Research and Innovation Strategy

Two years ago the Slovenian Research and Innovation Strategy for the period of 2011 – 2020 has been adopted by the Slovenian Parliament. Strategy puts a lot of emphasis on the RTD evaluation activities which have been seen as a precondition for enhancing RTD quality and smart specialisation of research community in Slovenia, on the one hand and for competitive distribution of limited budgetary funds, on the other hand.

One of the fundamental characteristics of Slovenian RTD evaluation system is not only fragmentation of evaluation activities which have been limited on evaluation review of funding applications and on their results and impacts, but rather absence of institutional evaluation and evaluation of STI policies and their instruments. Therefore some concrete measures of RTD institutional and policy evaluations are put forward in the current Strategy, such as establishing a comprehensive system to evaluate the research activities of public research organizations, including universities, as well as annual independent monitoring and reporting to the Government and Parliament on the implementation of national strategy by various actors and governmental policies.

In order to ensure adequate monitoring of the functioning of the research and innovation system, efficient institutional evaluation is needed that takes into account a wide range of indicators. The strategy emphasise that independent external evaluation of results and impact in scientific fields (and not based exclusively on quantitative data), is needed. One set of indicators will be aimed at measuring the scientific excellence of the institution and international visibility of the basic research work. Another set of indicators will address cooperation with the users and will measure social relevance of the research work. In accordance with the mission of research organisations, the latter will be more prominent in the evaluation of research institutes and will, among other things, take into account revenues from licensing, number of patents in patent office's performing a complete test, number of spin-off projects from the public research organisations and applicative success of the public research organisations.

The Bulgarian authorities may furthermore wish to consult the experience of Croatia who has just moved towards performance based funding, and Austria who have a longer established history of multi-annual performance agreements as well as the recent example of Poland (see case study further below). Moreover, the Research Excellence Framework in the UK includes methods for assessing knowledge transfer and innovation (see case study in Chapter 4). Competitive funding schemes for research centres are another approach to concentration of resources on the best research environments, which at the same time ensures some predictability in funding. An example of such multi-year funding scheme is given in the Portuguese case study below.

Case study 9: Multi-year funding scheme for research centres in Portugal

A programme was implemented in Portugal in 1990s, when the national research council centres were integrated in the universities and their public funds had begun to be allocated competitively based on international evaluations, with good results. The aim of the programme is to support the strengthening of public and semi-public research institutions and the enhancement of the quality of research, by building on their research capacity and by accommodating the wide diversity of centres in terms of size, legal status, and number of autonomous units contained in each of them.

The Multi-year Funding Programme is the key programme for the evaluation of quality of public and semi-public Portuguese research centres, by international evaluation panels. The volume of funds awarded is mainly determined by the evaluation ratings, by the number of doctorate holders part of each centre, and by the strategic plan of action. The management of the programme comprises regular monitoring and evaluation of the activity of research centres. The assessment is based on a report and strategic plan of the centres, as well as on site visits, which include meetings with staff. Bibliometric indicators are also taken into consideration. After each assessment, the centres are awarded a qualitative grade, from poor to excellent.

More information on this funding scheme and other national schemes promoting research excellence is available in OECD (2014): Promoting Research Excellence: New Approaches to Funding (http://www.oecd.org/science/promoting-research-excellence.htm).

When introducing performance-based funding, it is most important to maintain a base level of funding to enable all institutions to pursue research and scholarship activities. Reducing the institutional funding implies depriving the institutions of the ability to make any progress in research. At the same time, in a fragmented HEI landscape like the Bulgarian one, it is also an option to use (new) performance based research funding on concentrated research activities (e.g. in terms of multi-year centre schemes, see Portuguese case study above) or to urge the PROs to collaborate or merge, rather than to disperse funding on a large number of uncoordinated activities. **In this respect, a key issue in introducing performance-based funding is how to balance the need for concentration of resources versus the need to ensure predictable funding and general good conditions for research performance**. And as noted above, the funding implications need to be properly analysed in advance to avoid unintended impacts, and stakeholder involvement is needed. The Polish case study below focuses on these concerns.

Case study 10: Introduction of performance based funding in Poland

The current Polish scheme for Performance Based Funding was introduced in 2010. The scheme is based on the results of performance evaluation of the PROs that is due every four years. The evaluation is performed by a group of experts on the basis of four categories of performance metrics: scientific excellence, research potential, innovation activities and social activities.

Scientific excellence – i.e. publications, international projects,

Scientific potential – infrastructure, human capital,

Material results of research and scientific activities – i.e. patents, commercialization of knowledge, transfer of technologies,

Other activities – i.e. social activity, popularization of science.

The result of the evaluation is valid for 4 years and divides all PROs into 4 performance categories, A+, A, B and C. Every year, in order to distribute the statutory funding the ministry collects additional data (number of research staff) and defines the cost intensity of research in each research field. Using a published algorithm the ministry combines the results of the performance evaluation and the additional data. The result of the algorithm defines the amount of money each PRO gets from the central budget as a statutory funding. The model includes some safe catches that prevents the situation that a given PRO gets extraordinary high or low statutory funding.

Cornerstones of the system are:

The system is implemented in dialogue with the stakeholders (and introduced by the minister responsible for science).

The criteria for evaluation was defined by the Committee of Evaluation of Research Organizations (KEJN) and adopted in a law by the minister responsible for science.

KEJN is composed of representatives from different scientific areas, that discuss criteria for a given group of research organizations (life sciences, humanities, etc.). Hence, the model provides field-adjusted evaluations.

Some period of time between the publication of the law and the evaluation itself allowed the PROs to improve their performance before the evaluation (the law was published in 2012, and the first evaluation carried out in 2014).

Evaluation procedures and criteria are monitored and improved – after the first evaluation the criteria are being discussed and better aligned with the properties of every area of science, international cooperation and commercialization technologies will be more important. This process will end in 2015, defining the criteria for the 2017 evaluation.

What Bulgaria can learn from this:

Performance based funding needs to be implemented with a timeframe allowing stakeholders to cope with its requirements.

Researchers need to play an important role in the system.

System needs to have visible differences between the levels of the financing.

More generally, public research organisations in Bulgaria appear unable to deal with many of the challenges facing a modern university or research institution. Most universities and research institutes are still impeded by old bureaucratic practices and a lack of professional management for their daily effective and efficient administration. It is recommended that Bulgarian public research organisations professionalise their management, and develop and implement (their own) research strategies, including priority-setting. Such strategy development should take place only against the background of their funding according to proven performance. Integration and synergies between the various public research institutes should also be encouraged to build critical mass and avoid overlaps and duplications of resources.

Recommendation # 2.5: performance-based funding for PROs

The present model for funding Bulgarian higher education and research organisations is clearly inadequate when it comes to supporting research and encouraging building up high-level research environments. The PSF panel recommends to move to a progressively higher concentration of resources based on performance-based funding, to facilitate transparent, fair and efficient allocation of resources and enhancing incentives for high research performance. It should be a system recognising the binary nature of the Bulgarian system (with a separation between research institutes and higher education teaching establishments). Measures rewarding high quality such as performance-based funding schemes or performance contracts should be used.

In order to develop such a model, the panel therefore recommends that Bulgaria considers specific support under the Policy Support Facility to provide concrete recommendations as to how to address this issue. The government should try to achieve broad and long-term consensus and find criteria/indictors that are adequate for (or adaptable to) all fields of research. The model should offer the institutions predictable funding conditions, and in order to avoid the many pitfalls of performance based funding, implications of alternative models need to be properly analysed before implementation. In order for the PROs to adopt the model and take action to improve performance, at least one pilot or test year should be foreseen before introducing actual funding implications. Building strong and well-managed higher education and research institutions should be a prime objective of the funding model. In case a model including peer review is chosen, the use of international experts is highly recommended in order to avoid conflicts of interest.

2.4. PRO management and governance

Stakeholders both from within the universities and in their surroundings consider that the universities and Bulgarian Academy of Sciences are not up-to-date with the challenges of a modern university/research institution. The lack of a solid structure of management is clearly shaping universities' performance and their abilities and capabilities to progress. Universities in Bulgaria are not currently proactive actors and they seem sometimes on the verge of collapse surrounded by old bureaucratic practices. The same is true for most of the institutes of the Academy of Sciences.

The researchers need a well-functioning institutional environment with the capacity to facilitate research, handling Horizon 2020 applications and projects, IPR/other legislation, offer training in research project management and facilitate interaction with industry and international relations. More fundamentally, the fragmented institutional landscape does not permit the critical mass and administrative and financial resources needed to attract and recruit the staff needed to develop strong research environments. Professional management is the required condition for effective and efficient PROs administration.

In addressing the challenges at the institutional level, all universities and BAS centres would need to produce strategic plans on Research and Innovation, Knowledge Transfer and Public Outreach (showing how the institution serves society and the economy), Governance and Management. A strategic plan would mean that institutions would have to prioritise and set clear goals with metrics for success. Of course, it must be emphasised that this will only make sense if significant funds are made available. This would be part of the process of securing research and other funding for the institution.

One important element of the plan would be the introduction of a professional management of research and knowledge transfer in the institutions. Highly successful universities have a well-resourced Research Office (usually under the direction of the VP for Research) that provides support to academic staff competing for national and international funding schemes. Such a professional layer can bring real added value with specific expertise in grant application procedures and management thereby allowing academics to spend more time engaged in research activities.

As outlined in Section 2.3, the funding model should encourage the building of strong and well-managed institutions with the ability to prioritise and build strong research environments. In general, there is a need for policy instruments encouraging integration and synergies, and avoiding fragmentation, in the R&I system.

Recommendation #2.6: Management and governance of PROs

It is recommended that Bulgarian PROs professionalise their management of research and knowledge transfer, and develop and implement (their own) research strategies, including priority-setting and clear metrics for success. Strategy development should take place against a background of policy instruments that encourage integration and synergies. ***Integration and synergies between the various public research institutes should also be encouraged*** *to build critical mass and avoid overlaps and duplications of resources.*

2.5. Summary and conclusions

Predictable sources of funding and efficient funding agencies are particularly important in the Bulgarian system where the universities themselves have little or no funding available to run research projects, and companies are very short of financial instruments to help them to innovate. However, there seem to have been major challenges in establishing funding agencies with sustainable budgets and efficient, reliable and trustworthy operational procedures. Coordinating national research and innovation funds and providing researchers and businesses with predictable funding sources and funding schemes allocated on the basis of clear, transparent criteria that reward research quality and innovativeness should be a high priority for Bulgarian R&I policy. There may also be scope for, and merit in, 'Europeanising' national funding capacities and setting-up matching-funds schemes that provides national funding to Bulgarian proposals that have been positively evaluated but that were below the threshold to receive funding at the EU level.

However, there is a clear lack of professional bodies to support the policy-making processes, namely in the design of policies and programmes. There appears to be a "culture of benefit" for each participant, with minimal involvement of stakeholders, who themselves don't trust administrators, etc. The lack of professional bodies is then addressed through the mobilisation of 'International Organisations' expertise, like the Word Bank. Unfortunately, these processes are characterised by a low engagement of actors. There is a clear need for a common strategic support framework. A national research agency to help coordinate and implement the national R&I policy is highly recommended. Moreover, there is a need for an independent funding agency with stable funding sources and the ability to design and implement multi-annual programmes. The creation of new Councils, Agencies and coordination methods as well as associated systems to monitor and evaluate performance to international standards and norms is broadly welcomed. However, the present proposals for new entities and regulations leave some cause for concern with the PSF panel (see Annex 2.1 and 2.2).

At present, the Bulgarian research and innovation system also appears over-regulated due to a lack of systemic trust, and at the same time policymaking is often volatile, not surviving governmental changes. While current legislation mirrors the good intentions of many consecutive governments to make decisions more objective and transparent by creating a strong legal base, the high legislative output may be counter-productive and supporting systemic inertia. Anecdotal evidence provided to the PSF panel seems to suggest a growing weakness and unpredictability in the system due to a considerable turn-over of fragmented legal initiatives and incomplete implementation of legal acts. The laws and regulations might be approved but may have a low level of institutionalisation and of irreversibility. Trust needs to be restored in part by the authorities being seen to be tackling allegations of malpractice and taking steps to restore trust at all levels, even between public agencies and programmes.

The Bulgarian higher education system is not just relatively fragmented, systems for evaluating research and higher education are not yet established. Building stronger and better managed institutions are broadly a high priority in Bulgaria but building such institutions in the research and innovation area should be an absolute priority, given the importance of research and innovation for long-term growth and welfare. In particular, there is a need to ensure peer review processes in line with internationally established principles for expert assessments and transparency, in order to secure trust in the project selection procedures. In developing their review and evaluations systems, Bulgaria could and should profit from the expertise and experiences gathered in international guidelines such as the European Peer Review Guide[42], the Principles of the Global Summit on Merit Review[43], and The Leiden Manifesto for research metrics[44].

In the view of the review panel, a meritocracy based system of R&D policy development and implementation is within a transition economy perspective a must. Setting up a meritocracy based R&D policy system Bulgarian authorities will also show to the actors, in particular the new young generation of scientists, that being an excellent researcher is the key to success, much stronger and more effective than the old system based on networks of colleagues and friends. As a first step, PROs should be incentivised to develop and implement research strategies and professionalise their management of research and knowledge transfer. Strategy development should take place against a background of policy instruments that encouraging integration and synergies. And as explained in Section 2.3, the introduction of performance-based funding should enhance the accountability of public expenditure on PROs and should facilitate transparent, fair and efficient allocation of resources.

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[42] http://www.esf.org/fileadmin/Public_documents/Publications/European_Peer_Review_Guide_01.pdf.

[43] http://www.globalresearchcouncil.org/sites/default/files/pdfs/gs_principles-English.pdf.

[44] http://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.1735.

3. R&I HUMAN RESOURCES (HR) CAPACITY DEVELOPMENT

The PSF panel were asked to consider the ways in which the Bulgarian authorities might implement reforms to improve the academic career path by assessing the current legislation (Academic Career Development Act) and by making recommendations for overcoming the challenges of brain-drain and ageing of the research staff with a long-term prospective. They were also asked to consider how best to introduce a stimulus for the public research organisations and the universities for adopting the Charter and the Code as well as specific reintegration measures. Comments on the Academic Career Development Act are contained in Annex 3.1. Other issues are explored below with associated recommendations for action.

3.1. Introduction the critical need to reform researcher career development in Bulgaria

One of Bulgaria's main assets in research and innovation lies within its historic production of a highly skilled and educated population. Given the rapidly ageing structure of the population[45], and the clear on-going brain drain of the tertiary educated population, the further loss of talented and skilled people raises an alarm. There is a clear need to reverse this trend by improving job perspectives in science and research in Bulgaria. Publically funded science and research suffers from double brain drain, as high potential young researchers do not only seek employment abroad but also leave academia for non-research careers in business.

Over the past five years there have been a number of reports that include, the 2009 ALLEA-ESF (All European Academies – European Science Foundation), National Strategy for Development of Scientific Research (2010), the Law on Development of Academic Staff (2010), and the World Bank input for Smart Specialisation. All of the key HR related recommendations in these reports, if implemented, would bring about the changes needed to improve the Bulgarian national research system. **The challenge here is not simply to restate similar recommendations but rather to identify practical initiatives and feasible initiatives that can act as a catalyst for transforming the Bulgarian national research and innovation system through a reform of researcher career development.**

The objective of changing the HR capacity and profile of the national innovation system is to drive higher research performance, promote a dynamic knowledge base of the innovation system and a higher capacity to absorb and use the knowledge generated in the economy and society.

This will be achieved by **increasing the number of researchers and expanding the scope of training, education and professional development** to enable them to apply their talents to all sectors of the economy and society.

3.2. The Numbers

In terms of the total stock of researchers, Bulgaria has 4.43 per 1000 active labour force (Eurostat 2011) compared with an EU average of 10.55. The number of new doctoral graduates per 1000 population (age 25-34) is only 0.6 whereas the EU average is 1.7 (Eurostat 2011). This compares to 1.5 in Croatia, 1.9 in Slovakia and 1.7 in Romania. This is in the context of the number of doctoral candidates having almost doubled between 2000 and 2015. The low numbers of researchers reinforces the need to increase public investment in R&D (Recommendation 1.2).

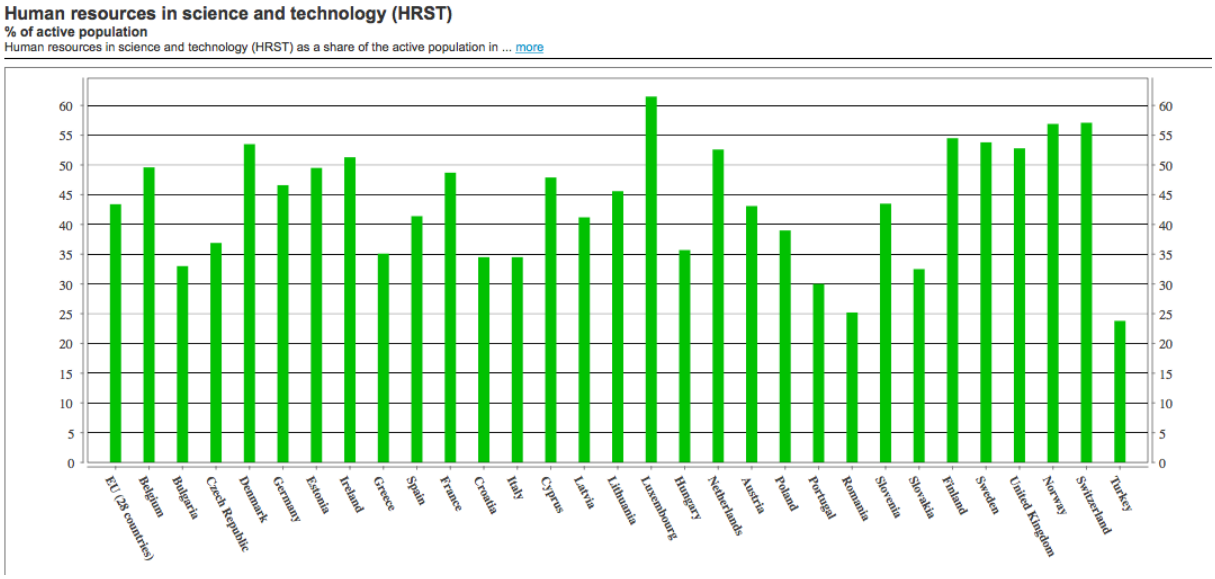
As is also illustrated in the macro-economic simulations carried out using the NEMESIS model, presented in Annex 3.2, it is important that raising the investment in R&D is done in a carefully planned manner in order to achieve key impacts including, raising research excellence, producing more employment ready PhD graduates, forging closer links to the business sector and increasing EU funding leverage (especially through Horizon 2020). The way in which spill-overs can be realized between the public and private sector is crucial here. Thus, as illustrated in the first scenario described in Annex 3.2, whereby an additional increase in the national funding of R&D in Bulgaria is limited to public laboratories, the rise in research employment increases real wages, especially for high skilled labour, and provokes a negative impact on external competitiveness until 2025. The resulting overall growth impact is hence limited primarily as the result of a crowding-out effect of the high-skilled research employment from production to public research. In case of scenario 3, where a crowding-in effect of the subsidies to public R&D on private R&D expenditures is included, there is still an even more significant crowding-out effect from production to research, now both public and private research jobs, but the long term overall growth impact is now much

[45] Bulgaria has the most rapidly shrinking population in the world, according to the Center for Demographic Policy: http://www.novinite.com/articles/156553/Bulgaria's+Population,+Fastest+Shrinking+Worldwide+-+Report#sthash.SiYgm3Dw.dpuf.

more significant. In short, increasing the public spending on research represents far more than a simple numerical target. It will have to involve a wide range of policies and funding instruments to increase sustainable R&D activity that will contribute to economic growth and societal well-being. The HR part of research plays here a central role.

Increasing the number of researchers must also be done carefully so that quality standards are also raised. This means first increasing the numbers through attracting and retaining school leavers and university graduates. This can only be done where there is an attractive and vibrant environment for researcher career development in the public and private sector. This of course also introduces into the argument the current level of pay in Bulgaria for researchers in the public and private sectors. This is explored in detail in sections 3.5.1 and 3.6. If one considers the current situation, the total population of human resources in S&T (Science and Technology) is well below that of the high performing countries in Europe. In Bulgaria the percentage of the population that is classified as such was 31% in 2013, a number that has changed little since 2002. It is to be noted that in those high performing research countries the corresponding numbers are in the region of 50%.

Figure 5. Human resources in science and technology (HRST) as a share of the active population in the age group 25-64[46].



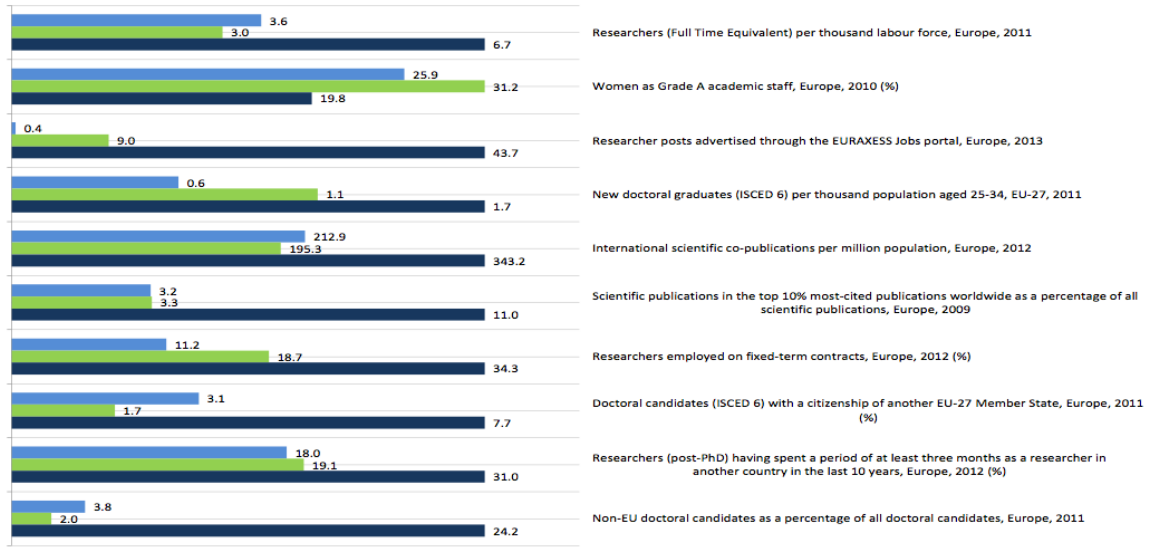
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat

The data in Figure 5 shows the active population in the age group 25-64 that is classified as HRST (i.e. having successfully completed an education at the third level or being employed in science and technology) as a percentage of total active population aged 25-64.

From Figure 6 below one can see that, over wide range of measures of HR capacity, Bulgaria is well below the European average. The exception is the number of women scientists.

[46] http://ec.europa.eu/eurostat/tgm/graph.do?tab=graph&plugin=1&language=en&pcode=tsc00025&toolbox=type

Figure 6: Key Indicators measuring Bulgaria's performance on aspects of an open labour market for researchers against a reference group of "modest innovators[47]" (BG, RO, LV) and the EU average (Researchers Report 2014 Country Profile: Bulgaria, Deloitte)



Source: Deloitte

Data: Eurostat, SHE Figures, EURAXESS Jobs Portal, UNESCO OECD Eurostat education survey, Innovation Union Scoreboard 2014, MORE2.
Notes: Based on their average innovation performance across 25 indicators, Bulgaria, Latvia and Romania show a performance well below that of the EU average. These countries are "Modest innovators"[4].

In terms of how to achieve an increase in the number of researchers there is first the need to attract more school leavers to study science[48] related subjects. This will take time, as it does need changes further upstream to be apparent, better job opportunities and salaries for researchers.

However, it is not sufficient to increase the number of students studying science; there must be strong reasons in place for them to progress to postgraduate research. First, it is important for them to be in an environment where they can have an experience of research. This has been shown to have a positive effect on choosing to pursue a PhD[49]. This does mean that research active universities are the best locations for promoting a career in research. For teaching focused universities (the large majority in Bulgaria), there is the possibility to collaborating with BAS institutes to give their students the opportunity for a research internship.

An undergraduate research experience may encourage students to pursue research and continue to do a PhD. However, it is critical for them to see that the doctorate will broaden their employment opportunities and give them excellent working and living conditions during the doctorate. With the numbers of PhD graduates less than half the EU average (Figure 6), the conditions conducive to retaining researchers will have to be excellent. Although there is some growth in the number of doctoral graduates, there is a real need to attract more PhD candidates from abroad. Apart from increasing the numbers, the international mix really enhances the national research environment.

At this point it is important to understand that increasing the number of researchers can have unintended consequences. One has to be aware that there is a global crisis of over-supply of postdocs as a consequence of increased R&D spending. The result is too many postdocs with little opportunity for academic / research career and severe challenges of moving to other sectors. The issue of 'permadocs' is being addressed in a variety of way globally[50]. In New Zealand, they have simply capped the numbers in order to solve the problem. France has introduced national legislation to limit the postdoctoral period to 6 years[51]. This has also been done within some institutions in Europe (e.g. Ireland and UK) and the United States (e.g. University of California

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47 http://ec.europa.eu/enterprise/policies/innovation/policy/innovation-scoreboard/index_en.htm

48 The term science is used here in its broadest context to include the physical, biological, environmental, engineering, economic, social and human sciences.

49 "Undergraduate Research Experiences: Benefits and Good Practice", Gubbins, Harmon, Delaney IUS (2008): http://www.iua.ie/wp-content/uploads/2013/08/IUS-05-2013-Undergraduate-Research-Experience-Benefits-and-Good-Practice.pdf

50 Nature 520, 144–147 (09 April 2015): http://www.nature.com/news/the-future-of-the-postdoc-1.17253

51 A time limit on postdoctoral contracts: The French experience, Science Careers, April 2015: http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2015_04_30/caredit.a1500111

system). The situation In Bulgaria is more or less the opposite given the shrinking population, and the net emigration of researchers. However the point remains that traditionally researchers, also in Bulgaria have been too exclusively educated and trained for the academic and public research sector. It will be important for the Bulgarian government not to lose sight of this issue in the pursuit of greater research activity.

In planning for a significant expansion of researcher numbers, it will be important for the Bulgarian government to ensure that the next generation of researchers are better able to make the transition from academia to the private and public employment sectors. This means that in addition to their research, they should acquire a broad variety of transferable skills including leadership, communication, project management, research commercialisation, public policy and entrepreneurship.

The experience of other countries presents the Bulgarian government with a real opportunity not to repeat their mistakes and ensure that their researchers are educated and trained for careers in a wide spectrum of employment areas, especially in the private sector.

Recommendation #3.1

Bulgaria suffers from an extreme pattern of demographic decline. It has fewer researchers in all main research categories compared with the EU average. Nearly half of its professors are over 65 years of age and migration of younger researchers to other EU countries or to jobs outside R&D is the rule. Bulgaria is urged to increase the number of researchers in higher education and research, both in the public and private sector. This is a challenge, not just in raising public funding for RI but also in developing and maintaining the necessary quality of any additional human resources. The benefits will include raising long-term economic growth in Bulgaria. However, when seeking ways to increase researchers numbers it will be essential that Bulgaria ensures that:

- *the spill-overs between the public and private sector are fully exploited;*
- *the increase in researcher numbers is based on research excellence and the way research fields fit labour market needs;*
- *the next generation of researchers are equipped to take up employment in both academic and non-academic sectors of the economy.*

3.3. The Researcher's HR Environment

Since 1989, Bulgaria's higher education sector has undergone a major transformation. There was a fast change from overregulation to academic and institutional autonomy of universities with the 1990 Law on Academic Autonomy of Higher Education institutions and the 1995 Law on Higher Education (the latter was amended in 2002). The university governance models were modified (1999), and a per capita financing based on student numbers was introduced (1999). The participation by Bulgaria in the Bologna process since 1999 has led to the introduction of the three-stage structure of higher education degrees (bachelor, master and PhD).

In Bulgaria, the universities themselves determine the number of study places for the institution. They are also responsible for the institutional budget, including the internal allocation of funds. Institutional governance in private universities are the same as the public ones. The salary scale for academic staff is determined at institutional level however the overall staff remuneration is regulated at central government level. The institution has responsibility for the following:

- Defining criteria for the evaluation of academic staff and promotion;
- Determining the individual basic annual salary, bonuses and additional increments.

There is a separate issue of professional management within the universities at the level of HR, research, contracts and finance that should be addressed.

The government and university are responsible for the definition of staff categories and recruitment/eligibility criteria. The university is responsible for the number of academic staff and available positions within faculties and departments.

The universities/BAS have a great deal of autonomy in how they run their affairs. This means that they can play a critical role in changing the researcher career structure, from PhD to Professor. This will require them to become more strategic in their planning for staff recruitment, career development and support. However it needs to be stressed that implementation of institutional strategies for HR depends heavily on the availability of funding from government (for example, the overall salary levels and the introduction of significant career development training programmes) as their current budget leaves them little room to manoeuvre. Nonetheless there are structural reforms in terms of recruitment and promotion procedures that can be changed by the universities/BAS using their institutional autonomy.

Bulgaria is no different to most European countries where university funding is mainly for staff salaries. The allocation of these funds is based on student numbers and that then determines the total number of academics. As academics are expected to carry out research the argument can be made that a portion of their salary is to support their research. In most countries, funding for research is awarded through a competitive process. Funding agencies provide grants to hire additional research staff, fund equipment etc. and usually add a fixed percentage as indirect cost or overhead. In addition, there may be national competitions where institutions compete for funding to support research infrastructure, additional staff, professional research management etc. The common characteristic of these funds is that they are all based on a peer reviewed competitive process. The two examples below show how national research funds can be distributed in a competitive manner that ensures excellence in research.

Case study 11: United Kingdom Research Assessment Framework (REF)

The REF[52] is the system for assessing the quality of research in UK higher education institutions. It replaced the Research Assessment Exercise (RAE), last conducted in 2008. The 2014 REF was conducted jointly by the Higher Education Funding Council for England (HEFCE), the Scottish Funding Council (SFC), the Higher Education Funding Council for Wales (HEFCW) and the Department for Employment and Learning, Northern Ireland (DEL). The REF is a comprehensive evaluation peer review evaluation of the research output, outcomes and impact of all the UK universities based on their submissions.

The primary purpose of REF 2014 was to assess the quality of research and produce outcomes for each submission made by institutions. This assessment provides accountability for public investment in research and produces evidence of the benefits of this investment.

The UK higher education funding bodies used the assessment outcomes to inform the selective allocation of €2.5 billion with effect from 2015-16.

Case study 12: Ireland's Programme for Research in Third-Level Institutions (PRTLI)

Launched in 1998, the Programme for Research in Third-Level Institutions (PRTLI)[53] has awarded €1.22 billion in exchequer and private matching funding. Over the five cycles from 1998 to 2010, the programme has helped to establish Ireland as a premier location for carrying out world-class research and development. Ireland has now moved from 36th to 16th position in terms of the Top Countries in all Fields of Science (Thomson-Reuters). This has been achieved by significant investments in human and physical infrastructure, thus strengthening national research capacity and capability.

PRTLI provided integrated financial support for institutional strategies, programmes and infrastructure in key areas of research spread across all disciplines. The programme supports research in humanities, science, technology and the social sciences, including business and law.

PRTLI funds were distributed based on strategies proposed by the higher education institutions. These strategies included their detailed planning for research expansion through new infrastructure, new staff and focusing on areas of strength. Moreover a fundamental principle of PRTLI was to demand collaboration between institutions in order to achieve greater international impact. These strategies were evaluated through international peer review that included site visits.

In contrast to the examples above Bulgaria operates a system where a base research subsidy is given to every academic/researcher in all institutions. Moreover this subvention for research is in the same budget line as that for printing and publication. The latter consumes most of this budget and diminishes further what is already a small amount for research. These two items should be separated and distributed separately. Research funding should not be evenly spread across institutions rather it should be through a competitive process based on research excellence.

The reality in Bulgaria is that only a small number of institutions have significant research activity. Indeed if there were a competitive process based on research excellence, then only a very small number of institutions would be successful as the majority of the 51 universities are teaching institutions with minor research activity. Therefore it makes no sense to spread 'research' money across the entire higher education and research sector and dilute its impact. It would be far better to concentrate this money where there is research excellence (see also 2.2.2) and recognise explicitly that there is a binary higher education system in Bulgaria.

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52 www.ref.ac.uk.

53 http://www.hea.ie/en/funding/research-funding/programme-for-research-in-third-level-institutions.

A model based on the Irish PRTLI (described above) could bring about really significant change in Bulgaria. For example, there would be a national competition that would provide funding for universities/BAS to develop research infrastructure, attract and retain researchers through special schemes that would include augmented salaries. Each institution would be required to develop a strategic plan that would be subject to international peer review. Strategies could include reintegration measures to attract back high performing Bulgarian researchers abroad. In addition, the funding stream could cover technology transfer and knowledge diffusion. This would really enable the universities/BAS to use their autonomy underpinned with State support to bring about major increases in research capacity and excellence. There is little doubt that this approach would concentrate the research funding in those institutions that are already high performers.

Recommendation #3.2

It is recommended that the binary education system in Bulgaria is recognised by having a binary research support policy: one pillar focusing on top research performing organisations supporting them towards the stairway to excellence with assistance offered to enable access to European research funding; a second pillar focusing on higher education teaching establishments. Identification of the top performing research organisation should be made via a regular competitive process based on peer review and metrics to identify research excellence and enable accountability for public investment in research and evidence to be collected of the benefits of this investment (as outlined in Chapter 2 and highlighted in recommendation 2.5).

3.4. The People

While it is a necessary condition to increase the number of researchers to achieve the 1.5% target, as stated above, this is not sufficient to attain policy objectives. There is a fundamental error made by many policy makers when discussing the output metrics of research. The focus is always on quantifiable "things" including[54] ideas, theories, discoveries and methods that are represented by publications, patents, teaching and education. This ignores the equally if not more important outcome of having highly trained researchers with the skills to analyse and solve complex problems. While the funding agencies and research performers can introduce the framework conditions for research that will benefit the economy and society, it is the researchers themselves that will actually achieve the overall objectives of national policy.

As this point it is worth introducing the European Framework for Research Careers[55] to discuss the issue of career development. This puts the population of researchers in four categories,

1) R1 - PhD Researchers (doctoral candidates)

2) R2 - Recognised Researchers (Postdocs)

3) R3 - Established Researchers (Senior Researchers, Associate Professors)

4) R4 - Leading Researchers (Professors)

With increased investment in research the main areas of expansion are at the R1 and R2 levels with far smaller increases at R3 and R4. This means that a bottleneck is created where the demand to progress to R2 and R4 can only be met for a small number of researchers. This is the experience internationally, for example, in Figure 7, the career pathways for PhD graduates is shown. A similar trend has been report in the UK by the Royal Society (2010). In the US there are over 70,000 postdoctoral researchers but only an annual total of 3000 track tenure positions[56] (Nature 2015).

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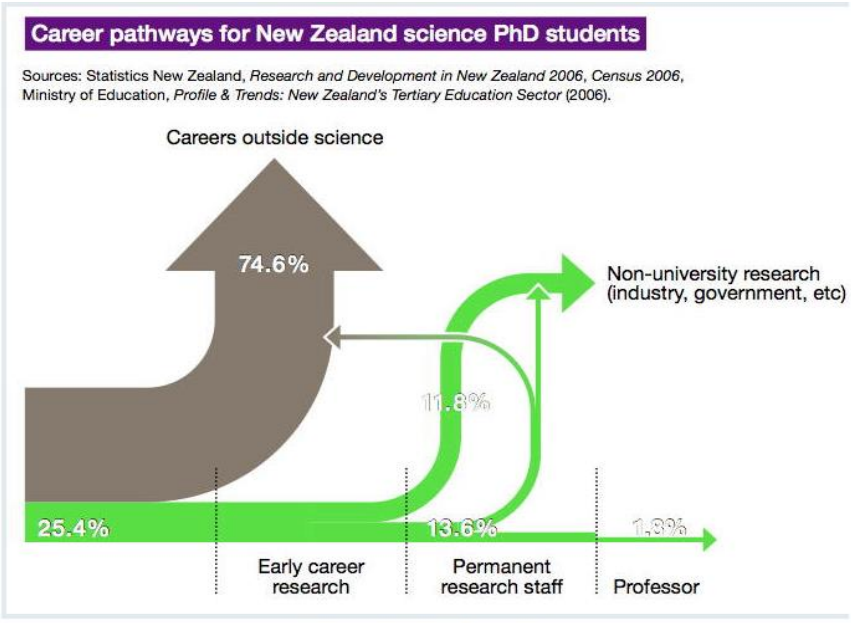
54 "Input for Bulgaria's Research and Innovation Strategies for Smart Specialization", page 93, World Bank (2013).

55 "European Framework for Research Careers", EC 2011 http://ec.europa.eu/euraxess/pdf/research_policies/Towards_a_European_Framework_for_Research_Careers_final.pdf.

56 "The future of the postdoc", Nature, 520, 7546 (2015).

Figure 7: Career pathways for PhD graduates.



(Source: Igniting Potential, p43; MoRST.)

This means that there must be a focus on the critical career stages R1 and R2. The traditional approach of an "academic apprenticeship" must change to give these researchers the skills through training and experience in other sectors.

Therefore increasing the number of researchers should only be done in tandem with a robust career development plan. This should recognise the fact that most will work in sectors outside the universities and BAS. Their professional development and training should incorporate opportunities in a variety of areas from leadership to commercialisation. This is considered in more detail in Section 3.5 below.

3.5. Career Stages

This section looks at the challenges at the four different researcher career stages.

3.5.1 Doctoral Candidates (R1)

The innovation performance of Bulgaria is in the "modest" sector of the European Union[57] but the growth rate is positive. One of the main contributors to this growth rate is the increasing number of doctoral graduates. One of the outcomes of increasing spend on R&D is an increase in the number of researchers especially the number of PhD graduates. The need to double investment in research to 1.5% of GDP by 2020 could imply a doubling of the number of PhD's. However this is not a necessary consequence and should be seen only as an upper limit on numbers. It will be important to ensure that any increase in numbers assures that quality standards do not drop. This means that increases in numbers must be based on minimum standards of excellence below which candidates will not be accepted on a PhD programme.

The current structure in Bulgaria places the doctoral candidate on a purely academic track. This will not be sustainable in the situation where the numbers increase with increasing R&D investment. This means that the structure of doctoral training should be reformed to ensure that PhD graduates can find employment in a wide range of sectors, both public and private.

In 2011 the ERA Steering Group on Human Resources and Mobility developed the Innovative Doctoral Training Principles (IDTP). The seven principles are as follows:

1) Research Excellence

Striving for excellent research is fundamental to all doctoral education and from this all other elements flow. Academic standards set via peer review procedures and research environments representing a critical mass are required. The new academic generation should be trained to become creative, critical and autonomous intellectual risk takers, pushing the boundaries of frontier research.

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[57] Innovation Union Scoreboard 2015.

2) Attractive Institutional Environment

Doctoral candidates should find good working conditions to empower them to become independent researchers taking responsibility at an early stage for the scope, direction and progress of their project. These should include career development opportunities, in line with the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

3) Interdisciplinary Research Options

Doctoral training must be embedded in an open research environment and culture to ensure that any appropriate opportunities for cross-fertilisation between disciplines can foster the necessary breadth and interdisciplinary approach.

4) Exposure to industry and other relevant employment sectors

The term 'industry' is used in the widest sense, including all fields of future workplaces and public engagement, from industry to business, government, NGO's, charities and cultural institutions (e.g. museums). This can include placements during research training; shared funding; involvement of non-academics from relevant industry in informing/delivering teaching and supervision; promoting financial contribution of the relevant industry to doctoral programmes; fostering alumni networks that can support the candidate (for example mentoring schemes) and the programme, and a wide array of people/technology/knowledge transfer activities.

5) International networking

Doctoral training should provide opportunities for international networking, i.e. through collaborative research, 'co-tutelle', dual and joint degrees. Mobility should be encouraged, be it through conferences, short research visits and secondments or longer stays abroad.

6) Transferable skills training

"Transferable skills are skills learned in one context (for example research) that are useful in another (for example future employment whether that is in research, business etc). They enable subject- and research-related skills to be applied and developed effectively. Transferable skills may be acquired through training or through work experience". It is essential to ensure that enough researchers have the skills demanded by the knowledge-based economy. Examples include communication, teamwork, entrepreneurship, project management, IPR, ethics, standardisation etc.

Business should also be more involved in curricula development and doctoral training so that skills better match industry needs, building on the work of the University Business Forum and the outcomes of the EUA DOC-CAREERS[58] project. There are good examples of inter- disciplinary approaches in universities bringing together skills ranging from research to financial and business skills and from creativity and design to intercultural skills.

7) Quality Assurance

The accountability procedures must be established on the research base of doctoral education and for that reason, they should be developed separately from the quality assurance in the first and second cycle. The goal of quality assurance in doctoral education should be to enhance the quality of the research environment as well as promoting transparent and accountable procedures for topics such as admission, supervision, awarding the doctorate degree and career development. It is important to stress that this is not about the quality assurance of the PhD itself rather the process or life cycle, from recruitment to graduation.

This 'common approach' is designed to provide a framework of reference, whilst preserving flexibility and autonomy for institutions and doctoral candidates. One of the purposes of the IDTP is to ensure that all PhD graduates are equipped to work in academia or to use their skills in other employment sectors. The Principles have been integrated into EHEA / ERA policies and the Horizon 2020 programme. The focus is to ensure that doctoral graduates have opportunities for 'triple-i' mobility: international, interdisciplinary and inter-sectoral. The application of these principles would ensure that PhD graduates in Bulgaria would have the opportunity to work outside the academic environment during their doctorate and gain valuable experience abroad. It would also introduce skills training in a wide range of areas including entrepreneurship, intellectual property and knowledge transfer. There is evidence to show that the application of the IDTP does actually produce positive benefits for student outcomes and the quality of the research they carry out as

[58] http://www.eua.be/doc-careersii.

part of their PhD[59]. Studies in Ireland (case study below) have demonstrated that doctoral candidates on organised structured PhD programmes (that include in particular skills training and overall quality assurance for the programme) leads to better research outcomes. These students were more likely to publish their results in internationally peer-reviewed journals and present their data at international conferences when compared to PhD students outside of structured programmes.

Case study 13: Doctoral education programmes in Ireland

Doctoral education programmes in Ireland educate and develop researchers to the highest skills levels so that they become creative, critical and independent individuals who will advance the boundaries of research. Through the process of doctoral education, the student is provided with opportunities to develop a range of skills to a very advanced level. These skills relate both to the research process itself and to broader professional training and development. The National Framework for Doctoral Education endorses the following skills and attributes, as articulated in the IUA PhD Graduates' Skills60 statement, as key educational objectives for all graduates of Irish doctoral programmes:

Research skills and awareness;
Ethics and social understanding;
Communication skills;
Personal effectiveness/development;
Team-working and leadership;
Career management;
Entrepreneurship and innovation.

The core and essential component of doctoral education remains the advancement of knowledge through original research—a fundamental societal value in itself, based on freedom of enquiry, the fostering of innovative thinking and the development of advanced critical skills.

There are many examples of good practice right across Europe on how to run effective doctoral programmes or schools. One example in the region would be the University of Zagreb that has doctoral training structured across wide range of disciplines[61].

While some institutions may have capacity to develop substantial doctoral programmes, there is always a strong case for collaborative ventures. This can bring together complementary expertise across disciplines and expertise in specific areas of skills training. Non-academic organisations can be involved, providing placements for PhD candidates and giving advice on skills training. National funding should be provided to support this development. This can be done by ensuring that PhD scholarships are only provided when there is a commitment by the host to implement the IDTP. This should be an integral component of institutional and funding agencies strategy.

There is already some international collaboration, for example with the Swiss SCIEX programme. Within the Scientific Exchange Programme between Switzerland and the New Member States of the EU (Sciex-NMSch[62]) and within Thematic Fund "Scholarships" of the Bulgarian-Swiss Cooperation Programme, scholarships to PhD students are funded in Swiss Universities for a period of 6 to 24 months. This would be an opportunity to engage with the Bulgarian research diaspora for short or long-term placement of doctoral candidates as part of their PhD programme.

The experience across many European countries is that the IDTP are best implemented though Doctoral Schools or Structured PhD Programmes. These provide a structure (usually within a specific discipline) to centrally organise the PhD programme for all students (see Case Study below). These are often formed by collaborations between different institutions in order to bring together complementary expertise to focus on area like Nanoscience, for example that require expertise from physics, chemistry and engineering. Such structures also engage with the relevant industry and provide placement opportunities for PhD students. This type of approach would be ideal for Bulgarian universities/BAS to collaborate on, for example, national priority areas. This

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59 O'Carroll C., et al., "The PhD in Europe: Developing a System of Doctoral Training That Will Increase the Internationalisation of Universities", European Higher Education at the Crossroads- Between the Bologna Process and National Reforms, Springer, 461-484, 2012.

60 Irish Universities Association, Irish Universities' Statement on PhD Graduate Skills Statement (2nd edition 2015)
http://www.iua.ie/publication/iua-graduate-skills-statement-brochure-2015/

61 http://uzdoc.eu/sites/default/files/smihaljevic_-_administrative_support_for_doctoral_programmes.pdf

62 https://www.eda.admin.ch/erweiterungsbeitrag/en/home/laender/bulgarien.html/countries/bulgaria/en/meta/news/2014/3/27/sciex-call.html

would provide the best learning and research environment for the PhD students in these areas of national importance (Food Processing, Mechatronics, Pharmaceuticals and ICT).

There is new initiative under Horizon 2020 to co-fund national doctoral programmes in the Marie Sklodowska Curie Actions (MSCA)[63]. The normal MSCA schemes have weighted salaries that make Bulgaria unattractive for foreign researchers. In contrast, the COFUND scheme has flat rate salaries that are the same for all countries (the minimum rate for PhD's is €1855 per month).

The national portion of the funding can be sourced from European Structural Funds. For example, in the first round (2014) the Nencki Institute of Experimental Biology[64], Polish Academy of Sciences was funded for a period of 5 years to train 22 PhD's. This shows what can be achieved when European Structural Funds are used to fund national doctoral programmes. This would be an excellent approach for the funding of doctoral programmes in Bulgaria.

Case study 14: EU Horizon 2020 Marie Curie COFUND Grant at the Nencki Institute

The Nencki Institute of Experimental Biology of the Polish Academy of Sciences has been awarded with an EU Horizon2020 Marie Curie COFUND grant to create the International PhD Studies, **Bio4Med: Bio**logy **for Me**dicine, International Doctoral Programme in Biological Bases of Human Diseases.

The main objective of the project is to create international, interdisciplinary and inter-sectoral doctoral studies in the field of biological bases of human diseases. The program will be implemented by 22 leading research groups from the Nencki Institute and their research partners from world-class laboratories located in the EU Member States, Switzerland, Japan, Canada, the USA and Ukraine. The aim of Bio4Med project is to support career development of young scientists through research and training in the area of molecular biology, biochemistry, cell biology, physiology, behavioural studies and bioinformatics.

Bio4Med objectives will be implemented through diverse activities including practical laboratory training, advanced training courses to enhance understanding of the topics of doctoral projects, as well as courses developing research-oriented generic skills.

See: http://en.nencki.gov.pl/article/eu-horizon2020-marie-curie-cofund-grant-at-the-nencki-institute

As illustrated by Figure 8**,** Bulgarian early stage researchers are amongst the most outwardly mobile in the European Union. There is no doubt that this issue of brain drain out of the country and out of academia will be difficult to resolve. This does make it difficult to retain graduates for doctoral programmes. A new approach to doctoral training using the IDTP will help especially if it can be seen that this leads to better employment prospects. In parallel there should also be measures introduced to increase the internationalisation of doctoral education. Between 2000 and 2015 the number of Bulgarian PhD almost doubled from 3,414 to 6,617 however the number of foreign PhD's remained almost constant. Attracting foreign PhD candidates can increase the number of researchers, changes the culture in predominantly national institutions and, in time, can lead to greater international collaboration. There is excellent experience across European universities in this regard and there is currently an European University Association (EUA) project FRINDOC[65] (Framework For The Internationalisation Of Doctoral Education) that is developing a framework on good practice and an online tool to support planning and implementing internationalisation strategies.

The National Evaluation and Accreditation Agency is the statutory body for evaluation, accreditation and monitoring of the quality in higher education institutions and scientific organizations. There seems to be an issue related to delays in the accreditation of PhD programmes of up to one year. This will act an obstacle to the development of PhD programmes using IDTP and attracting international doctoral candidates.

In addition to measures to retain doctoral candidates it is also important to accept that mobility is an integral component of career development. Therefore it may be advantageous to support international scholarships for those outstanding PhD candidates (who would leave anyway) but on condition that they return to Bulgaria upon completion. This is a policy that is actively pursued by some countries to build long-term research excellence and capacity (for example, the Brazilian Science without Borders[66] programme). In 2015, the Government of Montenegro introduced

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63 Note that the use of the Innovative Doctoral Training Principles (IDTP) is part of the evaluation criteria.

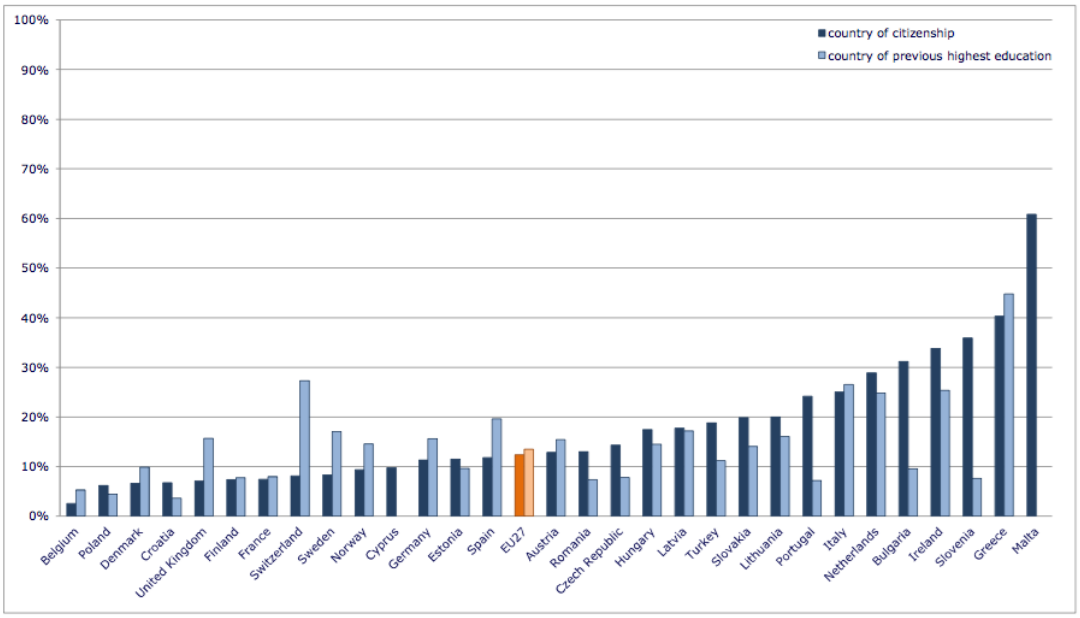
64 http://en.nencki.gov.pl/article/eu-horizon2020-marie-curie-cofund-grant-at-the-nencki-institute.

65 http://www.eua.be/FRINDOC.

66 http://www.cienciasemfronteiras.gov.br/web/csf-eng/faq.

scholarships for PhD's (also Masters and Postdocs) in areas of national importance to spend time abroad but critically to return afterwards.

Figure 8: International PhD degree mobility of R1 and R2 researchers per country of citizenship and previous highest education (departure)



Source: MORE2 Higher Education Survey (2012)

Case study 15: Montenegro - National Excellence Scholarship Programme

The purpose of the National Excellence Scholarship Programme is to build research capacity through the award of scholarships for Masters, PhD and Postdoctoral studies at recognized institutions of higher education and research abroad. This programme is implemented by the Ministry of Education and Ministry of Science under the project "Higher Education and Research for Innovation and Competitiveness". The Ministry of Education is implementing a scholarship programme for Masters Studies, and the Ministry of Science is implementing scholarships programmes for PhD and Postdoctoral Studies. The objectives of the National Excellence Scholarship Programme are as follows:

Strengthen national capacities for research, innovation and competitiveness;

Transfer and application of knowledge acquired through academic development and career development of researchers in Montenegro

Support for internationalization initiatives; and

Strengthen economic sector through investment in human resources.

The National Scholarship Programme provides support to highly talented Montenegrin citizens who live in Montenegro, with the aim of gaining international academic experience. The scholarship covers the cost of living (and tuition costs if applicable). Living costs include accommodation, food, health insurance and local public transport.

Scholarships will be awarded in equal numbers in the following areas:
natural-mathematical;
technical and technological;
medical;
agriculture; and
social-humanistic sciences.

Within above-mentioned areas, PhD and Postdoctoral Scholarships will concentrate on ten identified national priorities, namely: Energy; Identity; Information and Communication Technologies; Competitiveness of the national economy; Medicine and health of people; Science and education; New materials, products and services; Sustainable development and tourism; Agriculture and food; and Transport.

PhD Scholarships will be awarded to students who have enrolled in PhD studies at recognized universities abroad, for a period of one to two years, and students who have been granted a research stay of 6 to 12 months at one of the recognized universities / research institutions abroad, and who have enrolled in PhD studies in the country or ex-Yugoslavian region. Upon the completion of studies, the scholar will return to Montenegro.

Overall the numbers of PhD students in Bulgaria should increase through a combination of attracting and retaining more graduates to national PhD programmes and also attracting students from abroad. This must be done based on excellence of the candidates. There is a clear issue in relation to the low salaries of PhD students, as this will reduce the ability of the country to keep their own graduates and attract more from abroad. The rates of €400-€500 per month (see Figure 13) are highly unattractive for both national and international graduates intending to pursue a PhD. From a Bulgarian perspective this may be an opportunity to increase the salaries to the broad base of PhD candidates. In order to make an immediate change it may be necessary to take a radical approach and introduce a doubling the PhD salary to attract and retain graduates. Bulgaria might also consider more strategic approach of focusing salary increases in specific areas of research that are nationally important. Given the strong links between structural funds and economic development, the latter approach may be the first priority. This must be done based on competitive fellowships that select only the best candidates.

Recommendation #3.3

The Bulgarian government, in coordination with public research organisations which have a large degree of autonomy to set up salary levels, should address the very low salaries for PhD students and consider increasing them significantly particularly in areas of research that are nationally important (see also recommendation 3.8) and introduce dedicated fellowships to target the retention of excellent graduates and attract more international doctoral candidates. Initiatives based on individual research performance should be introduced in order to fix and/ or adjust researcher salary levels. A study should be undertaken by the Bulgarian authorities to determine the competitive salary levels for these schemes. More generally, we recommend a deep and overall change of remuneration and salary base in research and higher education that is linked to quality and performance.

The so-called European Principles of Innovative Doctoral Training, highlighted above, should be applied to Bulgarian doctoral programmes. This will lead to a more international (English taught), mobile (open to both national and foreign PhD candidates), better connected (to market needs), and higher quality doctoral programmes in different disciplines. Combining the research strengths of the Bulgarian research universities with that of the top BAS institutions such doctoral programmes could become attractors for foreign PhD students providing a sustainable source for new talent development both in the academic and non-academic world.

The National Evaluation and Accreditation Agency should ensure that the accreditation of new doctoral programmes is fast tracked.

3.5.2 Recognised Researchers (R2)

In most European countries, the Postdoctoral Researcher plays a vital role in any research team as they have the experience to work reasonably independently under the supervision of the academic. They can also act as mentors for the PhD students in the team. It will be important that any increase in postdoctoral numbers is done in a carefully planned manner. This must include longer term planning for the further career development of these researchers within the Bulgarian higher education and research system. The current career structure in Bulgaria does not have this type of researcher as their equivalent, Assistant Professor, is on an academic track on a fixed term contract usually greater than 4 years. Introducing the Postdoctoral Researcher will make Bulgaria more attractive to researchers at this career stage and can be used as a reintegration measure for Bulgarians who have graduated with a PhD abroad.

One can only restate many of points from the previous section concerning career development and training. However for this cohort it is more urgent as postdoctoral researchers find it harder than PhD graduates to move to other sectors.

Postdoctoral researchers are a highly internationally mobile community. A recent poll showed that of PhD graduates (within past 2 years) only 10% were not interested in mobility. In contrast for those who graduated more than 16 years ago, 40% were not interested in moving[67]. Internationally mobile researchers develop large networks that span continents. This is a rich source for establishing collaborative research networks.

The current salary structure is unattractive to researchers abroad and is a strong push factor to those at home to move. If institutions have funds available then they can increase salaries preferentially based on performance. They can also propose a salary premium to researchers coming from abroad. It must be emphasized that any such

[67] Nature 490, 326-329 (2012).

initiative must be done based on clear independent metrics of research performance so that only the best are selected. Despite universities/BAS autonomy in this regard, such measures depend entirely on government providing extra funding directly to institutions.

As mentioned in the previous section the Horizon 2020 MSCA COFUND programme also has a funding stream for postdoctoral researchers. Using Structural Funds, postdoctoral programmes could be proposed for co-funding. These postdoctoral programmes could be focused on areas of national priority and/or in collaboration with industry.

For postdoctoral researchers to find employment outside academia there must relevant professional development programmes. In addition there must be incentives in place for closer links to industry through research collaboration and placements. This must be recognised as part of career development (where currently high impact publications take precedence over all other achievements). The UK approach to researcher development is outlined below.

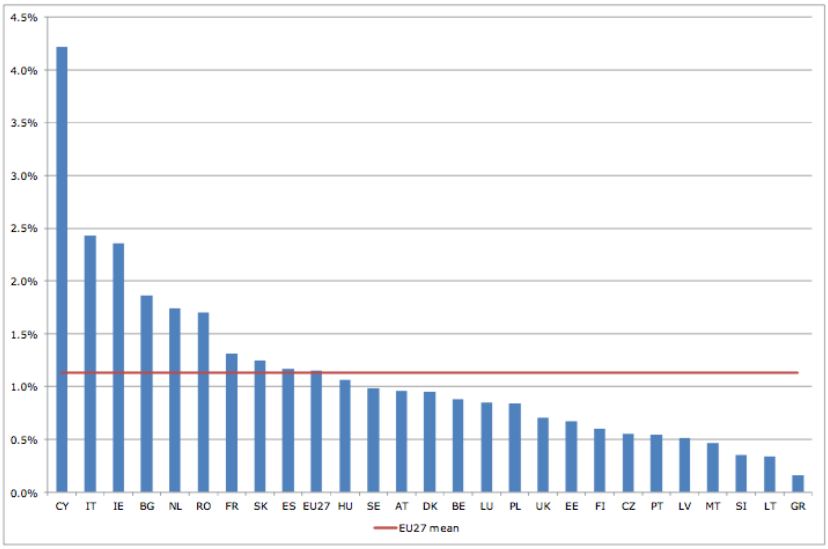
Case study 16: VITAE - Realising researcher potential in the UK

"Vitae works to meet society's need for high-level skills and innovation"

VITAE is a UK organisation dedicated to realising the potential of researchers through transforming their professional and career development. They have a number of aims that include building human capital by influencing the development and implementation of effective policy relating to researcher development. They enhance higher education provision to train and develop researchers and empower researchers to make an impact in their careers. They are funded by the Research Council UK and membership subscriptions.

VITAE acts as a means for universities to provide structured training programmes for their researchers and critically enables them to make informed career choices. They have changed the entire approach to researcher career development in UK.

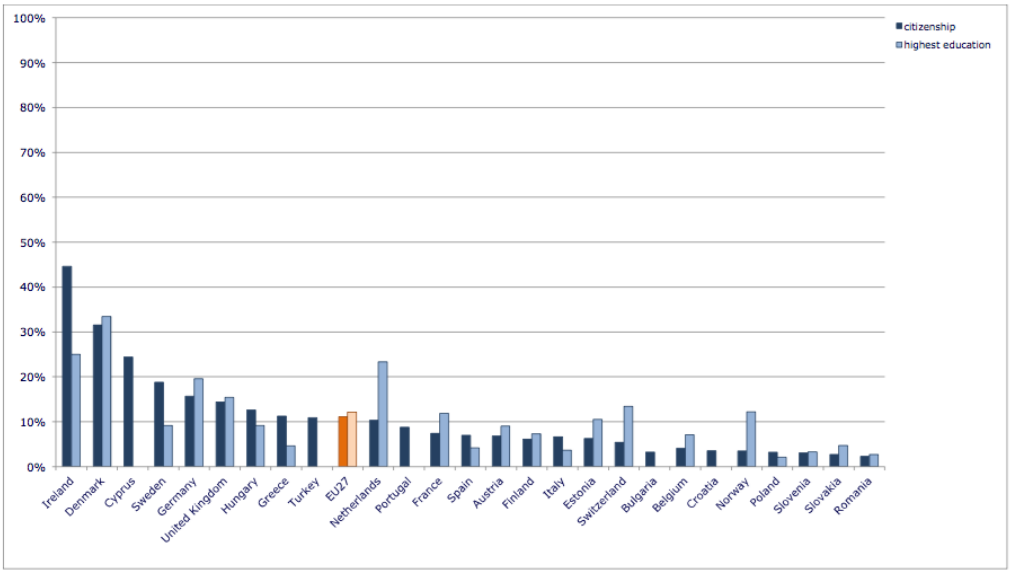
Figure 9: Number of scholars from EU27 Member States employed in US as a percentage of total researchers employed in the Member State in 2009



Source: Own calculations based on Institute of International Education. "Institutions Hosting the Most International Scholars, various years." Open Doors Report on International Educational Exchange.

Researchers are internationally mobile as this is an integral component of their career development. As can be seen from Figure 9, the number of Bulgarian researcher (mostly post-docs) employed in the USA is a substantial fraction of those at home. Both Italy and Ireland are higher but both countries have strong reintegration mechanisms.

Figure 10: Return mobility to country of citizenship or country of highest education.



Source: MORE2 Higher Education Survey (2012)

There will always be those who go abroad and the challenge to Bulgaria is to have opportunities that will attract them back in the future or at least maintain links and establish international research collaborations. Note that there was a Reintegration Grant scheme in place 2009/2010 but due to the comparative disadvantage of the Bulgarian research system, it did not attract many and was discontinued in 2011. Therefore any reintegration scheme will have to offer excellent funding and research prospects. This is emphasized in Figure 10 where one can see that few Bulgarian researchers return home.

In general, across Europe, the majority of postdoctoral researchers are funded through projects grants and are hired as part of the team. There are also individual fellowships for postdoctoral researchers from most funding agencies, the most notable being the Marie Sklodowska Curie Individual Fellowship Scheme (part of Horizon 2020). The MSCA fellowships have a broad remit to support the career development of researchers and not just carry out research. This means that fellows are expected to benefit from professional development (skill training etc.) opportunities. They are also expected to take every opportunity to interact with the business and industry sector. The MSCA Individual Fellowships would provide a good model for funding postdoctoral researchers in Bulgaria. The optimal approach would be to develop a national fellowship postdoctoral scheme that is open to applicants based in Bulgaria and abroad. As in the case of PhD fellowships, selection should be based on excellence as measured through international peer review.

Postdoctoral fellowships could be funded fully by the Bulgarian government but opportunities for co-funding with industry and the European Commission should definitely be explored. For example, there is a postdoctoral fellowship scheme in Ireland that is partly funded by government and industry (see case study below).

Case study 17: The Irish Research Council - Enterprise Partnership Scheme (Postdoctoral)

The Enterprise Partnership Scheme is an innovative initiative whereby the Irish Research Council, in partnership with private enterprises and public bodies, awards co-funded postdoctoral fellowships to the most promising researchers in Ireland.

The Scheme offers researchers the opportunity to gain additional beneficial experience and insight into the commercial arena while completing their research.

It provides industry with flexible and easy access to an exceptional pool of competitively selected, high-calibre researchers and the opportunity to build links with relevant academic research groups.

The Scheme facilitates the establishment of new relationships and the strengthening of existing ones between enterprise and academia while offering financial support to researchers at an early stage of their career development.

Examples of companies in this scheme include, Eli Lilly, Microsoft, Intel Ireland, Hewlett Packard, Boston Scientific and Pfizer.

As in the case of PhD's discussed above the Marie Sklodowska Curie (MSCA) Actions COFUND programme would facilitate co-funding of postdoctoral fellowships with Bulgarian organisations using Structural Funds.

Recommendation #3.4: Unlike in other EU Member States, the Bulgarian RI system does not recognise 'Postdoctoral Researcher' positions, the nearest equivalent being the 'Assistant Professor' figure with a fixed term contract usually greater than 4 years. Postdoctoral researchers in EU Member States have the experience to work independently under the supervision of an academic, and can act as mentors to PhD students. The Bulgarian authorities should commit to support postdoctoral researchers. Dedicated individual fellowship programmes for attracting international researchers to Bulgaria and reintegration schemes for Bulgarian postdocs working abroad should prove useful tools. The public universities, BAS and Agrarian Institutes should ensure that postdoctoral researchers get accommodated and absorbed into their institutional academic structures. All national research funding programmes should allow for the hiring of postdoctoral researchers.

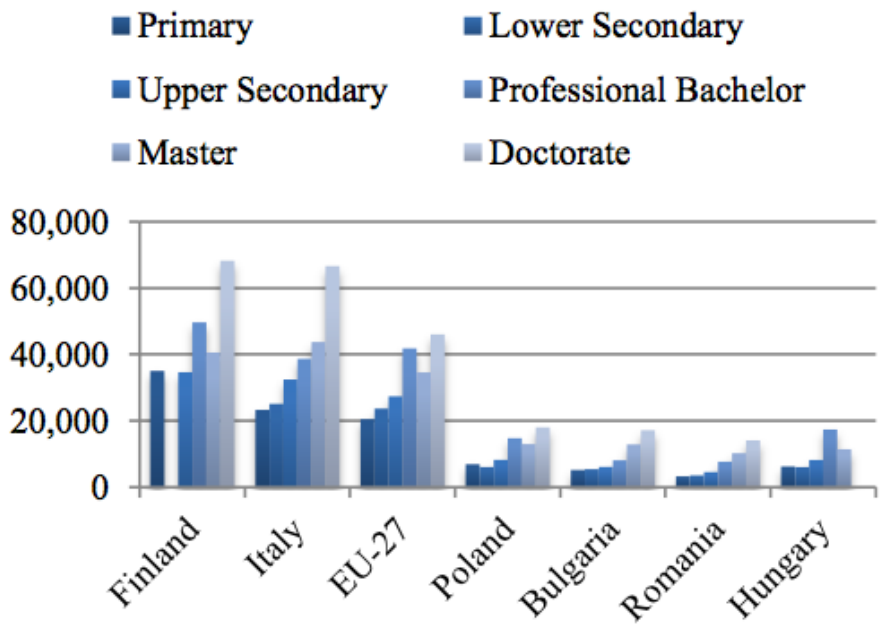
The universities/BAS should ensure that postdoctoral researchers can be accommodated and absorbed into their institutional academic structures.

The Bulgarian government and universities/BAS should commit to supporting the career development of all Recognised Researchers (R2) including their professional development and training. This should encompass leadership, communication, research integrity, ethics, project management, research commercialisation, public policy and entrepreneurship.

3.5.3 Established Researchers (R3) and Leading Researchers (R4)

These are the leading researchers in the country and for the most part are on permanent contract. The key issues for these researchers are salaries and promotion opportunities (especially for those at R3 level). As can be seen from Figure 11 and Figure 12 salaries are well below the European average for all levels of educational achievement.

Figure 11: Annual Earnings Based on Education Attainment in Euro, 2010.



Source: Eurostat/NSI, retrieved Nov 2012.

Figure 12: Gross annual salaries and PhD stipends of university researchers as percentage of the best paying country within career stages - a country comparison.

	EU		EU15	AT	BE	DE	DK	ES	FI	FR	GR	IE	IT	LU	NL	PT	SE	UK		EU12	BG	CY	CZ	EE	HU	LT	LV	PL	RO	SI
Salaries																														
Salary R1	45		55	70	>80	80	75	40	45	35	<20	.	.	.	65	.	45	75		30	<20	65	35	.	25	<20	<20	25	<20	55
Salary R2	50		60	80	80	70	65	45	55	25	50	50	60	.	75	75	55	55		35	<20	>80	40	35	25	<20	20	30	<20	70
Salary R3	55		65	65	80	65	65	60	60	45	45	75	65	.	>80	65	55	65		40	<20	>80	40	35	25	<20	.	30	<20	65
Salary R4	55		70	75	75	60	65	60	.	45	45	>80	75	.	>80	65	60	80		35	<20	>80	55	40	35	<20	<20	30	20	55
Annual Stipends for PhD candidates																														
R1	40		55	.	75	45	>80	55	35	65	20	45	60	.	.	55	.	75		20	20	.	<20	20	20	20	.	20	25	35

	non-EU	OECD non-EU		other Eur.	OECD Eur.	non-OECD Eur.	AL	BA	CH	FO	HR	IS	ME	MK	NO	RS	RU	TR		non-Eur.	OECD non-Eur.	AU	BR	CA	CN	IL	JP	KR	SG	US
Salaries																														
Salary R1	50	60		40	65	30	20	<20	60	.	50	40	35	40	>80	40	.	25		70	60	.	>80	.	.	55	75	30	.	75
Salary R2	50	60		45	70	35	.	35	>80	.	45	40	30	45	80*	35	.	25		55	55	60	>80	45	25	45	70	40	.	>80
Salary R3	55	65		50	65	40	30	40	>80	.	45	45	35	50	65*	35	.	40		65	65	70	>80	80	25	45	70	40	.	>80
Salary R4	60	70		55	70	45	.	45	>80	.	60	45	30	50	70	25	.	70		65	70	65	>80	75	30	45	65	65	.	>80
Annual Stipends for PhD candidates																														
R1	40	45		40	60	35	<20	40	.	.	35	60	50	65	.	30	.	30		40	40	45	.	35	.	20	.	.	45	65

Source: MORE II expert survey. Minimum, average and maximum of gross annual salaries and PhD stipends (in PPPs) of each country are compared with minimum, average, and maximum of the best paying country in the covered sample respectively. The resulting shares for each country are then averaged within the country and rounded to 5 percentage points. The shown shares for country groups are averages across the respective countries. Covered countries: other Europe: AL, BA, CH, FO, HR, IS, ME, MK, NO, RS, RU, TR; non-Europe: AU, BR, CA, CN, IL, JP, KR, SG, US; OECD (excl. EU): AU, CA, CH, IL, IS, JP, KR, NO, US.) The Norwegian Associate Professor is classified as both R2 and R3. Therefore, for Norway the comparison of R2 and R3 with the best paying country might be upward and downward biased respectively.*

The R3 and R4 cohort of researchers are scientific leaders however the main fields of activity have not changed in 20 years. The largest share of Bulgaria's published scientific work between 2001 and 2012 was in physics and astronomy, followed by medicine, chemistry, biochemistry, and material sciences. There have been increasing resources deployed towards medical and health sciences, whereas funding for agriculture research has dropped.

Analysis of the Bulgarian economy for Smart Specialisation by the World Bank has identified four priority sectors: Food Processing; Mechatronics; Pharmaceuticals; and ICT.

The constraints to innovation across these areas are a shortage of skilled labour and a lack of collaboration between the business, university and research communities (World Bank 2013). **Greater activity in these areas could be stimulated by salary bonuses and ensuring that collaborative links to industry are recognised by the university/BAS for promotion purposes**. Salary bonuses could also be introduced for high performing researchers across all disciplines.

In order to attract researchers at this level (R3 and R4) from abroad a fellowship that includes salary and research costs for five years should be offered. This was a strategy used in Ireland to support the best researchers and attract talent from abroad (especially from the scientific diaspora). The two examples below show different type of fellowship awards of this type. The first is to allow younger researchers the opportunity to establish themselves as prominent research and the second to support research leaders.

Case study 18: President of Ireland Young Researcher Award (PIYRA)

The President of Ireland Young Researcher Award (PIYRA) is Science Foundation Ireland's most prestigious award to recruit and retain early career researchers **to** carry out their research in Ireland. This programme emphasises the importance that Science Foundation Ireland places on the early development of academic careers. The award recognises outstanding engineers and scientists who, early in their careers, have already demonstrated or shown exceptional potential for leadership at the frontiers of knowledge. Awardees will be selected on the basis of exceptional accomplishments in science and engineering in all areas covered by SFI's legal remit and on the basis of creative research plans that are built on work that has attracted international attention. For the PIYRA programme, scientific excellence is both necessary and paramount but is not sufficient; applications must also demonstrate potential impact. The objectives of this scheme are,

- To identify **the** most promising of a new generation of top-tier cutting edge researchers in fields that are critical to Ireland's economic and social prosperity
- To offer funding opportunities that will help Irish research **bodies** attract top-tier young researchers to Ireland
- With the support of the host research body, including an identified mentor, to assist the awardee to build an internationally respected research activity
- To fund a period of intensive research to enhance the candidates' research programmes / projects and further encourage and promote Ireland's participation in the international research community
- To foster and support collaborations with academic and industry partners
- The duration is 5 years and the value is up to €1m.

SFI Research Professorship Programme (R4)

The agency, Science Foundation Ireland was established in 2001 with the express purpose of identifying and funding outstanding scientists. The SFI Research Professorship Programme is intended to support national strategic priorities by assisting research bodies in the recruitment of world-leading researchers for Professorial Chairs, or similar research leadership positions in targeted scientific areas in all areas covered by SFI's legal remit. The programme may also act as a mechanism to support the recruitment of individuals who possess a strong industry background, as well as for directorship roles in established research centres within eligible research bodies in Ireland. It is incumbent on the universities to seek out excellent scientists abroad and support their application to the agency. Funding of up to €5M (direct costs) will be provided to each successful applicant for a five-year programme of work.

The purpose of the Research Professorship Programme is to recruit iconic global research and leadership talent to Ireland to build the national research and enterprise base, and enhance Ireland's reputation as a centre of excellence for research. The ambitions of the appointed SFI Research Professor will be consistent with the strategic plans of the host research body.

Recommendation #3.5

The Bulgarian government should seek talent from abroad by providing attractive fellowship schemes for senior researchers based on international practice (5-year grants supporting salary, equipment and the hiring of PhD's and postdoctoral researchers). The fellowships should target excellent researchers abroad and should also act as a reintegration measure for the Bulgarian research diaspora.

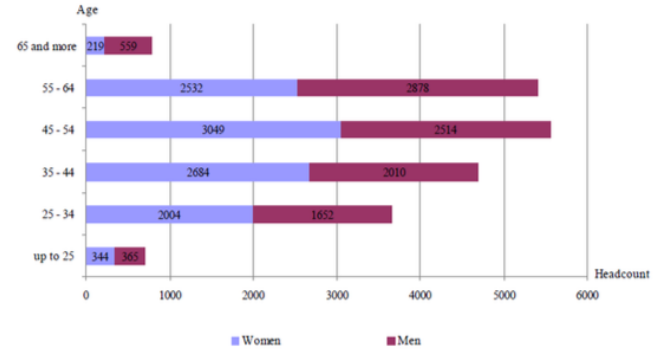
The universities/BAS should give clear commitments to provide the researchers with independence along with the necessary infrastructural and administrative support.

There should be a special focus on the four national priority areas of Food Processing, Mechatronics, Pharmaceuticals and ICT.

Figure 13: Age structure of R&D personnel[68]

The worsening age profile of scientists is a reflection of the limited opportunities for young researchers to enter the research system. According to the register of the academic staff at the universities supported by the Ministry of Education, Youth and Science (MEYS) in 2008 there was no professor under 35 and only 12 were between 35-44 years of age. Over 600 professors (out of 1290) are over 65. According to the Higher Attestation Commission (HAC) there are 134 senior scientific associates aged between 35 and 44 years (out of 2700) and the majority of senior scientific associates are between 45 and 54 years of age (990 out of 3138). The total ratio of scientists under 35 years old (defined as "young scientists" mainly for the purpose of program funding) to the scientists of other age groups is about 1:10."

Age structure of R&D personnel by gender as of 31.12.2011



Source: Bulgaria's National Strategy of Scientific Research to 2020.

The age profile in academic staff is moving to stagnation. Data from EUROSTAT does show that government and higher education R&D personnel above 55 years of age has remained around 30% of the total stock of researchers between 2005 and 2013. However when the details of the composition of the stock of researchers are considered, official figures from Bulgaria show that

[68] Input for Bulgaria's Research and Innovation Strategies for Smart Specialization, World Bank 2013.

nearly half of the population of **professors** are over 65 years, (see text in Figure 13: Age structure of R&D personnel), despite the fact that Bulgaria operates a compulsory retirement policy at 65. This policy seems to be undermined by the ability of PROs to rehire retired professors under civil contracts if they are considered to be irreplaceable. This presents a real barrier to career advancement of the R2 and R3 populations. **There is no single solution to this problem.** There are rather a suite of actions that should be considered including,

- A stronger restriction on utilising retired professors to undertake teaching and research activities.
- Voluntary Early Retirement Packages
- Fast tracking high performing researchers that could also be couple with attractive grants to bring in talent from abroad

The first two measures could free up a significant number of senior positions within the universities/BAS. One should be careful however that the implementation of such measure could lead to the loss of highly experienced excellent researchers. There should be provisions for such researchers to be retained with emeritus status.

An Early Retirement Package is where an employee is offered early access to partial or full pension along with a severance grant or lump sum. In the case of a university/BAS professor this could be offered to those in the age category of 60-65. They would immediately go on to full pension rights as if they had served the remaining years. This could be accompanied by a severance grant that would compensate for loss of earnings over 5 years. In some countries, early retirement is offered as early as 55 years of age. In that case the employee does not go in to full pension immediately. Rather they begin at a percentage, say 50% and gradually move to full pension at 65. Also there is a modest severance grant. This takes into account the fact that they may still find employment elsewhere. This is only one model and it would be appropriate for the Ministry to investigate fully in order to arrive at an acceptable system.

It would be important that these newly freed positions are not filled simply based on seniority of existing staff; promotion should be based primarily on research excellence. There should be the option to fast track high performing younger researcher to senior positions, based on research excellence.

Recommendation #3.6

The Bulgarian government should introduce initiatives to address the changing age profile of researchers and the renewal of the stock of professors.

More stringent controls should be introduced on the use of retired professors to undertake research and teaching that would otherwise be the role of younger colleagues. A suitable funding model should be developed and implemented by the universities/BAS in partnership with government. This can include a Voluntary Early Retirement Package for those aged 60-65 (with the necessary compensation for loss of income).

Ensure that all freed posts are filled through a rigorous procedure based on research excellence. Include the option to fast track outstanding younger researchers and bring talent from abroad especially from the Bulgarian research diaspora.

3.6. Career Progression and Salaries

"Quantitative evaluation should support qualitative, expert assessment[69]".

In section 3.5 there is a common recurring theme of measuring performance and the unattractive salaries for researchers at all career stages from PhD to Professor. If the national R&D system is to improve then this must be based on research excellence. This can be measured individually using a range of metrics that can be applied to all researchers. These should include publications, citation impact (and other bibliometrics), patents, international and industry collaboration. However this must be done with great care, as it required significant expertise to acquire and interpret these metrics. For example, bibliometrics are well suited to a number of disciplines but are severely limited in other, computer science and humanities, for example.

[69] Bibliometrics: The Leiden Manifesto for research metrics, Hicks et al, Nature, 520, 430 (2015).

All of this data can be gathered for individuals and stored in a database. It should be recognised, however, that this is a significant undertaking requiring a team of professionals who are expert in bibliometrics and evaluation. The quote above from the Leiden Manifesto[70] emphasises this point. The proper evaluation of research metrics can only be done by experts in the relevant fields. For this reason it is important to have peer assessment to add to individual research metrics. It is to be noted that there are already requirements in place in this regard. According to the Statute of BAS (article 58), BAS should publish officially the criteria for assessment researchers performance but this is not implemented. **While the autonomy of institutions should be respected there is also the responsibility of the same institutions to be transparent and accountable to the taxpayer.**

In order to grow confidence among the Bulgarian research community, it will be critical to have international peer reviewers. This should be applied to all of the fellowship schemes proposed in Recommendations 3.4 and 3.5. The participation of international reviewers can ensure that the assessment of individuals is carried out in an open, transparent and objective manner. It has the added bonus of measuring national excellence based on international norms.

Recommendation #3.7

The Bulgarian government and universities/BAS should ensure that the assessment of researchers for recruitment, promotion and research grant funding purposes is done in an open, transparent and merit-based manner on the basis of research excellence. Measurement should be based on a combination of metrics including publications, citation impact (and other bibliometrics), patents, throughput of graduate students, international and industry collaboration. This assessment should be underpinned by international peer review using the principles in the so-called Leiden Manifesto outlined above. The panel recommends that the government considers specific support under the Policy Support Facility to provide concrete recommendations as to how to address this issue.

The second recurring theme in this chapter is that of the low salaries for researchers at all career stages. This is evident from the data in Figure 14 and Figure 15 below. These are highly unattractive for researchers and moreover make it very difficult to retain Bulgarian researchers and attract international researchers.

Figure 14: Bulgarian salaries, stipends and benefits by job positions and employment contract.

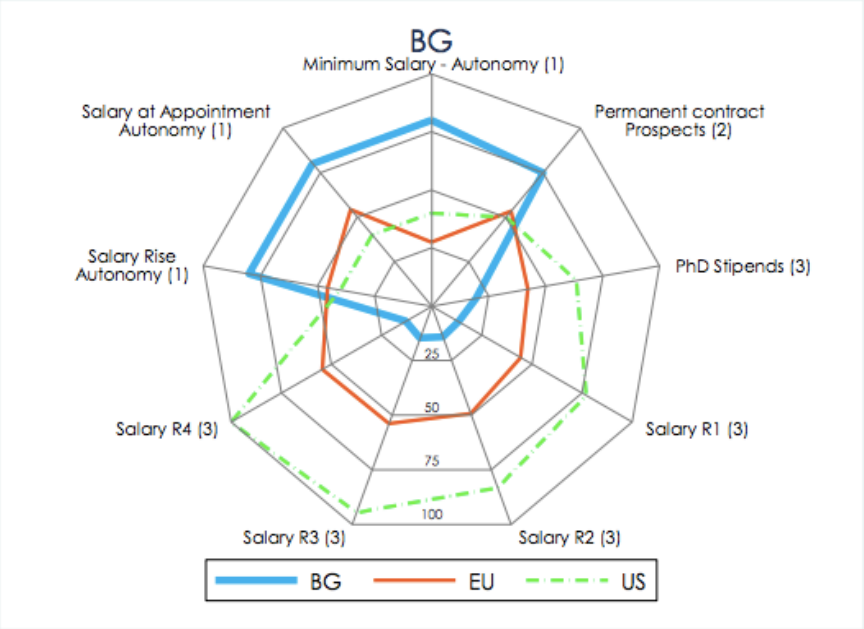
Rank	Name	Type of contract: Employment status	Type of contract: Contract duration	Annual Gross Salary in national currency and (in PPP €): Minimum	Annual Gross Salary: Average	Annual Gross Salary: Maximum	Mandatory insurances: Health care	Mandatory insurances: Unemployment	Mandatory insurances: Pension
R1	PhD-Candidate [1]	Stipendiary	Fixed 2-4 years	5,400 (4,767)	6,000 (5,298)	7,200 (6,357)	X	X	X
R1	Assistant [2]	Employee	Fixed >4 years	5,400 (4,768)	6,000 (5,298)	6,600 (5,827)	X	X	X
R2	Chief Assistant [3]	Employee	Permanent	7,800 (6,887)	8,400 (7,417)	9,600 (8,476)	X	X	X
R3	Associate Professor [4]	Employee	Permanent	9,360 (8,264)	10,800 (9,536)	12,000 (10,595)	X	X	X
R4	Professor [5]	Employee	Permanent	10,680 (9,430)	12,000 (10,595)	14,400 (12,715)	X	X	X

Source: MORE II - Expert Survey; National currency: BGN; **Annual Gross Salary:** Source: 1, 2, 3, 4, 5) 2012; Internal Rules of HEI; Notes: ad Stipends: The stipends of PhD candidates are regulated by a Council of Ministers Decree: only PhD-candidates in full-time education can receive stipends. Additional money can be awarded in case of successful completion of the thesis. Universities can restrict the working hours and therefore additional income of awardees; **PPP:** Salaries and Stipends in national currency are converted into PPP US-Dollar (2011) and the resulting PPPs are converted into EURO using the currency exchange rate of Eurostat 1,3920$ = 1EURO; if the year of the salary or the stipend is not 2011, the amount was grossed up to to 2011 using the unit labour costs index of the AMECO database.

Source: Country Profile – Remuneration Bulgaria, MORE2 report

[70] http://www.leidenmanifesto.org/.

Figure 15: Main Salary Indicators for Bulgaria (Country Profile – Remuneration Bulgaria, MORE2 report)



Source: MORE II expert survey

Spokes are normalised minimum = 0, and maximum = 100% in case of „PhD-Stipends" and „Salaries R1-R4", maximum = R1 in case of „Permanent contract", and maximum = 5 in case of „Salary rise", „Salary at appointment", and „Minimum salary". Missing values are set to zero.

1) Degree of autonomy: „Salary rise", „Salary at appointment", and „Minimum salary "based on the question: "Please indicate the institutional level at which the following aspects of public university researchers are determined?" Scale: (1) National, (2) Regional (state), (3) Sector/collective agreements, (4) University, (5) Individual negotiation, (0) missing value;
2) Prospect of a "permanent contract" shows the lowest career stage (R1-R4) at which university researchers can obtain permanent contracts.
3) Salaries: „PhD Stipends", „Salaries R1-R4" show gross annual salaries (in PPP €)paid in the country as a percentage of the best paying country at this career stage.

As can be seen in Figure 15 above, Bulgarian institutions have a very high level of autonomy in terms of setting salaries when compared to the US and other EU countries. However this is meaningless since the low level of funding for salary available from government give the universities/BAS no ability to use their autonomy to attract researchers and reward excellence.

Under the present legislation as well as the legislation under discussion in Bulgaria it is possible for research grants from the NSF to be used to 'top-up' the salaries of those working on the research[71]. The amount of the grant that can be used for salaries varies depending on the composition of the research team but it can be as high as 30%. The European Horizon 2020 programme does allow project participants to top up their salaries. However it is important to underline that this is in the context of a very large EU budget of €80bn and is intended to compensate for lower indirect costs as compared to previous Framework Programmes. However this top up only applies to the project leader and not to the researchers hired to work on the project. This makes it more complex to attract young researchers from abroad as part of national teams working on H2020 projects.

The practice of allowing researchers to draw down up to 30% from research grants can have unintended consequences and is also open to misuse. It can lead to a situation where research funding is sought primarily to augment salary rather than carry out high quality research. Research funding should be a means to carry out high quality research and should not be misused as a salary policy. In most countries, as outlined above, the practice is that research grants are to hire additional researchers (PhD's and postdoctoral researchers), fund equipment, consumables and other related expenses (including conference participation and publication costs). Having 30% of the grant diverted to the applicant's salary reduces funding for these components and therefore reduces the research output. This practice should be phased out in a planned manner so as not to dissuade academics from engaging in research. It should be replaced by a scheme that augments

[71] ПРАВИЛНИК НА ФОНД "НАУЧНИ ИЗСЛЕДВАНИЯ" last amended and supplemented 6 June 2014.

salaries for high performing researchers in Bulgaria. This would be through the fellowship schemes proposed for research at all career levels in section 3.5 (from PhD to Professor).

There could also be a separate scheme to augment salary for high performing researchers in Bulgaria; this could provide the bonus salary for a period of 5 years. The criteria for funding would be based on research excellence, throughput of graduate students, international collaboration and links with industry (the same criteria as in recommendation 3.7). This could be done through a national competition open to all and based in individual research performance. At this point in time it would be critical to inspire confidence among the academic and research community by using international peer review for this salary augmentation**.** Continuation of the salary bonus beyond 5 years would require a further application and this would depend on previous performance (including research output and leverage of international funding, especially Horizon 2020).

The Horizon 2020 programme operates on the principle that local salaries are paid to researchers in each country. This makes it unattractive to researchers in Bulgaria and, if successful, very complex for them to attract researchers from abroad. This is in fact an issue for most of the "new" Member States of the European Union and it certainly should be followed up directly with the European Commission. One approach for the Bulgarian government would be to provide a salary top up for all researchers funded under Horizon 2020 (apart from the project coordinator who already receives a top up under this programme) projects using European Structural Funds. This would certainly make it easier to attract researchers from abroad to work on Horizon 2020 projects.

In introducing higher salaries, the Bulgarian government will need to conduct an analysis to determine the level of competitive salaries to achieve their objectives. It is also important to understand that these changes will bring about different salary levels for researchers depending on the underlying funding stream. This is the case right across Europe as, for example, Marie Curie researchers are usually receiving salaries well above the national norm. However it must be recognised that this is usually in the context of a reasonable base salary for all researchers. This is clearly not the case in Bulgaria and while there is a strong argument for raising overall salary levels, the initial focus should be to reward excellence and concentrate on performance based funding.

Recommendation #3.8

The Bulgarian government and universities/BAS should introduce a number of initiatives based on individual research performance to increase researcher salaries. These include:

a) Fellowship schemes at all levels to attract and retain researchers
b) Fellowship scheme to provide salary bonus for outstanding researchers
c) Salary bonus for researchers hired to work in Horizon 2020 projects

A study should be carried out to determine competitive salary levels for these schemes.

In tandem with these new performance based salary initiatives, the current practice of allowing researchers to augment their salary from national research grants should be phased out and replaced with a merit-based system. Research funding should be a means to carry out high quality research and should not be misused as a salary policy.

3.7. Implementing Change – the European Researchers Charter and Code of Conduct for their Recruitment

In the previous section there have been a number of recommendations to increase the HR capacity and quality of the Bulgarian Research and Innovation system. These are not recommendations that can be implemented by government alone although it will play a key role in providing regulations, funding and oversight. It will be critical for the universities/BAS to take ownership of these recommendations and ensure that they put internal measures in place that facilitate their implementation.

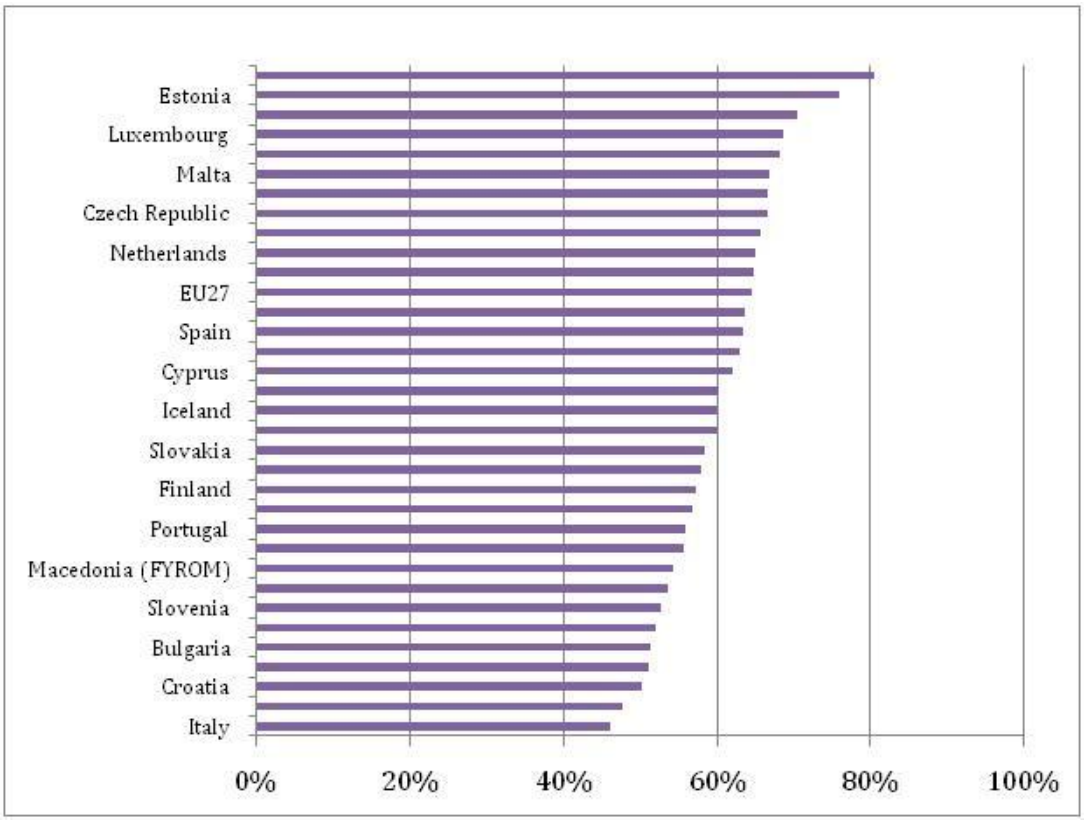
The European Researchers Charter and Code of Conduct for their Recruitment[72] ('Charter and Code') was published in 2005. It lays out clearly the rights and responsibilities of researchers. There are 40 principles that can be classified under four broad headings; Recruitment; Ethical and Professional aspects; Working Conditions; Training. The Charter and Code has been signed the

[72] http://ec.europa.eu/euraxess/index.cfm/rights/whatIsAResearcher.

Bulgarian Rectors Conference and the Free University of Varna. The role of the Charter and Code is central in current ERA policy that focuses on specific targets, the relevant one being and Open Labour Market for Researchers. Adopting and implementing the Charter and Code will give the universities/BAS a framework based on European policy to implement the changes recommended in 3.5 that will improve the academic career path help overcome the challenges of brain-drain and aging of the research staff.

While many organisations in Europe initially signed up to the Charter and Code it became apparent that many did little to actually implement the recommendations. In fact, the ERA Country reports often present a position that all national organisations are fully compliant with the Charter and Code. However research carried out by the Commission through the MORE2 survey[73] (Mobility Patterns and Career Paths of EU Researchers) demonstrate that this is clearly not the case.

Figure 16. Share of researchers that think that the recruitment process at their institution is sufficiently transparent



Source: MORE2 survey.

As can be seen in Figure 16 about **half of the researchers in Bulgaria believe that the recruitment process in their university/BAS is not open, transparent and merit based.** This shows that implementing the recommendations on researcher assessment will require significant reform in the universities/BAS. **The adoption of the Charter and Code is simply not enough for change**. Institutions must go through a critical self-analysis and form a clear plan for change in their HR structures and procedures. The Charter and Code is voluntary but it will be important to link reform in the universities/BAS to funding to provide a clear incentive for change.

In 2009, the Human Resources in Research Award (HRS4R)[74] was introduced as a means for institutions that adopt the Charter & Code to gain recognition with the HR Logo. The Human Resources Strategy for Researchers (HRS4R) supports research performing institutions and funding organisations in the implementation of the principles of the Charter & Code in their policies and practices. The concrete implementation of the Charter & Code by research institutions renders them more attractive to researchers looking for a new employer or for a host for their research project. Funding organisations implementing the Charter & Code principles will contribute to the attractiveness of their national research systems and to the attractiveness of the European Research Area more generally.

[73] http://www.more-2.eu/www/.

[74] http://ec.europa.eu/euraxess/index.cfm/rights/strategy4Researcher.

It is also important to underline that the implementation of the Charter and Code is a legal requirement of Article 32 of the Model Grant Agreement for all Horizon 2020 contract[75]s.

In the Bulgarian context the HRS4R could act as a catalyst for change. Working towards the award requires a number of actions to be taken by the institution. In order to assess their position, the universities/BAS would carry out a Gap Analysis that studies their current processes in relation to the Charter and Code. The 40 principles assessed in the Gap Analysis span four thematic areas;

Recruitment and Selection;

Ethical and Professional Status;

Working Conditions and Social Security;

Training and Professional Development.

Each institution would be obliged to the 'state of play' under these headings. As such, organisations must make a statement on their view of how they are performing in terms of the broader headings (as outlined above). Narrative is required which highlights the strategic priorities and emerging themes from the gap analysis.

The Gap Analysis should proceed as follows;

1. Set up a committee or working group to oversee the Gap Analysis. The committee or working group must be sponsored by the Rector/ President or other senior level position of the university/BAS.
2. The institution must take into consideration a wide range of stakeholders within the organisation including, Human Resources. It must include researchers at all stages of their career, R1-R4 (PhD to Professor). External stakeholders may be invited to enhance the process.

Following the Gap Analysis the institution should prepare a detailed Action Plan that will provide the details as how it will address the gaps in their own structures and procedures in relation to the Charter & Code. The Action Plan should have a clear timeline for addressing issues and how they will ensure that the Charter and Code is implemented; i.e. that all researchers from PhD to Professor will be treated in accordance with the Charter and Code. An important point is that researcher representatives from all career stages must be an integral part of this process. All of this must be done in the public domain and placed on the university/BAS website.

Applying for the Human Resources in Research Award (HRS4R) would ensure that the universities/BAS deal with all of the issues related to HR capacity from PhD to Professor. Looking at the four categories used in the Charter and Code it is easy to see how this would provide a holistic approach to career development of all research staff from recruitment to retirement. This would provide a single framework to integrate the recommendations 3.1 to 3.8.

For example an analysis of *Recruitment and Selection* would require the universities/BAS to look at how they advertise posts, assess and appoint candidates and ensure gender balance. In order to meet the conditions of the Charter and Code, all researcher posts would be advertised internationally (also in English) on the EURAXESS website. There would be clear selection criteria for each post and an open and transparent selection committee. Candidates would receive full feedback on their application in writing.

The issues concerning salary and performance would come under the heading of *Working Conditions and Social Security*. Promotion criteria would be published openly and explained in detail. As in the case of recruitment, there would be an open and transparent process for promotion. This would be based on performance and not seniority. The impact of seeking the HRS4R will enable universities/BAS to focus in a very structured manner on the recruitment, funding, career progression and promotion of researchers. It will not of course change the funding environment as that must come from without. However it will enable universities/BAS to make a strong case for change in order to achieve ERA objectives, a commitment made by the Bulgarian government. It would be preferable to have this done in a coordinated manner by the universities and BAS. In order to incentivise institutions, obtaining the HR Excellence in Research Award (HRS4R) should be linked to all national funding programmes. While it may take some time for institutions to gain the award, their intention should be considered in research funding proposal evaluations. Initially it should be a requirement for all to sign up to the Charter and Code.

However as pointed out above, signing the Charter and Code is meaningless if no further action is taken. All universities/BAS should initialise the process to obtain the Human Resources in Research Award (HRS4R). In order to incentivise institutions to embark on the process a special fund could be introduced that would provide support for researchers applying for European funding. This could

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[75] Horizon 2020 Annotated Model Grant Agreement of May 2015: http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf.

take the form of travel grants to meet potential partners and coordination grants to enable applicants to obtain professional support in the preparation of proposals[76].

Recommendation #3.9

It is recommended that all research performing institutions sign up to the Principles of the European Charter for Researchers and a Code of Conduct for the Recruitment of Researchers to build a working environment leading to successful performance and career development and to ensure open, efficient and transparent recruitment practices. This can progressively become a condition for access to all national funding for research.

All universities/BAS should seek to gain the HR Excellence in Research Award, described above, and in time this should become a necessary condition for all national research funding.

The Bulgarian government should introduce a funding programme to support applicants to European funding programmes. The institutions that apply for the Human Resources in Research Award (HRS4R) will become immediately eligible for this fund.

After 5 years, only universities/BAS that have received the Human Resources in Research Award (HRS4R) will be eligible to apply for national research grants.

3.8. Conclusions

Bulgaria faces a clear challenge to increase its stock of researchers in order to meet the national 2020 target of 1.5% investment of GDP on R&D. It will be essential to ensure that the increase of numbers is done in a way to maintain quality and encourage quality improvement. Moreover, researchers must be trained based on research excellence and also the needs of the economy and society must be taken into account.

Current practice spreads research funding broadly over the all PRO's in Bulgaria. Research funding should be directed towards those with significant research activity based on research excellence.

Researcher career progression proceeds from PhD to Professor. It will be important to ensure that the correct measures using international good practice are taken at each career stage to ensure the best outcomes. For PhD students, the Principles of Innovative Doctoral Training should be applied to their education and training. There must be initiatives to increase the internationalisation of PhD programmes and the retention of excellent Bulgarian graduates.

Regulations must ensure that accreditation of doctoral programmes and foreign PhD's are treated efficiently by the National Evaluation and Accreditation Agency (NEAA).

A new cohort of researchers within R2 (Recognised Researcher), the postdoctoral researcher, should be introduced to increase the flexibility of the Assistant Professor category. The provision of professional development opportunities through skills training should be made available to all researchers at this level. This will enable a greater flux of researchers in the Bulgarian system and stimulate international collaboration.

At more senior level there is an opportunity to attract leading research talent from abroad through high-level individual fellowships. This is a practice common in many European countries and can be an excellent way to attract back the Bulgarian research diaspora. There are bottlenecks to career progression at senior level due to age profiles. A number of measures including compulsory and early retirement packages can be used to open the system.

There are two recurring themes throughout this analysis, evaluation and salary. It will be important for researcher career development that both ensure a robust and attractive research system in Bulgaria.

The assessment of researchers themselves must be done in an independent, fair and transparent manner. An optimal method is based on research excellence that is measured through a combination of clear metrics and underpinned by international peer review using the Leiden Manifesto.

On examining the different career stages of researchers and the national needs, it is preferable to introduce individual fellowship schemes for increasing the numbers. In order to have the confidence of the scientific community and ensure excellence, international peer review should be used in the selection process to appoint new researchers. This could be implemented through a single national funding agency (as discussed in Chapter 2). In fact, these fellowships should be

[76] This type of support is available in a number of countries, for example, Enterprise Ireland the national body supporting access to Horizon 2020 provides this type of funding (www.horizon2020.ie).

introduced as a national programme for researcher career development. Along with scientific excellence, there must be a commitment to career development that includes professional development and training incorporating areas from leadership to technology transfer.

There is a problem in bringing researchers from abroad using Horizon 2020 funding, as the applicable salaries are unattractive. This is something that can only be solved in the long term by the Bulgarian government (working with countries in a similar situation) approaching the European Commission directly. In the short term, a solution would be to use Structural Funds to augment the salaries of those funded on Horizon 2020 salaries. Also use of the Marie Sklodowska Curie COFUND programme for PhD's and postdocs would be helpful, as the salaries do not have to match local levels.

Current practice allows for research to draw down up to 30% of research grants as salary top up. This practice should be phased out and introduce performance based pay to recruit, reward and retain excellence based on international peer review. It will be necessary for the Bulgarian government to conduct a short study in order to determine appropriate salary levels for all researcher career stages.

As a first step in researcher career development, all research performing institutions should sign up to the Principles of the European Charter for Researchers and a Code of Conduct for the Recruitment of Researchers. The long-term goal is then for all research performing institutions to obtain the HR Excellence in Research Award. This should become a necessary condition for applying to national funding agencies. It will certainly be important in seeking funding from Horizon 2020.

The process of applying for the HR Excellence in Research Award will mean that institutions must examine in great critical detail their own practices in staff recruitment and development following the headings of:

- Recruitment and Selection
- Ethical and Professional Status
- Working Conditions and Social Security
- Training and Professional Development

Not only will they identify areas where they can improve but also any bottlenecks and impediments that can be resolved externally by national legislation and funding agency procedures. In fact it would be preferable if national funding agencies were to adopt the Charter and Code and require its implementation through its funding schemes.

This collaborative approach between the PRO's and the funders could introduce a system that will develop a new cadre of researchers striving for scientific excellence and with the skills to form close links with business and industry.

4. TACKLING THE GAP BETWEEN RESEARCH AND BUSINESS

As part of the overall Peer review activities the PSF panel was asked specifically to consider how the Bulgarian authorities could best ***tackle the gap between research and business***. In this context 'research' is understood to mean the R&D supply side represented by universities, the BAS or other Bulgarian PROs while 'business' is understood to mean companies operating in Bulgaria (including Bulgarian subsidiaries of foreign firms). The PSF panel has focused on how Bulgaria might best implement reforms to "*build-up and enhance knowledge transfer policies and instruments, including evaluation of current legislation and introducing tailored measures for attracting industry and in particular the SMEs to collaborate with the public research organisations*".

This chapter starts by reviewing recent analysis of the situation and then explores 4 main topics and underlying challenges. A number of Best Practice examples have been introduced to illustrate how other MS have taken action to address similar challenges to good effect. Each of the four subsections concludes with a series of interlinked recommendations. The chapter ends with overall conclusions.

4.1. Background to the situation – analysis vs. implementation

A great deal of data collection and deep analysis has taken place in Bulgaria linked to the issue of stimulating and enhancing the national innovation system and associated strategy and policy. Recent key reports include '**Input for Bulgaria's Research and Innovation Strategies for Smart Specialization February 2013'** [77] and work by **HEInnovate**[78] dated December 2014.

In the case of the document produced by the World Bank **Input for Bulgaria's Research and Innovation Strategies for Smart Specialization February 2013** (hereafter 'Inputs for R&I') recommendations were offered to the Bulgarian authorities under 5 headings including, (see page 32), '*Stimulating Business Innovation and Entrepreneurship*', '*Research*' and '*Human Capital Formation*'. All three of these 3 categories contain strategic objectives and/ or short/ medium to long term recommendations that arguably address the issue of 'tackling the gap between research and business'.

A tabular summary of the Inputs for R&I recommendations can be found in Annex 4.1: Summary of Recommendations from the document Input for Bulgaria's Research and Innovation Strategies for Smart Specialization February 2013.

In the area of **Stimulating Business Innovation and Entrepreneurship**' the main strategic objective was to '***Create an environment that stimulates innovation'***. It was suggested that this might be achieved by addressing four sub-needs including explicitly (No. 2) the need for '***stronger linkages between research and business'***. However, regrettably the Inputs for R&D document does not offer clear alignment or obvious linkages between the four aspects of the strategic objective and the various short and medium/ long term recommendations. Arguably this has reduced any logical framework approach to their implementation and perhaps diminished their power as agents of change.

In the area of **Research** the main strategic objective was '***Develop a globally competitive and economically relevant research system'***. A number of short and medium/ long term recommendations were proposed. Several of these arguably relate to tackling the gap between research and business including:

- ***Redesign scientific support instruments to target collaborative and mission oriented research by building the capacity of existing research teams and facilitating the creation of public-private research consortia.***

and

- ***Develop policies that encourage IP disclosure, IP monetization, and public-private collaboration by establishing a central TTO (Technology Transfer Office) and strengthening the network of TTOs.***

Finally, in the area of **Human Capital Formation** the strategic objective was to ***Develop advanced human capital and reverse the brain drain***. However, short term recommendations include:

Make higher education more responsive to the needs of industry by:

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[77] Input for Bulgaria's Research and Innovation Strategies for Smart Specialization February 2013. Available at (15.06.2015) http://www.mi.government.bg/files/useruploads/files/innovations/full_report_3s.pdf.

[78] HEINNOVATE Reviews On Promoting Innovative And Entrepreneurial HEIS Country-Level Review Bulgaria Review Report Prepared by the Organisation for Economic Co-operation and Development DECEMBER 2014. Executive summary available at (15.06.2015) http://info.technopolis-group.com/HEInnovate_Bulgaria_summary/HEInnovate_BGR_executive_summary_EN_final.pdf.

- creating incentives for university/business collaboration
- developing courses with industry input
- offering scholarships in collaboration with industry

Arguably, these recommendations, and particularly the creation of incentives for university/ business collaboration also tackle the gap between research and business and align more strongly with the strategic recommendations for **Stimulating Business Innovation and Entrepreneurship** than they do with those for **Human Capital Formation.**

In the case of **the HEInnovation** document, the report outlines nine Key Findings and fourteen very specific Recommendations to encourage the emergence of more entrepreneurial Universities (see from p.8 of the Executive Summary onwards). A summary of these Key funding and recommendations can be found in Annex 4.2: Summary of Key Finding and Recommendations from HEInnovate Country-Level Review Bulgaria.

Five of the nine key findings are particularly relevant for the issue of tackling the gap between research and business. The first is the ***absence of a clearly defined role for HEIs in promoting innovation and entrepreneurship*** and its perceived link to the lack of a "*common policy framework that brings together these different strands of measures and clearly defines the role of higher education in promoting innovation and entrepreneurship*". HEInnovate notes that "the new strategy on higher education, whose adoption is currently pending, is expected to increase coordination efforts". The second key finding is the ***narrow understanding of the innovative and entrepreneurial HEI concept*** which focuses on *"the promotion of start-up activities, primarily targeted at students*" and fails to link the concept to "organisational capacity, stakeholder links, internationalisation, and leadership". Thirdly, HEInnovate notes that ***knowledge exchange is not yet part of the core-strategy of HEIs*** with "*many knowledge exchange activities of HEIs with business and other external partners focused on individuals"* with the associated risk that "*benefits from the high number of projects (often co-financed by the European Union), which provide the opportunity of a salary increase for individual staff members, remain constrained to individual benefits with little or no spillovers to the HEI as a whole*". Also noted are open issues in the legal framework for public private partnerships and public procurement "*which render business collaboration difficult for HEIs*". The report also notes that there are a number of ***barriers to up-scale entrepreneurship promotion in HEIs*** including a strong lack of "*rectors who consider themselves as entrepreneurship champions*". Finally, HEInnovate notes the detrimental effect of ***Missing or*** *"rare"* ***links between the HE system and the rapidly developing entrepreneurship ecosystem*** *"despite strong awareness of activities within the student community*".

HEInnovate makes a number of strong recommendations for mainstreaming the third mission in Bulgarian PROs and developing entrepreneurial universities (see Annex 4.2: Summary of Key Finding and Recommendations from HEInnovate Country-Level Review Bulgaria Recommendations). As development of more entrepreneurial universities is key to tackling the gap between research and business all these recommendation are relevant.

These two documents have been particularly highlighted in view of the four concrete, linked challenges that were identified by the PSF panel during their field trips as presently impeding bridging the gap between research and business. These are:

(1) Developing the National Innovation System (NIS) (see section 4.2.);

(2) Facilitating entrepreneurial behaviour in PROs (see section 4.3);

(3) Developing the innovation ecosystem and (see section 4.4.)

(4) Stimulating increased demand for R&D by the private sector (see section 4.5).

Even a rapid investigation into these four issues by the PSF panel quickly revealed that many of the obvious recommendations for policy reforms had already been made by the 2 documents referenced above. In addition, discussions with the Bulgarian authorities revealed that they are aware themselves and frustrated by of the lack of implementation of some recommendation that date back many years, for example the 2007 **Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations**[79]. The Authorities are also well aware of the reforms that have taken place in other Member States that have led to increased spinoff activities and the changes in some of their own institutions, for example the regulation in the Bulgarian Academy of Sciences regarding spinoff, that have not been reproduced in the Bulgaria Universities.

[79] See http://ec.europa.eu/invest-in-research/pdf/download_en/ip_recommendation.pdf.

In the view of the PSF panel the main challenge for the Bulgarian authorities in tackling the gap between research and business appears to be implementation of existing recommendations and in particular, to securing lasting change in institutions that are not under their direct control. This could be addressed by making future financing conditional on changes and the PSF panel supports this approach.

Below the PSF panel have outlined their main findings related to the 4 areas listed above and the recommendations already proposed by other groups. Along with reiterating recommendations the PSF panel has also deliberately focused on providing concrete example of how other MS have implemented activities based on case studies. It is hoped that these will help the Bulgarian authorities to implement recommendations that now come from 3 different groups.

4.2. Developing the National Innovation System (NIS)

Challenges facing concerning the present Bulgarian NIS:

The Bulgarian NIS is characterized by separation of "R&D" and "innovation" and in addition the NIS is highly fragmented. The NIS is mainly supply-push oriented however the business sector of R&D appears more vital and more ambitious than the public one and the public institutes lack entrepreneurial character. The public image of the NIS is inadequate to drive sustainable change.

Challenge 1.1: Bulgarian NIS is characterized by separation of 'R&D' and 'innovation' and is highly fragmented

The Bulgarian NIS is characterized by a separation of the publically funded "research and development pillar" on the one hand, and the private sector "innovation pillar" on the other. The research and development pillar is mainly under the governance of the Ministry of Education and Science and regarding SF this pillar is represented mainly in the Operational Programme "Science and Education for Smart Growth" and this pillar is managed by the National Science Fund (NSF). In contrast, the innovation pillar is mainly under the governance of the Ministry of Economy and regarding SF this pillar is represented mainly in the Operational Programme "Innovation and Competitiveness" and this pillar is managed by the National Innovation Fund (NIF).

A lack of designed complimentarily between the activities of the beneficiaries and stakeholder of the two pillars is perceived by the PSF panel as one of the main challenges of the present Bulgarian NIS. In order to achieve this objective there is a particular need for closer cooperation between the Ministry of Education and Science and the Ministry of Economy and for mechanisms to ensure synergy between Operating Programmes under their control. Only if the Ministries and their agencies consistently coordinate will there be significant improvements.

In addition the Bulgarian NIS is characterized by a highly fragmented institutional landscape with a strong concentration of activities in Sofia. The Webometrics Ranking lists 56 universities, while ERA Watch (2011) indicated 19 experimental stations at the Agricultural Academy and 87 research and supporting units at the Bulgarian Academy of Sciences. This is a very large number for a country of the size of Bulgaria. If all such institutions are to be maintained then improved cooperation mechanisms are necessary to ensure activities gain critical mass and knowledge spill-overs are maximised.

A good starting point for improved coordination between the Ministries and cooperation between the institutions could be centred on the Sofia Tech Park and similar regional initiates such as the centres of competency (CoCs) and excellence (COEs).

Challenge 1.2: Supply push policy vs. market demand conditions

Although real innovation processes are complex and interlinked, two simplified linear perspectives can be distinguished. This is important given the separation of R&D and Innovation in Bulgaria. The first perspective, the so called "technology push" or "supply-push" model, emphasizes a linear process commencing with R&D activities. The second perspective, the so called 'market demand' or 'market pull' model emphasizes the role of market need, which leads to concrete business led R&D activities. In this respect the World Bank report concludes: "*Science policy and funding instruments in Bulgaria have been designed with the idea of the "supply-push" model, in which scientists are at the origin of the project, the main barrier is selling the new idea on the market and the technological sophistication and risks tend to be high to medium. In this context, the priority is to giving* [sic] *scientists the resources to develop their projects until the applications are clear, under the assumption that a private partner can be attracted later on*."[80] This supply push model is outdated and Bulgaria is encouraged to move towards a more modern and balanced policy mix.

[80] See World Bank: Input for Bulgaria`s Research and Innovation Strategies for Smart Specialization, p. 117.

There is a clear present lack of entrepreneurial culture and skills among Bulgarian PRO researchers; this will strongly curtail results from a supply- push model. There are also strong indications (see chapter 1) that the R&D taking place in the Bulgarian business sector is currently more vital and more ambitious than the public one, particularly in some key priority industry sectors such as ICT where a market demand model would be more appropriate. At the same time, it is recognized that the commercialisation of publicly funded research through technology transfer from public to private sectors is also a major weakness within the Bulgarian NIS; there are very limited frameworks (and funds) for supporting collaboration between stakeholders in the knowledge triangle compared to the portfolio of measures observed in other EU MS.

In this situation there is a strong need to both stimulate the supply and demand sides and to create professional support services between the two groups. Given that the present dominate policy is supply-push there may be short term benefit in trying to improve entrepreneurial behaviour in the supply side e.g. that of the universities, BAS and other public research institutes including those under the Ministry of Agriculture. In this respect the very recent findings and recommendations of the HEInnovate report mentioned above are particularly relevant. In addition, there is a need to create a more balanced policy mix with instruments to support supply and demand sides and also to encourage their interaction. This need for a wider portfolio of instruments is explored more in Section 4.5.

Challenge 1.3: The public image of the NIS is inadequate to stimulate and secure lasting change

Bulgaria should promote science, creativity and innovativeness across society, but particularly in education. Promotion of science, creativity and innovativeness in society and education is the essential driving force behind the concept of a knowledge-based society. The public image and position of researchers in Bulgaria is inadequate in relation to the adopted strategies. We assume that citizens are often not aware of the contributions of researchers to solving social problems and the competitiveness of the economy, and are typically not familiar with globally recognized findings and products originating from domestic scientists and innovators. For that reason we propose more efforts towards the popularisation of science, the promotion of creativity, innovativeness and the culture of entrepreneurship and building the concept of responsible research between science and society. Such efforts should start at an early age, hence the importance of starting such promotion campaigns already in education. Many other MS have taken steps to raise the profile and the role of science within society. An example of how the Dutch government is engaging with stakeholders to build the Dutch Science Agenda is outlined below.

Case study 19: Wetenschapsagenda: the Dutch Science Agenda Netherlands (2015-ongoing)

The Dutch government has indicated that strategic choices and collaboration are needed to further strengthen the top position of Dutch science and that they wish to deploy resources and effort in a far more targeted manner with a view to scientific strengths, societal issues and economic opportunities. To realise this objective the government has commissioned the Knowledge Coalition to develop a Dutch Science Agenda.

Approach

Until 1 May 2015, everybody in the Netherlands could submit his or her 'questions to science' online. Questions can be broadly societal, clearly economic or generally scientific. In total individuals and parties from science, the business community and civil society organisations submitted more than 11,000 questions.

Five scientific juries, appointed by the Knowledge Coalition, are now clustering and assessing the questions submitted at this stage. This process is being coordinated by the Royal Netherlands Academy for Arts and Sciences (KNAW).

Conferences

In June 2015 3 conferences were held to discuss which questions are especially relevant for science (Science for Science), for the Dutch economy (Science for Competitiveness) and for society (Science for Society).

The conferences have formed the starting point for a dialogue about the submitted questions. Knowledge institutions, companies and civil society organisations were invited to enter into a discussion with the posers of questions and other interested parties on the basis of clusters of submitted questions about specific subjects and themes.
This phase will continue until the Weekend of Science on 3 and 4 October.
The steering group of the Knowledge Coalition will make a final selection of questions and will group these under a small number of themes. The Dutch Science Agenda will be presented at the end of November 2015.

For more information see: http://www.wetenschapsagenda.nl/?lang=en

Recommendation #4.1

To address the present challenges in the NIS, Bulgaria should move towards a better balance of instruments (policy mix) that will foster academic entrepreneurship, support both supply and demand led innovation and also encourage collaborations between public and private sector. This will require strong coordination between relevant Ministries and also the raising of awareness and engagement within society for the innovation agenda. This should be built on the structured dialogue with stakeholders in Bulgaria (see Chapter 1).

4.3. Facilitating entrepreneurial behaviour in PROs

Challenges concerning the entrepreneurial behaviour in PROs

There is significant uncertainty for PROs in behaving in a more entrepreneurial manner linked to their Not-For-Profit status.

Most Bulgarian PROs still lack policies to deal with intellectual property created in research and its transfer to the private sector.

PROs are not embracing well established good practice in knowledge exchange activities and knowledge exchange is not yet part of their core-strategy or the metrics of their assessment.

There is a strong need for more mission oriented research in Bulgaria and the introduction of institutional models to promote this.

Challenge 2.1: Reconciling a Not-for-Profit status with entrepreneurial behaviour

It was clear to the PSF panel from their face-to-face discussions that Bulgaria PROs faces a series of obstacles in increasing entrepreneurial activity in the Public Research Organisations (PROs) with regard to legal ambiguity and apparent contradiction in the status and activities of its research organisations. These observations echo those of the HEInnovate report which states in the Key Findings "*the legal framework for public private partnerships and public procurement has still some open issues, which render business collaboration difficult for HEIs*"[81]. These are challenges that have been faced by many of the newer EU member states who have moved from centrally managed to market economics. All can be successfully over-come with political will, institutional determination and courage and provision of external support.

PROs such as the Bulgarian Academy of Science and the public universities are by definition 'non profit organisations' or simply NPOs. As they are increasingly encouraged to embrace a model of entrepreneurship and become a partner in the Open Innovation system they find themselves acting more as commercial entities – licensing their research results to the private sector for money bearing royalties, starting and taking an ownership stake in commercial spinoff companies, negotiating and signing contract agreement to provide research services.

Most law systems are explicit about what activities may not be undertaken within the law. But they rarely offer guidance on what activities may be undertaken while still remaining within the law; these are implied rather than explicit. PROs in many newer MS who are engaging in commercial activities that generate a financial return have stated that they find themselves increasingly uneasy as to whether this is in contravention with the 'Not For Profit' status. This concern was clearly present in Bulgaria as evidenced by meetings with PRO representatives. Until these issues are addressed PROs in Bulgaria are likely to continue to 'turn a blind eye' to individual researchers to engaging in low level commercial activities but will not fully embrace entrepreneurial activity at institutional level. For this reason the PSF panel recommends that the Bulgarian authorities strongly support the PROs in moving openly and confidently into more commercial activity. An example of support to help institutions in Poland overcome concerns related to retrospective VAT payments when they 'commercialise' a research project and generate financial value from an associated grant payment is outlined below.

[81] HEINNOVATE Reviews On Promoting Innovative And Entrepreneurial HEIS Country-Level Review Bulgaria Review Report Prepared by the Organisation for Economic Co-operation and Development DECEMBER 2014 Key finding No 5 pp.8.

Case study 20: Poland advising PROs on VAT and other issues relevant to their commercialisation activities

PROs in Poland find themselves facing a complicated VAT regime if they commercialise their research results. This has led to concern and a degree of unwillingness to engage in commercialisation activities, even on research projects funded specifically for innovation outcomes.

To address this barrier to entrepreneurial behaviour the National Agency for Research and Development under the Ministry of Science commissioned a guide for the PROs, produced in the Polish Language, by an accountancy firm. The guide helps them to deal with the issues and has encouraged a more positive approach to commercialising the results of research projects.

The guide and other information relating to the issue can be downloaded from the website of the National Agency for Research and Development.

See http://ncbr.gov.pl/gfx/ncbir/pl/defaultopisy/1177/1/1/przewodnik_kwalifikowalnosc_vat_dzialania_komercjalizacyjne.pdf

And http://ncbr.gov.pl/fundusze-europejskie/program-operacyjny-innowacyjna-gospodarka/komercjalizacja-kwalifikowalnosc-vat/

Challenge 2.2: Development and adoption of institutional IP Policies and associated Good Practice in PROs

Failure to set-up institutional level legislation to protect and transfer research results is having a negative effect on the commercialisation of research in Bulgaria. The most obvious omission is failure to implement the **Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations[82].** This recommendation, dated from the same year that Bulgaria entered the EU (2007), is designed to help the identification, protection and efficient transfer of intellectual property of all types, created in PROs, to the private sector. Only the BAS appears to have set up and implemented an institutional IP Policy. Without this institutional framework entrepreneurial researchers will continue to commercialise research privately. This informal approach not only fails to benefit the PRO it also tends to keep commercialisation activity artificially low as Bulgarian researchers do not want to draw attention to their 'gray' activities and also lack the necessary support to realise the full potential of their inventions.

WIPO continues to support institutions who are still establishing IP Policy including through the development and dissemination of a '**Model Intellectual Property Policy for Universities and Research Institutions**'[83]. This tool is aimed at encouraging the practical application and the economic use of the results of research carried out at the institutions. It is intended to "*facilitate the efforts of Universities to elaborate their own Intellectual Property (IP) policies on the rights related to the protection and exploitation, the obtainment and transfer of intellectual products and the manner of determination of the author's share in the fees and other revenues arising from the exploitation of the product, as well as enhancing the moral acknowledgement of authors*". It is widely used as a template and as a set of guidelines on which universities and other PROs can base their own IP policies.

There are indications that future funding in Bulgaria will be reliant on the existence of internal IP regulations and provision of a commercialisation unit. This is a very positive move that the PSF panel strongly endorses. It will further strengthen this initiative if it can be linked to others e.g. linking individual academic career progression to parenting activity or Institutional assessment to knowledge exchange mechanisms as is done in the UK under the Research Assessment Framework (REF) (see case study later in this chapter) and more recently Poland.

However, if PROs are to be required to set up an IP Policy e.g. in return for access to some funding schemes, then Bulgaria should ensure that IP Policies can be implementable and not just Best Practice on paper. Feasible implementation requires the provision of sufficient funding to support commercialisations activities by the PRO and a level of professionalised activity that exceeds previous individual commercialisation efforts by scientists and researchers acting alone. If a new formalised institutional system is not better than the old informal personal system then the IP policy will be an inhibitor rather than a driver for entrepreneurial change. The PSF panel urges the Bulgarian authorities to make provision to support the professionalising of Technology Transfer activities and to encourage pooling of resources to gain critical mass and help overcome the highly fragmentation nature of the R&D system.

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[82] http://ec.europa.eu/invest-in-research/pdf/download_en/ip_recommendation.pdf.

[83] See (accessed on 17 June 2015): http://www.wipo.int/dcea/en/tools/tool_02_a/.

Challenge 2.3: Bulgarian PROS are not embracing well established good practice in knowledge exchange activities and knowledge exchange is not yet part of their core-strategy.

Bulgarian PROs are failing to take advantage of EU initiatives that would help them to improve the internal landscape for knowledge exchange activities. Notable amongst these are **the Responsible Partnering Initiative**[84], (developed through close collaboration between EUA (European University Association), the European Industrial Research Management Association (EIRMA), the European Association of Research and Technology Organisations (EARTO) and the European Network of Knowledge Transfer Offices linked to Universities and Public Research Organisations (ProTon Europe now ASPT-PROTON)). The original Responsible Partnering Guidelines date from 2004 and were further updated in 2009. They address issues that are clearly relevant for Bulgarian PROs moving towards a more entrepreneurial approach including **State Aid**, **European Community recommendations on IPR management** and the results of the **EUADOC-CAREERS project on university-industry partnerships in doctoral research**. EUA has also proposed to the European Research Area Board (ERAB) that the Responsible Partnering Guidelines should be taken forward as a best practice in the first steps to creating an "Open Innovation Charter" proposed as an ERA Milestone in the ERAB's recommendations in its "Strategic View of the European Research Area: Preparing Europe for a New Renaissance"[85].

The lack of progress towards institutional adoption of well-established policies and Good Practices in Bulgarian PROs to support Technology Transfer and Knowledge Exchange and lack of evidence for clear results e.g. formal spinout support programs and reported IP licensing activities suggests that they are insufficiently connected to international MS counterparts and European Technology Transfer Networks and initiatives that would help build capacity e.g. ASTP-PROTON and the WIPO University's initiative[86]. This suggests that the Bulgarian authorities should focus hard on 'internationalising' entrepreneurial activities at PROs and specifically encouraging PROs to exchange good practices perhaps using H2020, TEMPUS or similar funding schemes. An example of an ongoing TEMPUS project designed to help Ukrainian PROs to establish spinoff activities and other commercialisation actions at their institutes, including the development of IP Policy, by learning from international peers is outlined below.

Case study 21: TEMPUS SPINOFF UKRAINE

The SpinOff project aims to improve conditions for creation and commercialisation of innovations through a set of structural measures encompassing:

- improvement of regulatory framework;
- offering mechanisms to facilitate cooperation among stakeholders;
- providing a synergy of research and education.

The core objective of the project is to ensure that universities in Ukraine are capable of creation and delivery to the market innovations of high scientific and commercial value.

Project partners:

International partners: Lund University (LU)-Sweden; Instituto Politécnico do Porto (IPP)-Portugal; Gdansk University of Technology (GUT)-Poland; Coventry University (COVUNI)-UK

Ukrainian partners: Ivano-Frankivsk National Technical University of Oil and Gas (IFNTUOG); National Metallurgical Academy of Ukraine (NMAU); Sevastopol National Technical University (SevNTU); National University «Odessa Law Academy» (NU OLA); Donetsk National University of Economics and Trade (DonNUET); Oil and Gas Scientific and Technological Park Ltd (OGTP)-Ukraine; Technopark "Machine Building Technologies" (TMBT); Non-governmental Organization "Fund "Sevastopol" (NGO FS); Ministry of Education and Science of Ukraine (MESU)-Ukraine.

The project is utilising the WIPO Model Intellectual Property Policy for Universities and Research Institutions and has utilised national lawyers to help review and customise the WIPO model for adoption by national PROs.

See: http://www.spinoff-ua.com/.

This proposal for a stronger internationalisation strongly echoes the final recommendation of the HEInnovation Report. Although HEInnovate is emphasising the need to improve mobility and

84 http://www.eua.be/eua-work-and-policy-area/research-and-innovation/Responsible-Partnering-Initiative.aspx.

85 See (Accessed 15 June 2015) http://ec.europa.eu/research/erab/pdf/erab-first-annual-report-06102009_en.pdf.

86 http://www.wipo.int/uipc/en/.

exchange of individual students and researchers the PSF panel sees a clear parallel with the need to internationalise Bulgarian institutions.

Improvements to governance of the knowledge transfer with improvements to the flow of knowledge could be achieved by establishing and embedding knowledge transfer as a key strategic mission of PROs. In making this suggestion the PSF panel echoes a key finding of the HEInnovate report which states that "***Knowledge exchange is not yet part of the core-strategy of HEIs***" and recommends that HEIs:

> *"Review and reformulate the university strategy documents in light of current challenges and possible responses. This will also imply building a common understanding of what the concept of an innovative and entrepreneurial HEI means to a particular HEI and its socioeconomic situation context".*

The PSF panel notes that to make this happen PROs need to be fully aware of the significance of knowledge transfer and it should be defined as a significant part of their vision and strategic documents. This will in turn necessitate the following: Building trustful 'triple helix' relationships and a good level of integration within the public and private sector research communities and government; Making R&D processes fully transparent (access to information and results – enhancement of The Bulgarian Current Research Information System, BulCRIS) and open access to the R&D data; Encouraging PROs to solve social and economic problems.

The PROs themselves need to help create an environment that favours efficient knowledge transfer. This will require an alignment of the education system to the needs of the business and the creating of opportunities for students to gain entrepreneurial skills and develop and an entrepreneurial approach including stimulating entrepreneurship among young PhDs. This will require that the PROs themselves develop a more entrepreneurial culture. PROs will also need to invest more resources into this 'third stream mission', providing stable funding for the comprehensive support of transfer of knowledge and technologies between PRO's and companies including realistic funding for offices for technology transfer (TTO) and their activities including patent drafting and prosecution and fostering a culture of patent acquisition.

Alongside investment into resources the PROs will also need to develop and fully implement framework conditions, including the legislative provisions relating to IPR discussed above. If the PROs are not willing to take these steps by themselves then the government should consider making them a pre-requisite for receiving funding. However, it is important in this case not to limit mandatory actions to regulatory documents but to extend them to KPIs (Key Performance Indicators) so that the PRO is forced to actually implement the regulations. Implementation can be monitored by including associated KPIs in the overall assessment process. This is done in the UK as part of the national Research Assessment Framework or 'REF' under the pillar of Impact (see Case study below). Funding models partly based on impact assessment are also developed (but not yet implemented) in Sweden[87] and the Czech Republic[88].

Case study 22: UK REF

The Research Excellence Framework (REF) is the revised system for assessing the quality of research in UK higher education institutions. The 2014 REF assessed the quality and impact of UK universities' research in all disciplines. The results will be used to allocate research funding from 2015-16.

The REF is a process of expert review, carried out in 36 subject-based Units Of Assessment (UOAs). The assessment considers 3 pillars: Outputs, Impact and Environment.

Outputs: 65 per cent of the overall results

'Outputs' are the product of any form of research. For the 214 RAF they products published between January 2008 and December 2013. They include publications such as journal articles, monographs and chapters in books, as well as outputs disseminated in other ways such as designs, performances and exhibitions.

Impact: 20 per cent of the overall results

'Impact' is any effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia.

Impact is used to measure '3 mission' activities including technology transfer and knowledge exchange activities.

Environment: 15 per cent of the overall results

'Environment' refers to the strategy, resources and infrastructure that support research.

For more information on the RAF consult:
http://www.ref.ac.uk/media/ref/content/pub/REF%20Brief%20Guide%202014.pdf.

[87] https://publikationer.vr.se/en/product/research-quality-evaluation-in-sweden-fokus-2/.

[88] http://metodika.reformy-msmt.cz/souhrnna-zprava.

The Bulgarian authorities are urged to introduce KPIs for PROs that reflect a strategic third stream mission and measure impact of activities. They may wish to consider those proposed by the Commission for Horizon 2020[89] but should be aware that it will take a long time for Bulgarian PROs to be in a position to report at this level.

The PSF panel emphasises that, while it is a key step forward, improvement of the regulatory framework, provision of more support and an exposure to Good Practice example of Entrepreneurial behaviour of PROs alone will not unleash a flood of spinoff and licensed innovations from the PROs. Realistic and long term funding is a prerequisite rather than a focus on 'self-sustainability'.

In addition, there is a clear need for a broader understanding of the innovative and entrepreneurial HEI concept. This comment echoes that of the HEInnovate report which states "*The current understanding of the innovative and entrepreneurial university – in the HEI community – is focused on the promotion of start-up activities, primarily targeted at students. Organisational capacity, stakeholder links, internationalisation, and leadership are not yet associated with the concept*".

Challenge 4: There is a strong need for more 'mission oriented research' in Bulgaria and the introduction of institutional models to promote this.

Internationalisation also brings benefits in terms of exposing PROs to alternative models of operation that can help them diversify their funding sources and behave in a more entrepreneurial manner. In this respect the PSF welcomes the introduction of Centres of Excellence and Competence. In addition, the model of the **Fraunhofer-Gesellschaft** is one that is being more strongly studied and considered in a number of countries including the UK (see Case study below). All Fraunhofer-Gesellschaft are dedicated to applied research. That means that Fraunhofer institutes act as "profit centres" and develop their specific strategy to secure clients and R&D projects. The institutional funding of Fraunhofer institutes is connected to the success in contract research for private public clients. If there is no market for applied research then no Fraunhofer institute will follow that R&D path for example. This model leads to clear entrepreneurial behaviour of each institute, including HR strategy, marketing, establishing strategic partnerships and IP-portfolio management etc.

Case study 23: Fraunhofer-Gesellschaft

The Fraunhofer Gesellschaft is the largest organisation for applied research in Europe and was founded in 1949. Although there are more than 80 institutes, centres etc. Fraunhofer-Gesellschaft is one legal entity with its headquarters in Munich.

On the one hand, the institutes and independent research units develop their "institute cultures" on the other hand Fraunhofer is one single organization with a mission. On the one hand there are clear rules of a public institution on the other hand there is entrepreneurial action.

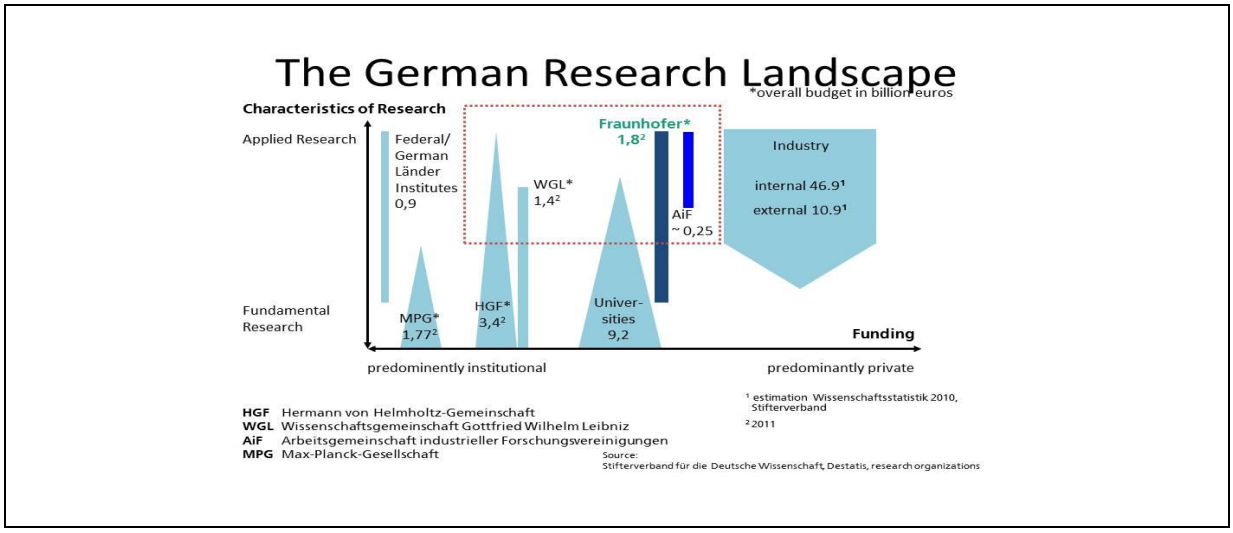
There are annual "performance-based" - negotiations between the Fraunhofer-Gesellschaft (Executive Board) with sources of funding (Policy Committee of the Fraunhofer-Gesellschaft)

The basic funding is provided first to the Executive Board. The distribution of these funds across the Fraunhofer Institutes is exclusively the province of the Executive Board (autonomy, no individual control from outside).

At the level of institutes each director holds a chair at the university. The institutes are responsible for the project results, the standing in the scientific community and the financial indicators (1/3 institutional funding, 2/3 from the market). At the same time there is structural freedom regarding the area of research, the allocation of resources, project acquisition and project management.

Fraunhofer is embedded in the German NIS, which is characterized by functional diversified institutions.

[89] See http://ec.europa.eu/research/horizon2020/pdf/proposals/horizon_2020_impact_assessment_report.pdf.



At the moment there seems to be a debate in Bulgaria centred on the possible benefits of merging the BAS with the research intensive Universities in order to reduce the number of research institution and to spread the teaching and research activities more evenly. Alongside the option to merge institutions the Bulgarian authorities could consider simply encouraging and enabling new working models to emerge such as the establishment of Fraunhofer style research units. This has been the approach taken by the UK (see below). Similar models in Austria include the Competence Centres for Excellent Technology (**COMET)** programme[90] and **Christian Doppler Forschungsgesellschaft (CDG)[91].**

Case study 24: Fraunhofer UK

Following an invitation in 2009 to explore closer connections between UK Universities and Fraunhofer, a series of discussions took place between UK government/academic institutions/learned societies and the Fraunhofer Society. Based on those discussions, in 2010 the University of Strathclyde took the lead in inviting members of the Fraunhofer Society to Glasgow to meet with University Senior Officers for initial discussions regarding methods of collaboration.

In May/June 2010 a Letter of Intent for collaboration in the area of 'photonics' (optical science and technology associated with communications, lasers, lighting, displays, sensing etc.) was sent by the University of Strathclyde to Fraunhofer and received a positive response. On this basis a draft 5-year business plan was put together covering the establishment of a Fraunhofer Centre in Applied Photonics (Fraunhofer CAP) in association with the University of Strathclyde. A funding package was then developed around this business plan, and supported by the University, Scottish Enterprise, the Scottish Funding Council, the Scottish Government and Fraunhofer Society.

The not-for-profit UK holding company, Fraunhofer UK Research Ltd, formally establishing Fraunhofer in the UK was registered in March 2012 and Fraunhofer CAP began operation in Glasgow in September 2012 (with a formal opening on 18th April 2013). Since Fraunhofer CAP started, it has won about £1.5 million in contract research projects.

Fraunhofer CAP is seen as the first of a prospective network of Fraunhofer Centres that could be established in the UK, administered by Fraunhofer UK Research Ltd. This is the broad aim and intention of the Fraunhofer Society.

See: http://www.fraunhofer.co.uk/

As importantly, the research organisations will need to be operating in a much better developed innovation ecosystem that enables the flow of technology and information among people, enterprises and institutions if they are to successfully develop a wider base of knowledge transfer activities. Development of the ecosystem lies strongly with government coordination and actions as outlined further below.

[90] www.ffg.at/comet.

[91] www.cdg.ac.at.

Recommendation #4.2

The present RI system in Bulgaria impedes public research organisations from becoming more entrepreneurial. To help PROs develop more institutional entrepreneurial behaviour the Bulgarian authorities should actively support resolution of issues that cause concerns, perhaps through a dedicated counselling service. The Bulgarian authorities need to urgently tackle existing barriers which impede public-private cooperation in RI linked notably to the not-for-profit status of public research organisations and to the fact that knowledge transfer is not part of the mission and core strategy of public universities. Future funding for PROs to undertake R&D should be linked to evidence that they have fully implemented the Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice including making adequate provision for commercialisation activities. Provision to support commercialisation activities including supporting the professionalising of Technology Transfer activities and encouraging pooling of resources to gain critical mass as well as funds for patenting and access to specialist support should be including in to funding calls.

Institutional models to encourage more mission-oriented research in Bulgaria are needed. The Bulgarian authorities are urged to encourage mainstreaming of the so-called 'third stream' activities, particularly in the CoEs and CoCs by linking their funding to evidence of a third stream strategic plan and to reinforce this by introducing metrics that capture their impact.

4.4. Development of the innovation ecosystem

Challenges concerning the development of the innovation ecosystem include:

Existing islands of excellence are not well connected to the PRO base.

Emerging innovation ecosystems will require pre-conditions that are not presently in place if they are to realise their potential and become sustainable;

There is a lack of shared research infrastructures in Bulgaria and a lack of transparency to encourage sharing;

Resources funded from SF need to foster the development of sustainable regional innovation ecosystems in Bulgaria;

A critical mass of skilled human capital is needed to enable RIs to function in a sustainable manner.

Challenge 3.1: Existing islands of excellence are not well connected to the PRO base.
Today, strong innovation economies are centred on high education systems that serve as hotbeds of innovation and entrepreneurship. However, in contrast, Bulgaria demonstrates almost the opposite situation: successful entrepreneurial hubs such as Eleven and LAUNCHub, while internationally recognised as examples of Best Practice, are almost completely unconnected to the HE / research system. This is a waste of resources in many respects. It needs to be addressed by stimulating a stronger commercialisation pull by the emerging start-up community in BG that presents a clear alternative to traditional R&D valorisation and exploitation strategies. This will require changes to the policy mix, making entrepreneurship a more strategic priority and development of a more entrepreneurial culture in PROs.

Challenge 3.2: Emerging innovation ecosystems will require pre-conditions for sustainability that are not presently in place

In contrast to Eleven and LAUNCHub, the Sofia Tech Park (SofiaTech) initiative, designed to open its doors in late 2015, appears to be involve partners almost exclusively from the not-for-profit sector without the clear presence of commercial partners; the exception is the EMIC - Electric vehicles industrial cluster. As one of the main objectives of the park is to 'strengthen the competitiveness of science and entrepreneurship in Bulgaria by improving the exchange of knowledge between academia and the business community' the involvement of the business community will be critical. However, SofiaTech will also rapidly put multiple important and related issues on the table that need to be addressed if the Park is to be economically viable and sustainable and also for it to realise its potential as an emerging innovation ecosystem in its own right. Arguably the Centres of Competency and Centres of Excellence will face similar challenges and opportunities, namely:

1. The need for a strong framework for PRO IPR ownership to enable commercialisation.

2. Legal ambiguities concerning the status of universities and their ability to operate in a more commercial or entrepreneurial manner to develop their third stream activities.

3. Being able to deploy contract research within the Tech Park facilities to help foster university education.

4. Being capable of connecting the know-how of foreign companies to Bulgarian SMEs and higher education institutions e.g. to increase the absorptive capacity of the Bulgarian NIS for international know-how or to help SMEs get connected with global innovation chains.

5. Developing first class R&D infrastructure management *competences* through international cooperation e.g. institutes of the academy of sciences and other PROs could benefit from the experiences of the Sofia Tech Park in increasing their opportunities for negotiating and managing contracts with companies, establishing long term relations with a sustainable client base etc.

When such issues arise, as they will rapidly in the case of Sofia Tech Park and also for the planned CoCs and CoEs it will become necessary to take a decision as to the organisation that should take primary responsibility and also obtain the commitment of all participating stakeholders. In this sense the Sofia Tech Park initiative provides a perfect pilot case for testing the developing ecosystem, identifying crucial gaps, barriers and blockages and bringing to the forefront all the management issues involved in dealing with technology transfer and knowledge exchange. Ideally the Sofia Tech Park initiative should represent a show case of meritocracy in research and innovation technology transfer in a transition economy. However, unless the issues above are addressed it will struggle to realise its potential.

Challenge 3.3: Absence of shared research infrastructures and information to enable access and sharing

Tackling the gap between publicly funded research and private business can take many forms. There is often a tendency to try and push the two 'sides' together and in particular to expect researchers to develop and embrace a business approach to their activities. A more constructive approach to tackling the gap between publicly funded research and private business is to start by filling the gap by developing the NIS and the innovation ecosystem, funding joint activates and creating shared spaces.

Many MS are promoting mechanisms to induce proximity of public and private research groups e.g. by encouraging them to share research equipment or to operate under the same roof. Such proximity often leads to the two groups identifying commonalities and shared goals and ultimately to unconsciously adopting aspects of the 'other' groups behaviours. In this way the 'gap' is again naturally narrowed, drawing the two sides closer together without the need for force. This approach can lead to the natural development of 'clusters', involving the main actors associated with successful clustering. It is also an approach that can be strongly reinforced by using structural funds linked to regional development. In this respect Bulgaria may have the preliminary ingredients for encouraging a 'proximity effect' by focusing on the planned Technology Parks, Centres of Competency and Excellence as well as the existing clusters and by investing in strategically Open Access research centres with shared and pooled research infrastructure.

The term Research Infrastructures has no single definition. The EC uses the term to refer to '*facilities, resources and related services used by the scientific community to conduct top-level research in their respective fields, ranging from social sciences to astronomy, genomics to nanotechnologies*'[92]. In its broadest sense the term can be interpreted to encompass a wide variety of physical items of research equipment, including individual and collections of such equipment, as well as dedicated research facilities that provide centralised access to suites of specialised items of equipment. It can include items of research equipment that are located in one single host institution or items of research equipment that are distributed across a number of different host institutions. The term Research Infrastructure may also include e-infrastructures and scientific collections (e.g. bio-banks/repositories/data collections). Such a broad definition is used in the Bulgarian National Research Infrastructure Roadmap.

Although Bulgaria has struggled to invest in modern research infrastructure and concerns have been raised with the PSF panel regarding the feasibility of implementing the national research infrastructures roadmap and to participate in the ESFRI Roadmap there is arguably scope for better use of existing facilities and more strategic investment into future facilities. As noted in the National Map '*Investments in research infrastructure should be planned and developed so that the*

[92] See https://ec.europa.eu/research/infrastructures/index_en.cfm?pg=what.

utmost contribution is insured on the part of the research and innovation system for economic development and social welfare'.

A starting point for inducing better use of facilities can be establishing a register of all existing 'capital' equipment, publicising at a single on-line platform and making this publically available under national guidelines for Open Access. Capital equipment can be defined as being above a certain value e.g. 0.1 MEUR and would normally exclude routine items of research equipment that are required for a normal functioning laboratory. A second step is to encourage individual PROs to map and publish their 'research potential', including equipment and facilities and make it available under similar Open Access guideline. At institutional level this can include equipment that does not reach the capital threshold. This approach not only avoids further duplication of equipment (with associated reduction in capital expenditure and maintenance costs) it can also be used to encourage public research teams to collaborate and private companies, including SMEs to make use of existing facilities.

Bulgaria does not yet seem to have taken the step of auditing capital equipment and making the audit publically available or of offering the output under Open Access with associated national Guidelines. Although there are individual examples of promotion of Research Facilities to the non-research community there is an absence of a systematic approach to offering the 'R&I potential' - expertise, facilities, services and research outputs – of an institution on a dedicated online portal with a contact point so that they can be easily discovered and used by the private sector.

A number of regional Good Practice Examples exists for countries and groups who have recently attempted to establish a public register of their equipment. These include Croatia and Slovenia (see case studies below).

Case study 25: Auditing and establishing databases of research equipment - Croatia

The Croatian ministry of Science, Education and Sports (MSES) carried out an audit of research equipment in 2013.

The Ministry requested that all public universities and public research institutes supply information on their "capital" equipment, defined as being worth more than 1 million Kuna (0.13 MEURO)

The primary objective of the exercise was to provide scientists and other relevant stakeholders with data on existing equipment and information on the possibilities for using the equipment.

MSES has now published the results on their web-site in PDF format. The list of research equipment is quite simple but it provides enough information to be useful. Importantly, it includes the contact details of a relevant individual so that anyone who is interested can make direct contact with the responsible person. It is intended that the database will be regularly up-dated.

The database is presently located on the Ministry website and available only in the Croatian language. http://public.mzos.hr/Default.aspx?art=12825&sec=2132

Case study 26: Transparency of Slovenian research infrastructure – SICRIS

Providing Slovenian researchers with access to developed and large research infrastructures is essential in order to reach and maintain a level of scientific development on a globally comparable scale. In Slovenia, the main instrument for developing research infrastructures are provided by the Slovenian Research Agency, in terms of co-financing and allocation of funds through calls for proposals, which subsidise the purchase of equipment needed by organisations to carry out scientific and research activities. The Slovenian Research Agency earmarks 2 to 4 million EUR annually for the purchase of new equipment, in addition to 7 to 8 million for research institutions' infrastructural programmes. The Agency subsidises the purchase of research, information and communications equipment on the basis of public tender. A subsidy for the purchase of research equipment within this programme can amount to a maximum of 75% the cost per unit of research equipment.

Slovenian research infrastructure is very spread out, partly obsolete, and in most cases does not attain the critical mass, neither excellence comparable with large European and global research infrastructures. Better exploitation of the existing national research infrastructure is therefore one of the key target of the Research and Innovation Strategy. In order to enhance access to research equipment (which is at the disposal of PRO's in Slovenia), a transparent and publicly accessible virtual portal (SICRIS[93]) was established. This platform provides transparent information for all the

[93] http://www.sicris.si/public/jqm/cris.aspx?lang=eng&opdescr=equipSearch&opt=2&subopt=8.

stakeholders on how to access research equipment. It is possible to search for research equipment by the name of equipment or by their classification, by the research organisation or by the person who is responsible for equipment.

In the future the platform will connect to similar ones in neighbouring countries, and will enable equipment to be linked up and fully exploited. It will also facilitate the international exchange of spare capacities and establish a mechanism for the usage of the available capacities.

The Croatian RI catalogue is published as a PDF document. This is arguably not the most optimize format to encourage use. A Best Practice example that is guided by national principals, covers the full spectrum of Research Infrastructures at national level and makes them available on an IT platform with multiple search approaches is the Republic of Ireland's Large Items of Research Equipment database; this is outlined below.

Case study 27: Ireland's National Principles for Access to Research Infrastructure and Large Items of Research Equipment Database

The Republic of Ireland (Ireland or Éire) has made significant investment in research infrastructure throughout the higher education sector in the last 10 – 12 years. The Higher Education Authority (HEA) of Ireland has stated that facilitating the widest possible access to this research infrastructure is essential in order to achieve the greatest return on investment and value for money for the state and for the research community in general.

Until recently there was no nationally accepted set of guidelines in place governing access to items of research infrastructure hosted within publically funded institutions. This has been addressed by the **National Principles for Access to Research Infrastructure ('Principals')**. These set out a set of agreed national guidelines that should apply, 'in so far as is practicable', to all items of research infrastructure within these institutions.

In doing so, it acknowledges that the enabling of access to research infrastructure by other researchers from Ireland and internationally and industry has cost implications. It also recognises that **proper access to research infrastructure requires that there be in place a professional and customer-orientated support service** including inter alia:

(i) open and transparent access policies;

(ii) auditable access cost basis;

(iii) proper record keeping including records of access requests including where relevant, decisions and reasons in the event of a refusal, usage data etc;

(iv) proper service and maintenance contracts in place, where relevant and

(v) support staff who can operate the research infrastructure and assist in the training of postgraduate students and other researchers.

The HEA has taken a deliberate decision to define the term Research Infrastructure broadly and not to use arbitrary monetary threshold values. The Large Item of Research Equipment database has a €100,000 threshold and it is not anticipated that the Principals should apply to routine items of research equipment that are required for a normal functioning laboratory. However, the €100,000 threshold is not intended to suggest that only those items of research equipment listed on the database fall under the scope of the access guidelines.

System Regulation

Then system is self-regulatory – it is the responsibility of the host institutions to determine what items of Research Infrastructure should/should not be accessible to external researchers. However, the exclusions of any item of RI from the access policy must be adequately justified. It is expected that access will be largely self-regulating, with other stakeholders seeking access to certain Research Infrastructure challenging a host institution if it is not accessible. In the absence of satisfactory justification, HEA/funding body may require the host institution to make the Research Infrastructure accessible to other researchers. The HEA may conduct periodic audits of higher education institutions and other research bodies in respect of their access policies.

For more information on the Large Items of Research Equipment Database and National Principles for Access to Research Infrastructure see: http://www.hea.ie/content/large-items-research-equipment-database.

For the National Guidelines see:
http://www.hea.ie/sites/default/files/national_guidelines_for_access_by_researchers_to_research_infrastructure_hosted_by_higher_education_institutions_or_other_research_bodies_in_ireland_0.pdf

The PSF panel urges Bulgaria to use the Best Practice of other MS to help them audit resources and establish pooled facilities and Open Access Labs as national policy under national guidelines. They should also use the opportunity to embrace the European Charter for Access to Research Infrastructures[94].

Challenge 3.4: Structural Fund resources need to foster the development of sustainable innovation ecosystems in Bulgaria

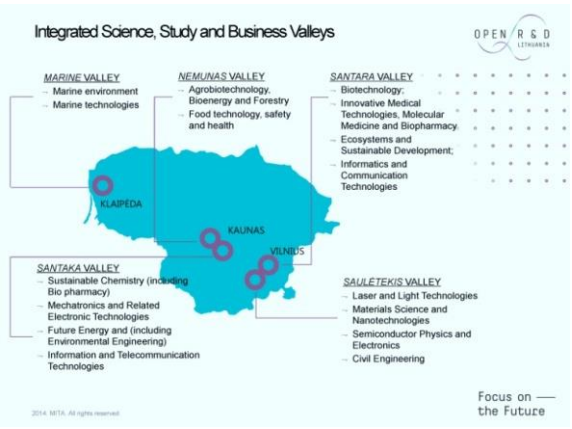
Investment in to Research Infrastructures using Structural Funds as a way to implement regional innovation policies has been practiced in many member states. Bulgaria is taking a positive approach by planning the establishment of regional Centres of Excellence (CoEs) and Competence (CoCs) with earmarked SF for the different regions and centres. This activity is important in helping to develop the regional innovation ecosystem. However, to strengthen the initiative Bulgaria should strongly link it to other activities such as RIs and clustering.

The PSF panel would urge Bulgaria to consider the example of Lithuania (case study below) who has combined SF investment and Open Access to RI with the development of R&D focused 'Valleys[95]'.

Case study 28: Establishing regional R&D valleys and Open Access Laboratories – Lithuania

The R&I potential of Lithuania includes a pool of nearly 18 000 R&D professionals. One third of research and experimental development research is carried out at universities.

Using Structural Funds Lithuania has developed a network of five R&D 'valleys'. The valleys are based in Vilnius, the capital of Lithuania, in Kaunas, the country's second largest city and industrial centre, and in Klaipėda, the non-freezing seaport city. They comprise Santara Valley (Vilnius), Sunrise Valley (Vilnius), Santaka Valley (Kaunas), Nemunas Valley (Kaunas), Maritime Valley (Klaipėda). Each valley specializes in a number of scientific research fields and involves one or more of the main Lithuanian research institutions.



Nearly 300 M Euros of structural funds have been invested to the development of the infrastructure of R&D valleys. The investment was made in regard to the expertise already possessed by research institutions in order to strengthen their capacities in respective R&D areas. For the new financial period of 2014-2020, structural support will be narrowed and aimed at national priorities distinguished under national Smart Specialisation Strategy.

According to the national rules, all R&D resources located in the valleys must be available for the public on the basis of open access. For this reason, universities and research institutes in the valleys must establish **Open Access centres** and provide access to their R&D resources. Other entities which possess R&D equipment are also eligible to establish an open access centre.

The Regulation of Management of Open-Access Centres defines the following aspects:

- **Principles of formation, management and the manner of use of the resources;**
- **Equipment use time ratio between separate subjects, maintenance costs, and the accumulation and investment of the funds received for the use of resources;**
- **Indicators of activity effectiveness;**
- **Principles of intellectual property protection;**
- **Provisions on solving the disputes.**

This strategic investment of structural funding has permitted the development of high-quality infrastructure and premises at the Open Access Centres– infrastructure for research, innovation and new technology development and comfortable conditions to establish new technology-oriented businesses – offices, labs, business incubators. So far, more than 26 open access centres have been created in Lithuania - centres of excellence with modern equipment, advanced technologies and world-class scientific potential. They specialize in laser, nanotechnologies, semiconductor physics, electronics, engineering, biotech, energy, environment, ICT and agriculture

[94] http://ec.europa.eu/research/infrastructures/pdf/2015_charterforaccessto-ris.pdf#view=fit&pagemode=none.
[95] The term Valley is an acknowledgement to Silicon Valley in the USA.

The high-quality infrastructure and premises at the Open Access Centres enable private companies to undertake experimental research and/or measurements, construct prototypes, create new advanced research-based products and improve existing technology. They also enable firms to access professional assistance in research, technology and innovation issues by working with both researchers and qualified technology transfer professionals.

Alongside high-quality infrastructure and premises the valleys structure also helps to promote:

- **Access to skills and networking – concentration of scientists, researchers, developers and university academia, close collaboration of knowledge-intensive businesses with science and study institutions, opportunity to be co-located with other companies in the same sector (clusters) and region.**
- **Research excellence – open access labs, R&D projects supported by EU/state, application of research results in industry and business**
- **Increased international competitiveness**

For a list of the open Access enters see: http://apc.mita.lt/open-access-centres

For more information on the Lithuanian Valleys see:http://www.investlithuania.com/wp-content/uploads/2014/03/Nemunas-Valley_Lithuania.pdf

Further investments in structural funds in Bulgaria should encourage specialisation, stimulate regional ecosystems, leverage shared RIs and support clustering.

Challenge 3.5: Developing associated competences: Human capital and critical mass

There is a frequent tendency to focus development of an R&I eco-system on infrastructure and equipment and not on the associated human capital. This can easily result in underutilised facilities and a lack of results and impact. No ecosystem will function well unless it also includes human capital with the necessary competencies to extract the envisaged potential. Development of HR competency needs to be at the heart of any R&I strategy. Human capital needs to include both the next generation of young researches, trained in modern infrastructure complexes and also the intermediaries who can help stimulate and manage the relationships between public and private partners. Intermediaries come in many forms and operate under many names but all are involved in helping to bring potential partners together, managing the ensuing relationship in a professional manner and helping to maximise results and impact.

Critical mass is also key issue in developing competencies to support innovation. When innovation activity is low there is a tendency to employ just a few people to support it and to expect them to deal with all aspects of the innovation cycle. Such intermediaries will, by necessity, be generalists and often young and lacking in experience and training. When a sufficiently critical mass of innovation activity is attained, e.g. through the development of activities such as the Sofia Tech Park or at regional centres of competency then it becomes possible to employ more people and to ensure that they are specialists e.g. able to advise on specialist topics such as legal partnership contracts, Innovation management, IPR strategy, marketing, licensing, venture funding, business growth etc. Although positive progress is being made Bulgaria still lacks sufficient critical mass of intermediary organisations including professionalised and well-resourced Technology Transfer Units able to offer access to both generalists and specialists.

Recommendation #4.3: Developing the innovation ecosystem

To help develop the innovation ecosystem it is recommended that Bulgaria identify entrepreneurship more strategically as a priority and build on the recent successes that are taking place in initiatives such as Eleven and LAUNCHub, by linking them more closely with the HEI institutions. This may require strategic additions to the mix of policy instruments (see recommendations 4.4).

The authorities are recommended to use Sofia Tech Park as an innovation ecosystem test bed, and to strongly reinforce its public-private cooperation dimension. They should put in place mechanisms for identifying and addressing barriers and challenges to full operation and ensure that lessons learned are captured and transmitted to the other initiatives, including CoCs and CoEs.

Bulgaria should also undertake a national audit of capital equipment and make the results of the audit publically available on a modern, easily searchable online portal. The auditing should be repeated at regular intervals to ensure the database remains up-to-date. All equipment identified under the audit should be made Open Access under National Policy and Guidelines. Guidelines should help PROs to develop the necessary pre-conditions for making the RIs viable for external

users, e.g. a professional and customer-orientated support service. National Policy and Guidelines should as far as possible reflect the European Charter for Access to Research Infrastructures[96]*.*

In addition, Bulgarian PROs should be required and supported to map their Innovation potential (expertise, facilities, services and research outputs) and promote these to the private sector through modern on-line searchable databases and identify a clear single point of contact for communications regarding their use. It is strongly recommended that Bulgaria takes steps to develop related human capital and in particular specialist competencies to complement associated investment in research infrastructures.

Bulgaria should ensure that further RI investments via structural funds encourage specialisation, stimulate regional ecosystems, leverage shared RIs and support clustering. They should also invest strongly in to developing a critical mass of professional intermediaries.

4.5. Stimulating increased demand for R&D by the private sector

Challenges related to stimulating increased demand for R&D by the private sector:

The present cooperation between PROs and SMEs is low, national adsorption capacity for R&D is poor and existing instruments focus on funding R&D rather than on funding people who can carry our knowledge transfer activities.

Tax incentives are one of the few existing measures designed to encourage private R&D but awareness and use appears to be low.

Challenge 4.1: Improving interaction and absorption

Bulgaria presently favours a 'supply push' approach to funding innovation. This approach favours countries where innovative firms are flourishing and providing an obvious target for transfer of research outputs. However, there is still a clear gap between the high R&D performance of some Bulgarian public research groups and the low absorptive capacity of most Bulgarian companies. If there is a strategic gap due to a lack of a local, national demand of first class R&D, the Bulgarian PROs should be supported to attract foreign companies to Bulgaria in those special fields of research and technology excellence. In this respect, cooperation with the regional development agencies and organisations like Bulgaria Invest may be crucial.

At the same time, the absorptive capacity for R&D-results of Bulgarian small and medium sized enterprises should also be increased by using special incentive schemes. Such schemes typically focus on the transfer of *people* who embody important knowledge and abilities rather than the transfer of codified research results.

There are many good examples in European countries, but the examples from Saxony in Germany within the program "Innovationsasisstenten"[97] are worth highlighting along with the UK 'Knowledge Transfer Partnership' scheme. The example of Spain who has used the National Youth Guarantee programme in 2014 with financial support from the European Union is also presented. Notable regional examples include the Student Internship Program (SIP) and the Industrial Fellowship Program (IFP) developed by the Collaborative Training Center Kragujevac at the University of Kragujevac in the framework of the Tempus project WBC-VMnet[98].

Case study 29: Innovations Assistant of the Saxony region of Germany

To strengthen the economic competitiveness of SMEs, to increase their R&D activities and their absorptive capacities for R&D results the Saxon State Ministry for Economic Affairs, Labour and Transport established the "Innovation Assistant Program". The program was implemented by the Development Bank of Saxony and was co-financed in 2000-2006 by the European Regional Development Fund and in 2007-2013 by the European Social Fund.

[96] http://ec.europa.eu/research/infrastructures/pdf/2015_charterforaccessto-ris.pdf#view=fit&pagemode=none.

[97] http://www.sab.sachsen.de/de/p_arbeit/download_sf_67458.jsp andhttp://www.sab.sachsen.de/de/p_wirtschaft/detailfp_wi_2460.jsp.

[98] See http://www.kg.ac.rs/eng/ctc.php.

The action supports the employment of innovation assistants (researchers from universities or universities of applied sciences) in small and medium-sized enterprises (SMEs) for a certain time, and with the option of a permanent position. The overarching goal is to increase innovation capacity and competitiveness of regional industrial SMEs, knowledge transfer from universities to industry, and the commercial exploitation of research outcome. Further, the measure targets high-quality employment in Saxony. The SME benefits from scientific knowledge that the innovation assistant transfers to the company and that promotes technological as well as business aspects of the company's innovation processes. Innovation assistants are for instance engaged in research and development, innovation or quality management, product development or design, management, human resources or marketing.

Eligible for funding are SMEs located in Saxony; innovation assistants should have their workplace in the region. Grants are allocated for up to 24 months and can be up to 50% of personnel expenditures (max. €2,000 per month).

The measure has existed since 1993 (formerly as "innovation managers"), but was modified in 2011 in order to broaden the share of companies and activities that are eligible for support. (It expired at the end of 2013).

See: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/support-innovation-assistants-and-exchange-personnel

Case study 30: UK Knowledge Transfer Partnerships (KTP)

Knowledge Transfer Partnerships (KTP) is a UK-wide programme helping businesses to improve their competitiveness and productivity through the better use of knowledge, technology and skills that reside within the UK Knowledge Base. It is regarded as a European Showcase for knowledge transfer.

A Knowledge Transfer Partnership serves to meet a core strategic need and to identify innovative solutions to help that business grow. KTP often delivers significant increased profitability for business partners as a direct result of the partnership through improved quality and operations, increased sales and access to new markets. Social enterprises see improved results, too.

There are three principle players within a partnership:

- Company partner- this is usually a company (including not-for-profit) but in some cases it can be a health or education organisation or Local Authority. KTP supports a broad cross-section of UK firms, regardless of size;
- Knowledge-base partner - this is a higher education institution (e.g. university), college or research organisation (public or privately funded);
- KTP Associates– Each partnership employs one or more high calibre Associates (recently qualified people), transferring the knowledge the company is seeking into the business via a strategic project.

Rationale for Knowledge Transfer Partnerships
Effective innovation (the successful commercial exploitation of new ideas) involves knowledge, technology, skills and adaptability to implement it, which is not always embodied in equipment or codified in an easily transferable form.

People embody the skills and often the real know-how to effect innovative change in businesses. Knowledge developed or improved in academic institutions (knowledge base) may need extensive or intensive adaptation to particular business applications. A qualified person with a direct link to the academic source is the ideal transfer agent.

Outcomes

There are over 700 Partnerships running at any one time and over 800 Associate projects

For every £1m of government spend the average benefits to the company amounted to a £4.25m annual increase in profit before tax, £3.25m investment in plant and machinery with 112 new jobs created and 214 company staff trained as a direct result of the project.

For the knowledge base partner (higher education institution mainly), on average, each KTP Associate project produces 3.6 new research projects and 2 research papers.

For the Associate 60% are offered and accept a post in their host company on completion of their KTP project. 41% register for a higher degree and 67% of these were awarded a higher degree.

Case study 31: Youth Guarantee Scheme in Spain in the domain of Research and Innovation

Spain established a National Youth Guarantee programme in 2014 with financial support from the European Union (Law 18/2014). The goal of the programme is to increase youth employment rates by offering offers companies incentives to hire young people who have less than 3 months of work experience with an open-ended contract.

When companies hire NEETs (not employed, not in education and not in training) less than 25 years of age they can receive a subsidy equivalent to 50% of the minimum wage for a maximum of one year (Ministerio de Empleo y Seguridad Social, 2014).

Targeted youth are those that have dropped out of formal education or who have recently graduated from lower-, upper-secondary or tertiary education.

In 2015, within the programme the State Secretariat for Research, Development and Innovation opened a public call directed to HEIs and RPOs within the public sector to hire young university and vocational training graduates to perform administrative and technical activities in research and innovation administration and management; provide technical support within research laboratories and infrastructures, or any other related within the public research sector.

The goal is twofold:

(1) provide young people with job and training opportunities and

(2) strengthen the capabilities of public research institutions and researchers that will benefit from financial incentives to hire people to perform support activities and to fulfil a long-term demand in those fields. Attention is paid to improve youth employability through employer-relevant training and ensuring better skills outcomes.

Total amount devoted to this specific action: 60.000.000 Euros (1.500 jobs).

For more information on the Youth Guarantee Programme see: COMMISSION STAFF WORKING DOCUMENT Accompanying the document Proposal for a Council Recommendation on Establishing a Youth Guarantee {COM(2012) 729 final}. And http://ec.europa.eu/social/main.jsp?catId=1079

The PSF panel urges the Bulgarian authorities to develop and adopt more schemes that enable flexible (short term) employment and sharing of knowledgably people to encourage innovation in SMEs.

Challenge 4.2: Tax incentives are one of the few existing measures designed to encourage private R&D and their use appears to be low.

Alongside transfer of people many countries also offer innovation vouchers and innovation grants to stimulate closer working between the public and private section and stimulate demand led innovation. In many ways the mechanisms of deployment are similar to the present Bulgarian R&D tax scheme in that they typically require a partnership between a firm and a PRO and the firm drives the project while the work is normally undertaken at or by the PRO.

However, verbal and anecdotal evidence presented to the panel suggests that the present system for R&D tax incentives in Bulgaria is not functioning well. Actual level of use of the system has not been possible to judge due to the lack of available data. However, the R&D tax credits system is clearly not well understood by either HEIs or firms and awareness of the scheme is worryingly low. There is no apparently linkage between R&D activities that are recognised for government support and activities that are eligible for relief under the present system.

Given the very low level of corporation tax (10%) it might be assumed that tax relief on R&D is unlikely to be a strong incentive to undertake R&D activities. This is unlikely to change. However, of more concern is that the present R&D tax credits scheme is designed to encourage more interactions between public and private sector research. If the tax credits system is not performing this function then alternative methods of stimulating and building linkages need to be introduced e.g. innovation vouchers and matching grant schemes. It is notable that introduction of more instruments to foster collaborative research was suggested in the 'Inputs for R&I' document including a collaborative research instrument (400.000 – 1.5 MEUR, at least 20% co-financing by private companies).[99]

Compared to 'SME voucher schemes' Innovation voucher schemes generally have a narrower focus on product (good or service) and process development and have been introduced to foster collaboration between SMEs and knowledge institutions. SMEs that have innovative ideas often lack the in-house expertise to successfully convert these ideas into new products. Innovation vouchers therefore work as empowering tools for SMEs to approach research institutions and acquire know-

[99] Input for Bulgaria`s Research and Innovation Strategies for Smart Specialization, p. 125, 126.

how. Importantly, they do not aim at financing the delivery of full research projects but seek to catalyse 'first innovation activities'. Finally, innovation vouchers encourage research institutions to work with small firms when their inclination might be to work with larger firms – in anticipation of greater returns – or to have no relationships with industry at all. The Dutch innovation voucher scheme[100]and the UK West Midlands voucher scheme[101] are good examples of this type of measure.

Given the apparent lack of understanding of the existing R&D tax credit scheme in Bulgaria and the obvious competition from the very low rate of corporation tax the Bulgarian authorities are urged to review innovation grant/ voucher schemes that have been shown to stimulate demands for R&D in other similar countries and consider their adaption and adoption. Recent assessment of different matching grants and innovation vouchers schemes that are designed to stimulate business led innovation, that may be suitable for use in Bulgaria, have been carried out by organizations such as OECD[102]. In addition, the mini-and matching grant schemes now operating in Serbia using EU IPA funds may be a useful regional example (see case study below) as well as the programmes run by HAMAG-BICRO in Croatia[103] including the pre-seed capital program (known as PoC), the seed capital program called RAZUM and the IRCRO program designed to encourage SMEs to cooperate with scientific institutions in order to start up and speed up their R&D activities. The purpose of the IRCRO program is to combine the experience and innovativeness of SMEs with the knowledge and infrastructure of scientific institutions into a single market-oriented project with commercial potential.

Case study 32: Implementing a Pilot SME Voucher Scheme in Montenegro

Beginning in 2011, each Western Balkan economy had the opportunity to implement a capacity building pilot project with the OECD IC. As its pilot project, the Montenegrin government requested assistance with the design and implementation of a voucher programme to support small and medium sized enterprises.

The OECD report recommended that a voucher scheme supporting SME development in Montenegro be implemented in two phases. In the first, or 'pilot' phase, approximately 50 SME vouchers would be distributed. One of the benefits of the pilot scheme is that it provides the implementing agency with capacity-building experience prior to the implementation of the scheme on a larger scale. A second, full 'implementation,' phase would follow if the results of the pilot phase proved successful. In keeping with international best practices, the OECD report also recommended maintaining a 'light-touch' administrative approach. This is important for the success of a voucher scheme as much of its appeal for participating businesses lies in its simplicity and low entry barriers. This is an important point for SMEs with stretched managerial resources.

Following the completion of the pilot phase, the report recommended that an evaluation should be performed to understand if the SMEs that received a voucher actually benefited from it and whether the scheme led to innovative activity and/or enhanced productivity of those recipient firms.

For more information on this and other innovation voucher schemes see: http://www.oecd.org/investmentcompact/Montenegro%20English%20Version.pdf and

http://www.centrope-tt.info/case-studies-from-abroad-en

Case study 33: The Serbian Mini and Matching grant schemes for market led innovation

The MINI GRANTS financing Program is aimed to support an early-stage, private, micro- and small- enterprises, which possess a technological innovation that have a potential for creation of a new intellectual property (IP), and clear market need. The purpose of the MINI GRANTS Program support is to stimulate creation of innovative enterprises based on knowledge via private sector start-ups or via spin-offs by providing financing for market-oriented innovative technologies and services with high commercialization potential.

100 See http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/dk/supportmeasure/support_mig_0003.

101 See http://www.aston.ac.uk/aston-business-school/business/innovation-vouchers/ and https://vouchers.innovateuk.org/innovation-vouchers-listing.

102 See for example http://www.oecd.org/investmentcompact/Montenegro%20English%20Version.pdf and http://www.oecd.org/innovation/policyplatform/48135973.pdf.

103 See http://www.investcroatia.hr/innovations/programs/

MINI GRANTS project must be designed for completion within 12 months and it can comprise any fields of science and technology in all industrial sectors. The applicant must be a private sector, micro- or small- company, incorporated in Serbia for no longer than two (2) years at the time of application, with the majority of applicant ownership Serbian.

The MATCHING GRANTS Program aims to expand collaboration opportunities for Serbian innovative micro, small and medium sized companies with strategic partners (e.g. private sector industry, R&D organizations and venture capital/private equity funds) with the goal to increase private sector investment in technology development and commercialization projects for new and improved products/services.

The MATCHING GRANTS Program is designed to help companies struggling to address the significant financial investment associated with the development cycle and the high cost of translating research into a commercially viable product. In addition the MATCHING GRANTS Program will help companies to develop their R&D activities, establish collaborations with strategic private sector and R&D partners, attract investors and to bring their innovation to the market.

For more information see: http://www.innovationfund.rs/

Company growth and improved survival rates will also depend on Bulgaria improving access to capital markets and developing specific instruments for high-growth potential companies (Gazelles). If Bulgaria is not yet targeting gazelles then it may benefit from the experience of neighbouring countries including Serbia who now have a sectoral gazelle program under their mini-grants scheme administered by the Serbian Innovation Fund.

Improvements to the market development also need to be encouraged, for example through innovative public procurements and by strengthening international development and business cooperation. Inducing innovation by public procurement could be a relatively low-cost but high-awareness and image-changing *demand-side* scheme to signal government's leadership and interest in cutting-edge and innovative solutions to public needs. Financial risk can be limited by setting a fixed percentage of a given procurement project apart for innovation or by awarding prizes for innovative solutions 'made in Bulgaria'. Innovative public procurement might not be the first reformatory step, as it demands also a high degree of learning on the procurer's side. However it has the potential to communicate government's reputation as a demanding partner that pushes companies to invest in innovative and sustainable development.[104]

Recommendation #4.4 stimulate increased demand for R&D by the private sector

It is strongly recommended that Bulgaria develops a much wider portfolio of instruments that target companies, stimulate private sector innovation, facilitate the creation of public private research consortia and foster collaborative research projects. These should include 'proof of concept' funds, innovation vouchers that can be 'spent' with an public sector R&D partner, matching grant schemes for companies tailored to the needs of different target groups e.g. sector, age and growth potential and schemes to transfer knowledge through flexible human resource capital deployment e.g. Innovation Assistants and Knowledge Transfer Partnerships.

4.6. Summary and conclusions

The R&I situation in Bulgaria has been recently analysed by a number of groups who have offered strong recommendations to address the issue of tackling the gap between research and business. Bulgaria now needs to focus efforts on implementing recommendations, basing them on Good Practice from other MS and from neighbours in the Western Balkans. Where implementation in not under the direct control of the Bulgarian government authorities they should link further funding to compliance with change.

The Bulgarian NIS remains under-developed and fragmented. Ministerial coordination and institutional cooperation is lacking. The present 'supply-push' policy model is not supported due to the traditional character of PROs who face barriers in moving towards a more entrepreneurial approach. In addition, a stronger dialogue with civil society is needed to drive sustainable change. To address the present challenges in the NIS, Bulgaria needs to foster academic entrepreneurship while moving towards a more appropriate model to drive R&I. This will necessitate a better balance of instruments (policy mix) that encourage a more demand driven model, support both supply and demand led innovation and also encourage collaborations between public and private sector. This in

[104] In 2012, several Austrian ministries and government agencies joined forces to launch a programme to induce innovation by public procurement. The IÖB programme (Innovationsfördernde Öffentliche Beschaffung, www.ioeb.at) runs several competitions, often connected to finding environmentally balanced solutions. The Federal Procurement Agency is organising events and service.

turn will require strong coordination between relevant Ministries and also the raising of awareness and engagement within society for the innovation agenda.

The present supply-push model relies strongly on increasing entrepreneurial behaviour in PROs. However, there is significant uncertainty for PROs in behaving in a more entrepreneurial manner and this will stop them from embracing a third stream mission as part of their core strategy. Institutional frameworks to enable open innovation are also not in-place with most Bulgarian PROs still lacking policies to deal with intellectual property created in research and its transfer to the private sector. Exposing Bulgarian PROs to more international practice as well as introducing metrics to measure the impact of third stream activity would help provide driver for change. Again, making future funding dependent on introducing and implementing institutional frameworks to foster Open Innovation is recommended.

There is a strong need for more 'mission oriented research' in Bulgaria and the introduction of more institutional models to promote this. This will require both a better understanding of the term and a greater exposure to alternative models of operation that can help PROs diversify their funding sources and behave in a more entrepreneurial manner.

Innovation ecosystems are only starting to emerge in Bulgaria and appear fragile. There are individual Good Practice examples of initiatives but these are isolated and lack links to the research base. Pre-conditions needed to enable new initiates such as the Sofia Tech Park and the CoCs and CoEs to realise their potential and become sustainable are not yet in place and in particular institutional frameworks to enable open innovation lag behind other Member States and also regional neighbours. A focus on large innovation pilot projects such as SofiaTech will help to test the innovation ecosystem and rapidly reveal weaknesses and gaps. The Bulgarian authorities must then be prepared to work together to successfully address the revealed issues as a priority.

There is an absence of transparent information about existing Research Infrastructure that would promote pooling, reduce further expensive and unnecessary duplication and initiate Open Access and Open Innovation. A number of MS have initiated activities related to open Access RI in the last few years and some have linked this to investment of SF at a regional level. The Bulgarian authorities are urged to examine, adapt and adopt Good Practice from similar MS and neighbours. However, alongside investment in RI there needs to be an associated investment in to development of a critical mass of skilled human capital to enable RIs to function in a sustainable manner.

Finally, a refocus away from 'supply driven' innovation towards 'demand driven' innovation is needed. This is likely to mean a strong refocus of policy support instruments and in particular introducing more measures that will stimulate a need for knowledge generation and transfer from PROs to companies. This should include flexible schemes to transfer knowledge though employment of skilled individuals.

For those research groups who's science does out-strip the existing absorption capacity of domestic companies there is a need to focus on entering global supply chains and, if appropriate, to encourage the formation of spinoff companies.

The present focus on stimulating business R&D through tax incentives should be widened to include a funding escalator from Proof of Concept to specialised matching grants and loads for innovative companies from different sectors. Many good regional examples now exit that could be adapted and adopted.

5. CONCLUSIONS

Bulgaria is the first member state which requested a Peer Review under the Horizon 2020 Policy Support Facility. The aim of the peer review is to provide external advice to the Bulgarian authorities in the design, implementation and evaluation of their policies on research and innovation as defined in the National Strategy for Development of Research 2020 and the Innovation Strategy for Smart Specialisation.

At the request of the Bulgarian authorities, we focused on three main areas – improving the quality and efficiency of public research organisations; research human resources capacity development; and building-up and enhancing knowledge transfer policies – which formed the core of Chapters 2, 3 and 4 and which led to a number of recommendations. Some of these were more general, some much more specific.

In conclusion, the PSF panel would just like to re-emphasize the points highlighted throughout the report, sketching out in a couple of pages the overall predicament of Bulgaria's research system.

Bulgaria has a historic opportunity to strengthen its economic potential with a long-lasting, consensual and trust-based national agenda that supports investments and reforms of its RI system

Considered historically as a country heavily committed towards science and technology, Bulgaria's accession to the EU took place in 2007, on the eve of the global, but over time increasingly, European "great recession". Many of the proposed reform measures, including those in research and innovation were postponed, or simply not implemented. Political uncertainty and instability started to dominate, basically leaving the R&I system in an ailing limbo.

Today, we are convinced that a more stable economic and political situation has emerged in which trust in the system can be built, investments can be sustained and the necessary structural reforms can have a real chance to be successfully implemented. The fact that the Bulgarian authorities were prepared to become so to say the first country "guinea pig" with respect to the European PSF exercise, is illustrative of a new, positive policy trend ready to address *and* hopefully implement the necessary reforms, as outlined in this report. It is also illustrative of the necessary political courage and determination to carry forward this agenda.

Implementation is, as highlighted in Chapters 2 and 3, one of the major weaknesses. In our second field visit, we presented as introduction to our first findings, just one slide stating: "***просто го направи!"*** (Just do it!). Many bits and parts of the Bulgarian R&I system have been analysed by national and international organisations who have offered strong recommendations to address the issue of tackling assessment, evaluation and performance based funding of PROs, human resources as well as the gap between research and business. There are, as was highlighted in the many country/case boxes which filled the various chapters, numerous good examples of "Good Practices" from other MS or from neighbouring countries in the Western Balkans to learn from. In short, implementation is now an absolute must. We furthermore would suggest that where not under the direct control of the Bulgarian government authorities, further funding should become directly linked to compliance with change.

To make our point even stronger, we propose to the Bulgarian authorities, to link implementation of those recommendations which can count on the support of the Bulgarian authorities, a post-PSF peer review assessment. Proposing that within an agreed but relatively short time period (one to five years), a similar PSF panel would come to assess the implementation of the proposed and mutually agreed upon reforms. As we highlighted in the last slide of our second field visit: ***ще се върнем***…

However, current political support for the many reforms argued for in this PSF report, is in the long-term global unstable political and economic environment insufficient. Support for implementing the sometimes difficult reforms will have to be based on broad-based and long-lasting public policy support, not hanging fully from the will of a particular administration. A pact with the relevant forces of society at large to prioritise research and innovation over the next five to ten years. Otherwise it will be difficult not just to sustain the reforms but also to rebuild trust in the science system at home and abroad, through foreign investors and the return of the Bulgarian research diaspora. Such a Bulgarian consensus for innovation as national priority seems, as a matter of fact, also a pre-requisite today to avoid fragmentation and disconnection with many other structural change measures.

We hence urge the Bulgarian authorities to launch a broad-based national dialogue inviting also the media, the regional authorities, citizens and more directly involved stakeholders in the science and technology system to raise questions considered crucial for the future of Bulgaria. But seeking actively consensus requires also strong policy leadership. As first priority, that leadership should be prepared to put R&D investments on top of the policy agenda. In current circumstances with so many demands on public funds undoubtedly a tough priority, but an essential one. In Bulgaria also

one which fits the times. A broad coalition government, such as the present one, provides actually a window of opportunity for conducting such an exercise. This dialogue should lead to a 'National Science Agenda' capable of rebuilding trust in the system. The Council for Smart Growth is best placed to take leadership in this process.

Bulgaria must set up a professional, independent and robust national research agency to design and manage research and innovation funding. It must also allocate funding to researchers in line with international practice and increasingly concentrate funding for institutions that perform research, so as to reward high performance

Of course, the necessary increases in public funding which we made a strong argument for in Chapter 1, will have to be accompanied by new and more effective implementation, evaluation and coordination structures as discussed in Chapter 2. Predictable sources of funding and efficient funding agencies are particularly important in the Bulgarian system where universities have little or no funding available to run research projects, and companies are short of financial instruments to help them to innovate. Coordinating national research and innovation funds and providing researchers and businesses with predictable funding sources and funding schemes allocated on the basis of clear, transparent criteria that reward research quality and innovativeness should be a high priority for Bulgarian R&I policy. There may also be scope for, and merit in, 'Europeanising' national funding capacities and setting-up matching-funds schemes that provides national funding to Bulgarian proposals that have been positively evaluated but that were below the threshold to receive funding at the EU level.

At present, the Bulgarian research and innovation system appears over-regulated due to a lack of systemic trust, and at the same time policymaking is often volatile, not surviving governmental changes. While current legislation mirrors the good intentions of many consecutive governments to make decisions more objective and transparent by creating a strong legal base, the high legislative output may be counter-productive and supporting systemic inertia; anecdotal evidence provided to the PSF panel seems to suggest a growing weakness and unpredictability in the system due to a considerable turn-over of fragmented legal initiatives and incomplete implementation of legal acts. The laws and regulations might be approved but may have a low level of institutionalisation and of irreversibility. Trust needs to be restored in part by the authorities being seen to be tackling allegations of malpractice and taking steps to restore trust at all levels, even between public agencies and programmes.

At present the Bulgarian RI system also appears characterized by silo thinking, often uncoordinated priorities and on-going concerns with regard to alleged malpractice. There is thus a clear need to redesign the RI Funding Agencies. This need can best be met by establishing an independent, robust agency, capable of designing and implementing multi-annual research programmes with impartial, transparent and efficient grant review procedures. The panel supports that the agency is built with an implementation-driven mission and that it should take a leading role in connecting the funding for the relevant policy fields both horizontally and vertically. As such, the Promotion Agency for RI ('PARI'), already proposed by the government, might partly satisfy those needs and should be upgraded to cover for such a professional, independent and robust national research agency.

The Bulgarian higher education system is not just relatively fragmented, systems for evaluating research and higher education are not yet established. Building stronger and better managed institutions are broadly a high priority in Bulgaria but building such institutions in the research and innovation area should be an absolute priority, given the importance of research and innovation for long-term growth and welfare. In particular, there is a need to ensure peer review processes in line with internationally established principles for expert assessments and transparency, in order to secure trust in the project selection procedures. In developing their review and evaluations systems, Bulgaria could and should profit from the expertise and experiences gathered in international guidelines such as the European Peer Review Guide[105], the Principles of the Global Summit on Merit Review[106], and The Leiden Manifesto for research metrics[107].

In the view of the review panel, a meritocracy based system of R&D policy development and implementation is within a transition economy perspective a must. Setting up a meritocracy based R&D policy system Bulgarian authorities will also show to the actors, in particular the new young generation of scientists, that being an excellent researcher is the key to success, much stronger and more effective than the old system based on networks of colleagues and friends. As a first step, PROs should be incentivised to develop and implement research strategies and

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105 http://www.esf.org/fileadmin/Public_documents/Publications/European_Peer_Review_Guide_01.pdf.

106 http://www.globalresearchcouncil.org/sites/default/files/pdfs/gs_principles-English.pdf.

107 http://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.1735.

professionalise their management of research and knowledge transfer. Strategy development should take place against a background of policy instruments that encouraging integration and synergies. The introduction of performance-based funding should enhance the accountability of public expenditure on PROs and should facilitate transparent, fair and efficient allocation of resources.

Bulgaria needs to build its way forward on its exceptional human resources base and take rapid action to rebuild incentives for research careers at all stages and to retain and attract young talent

As Chapter 3 highlights there is a clear need to increase the stock of researchers in order to meet the national 2020 target of 1.5% investment of GDP on R&D. But it will be essential to ensure that the increase of numbers is done in a way to maintain quality and encourage quality improvement. Researcher career progression proceeds from PhD to Professor. It is important to ensure that the correct measures using international good practice are taken at each career stage to ensure the best outcomes.

There are two recurring themes throughout the PSF analysis in Chapter 3: evaluation and salary. It will be important for researcher career development that both ensure a robust and attractive research system in Bulgaria. The assessment of researchers themselves must be done in an independent, fair and transparent manner. At the same time, there is a particular problem in bringing researchers from abroad using Horizon 2020 funding, as the applicable salaries are unattractive. Current practice allows for research to draw down up to 30% of research grants as salary top up. We believe that this practice should ultimately be phased out and replaced by performance based pay to recruit, reward and retain excellence based on international peer review.

Bulgaria must incentivise the opening up of its science base to businesses, step up the schemes to support public-private cooperation and create the conditions for regional and local innovation ecosystems to develop

Overall, the Bulgarian NIS remains under-developed and fragmented. Ministerial coordination and institutional cooperation is lacking. The present 'supply-push' policy model is not supported due to the traditional character of PROs who face barriers in moving towards a more entrepreneurial approach. In addition, a stronger dialogue with civil society is needed to drive sustainable change. To address the present challenges in the NIS, Bulgaria needs to foster academic entrepreneurship while moving towards a more appropriate model to drive R&I. This will necessitate a better balance of instruments (policy mix) that encourage a more demand driven model, support both supply and demand led innovation and also encourage collaborations between public and private sector. This in turn will require strong coordination between relevant Ministries and also the raising of awareness and engagement within society for the innovation agenda.

Innovation ecosystems are only starting to emerge in Bulgaria and appear fragile. There are individual Good Practice examples of initiatives but these are isolated and lack links to the research base. Pre-conditions needed to enable new initiates such as the Sofia Tech Park and the CoCs and CoEs to realise their potential and become sustainable are not yet in place. The Bulgarian authorities are encouraged to strongly reinforce the public-private cooperation dimension of the Sofia Tech Park and to use it as a strategic innovation test-bed, identifying and addressing barriers to its effective functioning as a true innovation ecosystem, and ensuring that these lessons are learned and transmitted to other initiatives. A refocus away from 'supply driven' innovation towards 'demand driven' innovation is clearly needed. This is likely to mean a strong refocus of policy support instruments and in particular introducing more measures that will stimulate a need for knowledge generation and transfer from PROs to companies. This should include flexible schemes to transfer knowledge though employment of skilled individuals.

The current Bulgarian government has started to put many of the reforms discussed and proposed here on the right track, clearly entering an implementation-driven approach of connecting relevant policy fields both horizontally and vertically. In view of the PSF panel this should now be integrated in a national roadmap underpinned by a financial envelope with an horizon of 5 to 8 years.

We hope that combined with the many recommendations put forward here, this national roadmap will help the Bulgarian authorities to set in motion and implement the many reforms on which we felt broad agreement with many stakeholders. We look forward to be of any help in any future PSF related exercise.

ANNEX 1. LIST OF DOCUMENTS RECEIVED AND STUDIED BY THE PANEL

1. The 2014 Innovation Union progress at country level: the Bulgarian country profile (public information)
2. Extracts from the European Semester country reports 2011-2014 (public information)
3. Research and Innovation Observatory (RIO) reports for 2015(drafts not yet public but provided for the use of the Peer Review):
   a. Draft 2015 Bulgarian (RIOWATCH) Country Report;
   b. Public support to R&D in Bulgaria
   c. Knowledge transfer in Bulgaria
4. Statistical trends in R&I in Bulgaria. Overview provided by DG RTD for the use of the Peer review (not public, information prepared for the use of the Bulgarian Peer Review)
5. Main strategic, legislative and regulatory documents in the area of research and innovation in Bulgaria
6. National Reform Programme of Bulgaria (2011–2015)
7. Action plan ISSS 2014 12 01 EN.docx
8. Alignment of ISSS areas with RI Roadmap
9. National Research Infrastructure Roadmap
10. List Of Research Infrastructure Projects Within The National Roadmap
11. The Indicative BG RI Roadmap Budget
12. Management and evaluation assessment of Research Infrastructure Roadmap of Bulgaria (Draft)
13. Draft/idea for evaluation of the RIs (working document)
14. National Strategy for SMEs promotion
15. National Strategy for SMEs Promotion - Small Business Act - 2014-2020 EN
16. National Research Strategy
17. Strategy Action-Plan+indicators-241014.doc
18. National Research Development Strategy
19. Innovation Strategy for Smart Specialization
20. Regulations of the NSF
21. Overall picture of the payments under the National Science Fund last
22. Overall picture of the payments under the National Innovation Fund last years
23. Overall picture of the public funding for research organizations and HEI in Bulgaria
24. Research at the Bulgarian Academy of Sciences A Report by the 2009 Science Review Committee
25. Extract of BAS participation in 7FP as institutes and funding
26. Ordinance 9 concerning state funding for research activities in universities + last-years-funding
27. Concept for evaluation and monitoring of research in ROs and HEIs
28. Draft of RoPs on the evaluation and monitoring of the research activity of the ROs and HEIs
29. Strategy for Modernization of HE
30. HE Action Plan
31. Act for the development of academic staff in the Republic of Bulgaria with amendments
32. OP Science and Education for Smart Growth
33. BG Monitoring Regulation for Research Activities And NSF draft
    Annex 1 List of research areas and research fields
    Annex 2 Criteria and Indicators for the evaluation of scientific research carried out by organizational units
    Annex 3 Reference Report for the Implementation And Reporting Of Financed Projects For X (Year)
34. Republic Of Bulgaria Council of Ministers Transcript Decree No. 116 Of 12 May 2015 For the Establishment of a Smart Growth Council
35. HEINNOVATE Reviews On Promoting Innovative And Entrepreneurial HEIS Country-Level Review Bulgaria Review Report Prepared by the Organisation for Economic Co-operation and Development DECEMBER 2014
36. Input for Bulgaria's Research and Innovation Strategies for Smart Specialization February 2013
37. Regulations on the monitoring and evaluation of research activities performed by higher education institutions and science organizations, as well as the activities of the Scientific Research Fund
38. Draft Decree on Council for Smart Growth
39. Draft Regulations of Fund "Scientific Research"
40. Draft ACT for the development of academic staff in the Republic of Bulgaria

ANNEX 2.1 COMMENT ON THE SMART GROWTH COUNCIL (SGC) AND ASSOCIATED DECREE

The CSG initiative offers a new opportunity for the Bulgarian authorities to revitalize research and innovation policies as well as to reorganize the fragmented landscape of R&I and related sectorial policies – such as higher education and industrial policies including ICT. The PSF panel welcomes the initiative. However, based on the present draft Decree No. 16 of 12 May 2015 the panel also has concerns that the current **definition of the council and its functions** (**Article 2**) presents some drawbacks that may limit its effectiveness, including:

1. **Concept and scope**. Mixing of functions strictly related to the Smart Specialization Strategy ISSS (priority definition, coordination of implementation, monitoring and potential amendments) and those that may have a major impact in the restructuring of the Bulgarian Innovation System such as the definition of sectorial priorities (education, science, innovation and ICT) and specially **the coordination of policies for the management of NIF and NSF**. The coordination of policies for the management of NIF and NSF or the future Agency (PARI) has a critical relevance in the context of the Peer Review but **the CSG will not succeed in achieving effectively this function unless it will be entitled with truly executive competencies** and that is presently constrained by the Council composition. The **Council for Smart Growth** main role is on advising and **monitoring** rather than on policy design and policy adoption. It is created to effectively monitor the ***Bulgarian Smart Specialization Strategy*** but it lacks effective decision making capabilities on budget allocation and coordination.
2. **Council composition**. Based on the documentation available the CSG will operate *the facto* as an advisory council: **2/3** (8 members of the Council) will be **representing stakeholders**, and though the participation of stakeholders is aimed at complying with the rules set by the European Commission (DG REGIO) in the conceptualization of the smart specialisation framework, **it clearly limits the potential policy action and scope of the Council**. The PSF panel also questions the apparent exclusion of the Ministry of Finance from the CSG (see more under specific comments on articles below).
3. **Executive Office**. The **Secretariat** of the Council will correspond to the Ministry of Economy through the Directorate of EU Funds Programming, but the role of the Secretariat is not clearly defined since it will work with the support of the administrative services of the Council of Ministers and a dedicated unit created within the Ministry of Economy for that purpose. There is a risk that bureaucratic and administrative tasks and contents may erode the basis and executive character of the Secretariat.
4. **Monitoring and impact assessment**. Those functions need professional and dedicated resources based on technical and professional expertise rather than on scattered evidence provided by a reduced number of stakeholders. In this context the Ministry of Economy may consider the opportunity of creating a dedicated unit to support the Council on the monitoring and impact assessment of the actions undertaken by government related to ISSS.
5. **Operational issues**. The CSG has been created to support the "Administrative Partner Network" to effectively promote policy coordination among the four Ministries involved but **the link between policy/strategic level and implementation and practice is not yet clearly established**. For it the Council of Smart Growth may set up a **permanent technical configuration** –it may be a permanent working group- formed by representatives of the four Ministries with **technical expertise/knowledge** and responsible of managing the operational programs through existing instruments. It should be set up with a double purpose: (1) monitoring implementation and level of execution, and (2) to provide top managers of different Ministries with new opportunities for sharing good practices and learning from each other.

Given the current definition and composition of the Council for Smart Growth and in order to reinforce the role of the Council to promote effective policy management of both ISSS and policy coordination across different departments it will be relevant to define the working of the Council at two different levels: (1) as a government body for inter-ministerial policy coordination concerning smart growth based on research and innovation including decisions on government budget allocation and (2) as a national advisory body to the government for the setting of national priorities to foster economic growth. Since the Decree and regulations on the CSG are already in place, the number of options to overcome the current definition and composition are limited; given the constraints the main instrument available may be the adoption of pluri-annual actions plans reflecting governmental coordinated actions and priorities. Finally, the Council for Smart Growth should focus more on the set of specific actions (and their implementation) and "priorities" that never lead to actions.

From the perspective of the PSF panel the Council for Smart Growth in Bulgaria has to fulfil:

1. **Policy relevance** through the engagement of the Prime Minister and other relevant Ministers and ensure that research and innovation are placed on top of the policy agenda.
2. **Strategic cohesion and coherence** across Ministries to capitalize on the opportunities of smart specialisation for economic growth.
3. **Synergies and planning of funding sources across Ministries and EU structural funds** to more effectively manage resources available.
4. **Advisory role and monitoring** of actions in place. It should be provided by a dedicated unit assisting the Council and through consultation of stakeholders as stated in Decree No. 16 of 12 May 2015.
5. **Capacity to mobilise stakeholders.** In view of the panel, the Council is uniquely placed to lead on the necessary trust-building exercise from the government's side and integrate views around the science and innovation spectrum.

Preliminary conclusions:

At its current configuration (Decree No. 16 of 12 May 2015) the PSF panel has concerns that the Council for Smart Growth will not ensure that the main weaknesses of the Bulgarian System of Innovation will be rightly addressed, including:

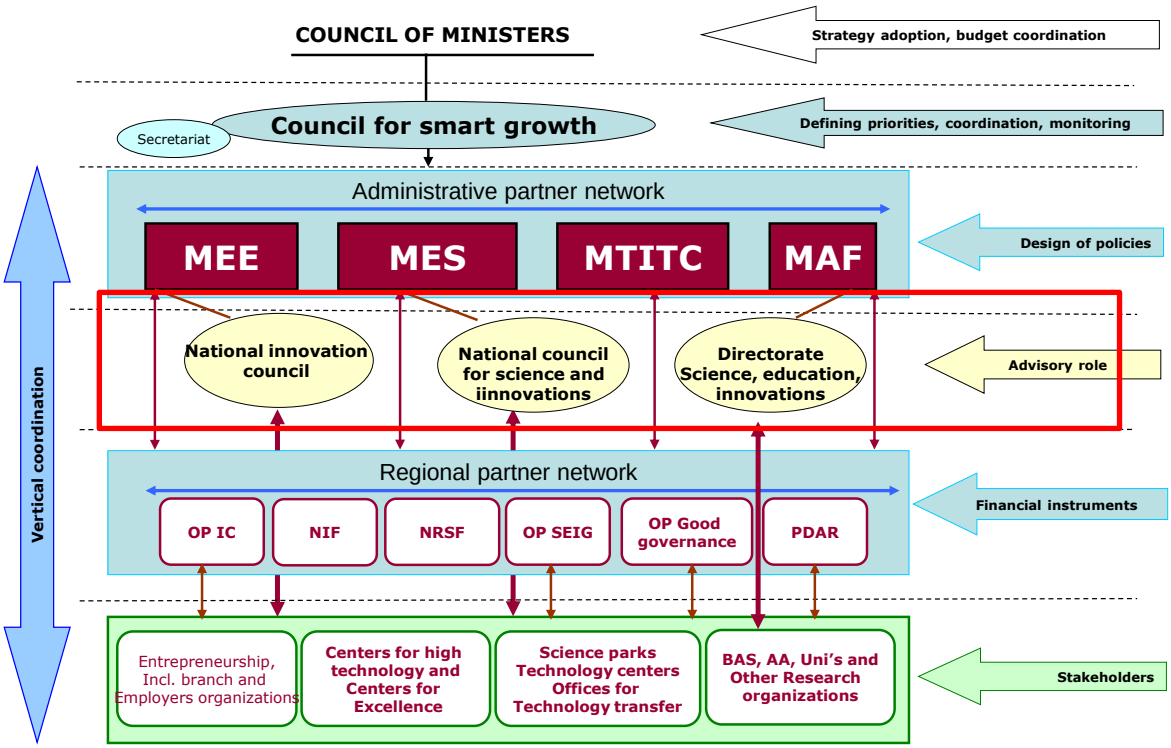
- Lack of pluri-annual commitments of government funding for research and innovation.
- Lack of planning and synergies across governmental actions.
- Fragmentation and inconsistencies across government instruments devoted to promote research and innovation and to create a solid research base to ensure long term growth opportunities.
- Adoption and institutionalization of rules of procedures and standards for the allocation of public funding to ensure quality and predictability.
- Leverage effects between investments between public and private actors and between government and abroad dedicated assets.
- Capitalization of the benefits and opportunities derived from the matching of funding sources (national and EU) around a limited set of policy instruments.
- The Smart Growth Council has been created as a new i**ntermediate body** between the Council of Ministers and the four Ministries involved in the Smart Specialization Strategy. It will contribute to place the topics under discussion, including research and innovation, higher on the political agenda, since the Council will be chaired by the Prime Minister but reasonable doubts on how the Council conclusions and recommendations will be translated into effective actions remain.

Other general issues:

- **Streamlining advisory structures**. In spite of its advisory role the creation of the Council for Smart Growth does not contribute to reduce the advisory structures that already exist within the Bulgarian research and innovation system. In a country of the size of Bulgaria and accordingly to the size of its academic and business community in science and innovation the number of advisory structures seems redundant and contributes to fragmentation. As indicated in the Figure below in spite of the advisory role of the CSG each Ministry still retains its own advisory structure concerning its own instruments. That is a clear signal of fragmentation that has to be overcome by the setting of the national advisory board at the national level grouping those established at sectorial/Ministerial level.

The figure below (from the BG SSS) illustrates clearly the scope of the Council but it limits the effectiveness of the Council for Smart Growth to drive reforms or to introduce a more coherent landscape in the domain of R&D.

Governance of the Innovation strategy for smart specialization



Other comments from the PSF panel members

1. BG might consider dividing the CSG in to two parts.
   a) Strategic - composed of government officials and non-government stakeholders, in equal parts. Only in this way can it be a **smart** growth body, as the smart growth requires interaction with social partners. Its task would be preparing the strategic documents like ISSS and monitoring their implementation.
   b) Operational, composed of government officials including the Ministry of Finance to organize implementing the ISSS and similar strategies.
2. The Participants of CSG: Stakeholders should have more visible impact. Unless this happens the social partners will be regarded primarily as a token gesture (or 'fig-leaf') for the government activities.
3. CSG Chair: As the Prime Minister can change quite regularly it may not be ideal from a long term perspective to have the council chaired by the PM. If the council is divided into strategic and operational parts then it might be preferable to make the PM chair of the operational part of the Council, while the broader composition could be chaired by the head of the parliament or the president, to highlight long term commitment and higher ranking.
4. CSG, in both compositions, should have a set of working groups preparing the documents, action plans – suggesting the technological changes in ISSS. These technical issues should not be performed by ministers and the PM.

The PSF panel makes the following specific comments on the draft articles of the Decree:

1. Art 2. Council activities. The PSF panel suggest that this article might be extended to include specific mention of implementation e.g. "(2) The Council shall perform its activities by proposing to the Council of Ministers policy packages for implementation, allocated to specific ministries". In addition, it should be foreseen that the Council takes an active role in developing the necessary trust-building and integrating views around the science and innovation spectrum.

2. Art. 3. (3) Members of the Council: Involvement/ exclusion of the Ministry of Finance. The PSF panel notes that it can be a deliberate move to either involve or not involve the Minister of Finance. However, either option should support the drive for implementation.

3. Art. 4. (1) The Council shall hold regular meetings at least once every six months.

The PSF panel suggests that if the Council is to become a working formation of the Council of Ministers (CoM) meetings should be at least every four or three months with extra-ordinary topical meetings in-between.

4. With regard to Art. 5 "Extraordinary" meetings BG might consider:

i. a focus on implementation

ii. involving additional members of the Council of Ministers and experts to promote implementation in a specific policy area: e.g. "preparing a policy package for „Welcoming Culture" together with the Minister of Interior, Minister of Labour/Social Affairs on measures involving migration, citizenship, access to the labour market for researchers and other issues; or a policy package on tax incentives, involving the Minister of Finance, state aid experts etc."

iii. involving key stakeholders from the science, technology and innovation community

5. The PSF panel suggests considering a final Article relating to establishing an inter-ministerial task force e.g. "Art. 13 The Council shall be mirrored by an inter-ministerial task force at high administrative level to ensure and report the inter-disciplinary implementation of policy packages in a permanent consultation. Implementation groups in member ministries and high-level contact persons shall be named in other ministries".

ANNEX 2.2. COMMENT ON THE PLANNED AGENCY FOR THE PROMOTION OF SCIENTIFIC RESEARCH (PARI)

Information and documents available on the initiative for PARI are still preliminary. For this reason so are the conclusions from the PSF panel concerning this area.

- The idea of having an agency dealing and streamlining scientific policy implementation is a good one but the tasks of the agency should be very well defined. It should be clear from the beginning if PARI is a planning or an implementing agency. The current idea is a mix of both, which in the opinion of the PSF panel is not the best option. According to the briefing paper received PARI should prepare calls and coordinate drafting the National Research Programme (capacity also attributed to the CSG).
- If PARI will be organized in a way presented in the document it will require quite sophisticated procedures and governing structures. As it will have quite different tasks-from H2020 to research infrastructures-it needs to have effective information and knowledge exchange mechanism between each part.
- The new Agency only concerns the National Science Fund (NSF) and **excludes the allocation of ESIF funds linked to ISSS**. In the view of the PSF panel, the allocation of both national and EU funds for R&D cannot be dissociated since funding sources are not the main criteria to be considered in the definition of instruments nor in the articulation of national policies for the promotion of R&I. If PARI has no competences in ESIF it will not fulfil its overall mission.
- With regard to the structure of PARI the panel suggests that ideally it should be the only implementing agency in BG with a clear three operational pillar structure: H2020, ESIF and research infrastructures, supplemented by a monitoring and evaluation unit. NSF actions should be within H2020 structures and NIF within ESIF. It should become an effective mechanism for: selecting the best researchers and R&D intensive entrepreneurs from national funding mechanism and encourage them to apply in H2020 and financing the projects considered excellent within H2020 but which failed to reach the funding threshold.
- As highlighted in the briefing paper, the Agency focuses in particular on the promotion of research, and more specifically the promotion of EU R&I funding mechanisms. However, in view of the PSF panel, ideally PARI should become defined as the Bulgarian Research Funding Agency. As it has been currently defined PARI it is not a truly research funding agency but mainly a European Promotion Agency. The functions and actions to promote Bulgarian participation into H2020 represent a subset of the actions to be undertaken by the Bulgarian Research Agency that should take over the full range of instruments available and not only the European ones. We name a few actions below:
    - Research Evaluation both at individual and institutional level.
    - Research Planning and definition of roadmap (multi-annual) of funding instruments.
    - Coordination with the Bulgarian Innovation Agency and standardization of administrative mechanisms as well as the coordination for the setup of instruments based on public-private-partnerships.
    - Development of the Bulgarian portfolio of instruments supported by government.
    - New regulations concerning institutional funding. Such regulation cannot be isolated from the new Agency otherwise the fragmentation of actions will persist against a single, clear and transparent roadmap for scientific research.
    - A clear communication of objectives.
    - Openness for new innovative areas and the possibility of stakeholders to co-create the agenda.
    - Securing funding in the strategic and priority areas.
- Advising in writing the proposals for different programmes is not directly a task that should be implemented on a central level. If PARI will be responsible for being an NCP than its staff will have many other tasks and will have no capacity to serve as advisors for scientists. If PARI is to have also external structures, then such a task is ideal for regional points. The panel suggests that at each important research university or PRO (the main BAS institutes) the government should sponsor 2-3 persons that should be PARI employees and could help writing the proposals. On the central level PARI should implement programs like "Grants for grants" – money for preparation of proposal and external evaluation of the proposal. Such schemes are available in many EU countries contributing to better quality of the proposals submitted for H2020 or other programmes.
- The role of a Scientific Council for "ethics in science" within the PARI is not clear to the Panel. It does not seem to fit well with other parts that have rather operational character.

In short the PSF panel feel that the PARI document contains many good ideas, and the knowledge triangle is a good starting point that is also mirrored in the CSG design; however it would benefit from being developed into a clear funding and competence portfolio, including both the human and financial resources needed to accomplish its mission. See Chapter 2 for a description of the recommendations by the Panel.

ANNEX 3.1 COMMENTS ON THE ACT FOR THE DEVELOPMENT OF ACADEMIC STAFF IN THE REPUBLIC OF BULGARIA

The present act has the aim to structure the academic degrees and the academic positions in Bulgaria, and to re-launch the registry of the academic achievements. From the analysis of the document there are some points that deserve reflection by chapter, namely:

Chapter 1 presents the academic positions existing in Bulgaria and the doctoral degree including the register for the academic achievements.

1. The combination in the same legal act of procedures for academic degrees and academic career accession and progression might be cumbersome. Although there is an evident link between the two topics, because the doctoral degree is on the basis of the entrance in the academic career. The question is if this combination would not prevent for more detailed regulations, for instances in the doctoral degrees.
2. On the art. 2.b related to the register and to the minimum requirements that should be observed to enter or changing position, there are listed several indicators and outputs of the academic scientific and technology knowledge production. Two issues are important to mention: 1) The outputs described are highly dependent in terms of its nature and quantity of the scientific field in which they are produced, which is acknowledge in paragraph 3, but not defined, 2) It is not clear how these indicators are compared between them, and how they are aggregated in order to establish the minimum requirements.
3. Point 3 needs clarifying as it is not clear if the requirements listed as valid for PhD students to pass their exam or if they are for the members of the jury.
4. Doctoral programmes are briefly mentioned in the chapter (art. 6) and they are defined in the additional provisions. The PSF panel suggestion is to include them in this chapter.
5. There is no reference in the diploma to Post-Doc positions.

Chapter 2 defines the procedures for the acquisition of the PhD. The major issue is related to what has been identified by stakeholders as a major bottleneck i.e. the length of time that takes in Bulgaria to recognize a foreign degree.

According to stakeholder feedback, currently the system requires long periods of time for the recognition of a degree, which has important negative impacts on the career of many who wish to enter the Bulgarian system.

This issue would benefit if a more detailed description of the process, duration and responsibility of each phase is included in the regulation, in order to avoid such delays. In principle, it should be advisable to have a maximum up to 90 days (Chapter 2, art. 6).

Chapter 3 lists the conditions and procedures for the occupation of academic positions.

1. In the list of the academic positions there is no reference to visiting professors position, which in our opinion would be beneficial to include. Among many benefits, it is worth mentioning the possibility of linking Bulgarian expatriates to the national academic system, or to invite distinguish professors from abroad or from other sectors in Bulgaria to be partially or fully involved in the higher education/BA for a period of time.

2. To consider part of the jury for the promotion to be composed by recognized foreign members and address the missing issue of gender balance.

Chapter 4 contains the mechanisms of control which includes several references to plagiarism but would improve if included within the framework of research integrity.

ANNEX 3.2: AN ASSESSMENT OF R&I POLICIES FOR BULGARIA WITH THE MODEL NEMESIS [108]

In this note, assessments of different R&I policies for Bulgaria realised with the Large Scale Macrosectoral Simulation model NEMESIS are presented. The assessments cover the period 2015-2045. The first section details the scenarios that are analysed, the second section the methodology used and, then, the last section presents the results of the simulations.

Description of the scenarios: The context

The 2014's Innovation Union country report,[109] states that "Bulgaria's research and innovation systems face serious challenges", that are reflected in the level of its science and technology performance indicator which is the lowest in EU28 and twice as small as the EU average (47.8) with a value of 24.5. This poor R&I performance of Bulgaria might be related to both "the insufficient and falling public funding" and to "the fragmentation of the allocation of funds for R&I" with, for example, "only very limited frameworks for supporting collaboration between public research establishments, universities and the private sector".

Concerning the Bulgarian participation in EU Framework Programmes, it remains low: "Both the applicant success rate of 16.4 % and the EC financial contribution success rate of 10.5 % are much lower than the EU averages (21.9 % and 19.7 % respectively). Bulgaria received about 95.1 million € in FP7 funding, which is equivalent to about 5% of its total R&D budget.

In order to analyse the impacts of national structural reforms that could be introduced in the coming years, scenarios are added where the additional investments in the Bulgarian public research sector result in a higher level of research performance than in the reference scenario.[110] The rise in research performance is obtained from two alternative channels: (i) an increase of research output that is modelled by doubling the knowledge externalities from the public sector towards the private sector or, alternatively, (ii) an increase of Public-Private cooperation expressed by a crowding-in effect of each extra € invested by the public sector of ½ € on the R&D investments realised by the private sector.

Results

This section presents the results of the different scenarios, with brief comments. For each scenario (1) a graph is provided that displays the evolutions of GDP, of GDP main counterparts, and of total employment, in % deviation from the reference scenario, between 2015 and 2045; (2) a detailed table for the main macro-economic aggregates, labour market and innovation and competitiveness indicators; (3) a sectoral table – with a re-aggregation of results in eleven sectors - for value-added, employment in production, and labour productivity evolutions.

For every scenario, two separate periods are distinguished: (i) the so-called ***'sowing period'***, that last until 2025, during which the R&D effort increase is not transformed in substantial process and product innovations and (ii) the ***'reaping period'***, after 2025, which starts when innovations bear their first fruits and induce positive impacts on economic performance and on employment.

Scenario 1: increasing the national funding of public R&D

In the first scenario national funding of R&D in Bulgaria is increased such that this financing grows at 6% (instead of 4.3% in the reference scenario) between 2015 and 2025 and the intensity of this national funding is then assumed constant in % of GDP from 2025 to 2045. The simulations assume that this increase of national funding only finances public laboratories and public R&D

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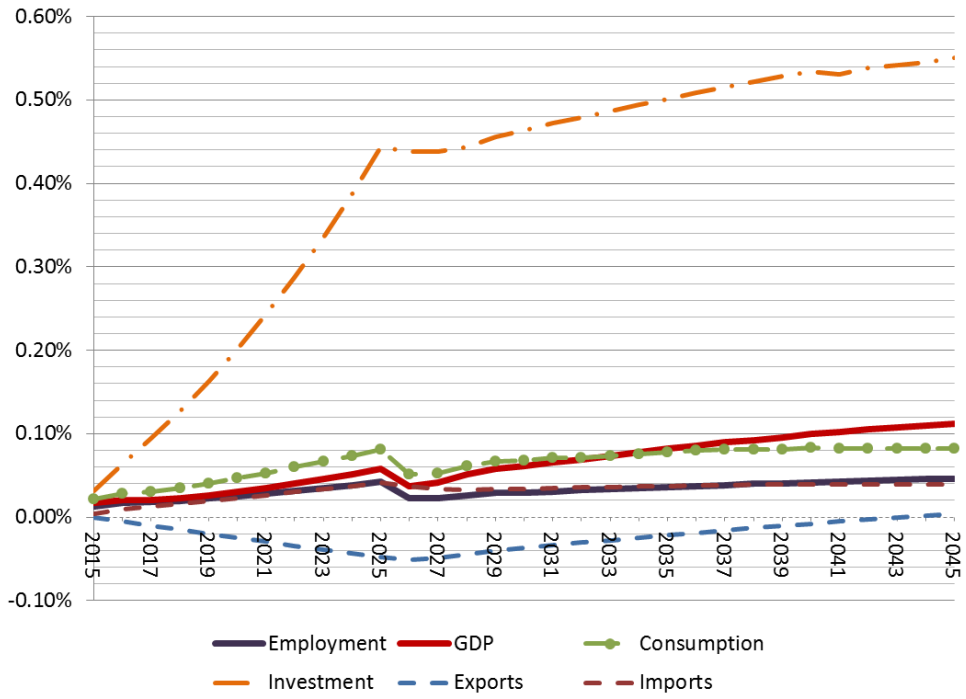
[108] This note is based on the report submitted by Seureco/Erasme on July 24th, 2015 by Boris Le-Hir, Pierre Le Mouël and Paul Zagamé. The report provides more detailed information on the methodology chosen as well as alternative scenario's involving increased funding from the FP, such as H2020. These results are not included here as they fall outside of the framework of this PSF report.

[109] http://ec.europa.eu/research/innovation-union/pdf/state-of-the-union/2014/countries/bulgaria.pdf.

[110] Based on these observations, the scenarios simulated for Bulgaria with the NEMESIS model, analyse and compare as number of alternative and simultaneous impacts of rises in the national funding of research. These simulations are based on the assumptions provided by the Directorate-General for Research & Innovation of the European Commission for the time series of national and the EC annual funding increase between 2015 and 2025, compared to the situation of a reference scenario where these sources of funding follow the past trends observed over the period 2000-2012.

investments. Compared to the reference scenario, research performed by the public sector rises progressively from 2015 to 2025, to reach 0.06 GDP point in 2025, and remains then constant, in % GDP, up to 2045.

Figure A3.2.1: Scenario 1 - Evolution of macroeconomic aggregates, 2015-2045, (in % dev. From ref. Scenario)



During the 'sowing period", the increase in public research is reflected first by the hiring of new research personnel and by other current costs and capital expenditures, that pull-up mechanically the final demand, mainly through households' final consumption, in the model. The final consumption rises gradually up to 2025, and the rise in investment reflects the increase of the R&D expenditure which is capitalised in the GDP, according to the new national accounting rules introduced in 2014. At first, the rise in research employment increases slightly real wages, especially for high skilled labour, and it provokes a negative impact on external competitiveness, with a slight decrease of exports, and a rise of imports, until 2025. Then after 2025, the increase of public R&D expenditures begins to produce substantial process and product innovations. The GDP rises progressively towards its new long term trajectory, with an increased labour productivity and a gradual improvement of external balance.

When looking more precisely at the macro-economic figures one can see that, at the end of the sowing period (2025), the GDP increase is 0.06%, which is similar to the rise in public R&D expenditure. Final consumption and investment contribute positively to this rise, with respectively +0.05 and + 0.09 GDP point, while the external trade contributes negatively (-0.08 GDP point).

At this date (2025), total employment is increased of 1,270 units, while employment in research has increased of 3,750 units. There is consequently a crowding-out effect of employment in research on employment in production. This crowding-out effect comes from the market for high skilled labour, where we observe a rise of 3,340 units of high skilled labour (Doctors/Engineers plus Technicians) in the research sector and a decrease of 2,080 units (3,340 - 1,260) in production. At the same time, at a lower level, low skilled labour increases with 420 units in research and decreases with 400 units in production.

Concerning the Innovation and Competitiveness indicators, in 2025 the impacts are rather limited, with an increase of 0.02% for labour productivity, -0.01% for TFP and 0.02% in the terms of trade. The deterioration of the external balance comes mainly from the rise in imports induced by the increase of internal demand. Finally, one observes that the rise in public R&D expenditures does not influence the R&D intensity in the private sector. The volume of R&D expenditures in the private sector is slightly increased, +0.15% in 2025 (as for GDP), but this is insufficient to significantly increase the private R&D intensity. Nevertheless, the productivity of private research is increased by the positive knowledge spill-overs from public to private sector.

Table A3.2.1: Scenario 1 - Macro-economic results

	2020	2025	2030	2035	2040	2045
MACRO ECONOMIC AGGREGATES						
GDP (1)	0.03%	0.06%	0.06%	0.08%	0.10%	0.11%
Contributions to GDP Growth (2) :						
- Consumption	0.03%	0.05%	0.04%	0.05%	0.05%	0.05%
- Investment	0.04%	0.09%	0.08%	0.08%	0.08%	0.08%
- Extra European Trade	-0.02%	-0.03%	-0.03%	-0.02%	-0.01%	-0.01%
- Intra European Trade	-0.02%	-0.05%	-0.04%	-0.03%	-0.03%	-0.02%
LABOUR MARKET						
Total Employment (4)	0.79	1.27	0.85	0.98	1.08	1.15
- Low Skilled Labour	0.08	0.02	0.01	0.17	0.27	0.33
- High Skilled Labour	0.72	1.26	0.85	0.82	0.82	0.82
Employment in Research (4)	1.76	3.75	3.62	3.44	3.24	3.02
- Doctors and Engineers	1.26	2.70	2.61	2.48	2.33	2.17
- Technicians	0.30	0.64	0.61	0.58	0.55	0.51
- Other	0.20	0.42	0.41	0.38	0.36	0.34
INNOVATION & COMPETITIVENESS						
Private Innovative Inputs Intensity (3)	0.000	0.001	0.001	0.001	0.001	0.001
- Research	0.000	0.001	0.001	0.001	0.001	0.001
- ICT	0.000	0.000	0.000	0.000	0.000	0.000
- OI	0.000	0.000	0.000	0.000	0.000	0.000
Labour Productivity (1)	0.01%	0.02%	0.03%	0.05%	0.06%	0.07%
TFP (1)	0.00%	-0.01%	-0.02%	-0.02%	-0.02%	-0.02%
Terms of Trade (1)	0.01%	0.02%	0.02%	0.02%	0.02%	0.02%

(1) in % deviation from baseline scenario; (2) GDP component contribution to GDP deviation from baseline; (3) in % GDP, difference from baseline scenario; (4) in thousands FTE.

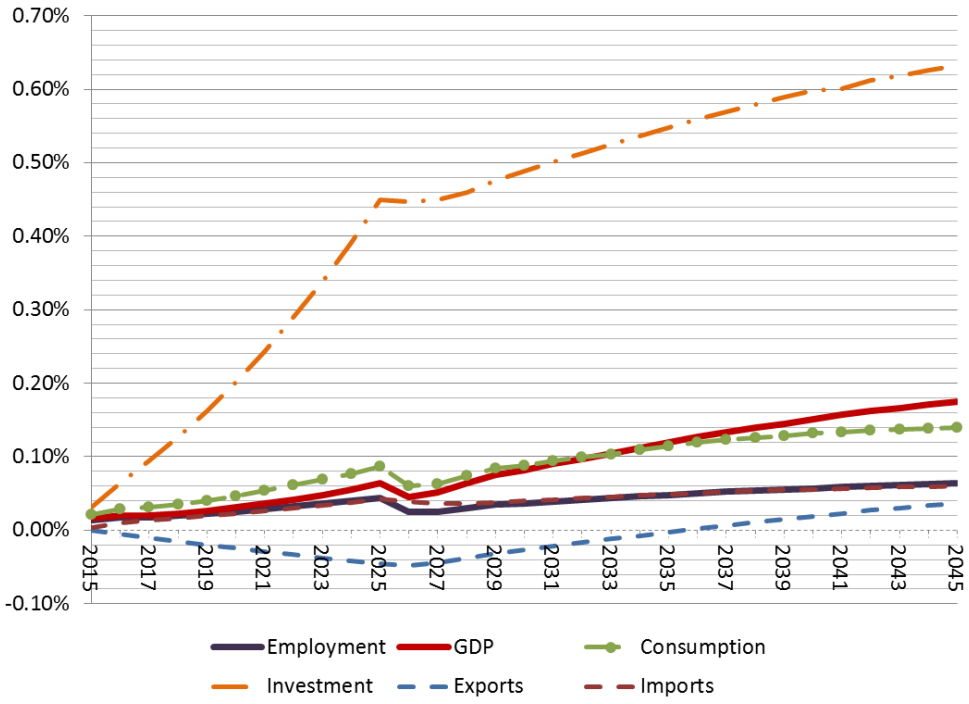
After 2025 all these preceding figures increase gradually. In 2045, GDP is 0.11% higher than in the reference scenario, that is to say twice the rise of public R&D intensity. This rather low long term multiplier effect of the rise of public R&D on GDP reflects the low contribution of national knowledge to the overall knowledge stock used by the different sectors to innovate, and, on the other hand, the low knowledge productivity in Bulgaria, since the private R&D intensity, reflecting the ability of firms to use external knowledge, is only 0.1 GDP point[111] and far behind the EU average. Employment is increased with 1,150 units in 2045, respectively +330 and +820 units for low and high skilled labours. There is still an important crowding-out effect of high skilled labour in research, on high skilled labour in production (-1,660 units). Labour productivity is 0.07% higher than in the reference scenario, TFP -0.02%, and external competitiveness is improved by 0.02%. All these impacts stay too limited to provoke important long term positive effects on total employment that stabilises about 2035. After this date, the annual growth rate of GDP is 0.003 point higher than in the reference scenario.

Scenario 2: increasing the national funding of public R&D with focus on better performance

In this scenario 2, a same increase of national funding targeting again only public laboratories is implemented. However, it is now assumed that the additional R&D expenditures are realised with a higher efficiency than the actual productivity of the public research in Bulgaria. This increased efficiency is reflected in the doubling of public R&D externalities toward private sectors for these extra R&D expenditures, compared to the situation in the previous scenario.

[111] If we exclude the rise in R&D intensity due to foreign pharmaceutical firms.

Figure A3.2.17: Scenario 2 - Evolution of macroeconomic aggregates, 2015-2045, (in % dev. From ref. Scenario)



As illustrated in Figure 3.2 the general shapes of the curves have not changed, but are shifted upwards compared to the preceding case.

Regarding the macro-economic figures in Table A3.2.2, the long term GDP gains reach 0.18% in 2045, with a multiplier effect on GDP of 3, against only 2 in the first scenario (around 1.5 time higher). Labour gains are similarly multiplied by 1.4 compared to the first scenario in the long run. In 2045, labour productivity gains reach 0.11% (against 0.07% - 1.6 times more), TFP increases with 0.2% (against -0.02%) and the long term potential GDP growth rate is about 0.006 point higher than in the reference scenario (against 0.003 in scenario 1).

Table A3.2.2: Scenario 2 – Macro-economic results

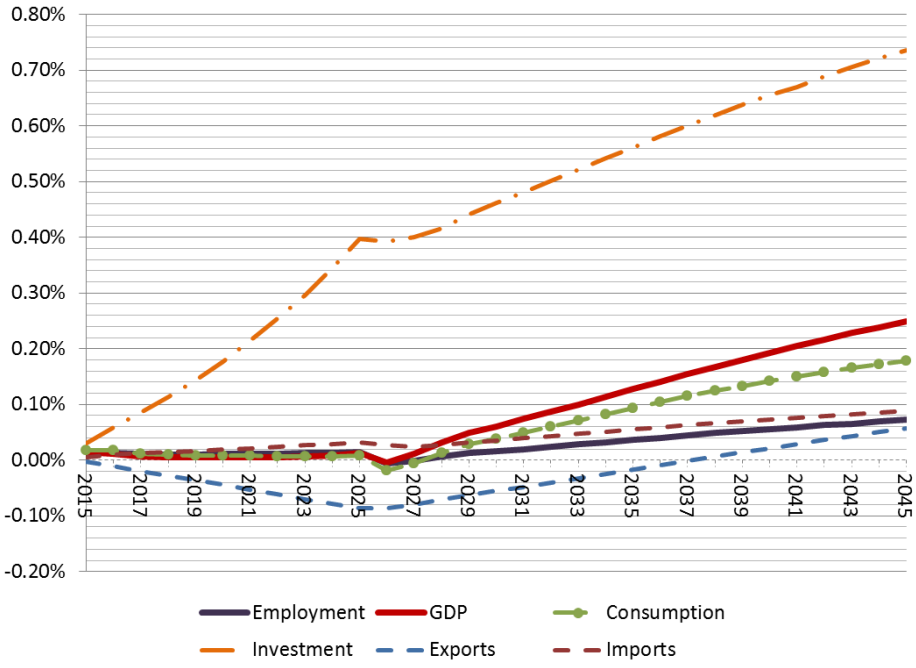
	2020	2025	2030	2035	2040	2045
MACRO ECONOMIC AGGREGATES						
GDP (1)	0.03%	0.06%	0.08%	0.12%	0.15%	0.18%
Contributions to GDP Growth (2) *:*						
- Consumption	0.03%	0.06%	0.06%	0.07%	0.09%	0.09%
- Investment	0.04%	0.09%	0.08%	0.08%	0.09%	0.09%
- Extra European Trade	-0.02%	-0.03%	-0.02%	-0.01%	0.00%	0.00%
- Intra European Trade	-0.02%	-0.05%	-0.04%	-0.03%	-0.02%	-0.01%
LABOUR MARKET						
Total Employment (4)	0.79	1.33	1.05	1.32	1.49	1.60
- Low Skilled Labour	0.08	0.07	0.19	0.44	0.58	0.66
- High Skilled Labour	0.72	1.26	0.87	0.89	0.91	0.94
Employment in Research (4)	1.75	3.73	3.58	3.40	3.21	2.99
- Doctors and Engineers	1.26	2.68	2.58	2.45	2.31	2.15
- Technicians	0.30	0.63	0.60	0.57	0.54	0.50
- Other	0.20	0.42	0.40	0.38	0.36	0.33
INNOVATION & COMPETITIVENESS						
Private Innovative Inputs Intensity (3)	0.000	0.001	0.001	0.001	0.001	0.001
- Research	0.000	0.001	0.001	0.001	0.001	0.001
- ICT	0.000	0.000	0.000	0.000	0.000	0.000
- OI	0.000	0.000	0.000	0.000	0.000	0.000
Labour Productivity (1)	0.01%	0.02%	0.05%	0.07%	0.09%	0.11%
TFP (1)	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%
Terms of Trade (1)	0.01%	0.02%	0.02%	0.02%	0.02%	0.02%

(1) in % deviation from baseline scenario; (2) GDP component contribution to GDP deviation from baseline; (3) in % GDP, difference from baseline scenario; (4) in thousands FTE.

Scenario 3: increasing the national funding of public R&D accompanied by increased public-private collaboration

In scenario 3, the increase of national funding to R&D in Bulgaria is once again targeted on public laboratories with a progressive rise in public R&D intensity of 0.06 GDP point between 2015 and 2025. The difference with the first scenario is that a crowding-in effect is now introduced from the public support for R&D on private R&D expenditures equal to 0.5, leading to a progressive increase of private R&D intensity of 0.03 GDP point.

Figure A3.2.18: Scenario 3 - Evolution of macroeconomic aggregates, 2015-2045, (in % dev. From ref. Scenario)



The long term macro-economic impacts in 2045 lead to an increase of GDP higher than in scenario 1 with +0.25%. The impact on total employment is also higher with +1,790 units. Moreover, in the present scenario, the rise of R&D intensity in the private sector, in addition to the rise in the public sector, increases the crowding-out effect of employment in research on employment in production. As a consequence, the long term impacts on labour productivity, +0.18%, and on long term potential GDP growth rate, +0.012 point, are also significantly more important.

Table A3.2.3: Scenario 3: Macro-economic results

	2020	2025	2030	2035	2040	2045
MACRO ECONOMIC AGGREGATES						
GDP [1]	0.00%	0.01%	0.06%	0.13%	0.19%	0.25%
Contributions to GDP Growth [2] *:*						
- Consumption	0.01%	0.01%	0.02%	0.06%	0.09%	0.12%
- Investment	0.06%	0.12%	0.12%	0.12%	0.12%	0.13%
- Extra European Trade	-0.02%	-0.05%	-0.03%	-0.02%	-0.01%	0.00%
- Intra European Trade	-0.03%	-0.07%	-0.05%	-0.03%	-0.02%	0.00%
LABOUR MARKET						
Total Employment [4]	0.35	0.45	0.47	1.00	1.44	1.79
- Low Skilled Labour	-0.46	-0.97	-0.51	-0.01	0.36	0.64
- High Skilled Labour	0.81	1.42	0.99	1.02	1.08	1.15
Employment in Research [4]	2.30	4.94	4.79	4.59	4.37	4.11
- Doctors and Engineers	1.60	3.45	3.35	3.21	3.05	2.86
- Technicians	0.45	0.96	0.93	0.90	0.86	0.81
- Other	0.25	0.53	0.51	0.49	0.47	0.44
INNOVATION & COMPETITIVENESS						
Private Innovative Inputs Intensity [3]	0.001	0.001	0.001	0.001	0.001	0.001
- Research	0.001	0.001	0.001	0.001	0.001	0.001
- ICT	0.000	0.000	0.000	0.000	0.000	0.000
- OI	0.000	0.000	0.000	0.000	0.000	0.000
Labour Productivity [1]	-0.01%	0.00%	0.04%	0.09%	0.14%	0.18%
TFP [1]	-0.02%	-0.04%	-0.03%	-0.01%	0.02%	0.03%
Terms of Trade [1]	0.02%	0.03%	0.03%	0.03%	0.03%	0.03%

(1) in % deviation from baseline scenario; (2) GDP component contribution to GDP deviation from baseline; (3) in % GDP, difference from baseline scenario; (4) in thousands FTE.

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ANNEX 4.1: SUMMARY OF RECOMMENDATIONS FROM THE DOCUMENT 'INPUT FOR BULGARIA'S RESEARCH AND INNOVATION STRATEGIES FOR SMART SPECIALIZATION' OF FEBRUARY 2013

Area	***Strategic Objective***	***Recommendations***	
		Short-term	***Medium and Long-term***
Stimulating Business Innovation and Entrepreneurship	***Create an environment that stimulates innovation, by addressing the need for:*** • effective funding mechanisms (Operational Programs, national instruments, venture capital) • stronger linkages between research and business • well-designed IPR guidelines that facilitate uptake and increase the incentives to innovate • a functional system for commercialization of technology.	***Conduct industry specific technology road-mapping exercises to:*** • identify the challenges of the industry, • forecast emerging market requirements, • pinpoint the technology gaps and R&D projects that would help the sector become more competitive. ***Improve innovation funding instruments by:*** • engaging specialized expertise for evaluating matching grants • simplifying and shortening the project evaluation procedures • expanding support for early stage investments and empowering the private sector to lead and control the entire venture capital funding process • strengthening monitoring and evaluation by having a richer set of indicators that balance outputs and outcomes • introducing rigorous impact evaluation to measure the additionality of different instruments • improving the coordination with other ministries so that the results achieved are visible. ***Ensure the instruments housed within the Sofia Tech park are demand driven and that the private sector is adequately represented in its governance***	***Revise IPR guidelines pertaining to:*** • government funded research • joint public/private and academic/private research • in-house firm research

Research	***Develop a globally competitive and economically relevant research system***	***Address institutional imbalances in the research system by:*** • Commissioning a system-wide independent evaluation to assess and rank all PROs • Convening a high-level task force to discuss and agree on a roadmap for restructuring BAS institutes and the universities that would distribute research funds and human resources more equitably throughout the system. ***Improve the efficiency of*** ***public expenditures on research by:*** • Making funding increases conditional on the performance of PROs, based on independent monitoring and evaluation. • Matching the resources that PROs can secure from external sources to realign the incentives. ***Redesign scientific support instruments to target collaborative and mission oriented research by building the capacity of existing research teams and facilitating the creation of public-private research consortia*** ***Introduce a merit-based funding program to retain and attract top scientists and young researchers with clear potential based on regular independent evaluations*** ***Develop policies that encourage IP disclosure, IP monetization, and public-private collaboration by establishing a central TTO and strengthening the network of TTOs***	***Initiate the restructuring of PROs taking into consideration the lessons learned from other ECA countries*** ***Create centres of excellence that have a strong position in European Research.***

Human Capital Formation	***Develop advanced human capital and reverse the brain drain, by:*** • improving the higher education system • increasing synergies between research and teaching institutions • putting in place incentives to retain talent and reward excellence • facilitating participation in international communities of practice • addressing regional imbalances in education and research opportunities	***Expand efforts to introduce accountability into higher education financing, and consolidate the sector based on performance*** • develop additional indicators (aside from labour market performance) to assess performance of higher education institutes. ***Provide incentives for studying science and technical specialties, and increase opportunities for academic careers in those areas*** ***Make higher education more responsive to the needs of industry by:*** • creating incentives for university/business collaboration • developing courses with industry input • offering scholarships in collaboration with industry	***Increase share of the people aged 30-34 with higher education to 36 percent by 2020 by:*** • improving coordination and refocusing funding mechanisms at universities towards skills required by key sectors • expanding access to and eligibility for student loans

ANNEX 4.2: SUMMARY OF KEY FINDINGS AND RECOMMENDATIONS FROM THE HEINNOVATE COUNTRY-LEVEL REVIEW OF BULGARIA

Key findings

1. Absence of a clearly defined role for HEIs in promoting innovation and entrepreneurship

Various policy documents and operational programmes refer to the role of HEIs in Bulgaria's emerging knowledge economy from skills development and lifelong learning, research, development, start-ups, innovation and smart specialisation. However, there is no common policy framework that brings together these different strands of measures and clearly defines the role of higher education in promoting innovation and entrepreneurship. The new strategy on higher education, whose adoption is currently pending, is expected to increase coordination efforts.

2. Narrow understanding of the innovative and entrepreneurial HEI concept

The current understanding of the innovative and entrepreneurial university – in the HEI

community – is focused on the promotion of start-up activities, primarily targeted at students.

Organisational capacity, stakeholder links, internationalisation, and leadership are not yet associated

with the concept.

3. Marginal involvement of HEIs in smart specialisation

The involvement of HEIs in the smart specialisation process so far has been only marginal. As a result, HEIs are not fully aware of the funding opportunities and requirements. Only few universities have taken on an active role in local development, for example by defining strategic objectives and starting or leading key industry clusters. Information about these examples is, however, not widely available for the wider HEI community and cannot be found on key communication channels such as the Rector's Conference website[112].

4. 'Separation' of teaching and research

The separation of teaching and research, established during the Communist era, left lasting footprints. Research activities, especially in basic research, are still largely taking place in the Bulgarian Academy of Sciences. Universities have difficulties in absorbing institutional research funding, although some are very successful with project-based research financing and in establishing themselves successfully in the country's emerging innovation system.

5. Knowledge exchange is not yet part of the core-strategy of HEIs

Many knowledge exchange activities of HEIs with business and other external partners are focused on individuals, for example collaboration between researchers in HEIs and researchers in local companies. Without clear and vocal leadership promoting collaboration, knowledge exchange risks to be a matter of personal motivation rather than being 'part of the job'. Benefits from the high number of projects (often co-financed by the European Union), which provide the opportunity of a salary increase for individual staff members, risk remaining constrained to individual benefits with little or no spillovers to the HEI as a whole. Also, the legal framework for public private partnerships and public procurement has still some open issues, which render business collaboration difficult for HEIs.

6. Difficulties in the organisation of internships

Organising internships is difficult in a threefold way, in terms of: (i) finding a place, (ii) guidance and support during the internship, and (iii) the latter's relevance as learning experience. When searching on their own for internship places, many students encountered situations where firms said "we sign the internship report for you, but we are not interested in having you as an intern". Only students who found an internship through their professors had a contact person to reach out to during the internship for advice. Firms argue that students are not interested in practical learning, and students criticise that there is no learning and that they get overloaded with routine tasks. Entrepreneurial project work, co-designed by students and their tutors, is rare. Furthermore, there is no structured reflection of internship experiences in class. Students talk about this in their free time or, in the best case, extra curricular activities.

[112] At the time of this report, the last update of the website was in March 2014.

7. Systemic barriers in raising the attractiveness of HEIs

The number of newly enrolled students is decreasing, and reaching 'critical mass' has become a serious issue for several HEIs. The number of students opting to study abroad is increasing. The unfilled surplus of 8,000 study places (11.3% of the total offer) in the academic year 2014 risks becoming a recurring phenomenon.

Average numbers of students are between 6,200 for public HEIs and 3,500 for private HEIs. The University of Sofia "St. Kliment Ohridski" is with 21,000 students the outlier, followed by the Technical University of Sofia, which is with 9,200 students the second largest HEI. Co-operation between HEIs remains low and there are examples of spurious competition in establishing faculties, departments and study programmes. The number of PhD programmes per university is very high (on average between eight to 15 programmes). There is a risk that the offer of PhD programmes serves as an additional source of income rather than a way of broadening research activities.

There is an urgent need for re-organisation towards more collaboration between HEIs and more joint utilisation of infrastructure and resources. The aim should be to build a well-functioning system that allows and caters for diversity, so that institutional-level priorities and goals can be realistically set and achieved within the wider system-level strategic objectives.

Accreditation concerns separately institutions and study programmes. Activities to promote entrepreneurship as a key competence are not considered in the accreditation process. Currently the composition of the evaluation panels, mostly professors working at HEIs in the country, presents high potential for conflict of interest. Foreign academics and key local and national stakeholders e.g. employers and research partners, have not yet been included in the teams.

Tailoring study programmes to the needs and arising opportunities in the local economy is burdensome and costly. Adjustments during the accreditation time are difficult to organise, and there is a tendency to apply with study programmes that are similar to programmes already accredited at HEIs elsewhere in the country. There is some collaboration on co-designing curricula but this is not yet part of a systemic approach. The focus seems to be more on lifelong learning activities and less on study programmes. Interdisciplinary activities, which are open to students from different faculties, are often limited to extra curricular activities.

Bulgaria is one of the few countries in the EU where the establishment of joint programmes and joint degrees with partner HEIs from abroad is not addressed in legislation (EU, 2012). Currently less than 10% of HEIs in the country participate in joint programmes, whereas in neighbouring Romania up to 75% are participating in international study programmes.

8. Barriers to up-scale entrepreneurship promotion in HEIs

Many individual academics in Bulgaria promote entrepreneurship in their HEIs and participate in research conferences in the country and abroad. However overall, entrepreneurship promotion has not yet become a matter of strategic interest for HEI leadership. There are some HEIs where motivated individuals receive recognition and support for their commitment and additional work, but only very few HEIs actually have rectors who consider themselves as "entrepreneurship champions".

9. Missing links to the entrepreneurship ecosystem

The entrepreneurship ecosystem in Bulgaria is quickly developing. Eleven and LauncHub are seed venture capital funds, which provide support for individuals and teams to develop innovative ideas from very early stages on. They are well known amongst the student community. Start-up weekends are also regularly organised in several cities across the country. Yet links with the HE system are rare.

Recommendations

1. ***A national-level HEInnovate committee should be established***, which includes senior representatives from the ministries of education and science, economics, and labour and social affairs, the Rectors Conference, and the main economic actors (Chambers, etc., entrepreneurship ecosystem).

   The objective of the national-level HEInnovate committee is to (i) promote the concept of the innovative and entrepreneurial higher education institution, (ii) identify key national challenges and opportunities in the higher education system with regard to the seven dimensions of HEInnovate, and (iii) to monitor and evaluate pilot projects for a potential mainstreaming. The establishment of working groups, involving HEI representatives, should be considered.

2. ***To trigger innovation in the higher education system and to sustain already existing promising initiatives, the creation of a HEInnovate Fund, co-financed with ESIF funding is proposed***. The HEInnovate fund should provide co-financing for pilot projects, proposed and implemented by HEIs in Bulgaria. The allocation of co-funding shall be competitive. Key areas of fundable projects should be defined by the national-level HEInnovate committee, taking in the findings and recommendations from the HEInnovate country-level review. Furthermore HEInnovate key performance indicators, applied by NEEA and the University Ranking, should be used.

The following recommendations should be taken into consideration when establishing the national-level HEInnovate committee and the HEInnovate Fund. A discussion of below recommendations in the Rectors Conference is suggested. It is understood that some of the following recommendations require higher-tier level support to be fully implemented.

3. ***HEIs should review and reformulate their vision statements and missions, and adapt these in light of current challenges and possible responses.*** To this end, undertake an analysis of the strengths and weaknesses, opportunities and threats, involving the entire university community – including students, alumni – and key external partners. This will also imply defining and building a common understanding of what being innovative and entrepreneurial means to the university, and how this understanding can/should be linked with the socio-economic situation of the surrounding local economy. In all this, it will be important to build effective ways to increase graduate retention in the university's surrounding economy.

4. ***Establish a senior management post in charge of the innovative and entrepreneurial agenda.***

   To steer and sustain the innovative and entrepreneurial agenda, HEIs should establish the position of a senior management post or Vice-Rector who will be responsible for entrepreneurship, organisational change and interaction with the local community. It is suggested that a "Strategy Council", which includes members from local/regional governments, key business and industry partners, and civil society, is established to advise and support the HEI in building trust, achieving its mission and vision and design a roadmap to become one of the drivers of entrepreneurship and development in the local/regional economy.

5. ***Provide training possibilities for staff and reward excellent performance in teaching, research and entrepreneurship.*** A formal policy for career development should be in place, which is sufficiently resourced and provides room for individual goals and objectives. Training possibilities should be offered to enhance the quality of teaching e.g. interdisciplinary intra-curricula education activities, student-centred pedagogies, involvement of externals into teaching, organisation of internships, knowledge exchange, and internationalisation. In addition training possibilities should also exist for academic staff, who would like to contribute to the organisational change agenda.

6. ***Further invest in the establishment of coordination mechanisms for entrepreneurship promotion, and involve students in this.*** Existing co-ordination mechanisms for entrepreneurship promotion, such as entrepreneurship centres and technology transfer centres, should be continued and improved in order to reach out all across campus. The aim should be to develop dynamic structures that link the HEI with the entrepreneurship ecosystem and offer easy access to different publics inside and outside the HEI. The richness of student associations in Bulgarian HEIs is a good starting point. It is important to mobilise students for entrepreneurship & strategic HEI development, and give them opportunities to contribute.

7. ***Incentivise the strategic involvement of key external stakeholders***. Providing recognition and rewards for strategic partners is important. HEIs may need to adapt or introduce new criteria for awarding external stakeholders such as entrepreneurs, regional organisations and associations, alumni and others for their contributions to organisational change.

8. ***Build strategic bonds with alumni***. A network of alumni can be very useful to help the university to understand how their curriculum can be improved. After all their perceived value in the job market is very much linked to the reputation of the university where they obtained the degree. Stronger alumni connections can be facilitated in multiple ways, such as regular surveys of the alumni, inviting successful alumni as guest speakers to university events, inviting alumni members to speak to the students, and matching alumni members as mentors to students. As an incentive, to maintain contact with the university, graduates could be

allowed to keep their email account. Nascent initiatives across HEIs in the country should be reviewed and sustained.

9. ***Build on existing good practices in novel pedagogies and mainstream them in the wider HE system***. There are several good and promising initiatives all across HEIs in Bulgaria. Information about these should be widely circulated and mainstreaming should be considered. This will require the following steps (i) awareness creation for non-traditional pedagogies & requirements (preparation, resources, learning outcome assessment) and incentive systems to promote experimentation with innovative teaching methods, (ii) provision of training and teaching materials, and guidance on how to assess learning outcomes, (iii) establishment of all-HEI network.

10. ***Promote entrepreneurship education as cross-section faculty portfolio***. Entrepreneurship education, aiming at the development of an entrepreneurial competence portfolio (attitudes, soft skills/social/methodological competences), should be expanded and tailored to all students of the HEI at all faculties and levels.

11. ***Develop an easily accessible system of fundamental business start-up support for academic entrepreneurs***. Easy access to start-up support is crucial for the initial exploitation and development of ideas. Key to this is linking HEI-internal efforts with the entrepreneurship ecosystem. Would-be entrepreneurs need not know where they can get information and support. This keeps motivation high. Offering academic would-be entrepreneurs an "address" , for example in form of a co-working space with access to laboratories, is not only helping to commercialise research, but also to build lasting bonds with entrepreneurial alumni.

12. ***Increase the institutional embedding of knowledge exchange activities***. Without clear and vocal leadership promoting collaboration, knowledge exchange might be a matter of personal motivation rather than being "part of their job". Taking into consideration the importance of individual incentives will be important but as part of an institution-wide strategy. Communication efforts are needed to ensure that all current and future partners have a clear understanding of the HEI's work culture, routines and regulations, also in light of possible impacts on performance and timelines. Different knowledge exchange activities have different impacts: some are more tangible than others. Monitoring and evaluation starts with a mapping of people and organisational units exposed to and involved in knowledge exchange activities, distinguishing different types of activities in order to establish an understanding of how many staff and students are aware of the university's knowledge exchange strategy and the opportunities to contribute to it.

13. ***Make internships entitlement for students*.** Internships should be an entitlement for all students.

    Internships need to be supported by HEIs in terms of (i) spreading information, since hosting organisations prefer to have single interlocutors which provide them access to several candidates and routine procedures, (ii) facilitating the supervision of interns, especially if related to academic requirements and co-tutorship arrangements, (iii) providing assistance to the intern during the internship, (iv) making sure that experience reports are prepared for the double purpose of reflecting about the learning experience off campus, and informing other students and teachers. Host organisations, in particular small and medium-sized firms, will welcome greater accompanying support as this reduces costs and resource allocation on their side.

14. ***Increase internationalisation efforts***. HEIs in Bulgaria need to develop their international agenda more. One simple way of attracting more exchange students and promoting the university is to use the Diaspora. A common policy needs to be in place at the institutional level to deal with all matters related with mobility in order to ensure consistency of information and approach. HEIs should offer language courses after work to increase performance and mobility rates of staff and students. The question of double degrees and open issues concerning the recognition of foreign degrees need to be taken up at the level of the Ministry of Education and Science.

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The Directorate-General for Research & Innovation of the European Commission set up a 'Policy Support Facility' (PSF) under the European Framework Programme for Research & Innovation 'Horizon 2020' to support Member States in reforming their national science, technology and innovation systems.

The first activity of the PSF has been a Peer Review analysis to support wide-ranging reforms in Bulgaria. More concretely, the aim of the peer review was to provide external advice to the Bulgarian authorities in the process of evaluating their research and innovation (R&I) system and assist where necessary in implementing national strategies and policy measures, with a focus on three main areas: (1) assessment of R&I funding and performing bodies and instruments; (2) R&I Human resources capacity development; and (3) tackling the gap between research and business. The Bulgarian national authorities expressed a strong political commitment to this exercise.

This comprehensive report was produced during April-September 2015 by an independent panel of senior officials working in policy-making at the national level and acting in a personal capacity, and high-level independent experts from Germany, Ireland, Norway, the Netherlands and the UK with expertise in relevant research and innovation fields. Ten persons composed this panel: Luc Soete (Chair, Maastricht University, The Netherlands), Lisa Cowey (rapporteur, independent expert, United Kingdom), Mateusz Gaczynski (Ministry of Science and Higher Education, Poland), Clara E. Garcia (Ministry of Economy and Competitiveness, Spain), Luisa Henriques (Foundation for Science and Technology, Portugal), Armin Mahr (Federal Ministry of Science, Research and Economy, Austria), Stojan Sorčan (Ministry of Education, Science and Sport, Slovenia), Liv Langfeldt (Expert for institution assessment and evaluation, Norway), Conor O'Carroll (Expert for funding agencies, research human resources and mobility policy, Ireland), and Steffen Preissler (Expert for innovative transfer systems, Germany).

The PSF expert panel arrived at the ten Policy Messages highlighted upfront in the report, each one supported by a number of detailed recommendations. The report explains the rationale supporting each of those ten policy statements and the corresponding recommendations. Many country and case boxes fill the different chapters of the report, presenting numerous good examples of 'good practices' from other Member States or neighbouring countries, to learn from. Finally, in its conclusion the panel proposes to the Bulgarian government that in three years from now a broadly similar PSF panel comes to assess the implementation of the recommendations contained in this report.

Publications Office

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