European Commission

Peer Review of the Ukrainian Research and Innovation System

Horizon 2020 Policy Support Facility

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Directorate-General for Research & Innovation
Directorate A — Policy Development and Coordination
Unit A4— Analysis and monitoring of national research and innovation policies

Contact (H2020 PSF Peer Review of Ukraine):
Diana SENCZYSZYN, Coordinator of the Peer Review, Unit A4 – Diana.SENCZYSZYN@ec.europa.eu
Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu

Contact (H2020 PSF coordination team):
Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu
Stéphane VANKALCK, PSF Head of Sector, Unit A4 - Stéphane.VANKALCK@ec.europa.eu
Diana SENCZYSZYN, PSF Team Leader, Unit A4 - Diana.SENCZYSZYN@ec.europa.eu

RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Written by the independent panel of experts and national peers:

National Peers

Agrita Kiopa, Ministry of Education and Science, Latvia

Michael Schlicht, German Federal Ministry of Education and Research, Germany

Philip Sinclair, Prime Minister's Cabinet Office, United Kingdom

László Szilágyi, Ministry for National Economy, Hungary

Independent Experts

Hans Chang, Chair, Former Director-General of the Royal Netherlands Academy of Arts & Sciences, Advisor on science policy

Jelena Angelis, Deputy Director of Technopolis Group Baltics, expert on innovation policy, Lithuania

Claire Nauwelaers, Independent Policy Analyst and Governmental Adviser in research and innovation policy, Belgium

Thorsten Posselt, Head of the Fraunhofer-Centre for International Management and Knowledge Economy IMW, Germany

Klaus Schuch, Rapporteur, Scientific Director at ZSI-Centre for Social Innovation, Austria

Directorate-General for Research and Innovation

2016 EN

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Luxembourg: Publications Office of the European Union, 2016.

ISBN: 978-92-79-62755-2 DOI: 10.2777/095726 KI-01-16-932-EN-N

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ABOUT THE PSF PEER REVIEW EXPERT PANEL

Hans Chang, chair (The Netherlands): Advisor on issues of national science policy, research infrastructures and research management. From 2009-2015 he was director-general of the Royal Netherlands Academy of Arts & Sciences. From 1985-2009 Hans directed FOM, an umbrella organisation for national physics laboratories. From 1975-1985 he was director research policy at the Ministry Education & Sciences. Hans was also co-founder and inaugural Chair of ESFRI (European Forum Research Infrastructures) and former vice-chairman of the OECD Megascience Forum as well as a member/chair of committees advising governments on matters dealing with university research, funding agencies, large facilities, etc.

Klaus Schuch, rapporteur (Austria): Scientific director at ZSI (Centre for Social Innovation) and managing director of the Austrian Platform for Research and Technology Policy Evaluation. His research interests are on techno-globalisation, RTI system research, evaluation and social innovation. In 2007 he was scientific expert of the CREST Working Group on internationalisation in S&T and in 2012 member of the external expert group of the EC to advise on the new European RTI-internationalisation strategy. Among other assignments, he is a member of the Scientific Committee of COST and advisor to several Austrian agencies and ministries dealing with RTI. Klaus lectured at the University of Vienna and other Austrian universities in evaluation, techno-globalisation and knowledge-based regional economics.

Jelena Angelis, expert (Lithuania): Deputy Director of Technopolis Group Baltics and Senior Consultant in the field of innovation policy, including analysis of R&I policies and smart specialisation; evaluation of R&I programmes and support measures; science-business cooperation; monitoring and assessment of impacts of research infrastructures. She has also hands-on experience in supporting entrepreneurs from her work with incubators in the UK and as a Board Member of UBI Global, a Swedish SME involved in benchmarking and indexing university business incubators and accelerators across the world. Among other assignments, she acts as an external evaluator for Vinnova (Swedish Innovation Agency) and Horizon 2020.

Agrita Kiopa, peer (Latvia): Deputy State Secretary, Director of the Higher Education, Science and Innovation Department at the Ministry of Education and Science of Latvia. She leads a structural reform programme with a focus of establishing core institutions that foster excellence and relevance of research and higher education. She has been involved in the design of the Latvian Smart Specialization Strategy and works to ensure its delivery. Prior to joining the ministry she was researcher at the University of Liverpool and Georgia Institute of Technology where she was awarded PhD in Public Policy with specialisation in Science and Technology and public organisations.

Claire Nauwelaers, expert (Belgium): Independent Policy Analyst and Governmental Adviser, specialised in research and innovation policy. Until 2011 she was working on innovation as senior policy analyst in the Regional Development Policy Division at OECD. Previously she was Research Director at UNU-MERIT, the University of Maastricht and United Nations University, and senior researcher at the University of Louvain, working on policy–relevant studies on the governance of science, technology and innovation. She is regularly involved in EU-funded assignments such as peer reviews of research and innovation systems, evaluation of innovation programmes under the Structural Funds, and expert groups on key issues under the European Research Area. She is a specialist in smart specialisation strategies and advises regions and countries for their development of such strategies.

Thorten Posselt, expert (Germany): Head of the Fraunhofer-Centre for International Management and Knowledge Economy IMW and Professor of Innovation: Management and Economics at the University of Leipzig, both since 2008. From 2005-2011 he served as professor of service management, retailing and e-commerce in Wuppertal and 2000–2005 professor of service management in Leipzig. Thorsten is member of the European Academy of Sciences and Arts and he acts as member of the subgroup on internationalisation of the German High-Tech Forum. He also has been member of EU-related groups such as the expert group on service innovation. He studied economics and business in Frankfurt University and Stanford University. His research interest focuses on the industry–science link. He was involved in many projects on these topics involving in particular Eastern Europe as well as other European countries and a number of selected non-European countries.

Michael Schlicht, peer (Germany): Director, German Federal Ministry of Education and Research, Cooperation with EaP Countries, Russia and central Asia.

Philip Sinclair, peer (United Kingdom): Philip is Head of Innovation and Growth in the Cabinet Office, and leads inward innovation in government, with a focus on making public sector business more accessible to SMEs. Prior to joining the Civil Service he worked in management consulting, corporate finance and law. As an entrepreneur he has founded two businesses, most recently in the education sector for the Asia-Pacific region. As a non-executive director he has advised several others on strategy, growth, and intellectual property. He has mentored entrepreneurs, executives, and students in the UK and abroad. Philip is a Fellow of the Royal Society for the encouragement of Arts, Manufacturers & Commerce.

László Szilágyi, peer (Hungary): Deputy Head of the Economic Planning Department at the Ministry for National Economy. He started his career in the Ministry in 2005 where he was involved in the programming of ERDF co-financed Operational Programmes. In 2009 he joined the National Office for Research and Technology, where he was coordinating the external evaluation of the Research, Technology and Innovation Fund's 2004-2009 activities. He joined the Ministry in 2010 again as head of unit at the Department for Innovation and R&D. Between 2013-2015 he was science and technology attaché in Brussels.

PSF Team Leader (observer, European Commission): Diana Senczyszyn, DG RTD, Unit A4 "Monitoring and analysis of national research and innovation policies."

PSF contractor (project manager, Technopolis Group): Agis Evrigenis, is the Director of Technopolis Group Belgium and expert in the sphere of science, technology and innovation.

The PSF contract is implemented by Technopolis Group, in partnership with Manchester Institute for Innovation Research (MIOIR) and the Centre for Social Innovation (ZSI) along with a network of 48 associated institutes, companies and experts.

The PSF Panel is thankful for the support of the Ukrainian Ministry of Education and Science, which was in charge of organising the meetings with Ukrainian stakeholders in situ. We specifically thank Vice Minister Dr Strikha, Ms Shapoval and Ms Novosad, who organised the process together with the European Commission and the PSF Consortium in an efficient and effective way. The PSF Panel acknowledges the support of the Academy of Sciences of Ukraine for hosting two meetings with us. The Panel also wishes to express thanks to the Delegation of the European Commission in Kyiv for providing meeting rooms for Ukrainian stakeholders to discuss with us the situation of science, technology development and innovation (STI) in Ukraine. We sincerely appreciated the open, constructive and fruitful talks with these distinguished Ukrainian experts and delegates with different organisational and professional backgrounds. They enriched and deepened our understanding of the structure and practice of STI in Ukraine.

KEY POLICY MESSAGES

Ukraine's **pockets of scientific excellence** reflect the country's successful contribution to scientific advancement over the past decades. However, while the economic and geopolitical framework of the country transformed enormously during the last 25 years, its science, technological development and innovation (STI) policy and performance were not responsive enough in adapting to this new situation. If the reforms triggered by the ***new Law* on Scientific and Technical Activity** do not receive the highest attention and support by government and stakeholders, it is highly probable that Ukraine will lose its connectivity to international STI progress. The panel believes that the country's STI system needs to become more efficient and ***additional budget*** from national, international, EU and private sources must be secured within the next three years for strategic investments from fundamental research to market uptake.

The PSF Panel recommends to the Ukrainian government to **inspire the design and implementation of reforms** of the national STI system on the seven policy messages below:

1. ***Ukraine's STI system needs ambitious reforms to boost its efficiency and impact. These should be coupled with strong governmental commitment to invest more.*** The target of 1.7% of public R&D expenditures/GDP in the new Law on Scientific and Technical Activity, although unlikely to be reached soon, should remain valid and support the STI reform agenda. Competitive research funding should gain relevance to reach 40% by 2022.
2. ***The country needs to "innovate its path to growth" with a cross-governmental STI Strategy that is backed by adequate tools.*** This will require a cross-government effort that involves the intellectual, material and financial assets of the country. Ukraine must place research and innovation high on its political and policy agenda. The Strategy should be developed and implemented to exploit the potential of STI for growth and societal wellbeing.
3. ***Science in Ukraine should benefit society and the economy.*** This will require a fundamental change in the way Ukraine orients and carries out its STI. Notably, the science community must realise that in these difficult times "science for the benefit of society and the economy" is a must. This has to be firmly anchored in the mission and rules of all research performing organisations (including universities and the Academies of Sciences).
4. ***Urgent decisions are needed to prioritise Ukraine's STI actions*** based on the principles of scientific excellence and on opportunities for innovation-driven economic growth in Ukraine.
5. ***STI institutions, funding and procedures need strong institutional revamp***. Global standards and good practice should be leading forces of change. Legal reforms such as the new Law on Scientific and Technical Activity and the forthcoming Law on Innovation must be optimally deployed to roll out a fully coordinated cross-government approach on STI.
6. ***Ukraine should push for the internationalisation and opening-up of its STI system***. It should use the manifold opportunities gained by its accession to Horizon 2020 and establish adequate mechanisms to support the success of Ukrainian participants in Horizon 2020. At the same time, Ukraine should take the European Research Area agenda as a backdrop for its national reforms. Openness and internationalisation create vibrant and advanced STI systems.
7. ***Finally, the government and the STI community must take ownership and communicate on the STI reforms undertaken and on their positive results for the country***. This should be a joint effort by policy-makers from all political parties and the country's leading intellectuals. STI delivers returns for Ukraine's economy and society, and these should be promoted, shared, and used with and between society and economic actors.

The PSF Panel ***considers the new Law on Scientific and Technical Activity as a critically important initial step towards a breakthrough in improving the STI situation.*** The major components of this Law should be implemented as soon as possible. The ***National Board on the Development of S&T and the National Research Foundation appear as the potentially strongest change-makers*** to champion Ukraine's STI reform efforts. The Panel also considered other institutional actors tackled by the Law such as ***the National Academy of Sciences, which could become a change-maker too,*** or the Ukrainian universities and their aspirations on how to best support growth and the country's R&D pool of talent. Finally, the panel considers that ***internationalisation and innovation policies are both critical*** in ensuring that Ukraine develops into a knowledge-driven economy.

The Ministry of Education & Science (MESU) is advised to publish an action plan, with a roadmap for implementation of the new Law on Scientific and Technical Activity in the first quarter of 2017. The recommendations of the PSF Panel should be considered in this context, notably as regards the creation of a National Board on the Development of S&T and a National Research Foundation.

EXECUTIVE SUMMARY

1. RAISE QUALITY AND RELEVANCE OF THE SCIENCE BASE

PROMOTE CHANGE AND REFORM THROUGH A STRONG MANDATE OF THE NATIONAL BOARD ON THE DEVELOPMENT OF S&T

The re-orientation of the STI system of Ukraine towards higher socio-economic relevance, effectiveness and a stronger innovation focus accompanied by the necessary reforms requires strong guidance, supervision and monitoring from an independent board which has responsibility in defining a challenging reform agenda in consultation with important stakeholders. ***The 'National Board on the Development of S&T'[1] has to be in the position to be politically influential and to dispose of strategic intelligence.*** To secure political strength, the Board has to receive the highest political leadership and commitment. Moreover, the Board must be assisted by a well-equipped secretariat staffed with subject-matter experts. In order to do its work substantially, the Board should also have adequate budgetary means at its disposal.

The Board should focus its short-term agenda (next 2 years) on several key activities to radically re-orient the system of STI in Ukraine. These include *(see Recommendation 1 in detail):*

- ***Decide/advise on the distribution of research funding between institutional research funding and competitive project-based research funding***. A transparent action-oriented roadmap should be established on how to reach the agreed proportion of funding between institutional and competitive R&D funding within a maximum of 5 to 7 years also in the current perspective of a constant budget scenario.
- ***Introduce a comprehensive national socio-economic priority setting process.*** The aim of this process is to derive the relevant national research priorities from the identified overall national priorities by taking into account the existing scientific excellence according to world standards and the need to maintain the nation's broad knowledge absorption capacity. The identified national research priorities have to correspond with and directly contribute to the overall national priorities, which should support the transformation of Ukraine towards an innovation-oriented economy and society.
- ***Re-orient the STI systems towards innovation.*** R&D in Ukraine should be based on "excellence" in terms of academic world-class science and on "excellent science for innovation" principally in the fields of engineering and natural sciences. Institutionalised participation of the business sector in the National Board on the Development of S&T is advocated. A high-level representative of the Ministry of Economic Development and Trade with a permanent seat in the Administrative Committee of the National Board on the Development of S&T is further recommended.
- ***Set up a system to continuously monitor the development of STI policies*** in Ukraine and introduce a fully-fledged evaluation culture and system.

RAISE QUALITY AND RELEVANCE OF S&T THROUGH COMPETITIVE RESEARCH FUNDING

A powerful competitive R&D (research and technological development) project funding mechanism is of utmost importance for Ukraine. In practice it would introduce change in a contained system and increase scientific excellence and relevance, enhance inter-organisational collaboration – including science-industry cooperation and knowledge transfer – and contribute to priority setting through funding the best projects. Establishment of the National Research Foundation (NRF), as stipulated by the new Law on Scientific and Technical Activity, is the first step in that direction. ***The PSF Panel recommends to distribute by 2022 40% of all available public funding for research and technological development (R&D) through competitive project funding*** *(see Recommendation 2 in detail).* The remaining 60% should be allocated through institutional funding procedures. To reach this goal, a stepwise increase of competitive research funding up to 20% in 2018; 30% in 2020; and 40% in 2022 is respectively suggested. This stepwise approach should also generate the development of qualitatively sufficient absorption capacities in Ukraine for this kind of funding.

To make the NRF operational, the NRF requires substantial extra budget allocations. The following budget sources for the NRF could be implemented:

1. Substantial extra budget resources should be allocated to the NRF in accordance with the 1.7% target stipulated by the Law on Scientific and Technical Activity.

[1] The Board is proposed by the new Law on Scientific and Technical Activity.

2. The budget of the State Fund for Basic Research should be transferred to the NRF and the State Fund should be dissolved.
3. 50% of the competitive funding for R&D projects of the universities, which is annually directly distributed by MESU, should be transferred to the NRF to restock the budget for open competitive calls for R&D proposals.
4. Only in cases where no substantial extra budget can be allocated (point 1 above), it is suggested to transfer as a 4th source also 50% of the competitive funding for projects, which NASU directly distributed under its authority and autonomy during the last years on average, to the NRF to restock the budget for open competitive calls for R&D proposals. The PSF Panel, however, would see this as an infringement to reach the 1.7% goal stipulated by the Law and takes note that this would be against the spirit of Art. 48.

The PSF Panel advises that ***all research groups in universities and research institutes irrespectively of their affiliation should be eligible to compete*** for research projects granted by the NRF. This includes NASU institutes as well.

The system of STI funding in Ukraine is not free of allegations of opaqueness and nepotism. In order to contribute to trust-building, which is essential for any funding allocation mechanism, ***the NRF should from its inception be internationally supervised and assisted*** regarding its grant review procedures *(see Recommendation 3 in detail).* By doing so, it would send a strong signal to the Ukrainian and international research communities. Moreover, to overcome the relative international isolation of Ukrainian R&D, which is partly caused by a poor general level of English, and to avoid scientific "inbreeding"***, an international peer review system for projects should be introduced along with increased use of English*** in research as well as in the application, review and reporting processes *(see Recommendation 4 in detail).*

ENHANCE R&D AT UNIVERSITIES AND MAKE AUTONOMY A REALITY

To strategically enhance autonomous R&D priority setting and profiling at universities, MESU should use the remaining 50% of its competitively allocated funding to universities as incentivising budget. This budget share, however, should not be allocated on basis of competitive project funding, but through ***an institutional allocation mechanism which has to be based on strategic R&D development plans and roadmaps*** to be drafted and delivered by the universities. The use of this budget should completely fall under the autonomy of the universities. *Recommendation 5 details* how this allocation should be financed and distributed. After a five year long transition period, MESU should evaluate the R&D progress and achievement of the universities, select the most competitive ones and introduce for the few selected ones a "research university" support system. ***The status of a research university has to be earned, not granted upfront, and should not automatically last forever.***

Not at least because of the predicted shrinking number of student enrolments, it seems in the medium term unavoidable to ***restructure and re-dimension the higher education system in Ukraine.*** To prevent a further 'mushrooming' of higher education institutions in Ukraine, which also makes the overall governance and quality assurance within the higher education sector highly complex, two approaches are suggested: one is to introduce strategic mergers of existing universities to establish critical masses, and the other approach is to strategically work on distinct profiles for universities to make them distinguishable from each other in terms of their missions, functions and roles. The two approaches can also be combined *(see Recommendation 6 in detail).*

A system of competitive R&D funding, which is also strongly promoted by Ukraine's association to Horizon 2020, can only function smoothly if the right incentives and structures are in place. Therefore, ***surplus budget generated by research institutes and universities[2] should not be given back to the treasury, but its use should fall under the autonomy of the institutes and universities*** *(see Recommendation 7 in detail)*. In this context universities should be enabled and empowered to operate hard currency accounts, which is a necessity for successful engagement in European projects, in particular as coordinators of such projects.

RAISE THE EFFICIENCY AND CONTRIBUTION OF THE NATIONAL ACADEMY OF SCIENCES

The stronger consideration of innovation in the overall STI reform process should also have some effect on Ukraine's most important and prestigious scientific organisation. It has been acknowledged by the PSF Panel that the National Academy of Sciences of Ukraine (NASU) sees as one of its primary tasks to provide support for the progress of the Ukrainian economic development. NASU should ***indicate how the research activities of NASU institutes will contribute to innovative progress and which fields of research (and corresponding***

[2] E.g. through third party financing; consultancy work; contracts with industry etc.

institutes) should be strengthened to meet this goal *(see Recommendation 8 in detail).* This, however, does not mean that NASU should refrain in its entirety from fundamental research, but rather make clear how to develop both the excellence and the relevance of its research endeavours and how to set priorities and act accordingly. There is also a need to define more targeted niches within these broad fields where Ukraine holds promising assets.

In the current 'frozen' financial situation any decision of NASU to put more efforts in national priority areas or to enter new research fields will have as a consequence the reduction or even termination of activities in other fields/areas. This may include the ultimate termination of institutes which are not performing well. In any case, the troublesome financial situation is no excuse for inertia in the sphere of decision-making for supporting the internationally outstanding in-house research groups and for raising the efficiency of the administration.

NASU as an organisation responsible for national research institutes should continue organising periodic evaluations according to international standards to enable learning, strategic decision-making and to demonstrate accountability and legitimacy by assessing the quality, relevance, usefulness, efficiency and efficacy of its work and the work of its institutes. By now, however, only a select number of NASU institutes have been evaluated along the adapted Leibniz model. NASU should evaluate *all* research institutes and research groups within the next four to five years *(see Recommendation 9 in detail).* This ***evaluation should lead to a process of concentration*** along a basic decision on strategic re-orientation and a continuous improvement and increasing competitiveness of the research undertaken under the umbrella of NASU. ***Those institutes and research groups which perform far below the Academy's benchmark should be terminated and the freed budgets should be invested in the best performing research groups and the most pressing upcoming challenges.***

To ***increase public awareness for the importance of science for tackling societal problems, wealth creation and cultural heritage,*** NASU as a "Learned Society" is also advised to initiate several science communication activities *(see Recommendation 10 in detail).* A lack of wider public recognition of the importance of STI for a better society and economy in Ukraine is a big hurdle for governmental action in support to the STI system. Allocating scarce public money – which faces fierce competition – to this domain, requires the support of society as a whole, beyond the small fraction of people directly involved.

In order to ***introduce more dynamism and a broader diversity of views and more awareness for societal relevance within its own structures,*** NASU should reflect international developments with respect to age diversity and gender in human capital within large research organisations and act accordingly. This refers to the Presidium but also to the composition of different bodies and panels as well as to the composition of research teams in all institutes *(see Recommendation 11 in detail).*

Excellence in public research activities goes along with a wide diffusion of research results in acknowledged professional international journals. Ukrainian scientists publish mostly in Ukrainian and Russian and in in-house published journals which prevents the findings from being diffused on a global scale and international research cooperation. Therefore, universities and NASU should ***promote the use of English in publications*** and introduce this element in the criteria for individual and institutional assessments. Open access and open data developments drastically undermine the value of articles in journals that are not widely available. As a consequence, NASU and the universities should ***downsize in-house publishing activities*** by safeguarding only those scientific journals that have a competitive impact factor *(see Recommendation 12 in detail).*

INCREASE THE EFFICIENCY OF OTHER RESEARCH PERFORMING ORGANISATIONS THROUGH INSTITUTIONAL REFORMS

Despite some differences and necessary variations, the existing ***Sectoral Academies of Sciences should be transformed along the recommendations given to NASU in this document*** *(see Recommendation 13 in detail).* All autonomous Academies of Sciences as well as the institutes which are directly subsumed under MESU should be comprehensively evaluated to assess their added-value within the system of research and – as regards the latter group of institutes – for their particular value for MESU. ***MESU should only remain directly responsible for the mission, strategy, management and financing of those institutes which directly serve the political tasks of the ministry by providing relevant intelligence, evidence and/or operational support to it. Those institutes which do not have a direct added-value for MESU should be either integrated into appropriate universities or into the National Academies of Sciences of Ukraine***. Institutes whose performance is weak should be either radically reformed or terminated *(see Recommendation 14 in detail).*

DEVELOP TALENT AND CAPACITY

One of the most urgent concerns of Ukraine is not to further lose furthermore large numbers of human talent. ***A mix of policy instruments should be implemented to safeguard the scientific human capital base and to make Ukraine an attractive location for young researchers*** within the global research market *(see Recommendation 15 in detail).* This refers also to the provision of travel budget, e.g. via project funding through the NRF; especially for junior and middle-career researchers to gain international experience.

As regards management and administration procedures at universities, research institutes and academies in Ukraine, issues of substantial inefficiencies, delays and unnecessary work leading to frustration and demotivation to conduct challenging inter- and trans-disciplinary research need to be addressed. Administration processes should be thoroughly scrutinised aimed at simplifying those processes which are unnecessarily cumbersome and inflated *(see Recommendation 16 in detail*). ***Inflated administration structures and procedures need to be streamlined and corruption needs to be vigorously combated at all levels.***

2. OPEN UP UKRAINIAN RESARCH AND INNOVATION TO THE WORLD

INCREASE PARTICIPATION IN EUROPEAN RESEARCH

The association of Ukraine to Horizon 2020 was an important step which should be further strategically and operationally capitalised upon by implementing a number of concrete accompanying support measures and initiatives including:

1. Setting up a dedicated unit in MESU dealing with Horizon 2020 and ERA integration;
2. Establishing a liaison office in Brussels;
3. Unifying the existing National Contact Points (NCP) networks into one professional, powerful and united NCP system;
4. Establishing a knowledgeable system of delegates to the Programme Committee of Horizon 2020 with the so-called 14 configurations;
5. Regularly monitoring and analysing how the participation of Ukrainian organisations in Horizon 2020 applications and funded projects is structured and how it develops;
6. Establishing and incentivising learning cycles on the use of Horizon 2020;
7. Establishing responsive and adequately performing administrations at universities and research organisations in order to reduce problems in participating in Horizon 2020
8. Launching of national programmes to support Horizon 2020 participation;
9. Participating in carefully selected multilateral programme based European initiatives, which are directly contributing to the national STI priorities;
10. Engaging in strategically important European material and immaterial research infrastructure initiatives; *(see Recommendation 17 in detail).*

Furthermore, the PSF Panel strongly advises Ukraine to ***explore membership in COST***, the longest-running European framework supporting trans-national cooperation among researchers, engineers and scholars and to ***enhance the low participation in EUREKA through the provision of financial incentives for innovative companies*** which successfully participate in this publicly-funded, intergovernmental network, in which Ukraine has been a member since 2006. This would facilitate the international out- and in-reach of Ukrainian companies at the European technology frontier *(see Recommendation 18 in detail).*

Membership in COST would contribute to higher short-term mobility of Ukrainian researchers, which – for the time being – is insufficient, especially as regards junior and middle-career researchers. Therefore, it is also important to ***invest more national budget in mobility opportunities*** to attend international conferences abroad and to visit international research partners *(see Recommendation 19 in detail).*

Researchers, both from academia and business, need to have ***access to modern research infrastructures to have the possibility to conduct cutting-edge research***. In several scientific disciplines this is considered to be a *sine qua non* condition. Access to research infrastructure is especially important for (i) young researchers as part of their scientific education and early career consolidation and (ii) for companies which usually cannot afford – also due to capacity problems – their own measuring and testing as well as research equipment. MESU should also seek to establish beneficial agreements with European research infrastructures *(see Recommendation 20 in detail).*

ENHANCE RESEARCH QUALITY BY USING THE EXPERTISE OF THE RESEARCH DIASPORA

For engaging and developing the talent base ***an active approach towards the Ukrainian scientific diaspora is recommended.*** This should be done, firstly, through an official welcoming culture to invite and engage the scientific diaspora in interacting and cooperating with local research teams. Secondly, few outstanding researchers should be selected on a competitive basis and financially sponsored to resettle back in Ukraine for a longer-term period. Admittedly, the latter approach would likely be difficult to realise. MESU and the National Board on the Development of S&T should ***prepare an action plan on how to properly address and engage the Ukrainian research diaspora in the reform process***. As a first step, a database on the Ukrainian diaspora should be established for active communication and outreach measures *(see Recommendation 21 in detail)*.

POLICY LEARNING AND STRATEGIC DECISION MAKING

Ukraine should consider Horizon 2020 not just as a powerful source of funding for research partnerships, but also as a source for policy learning. It is important that ***Ukraine follows closely the activities of the European Research Area (ERA)-related working groups and aspires for policy learning with and from them***. Opportunities triggered by the European level through Horizon 2020 or ERA should be used to ***generate policy spill-overs to enhance the national agenda and for the best combination of national and European policies***. Ukrainian STI policy makers should ***prepare a pragmatic national ERA roadmap*** to compare the different legal, thematic and operational approaches between Ukraine and the EU Member States in terms of the pertinent ERA dimensions and to reflect a strategic alignment *(see Recommendation 22 in detail).*

It is further advised to use bilateral S&T agreements between Ukraine and other countries as a basis to prepare joint projects between domestic researchers and colleagues from the diaspora. In general, ***STI internationalisation policies should be more strategically aligned with national priorities and strategies.*** This relates to all uni-, bi- and multilateral levels, where consent with the international partners can be agreed. In the short-term, for instance, existing bilateral agreements with EU partners should, if possible, be jointly transformed into instruments that incentivise the creation of tri- and multilateral research consortia to prepare the ground for further submissions under Horizon 2020. S&T agreements should also be capitalised upwards, if possible, to drive forward horizontal priority concerns such as raising public awareness of science and innovation and of facilitating access to foreign research infrastructures *(see Recommendation 23 in detail)*.

3. BUILD A CONDUCIVE FRAMEWORK FOR AN INNOVATION-DRIVEN ECONOMY IN UKRAINE

PUT INNOVATION HIGH ON THE POLITICAL AGENDA

The National Board on the Development of S&T is supposed to be a change-maker within the system of STI, but its work would be facilitated if it would operate in a political climate in which STI is high on the national policy agenda. Policy makers should acknowledge that ***Ukraine needs to innovate its path to growth, which requires a cross-government effort involving the intellectual, material and financial assets of the country***. Policy makers should also acknowledge that funding of STI is an investment in the future, provided that reforms towards efficiency, effectiveness and relevance are seriously tackled.

The importance of innovation in a broad sense, both for the economic and social development of the country should be promoted, valorised and actively taken-up by STI stakeholders. To reach a government-wide consensus on the importance and the pervasive role of innovation for all sectors of life in Ukraine, a dedicated cooperation mechanism is required where all Ministries can communicate their views and exchange with others on the best ways to integrate innovation into their priorities and actions. This will help to overcome the current fragmentation. ***Currently innovation is a "homeless policy" in Ukraine and there is a need to create a "home" for it at cabinet level.***

Therefore, the PSF Panel advises the government to ***develop a cross-governmental Research and Innovation Strategy and corresponding instruments aimed to facilitate economic growth and societal wellbeing by acknowledging the importance and exploiting the potential of STI***. The development of the National Innovation Strategy should be based on the work of the National Board and its working groups. It should aim to position the overall role of innovation for development in Ukraine; assess the present situation highlighting assets and constraints for Ukraine as an (not yet) innovation-driven economy; and present ways forward in terms of priorities for supporting innovation *(see Recommendation 24 in detail)*. Priorities should include both thematic priorities (such as improving access to innovation finance, etc.) and the domains where Ukraine holds the most promising assets for innovation-based development. The

Strategy should ***include an Action Plan that translates the broad directions into operational instruments,*** indicating goals and responsibilities for each of them (funding, implementation) and highlighting the priority fields. Attracting private funds for innovation should constitute an important component of this Strategy.

In order not to risk that the National Board on the Development of S&T focuses only on "excellence of science" as one of the pillars for innovation, but instead is in the position to fulfil its legal mandate at full extent, the viewpoint of economic policy and innovation actors on the Board must be safeguarded. Therefore, the PSF Panel recommends two organisational precautions:

1) ***Representation of the Ministry of Economic Development and Trade as well as innovation actors in the Board*** *(see Recommendation 25 in detail)*

2) Establishment of a ***permanent "innovation" working group to prepare proposals for better promoting and exploiting the "relevance of science" for innovation.***

The working group should start its work by investigating bottlenecks in the Ukrainian innovation system and preparing proposals for policy actions needed to address the identified barriers. The following barriers provide a starting point for the identification of priority issues for the working group *(see Recommendation 26 in detail):*

1. **Barriers on the "supply-side"**: poor state of the scientific infrastructure; lack of incentives for public research organisations to get involved in innovation-related activities; absence of a "third mission" agenda in public research organisations; lack of entrepreneurship and innovation culture in the public research sector; exploitation of research results in foreign countries, where it is taking place in more attractive conditions.
2. **Barriers on the "demand side"**: insufficient interest in R&D activities from the side of the economic actors; lack of awareness and capacities of SMEs to undertake innovation; need to reinforce managerial competences in start-ups established by scientists and technicians; lack of visibility and understanding of the potential in Ukrainian public research organisations from the side of companies; public authorities not ready to use STI results in their field (e.g. acting as "first buyer of innovation").
3. **Barriers at the interface between "supply" and "demand"**: little experience in public-private partnerships for innovation; absence of formal and effective channels to convey messages from industry with respect to expectations from the science and education sector.
4. **Lack of prioritisation**: given severe state budget restrictions, there is a need to concentrate public support on those activities where the Ukrainian research and competence base can best contribute to innovation in the private sector. This is the best approach to secure the attraction of private funds to innovation.

SUPPORTING INNOVATION WITH CONCRETE INSTRUMENTS, PROGRAMMES AND SCHEMES

Ukraine has very few instruments to support innovation. Despite strong public budget constraints and bad experiences in the past regarding the misuse of funding, ***Ukraine should make a new attempt to establish and allocate public money to a range of innovation support instruments, programmes and schemes***. This expenditure should be thought of as a national investment rather than a budgetary expense. Establishing a full portfolio of innovation support interventions, however, is a long term endeavour *(see Recommendation 27 in detail)*. In the short term, it is necessary to start this process by defining instruments with limited budgetary implications and rapid and visible results ("quick wins") to nurture positive demonstration effects. The PSF Panel proposes the introduction of three specific innovation support instruments:

- Innovation vouchers *(see Recommendation 28 in detail);*
- Science-industry mobility schemes *(see Recommendation 29 in detail);*
- Collaborative projects between public research organisations and industry through the NRF *(see Recommendation 30 in detail).*

In the medium to long term, other elements of an innovation support system which are necessary to create favourable conditions for innovation should also receive consideration by Ukrainian authorities and progressively be put on the policy agenda and implemented. Such instruments or programmes should address shortcomings at the supply side of R&D, the demand side for R&D and the collaboration between public research and companies. They should additionally be complemented by dedicated activities to develop an innovation culture and a functioning system of innovation.

1. INTRODUCTION, AIM AND METHODOLOGY

1.1 Policy Support Facility

The Policy Support Facility (PSF) is a tool set up by the European Commission – DG Research & Innovation – under Horizon 2020, the EU's funding programme for research and innovation (R&I), to support EU Member States and countries associated to Horizon 2020 in improving the design, implementation and evaluation of national R&I policies.

The Peer Reviews of national R&I systems are one of the main services offered by the PSF. Peer Reviews constitute an in-depth assessment of a country's R&I system carried out by a panel of international experts at the country's request. The Panel formulates concrete and operational recommendations to the national authorities on the reforms which are necessary to improve and strengthen the quality of the national R&I system.

1.2 Aim and focus areas

The Ukrainian authorities expressed their interest for a Peer Review of their R&I system in mid-2015. After a series of internal meetings and discussions, in his letter of 16 December 2016, the Deputy-Minister of Education and Science of Ukraine (MESU), M. Strikha, proposed a number of focus areas for the Peer Review, which are in need of in-depth evaluation and of recommendations for further structural changes.

In compliance with this request the aim of the Peer Review presented in this report is to provide external advice and recommendations to the Ukrainian authorities on possible reforms by reflecting the new Law on Scientific and Technical Activity of Ukraine.

The **focus areas** of the Peer Review were the following:

1. Optimisation of existing policy instruments to support the national research system, including the assessment and advice on the tools introduced by the new Law on Scientific and Technical Activity, mobility of researchers and potential priority research areas.
2. Internationalisation of research and integration of Ukraine into the European Research Area, including advice on how to better enhance the presence of the Ukrainian scientists and SMEs in European cooperation schemes.
3. Role of science in the development of innovation in Ukraine, including advice on how to improve the links between science and business and the innovation system in Ukraine.

The three focus areas are reflected in the chapter structure of this report:

- Chapter 3 addresses the first set of questions addressing issues of quality and relevance of the Ukrainian science base.
- Chapter 4 deals with the questions addressing the internationalisation of Ukrainian S&T.
- Chapter 5 responds to the third set of questions of MESU addressing the issue of innovation with an emphasis on science and technology for innovation.

These chapters present a situational analysis with extensive empirical evidence, identify bottlenecks and make a series of detailed policy recommendations, supported by relevant examples of good practices from other countries and additional justifications.

1.3 Methodology

The Peer Review was carried out by a panel of five independent experts from Austria, Belgium, Germany, Lithuania, and the Netherlands, acting in their personal capacity, as well as four peer reviewers as policy makers from Germany, Hungary, Latvia, and the United Kingdom.

The PSF Peer Review of the Ukrainian R&I system started by gathering and analysing a comprehensive set of qualitative and quantitative information from Ukrainian and international sources and by mobilizing all key actors of the Ukrainian R&I system. The self-assessment report drafted by the Ministry of Education and Science of Ukraine (MESU) and the PSF background report[3] aimed at summarising evidence on the situation in the field of science, technology and

[3] Background Report- Peer Review of The Ukrainian Research and Innovation System under the Horizon 2020 Policy Support Facility is available via: https://rio.jrc.ec.europa.eu/en/library/background-report-peer-review-ukrainian-research-and-innovation-system-under-horizon-2020

innovation (STI) in Ukraine and constituted important starting point for the PSF Panel work. In addition, relevant strategies and legal documents were translated from Ukrainian into English for the PSF Panel. The "References" section of the report (section 6) lists the documents that were cited in the report or analysed during the process.

The PSF panel conducted two field visits in Kyiv. The first visit, from 6-9 June 2016, was devoted to fact finding meetings with all key stakeholders i.e. public administration bodies, R&I performers, intermediary organisations in the RTI system and individuals representing scientific or business sectors. A proposal for the structure, main messages and preliminary policy options of the draft Peer Review report followed. The PSF Panel discussed its preliminary findings with an extensive set of Ukrainian stakeholders during a second mission to Ukraine on 5-7 September 2016. Numerous organisations and individuals sent their written inputs to the PSF Panel. The work was based on information collected until the end of September 2016; subsequent evolutions were not taken into account.

On the basis of the various documents analysed, Ukrainian feedback on PSF Panel's preliminary findings as well as drawing on the in-depth discussions with various stakeholders and experts and the comments received at the meetings during the field visits, the PSF Panel drafted this report. It includes analysis and operational policy recommendations, with supporting evidence gathered during the Peer Review process.

Follow-up to the Peer Review

The Panel would like to emphasise that, in line with the PSF principles, it is the country's responsibility to ensure the follow-up to the Peer Review as well as the potential implementation of its recommendations through concrete reforms. In rolling out these reforms, the Ukrainian authorities can continue to call upon the PSF for support and envisage the assessment of the implementation of the Panel recommendations within a three-year time span through a PSF post-Peer Review.

The PSF Panel advises MESU to *publish an action plan [including time schedule] for the implementation of the Law on Scientific and Technical Activity* in the first quarter of 2017. In this action plan the core messages and recommendations of the PSF Panel should be taken into account.

2. THE ECONOMIC AND STI CONTEXT IN UKRAINE

A large country both in terms of surface and population, Ukraine has been an important player within the field of science in the former Soviet Union. A diversity of several crises, including the current war, has led to the present situation, which is characterised by a rather low performance of the R&D system, a weak economy with limited demand for R&D and a dramatic brain drain both external (to other countries) and internal (where people with higher education opted for working in professions not requiring such level of education)

2.1 The economic and political situation in Ukraine

Ukraine is a lower middle-income[4] transformation country with a rich scientific heritage from the Soviet Union and with a good standard of education. The last 25 years were characterised by a quick sequence of economic and political crises and intermediate phases of recovery. The last crisis in the aftermath of the Maidan revolution, caused by the annexation of the Autonomous Republic of Crimea and Sevastopol by Russia and the war at Donbas region is severely critical. It resulted in massive losses of Ukrainian research infrastructure. 27 universities and scientific institutions with over 12,000 displaced researchers and university teachers had to be relocated.

Ukraine's economy shrank most in 2009, by 15%. It is the only Black Sea country where ***GDP per capita remains below 2008 levels***. In 2015, its GDP drastically dropped by 10% to €82bn, or €1.907 per capita[5]. However, the outlook for this year and the upcoming years is positive. According to the World Bank, GDP will grow by 1% to 2% from 2016 to 2018.[6]

After a negative population trend (-2.6% growth) in 2008-2014, Ukraine now has a population of around 42.7m inhabitants (not including the Crimea peninsula and Sevastopol). The dependency ratio of older aged persons (65 and older) among all people aged 15 to 64 years is 21.2% and of young aged persons (below 15 years of age) among all people aged 15 to 64 years is 21.4%. The median age is 39.9 years.[7] The country's rate of unemployment is currently 10-12%.[8] In fact, the rate is probably higher as the statistical counting often does not cover sufficiently enough all unemployed people (non-registered people in black labour etc.). The long-term unemployment rate is 2.1% and the youth unemployment rate is 17.4% (ages 15-24).[9]

Ukraine is both an industrial and agrarian country, predominantly producing different kinds of raw materials. The main prevailing sectors in accordance with the United Nations International Standard Industrial Classification[10] are heavy engineering; ferrous and non-ferrous metallurgy; shipbuilding; automotive industry; aerospace industry; manufacturing and supply for power plants; and oil, gas and chemical industry. It has to be noted, however, that the remaining aerospace industry in Ukraine is severely affected by the termination of contractual relations with Russia. Also the automotive sector and the shipbuilding sectors are declining.

The World Economic Forum's Global Competitiveness Report shows Ukraine in a mediocre position, both in 2014-2015 and 2015-2016. While the country was ranked 76 previously, it ranks 79 now.[11] The drop is a consequence of the country's worsened performance in such areas as Macroeconomic Environment (134th place vs previous 105th); Financial Market Development (121st vs 107th); Infrastructure (69th vs 68th); and Technological Readiness (86th vs 85th).[12]

The ***problem of corruption*** also plays an important role. In 2015, the corruption perceptions index from Transparency International ranked Ukraine 130 out of 188 countries. A composite

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[4] Cornell University, INSEAD, and WIPO: "The Global Innovation Index 2015: Effective Innovation Policies for Development", Fontainebleau, Ithaca, and Geneva, 2015, p.292

[5] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Real_GDP_growth,_2005%E2%80%9315_%28%25_change_compared_with_previous_year%29_ENPE16.png; accessed on 4 November 2016.

[6] http://data.worldbank.org/country/ukraine: accessed on 2 May 2016.

[7] http://hdr.undp.org/en/countries/profiles/UKR: accessed on 4 May 2016.

[8] http://www.ilo.org/gateway/faces/home/polareas/empandlab?locale=en&countryCode=UKR&track=STAT&policyId=2&_adf.ctrl-state=n2480je04_78: accessed on 2 May 2016.

[9] Ibid.

[10] http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27 : accessed on 4 May 2016.

[11] The absolute positions of countries in the WEF's Global Competitiveness Report has to be interpreted with care, because the number of countries in the annual surveys change.

[12] Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016, p. 6.

index, it draws on different sources of corruption-related data.[13] As regards the control of corruption in Ukraine (control of corruption reflects perceptions of the extent to which public power is exercised for private gain), Ukraine achieved a low 17% from a possible total of 100% control.

In addition to the indicators affecting international competitiveness, the productivity of Ukrainian enterprises depends on investment in modern equipment, their capacity to adapt this to customer requirements and to offer additional services or added-value vis-à-vis their competitors. The growth of an economy is often directly linked to gains in investment- and efficiency-driven productivity. However, as the "Innovation Performance Review for Ukraine" states, *"Ukraine is poorly integrated in global value chains, with research showing it to be outside both "buyer-driven" networks (e.g., clothing), as well as "producer-driven" global networks, including trade in parts and final manufacturing products"*.[14]

Despite these weaknesses, Ukraine relies on its export-oriented sectors. Ukraine had the highest export rate in 2000, amounting to 62.44% of the total GDP in that year. More recently, Ukraine's export rate was more or less stable and reached between 40% and 50% of GDP. In 2014, exports contributed nearly half of the total Ukrainian GDP. The best exporters are heavy engineering, oil, gas and chemical engineering or ferrous and non-ferrous metallurgy. The export of high-tech products, on the other hand, is still weak. The situation with imports is also weak (see Figure 1). Ukraine experienced a significant drop in imports in 2009, when net imports decreased by 38.90%. This drop must be seen against the backdrop of the gas crisis at that time, when Russia stopped supplying Ukraine with gas for several weeks.[15] From 2010 to 2012 imports began to grow again, however since 2013 the trend is again negative.

FDI in Ukraine plays still a minor role. In 2013 Ukraine attracted only 2.13% of FDI as compared to the national GDP. The FDI outflow from Ukraine into other countries in 2013 was even lower, amounting to 0.24% of the GDP of that year.[16] Compared to economically more advanced countries in Central and Eastern Europe, both FDI inflow and outflow levels remain relatively low.

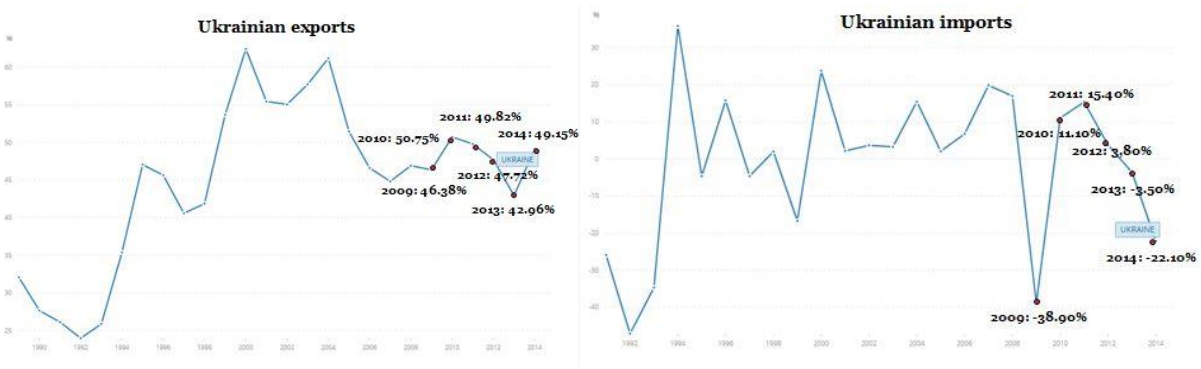

Figure 1: Ukraine's export and import rates of goods and services (annual growth in %)
Source: World Bank Open Economic Data

Availability and quality of human capacity is crucial for the development of research and innovation both in the public and private sectors. Ukraine inherited a relatively ***well-developed education system*** form the Soviet area, which still preserves some positive features with an emphasis on mathematics and natural sciences at school level. However, serious concerns have risen as to the quality of S&T education since the early 1990s. Although the Ukrainian education system seems to be chronically underfinanced[17], almost all major indicators, such as share of public expenditures for education in % of GDP or in % of the public budget show Ukraine in a comparatively favourable position.[18] This contradiction can be partially explained by the relatively low absolute financial allocation, which might not be sufficient to maintain the comprehensive system of education in a

[13] https://www.transparency.org/country/#UKR : accessed on 4 May 2016.

[14] World Bank, 2005, From Disintegration to Reintegration: Eastern Europe and the Former Soviet Union in International Trade, edited by Harry G. Broadman, Chapter 7, cited in: United Nations Economic Commission for Europe: "Innovation Performance Review Ukraine", New York and Geneva, 2013, p.50

[15] See here for an example of media reports on the gas crisis in 2009: http://www.economist.com/news/briefing/21600111-reducing-europes-dependence-russian-gas-possiblebut-it-will-take-time-money-and-sustained: accessed on 2 May 2016.

[16] World Bank World Development Indicators Database, cited in: The Global Innovation Index 2015, p.374

[17] https://www.liportal.de/ukraine/gesellschaft/#c4543 : accessed on 6 May 2016.

[18] http://www.kooperation-international.de/buf/ukraine/bildungs-forschungs-und-innovationslandschaft/bildungslandschaft.html : accessed on 6 May 2016.

country as big as Ukraine. It could indicate, however, inefficiencies within the system too. For instance, in elementary schools around 600 teaching hours are taught per school year, which is 100 - 200 teaching hours less than in the majority of European countries.

University enrolment in Ukraine is very high. Around 80% of 19-25 year-old Ukrainians are enrolled in universities.[19] With 2.35m students, Ukraine belongs to the group of five countries of the European Higher Education Area (EHEA), which together represent slightly more than 54 % of the total tertiary student population in the EHEA.[20] Most of the university students in Ukraine are aiming to receive a Master's degree. The fraction of students enrolled at ISCED 6 level, which are programmes that lead directly to the award of an advanced research qualification (e.g. PhD), is considerably lower in Ukraine (1.52%) than overall in the EHEA (2.7%), which indicates a rather low interest to pursue a scientific career.

2.2 Governance of the STI system, main R&D performing organisations and reform process

The key players defining R&I in Ukraine are the Ukrainian President[21], who sets the strategic development, the Ukrainian Parliament (Vrkhovna Rada) with its parliamentary body responsible for R&I, and the Committee for Education and Science,[22] which in its capacity as the main legislative body shapes the country's R&I by adopting all legal acts, strategies and priorities as well as international agreements in the field of R&I; and the Cabinet of Ministers, which creates incentives for the national R&I infrastructure (see Figure 2).

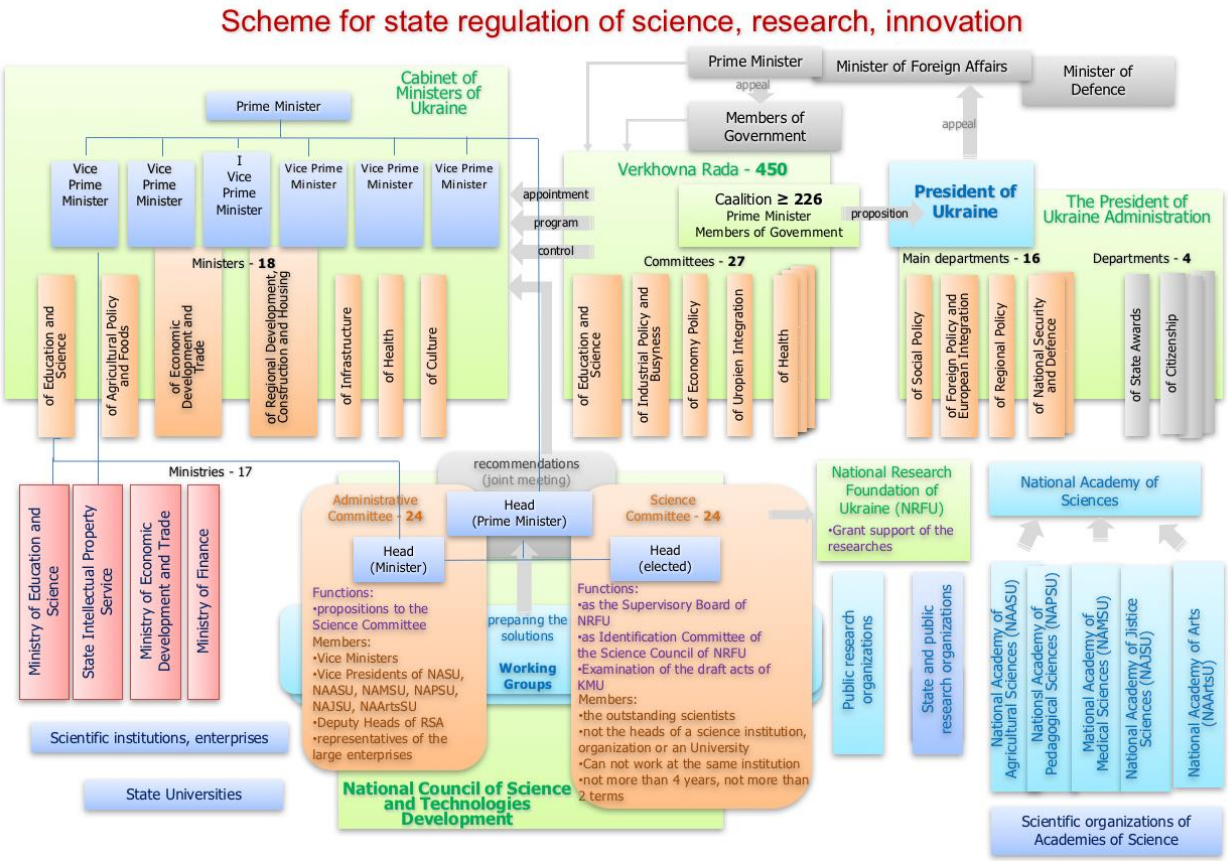

Figure 2: Organogram of the R&I system in Ukraine[23]

Note: The State Intellectual Property Service was recently incorporated into the MEDT

On the operational level the Ministry of Education and Science of Ukraine (MESU), among other issues, is in charge of the implementation of the state sectorial policy in R&I and Higher Education

[19] UNESCO Science Report 2015.

[20] Bologna Process Implementation Report 2015.

[21] President of Ukraine: http://www.president.gov.ua/en/ : accessed on 16 April 2016.

[22] Ukrainian Parliament: http://gapp.rada.gov.ua/radatransl/Home/Committees/en : accessed on 10 April 2016.

[23] Complied by the authors of this report from the information provided by MESU.

on behalf of the Government of Ukraine.[24] It is also responsible for strengthening research capacities in universities. Approximately 180 institutions (universities and research institutions) are directly subordinated to MESU.[25]

Apart from MESU, several ministries deal with R&D and innovation issues.[26] The Ministry of Finance has a very important role by determining the national budget for the R&I sector. The Ministry of Economic Development and Trade (MEDT) is responsible for innovation in industry. It is accountable for some S&T programmes targeting economic development. The Ministry for Foreign Affairs is responsible for international agreements with other countries and international organisations. Currently, there are approximately 50[27] bilateral agreements in force. R&I activities are also carried out in research institutions and universities subordinated to the Ministry of Health, Ministry of Infrastructure, Ministry of Internal Affairs, and Ministry of Culture and Ministry of Agrarian Policy and Food.[28] All these ministries have some sector budgets related to R&I activities.

According to Ukrainian legislation regions can also provide funds from their own regional budget for R&I.[29] Some of the regions and bigger cities have their own departments and offices responsible for innovation issues. MESU, being responsible for the implementation of Horizon 2020 in Ukraine, has established not only National Contact Points, but also Regional Horizon 2020 Contact Points[30] in all regions.

Around 1,000 academic and industrial research institutions operate in Ukraine.[31] The number of research organisations is constantly declining, especially in the field of technical sciences (see Figure 3). Most of them are public research organisations, although the boundaries between public and private are blurred in Ukraine. The latter situation refers especially to industrial research institutes, engineering departments and special engineering bureaus which also carry out research. Most of the Ukrainian research institutions are located in Kyiv (city) (26%), Kharkiv (16%), Lviv (6%) and Dnipro (6%).

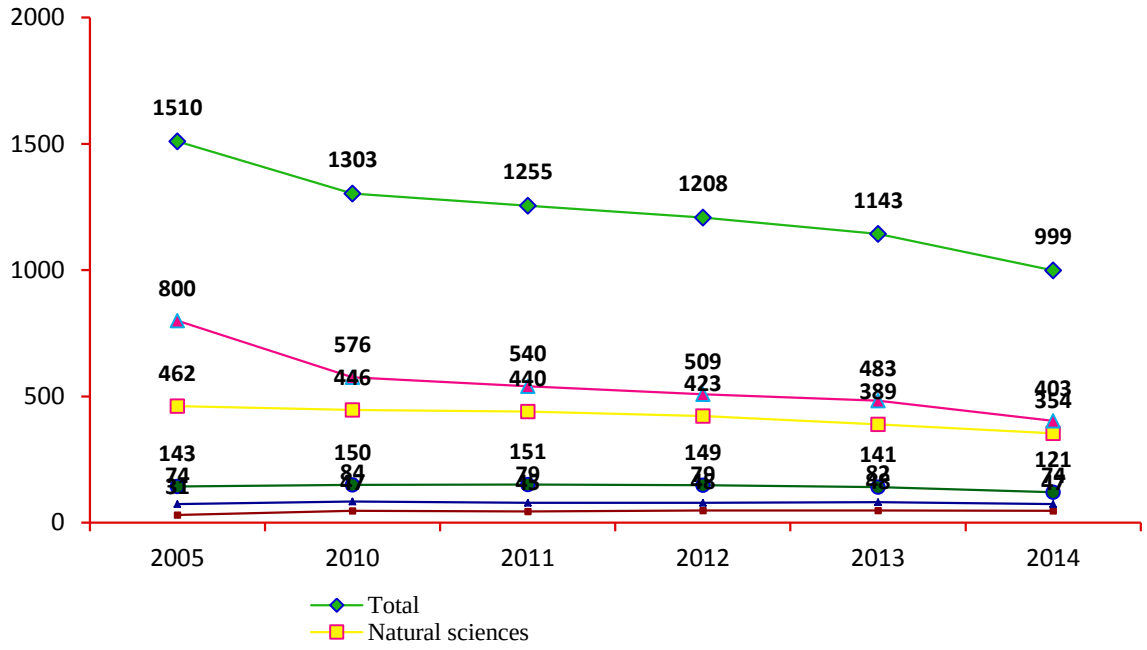

Figure 3: Changes in the number of research institutions by field of science
Source: MESU Self-Assessment Report

[24] Government of Ukraine (EN): http://www.kmu.gov.ua/control/en/publish/article?art_id=247077686&cat_id=247605901: accessed on 20 April 2016.

[25] Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016

[26] Source: MESU, Department International Cooperation and European Integration

[27] Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016

[28] Source: MESU, Department of International Cooperation and European Integration

[29] Source: MESU, Department of International Cooperation and European Integration

[30] List of NCPs and RCPs: http://www.bilat-ukraina.eu/en/393.php#RCP : accessed on 20 April 2016.

[31] https:// http://www.ukrstat.gov.ua/ : accessed on 4 May 2016.

Fundamental science is mainly forwarded by the National Academy of Sciences of Ukraine[32] (NASU), which is the highest state-supported research organisation receiving around 50%[33] of the yearly state budget allocated for S&T. It unites under its roof academicians, corresponding members and foreign members as well as regular researchers working in around 120 institutions and 200 research establishments, summing up to around 37,000 employees[34]. The academy's main task is to carry out basic and applied research on the most important problems of natural, technical, social sciences and humanities.

In addition, specialised academies of sciences are active, including the Ukrainian Academy of Agrarian Sciences, the Academy of Medical Sciences, the Academy of Pedagogical Sciences, the Academy of Legal Sciences and the Academy of Arts. These consume another 25% of the state budget allocated for R&D. ***The Academies are responsible for basic research but they also have co-ordinating and delivery functions in many R&D and innovation-related programmes***, the establishment of S&T priorities and the provision of scientific advice (e.g. to the ministries, including MESU).

State-sponsored academies of sciences are not subsumed to the Ministry of Education and Science but rather to the Cabinet of Ministries of Ukraine. They have a relative autonomy and need to coordinate their activities with the Ministry.

As of 2015, 664 universities, colleges and technical schools are active in Ukraine. According to the latest ERAWATCH report on Ukraine (2012), ***only half of the slightly more than 350 universities performed any kind of R&D in 2011.***[35] About 25% of the universities are private institutions. The total expenditure on R&D in higher education was less than 7% of GERD in 2011. 70% of this funding came from the state and regional budgets. Two thirds of persons with degrees of candidates of sciences and doctors of sciences are working in the higher education sector. According to the national statistics, they produce almost 78% of research papers; however, the National Academy of Sciences has more publications in internationally recognised journals.

The main focus of Ukrainian universities is on teaching. The number of students grew from 1.5m in 2001 to 2.5m in 2009-2011, but at the same time the demographic situation in Ukraine is such that the number of students is expected to decline in the coming years. The number of foreign students is low overall and they do not play a significant role in the educational system. Several foreign universities have established campuses in Ukraine, including Lomonosov Moscow State University[36] and the International Solomon University.[37]

All universities are now supervised by MESU instead of corresponding ministries, even if they have industry affiliations. This refers for example to the University of Civil Aviation and the Academy of Railway Transport.

The industrial research institutes, engineering departments and special engineering bureaus are associated with specific economic areas and focus on industrial R&D. These organisations are formally subordinated to the different ministries and state agencies but in recent years ties with the ministries have weakened.[38] As such, the boundaries between the state and private R&D organisations in Ukraine are 'blurred' and a number of 'mixed ownership' organisations exists, which are owned partly by the state and partially by the employees. These organisations receive a fraction of their financing from the state in form of block grants, giving the ministries the right to be involved in the nomination of their directors. The share of direct financing from the ministries is usually not higher than 25% of an organisation's total budget. The remainder of the financing is contracted both from state-owned and private companies. Many Ukrainian companies, however, prefer to purchase technologies from abroad, as foreign partners are perceived to provide more effective solutions and better services.[39]

Systematic business R&D beyond the operations of the industrial research institutes, engineering departments and special engineering bureaus is either scarcely present in Ukraine or statistically insufficiently recorded. ***The demand for R&D results and innovation from the side of***

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[32] http://www.nas.gov.ua/Pages/default.aspx : accessed on 20 April 2016.

[33] Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016

[34] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[35] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[36] The campus of Lomonosov Moscow State University was established in Sevastopol in 2000, illegally annexed by Russia.

[37] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[38] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[39] ibid

domestic companies dropped substantially since the independence of the country. This is also evidenced by the fact that the share of Ukraine's high and medium tech sectors shrunk threefold since the beginning of the 1990s, while at the same time the shares of the energy and ferrous metallurgy sectors substantially grew.[40] These low value added sectors have a more stable and mature technological base, which does not require a lot of R&D, but are less innovative than high and medium tech sectors that contributed to the overall decline of the number of innovative enterprises. Even the remaining enterprises of the machine-building sector (for example shipbuilding) occupy very often the lowest segments in the world markets. Competition in such markets is particularly fierce and Ukrainian companies are persistently under pressure to lose their existing positions to firms from developing countries.[41]

Ukrainian STI national priorities are not defined in a common national strategy but by law.[42] Currently, two laws adopted by Verkhovna Rada of Ukraine (the unicameral parliament) define the national STI priorities[43]. The first one, the Law of Ukraine on the Priority Directions of Science and Technology (adopted in 2001) defines the national S&T priorities for the period 2010-2020. The innovation related priorities are defined by the Law of Ukraine on Priorities in Innovation Activities in Ukraine (adopted in 2011). The above mentioned priorities were targeted by different national policies, policy instruments, etc. For the implementation of national priorities only two State Targeted Funding Programmes[44] are currently in force:

- State Target Science and Technology Programme on realisation of research in the Antarctic 2011 – 2020;
- State Target Scientific and Technical Space Programme.

The State Target Programme for innovation infrastructure development as well as the State Target Programme on marine research were stopped in 2014.

The government formed in 2014 (until 18 April 2016) developed a series of measures to address the following key issues in Ukrainian research policy[45]:

- establishment of research priorities which correspond to the goals of national development;
- a clear orientation of R&D towards respecting the best EU standards, with the intention of joining the European Research Area;
- administrative changes to improve the governance of the R&D system.

Currently, ***Ukraine is going through systemic reforms aimed at improving the overall RTI governance. The basis for these reform endeavours is the Law on Scientific and Technical Activity***, which – among many other issues – foresees the creation of a National Board on the Development of S&T (art. 20ff) and of the National Research Foundation (art. 49ff). It addresses issues of research promotion at the National Academies of Sciences (art. 17ff) and in the higher education system (art. 19) and suggests precautions to ensure the growth of the talent pool in R&D (art.61). The Law also stipulates that the public funding of R&D should be at least 1.7% of GDP (art. 48). The Law has received broad support in the scientific community, but there is a great deal of scepticism about its implementation. The Law on Innovation is currently still under preparation.

2.3 Financing of STI (including approaches, programmes and instruments)

In comparison with Ukraine's GDP per capita, ***Ukraine afforded a relatively high level of GERD/GDP despite a decrease from 1.17% in 2005 to 0.66% in 2014*** (see Figure 4)[46]. Although this equalled the levels of significantly richer countries (measured in GDP per capita) such as Slovakia, Poland, Croatia or South Africa,[47] the drop in GERD/GDP also caused a decline in the total number of researchers and a considerable brain drain. The state budget was used mainly for the institutional (basic) funding of academies and research institutions. A comparatively small public budget fraction was used for competitive project funding for universities. Competitively

[40] ibid

[41] ibid

[42] ibid

[43] Bilat UKR*AINA project - http://www.st-gateukr.eu/en/195.php : accessed on 18 April 2016.

[44] Ministry of Education and Science of Ukraine and www.bilat.eu : accessed on 18 April 2016.

[45] UNESCO Science report towards 2030 (2015): http://unesdoc.unesco.org/images/0023/002354/235406e.pdf : accessed on 5 April 2016.

[46] Source 2015: OECD Statistics, MESU

[47] UNESCO Science Report 2015.

allocated grants for bigger research projects were almost not available at all. In 2016, however, the total funding for R&D in Ukraine has supposedly decreased to the low level of 0.32%.[48] This extreme shrinkage seems neither sufficient to maintain the functionality of the RTI system in Ukraine nor to initiate positive reform stimuli.

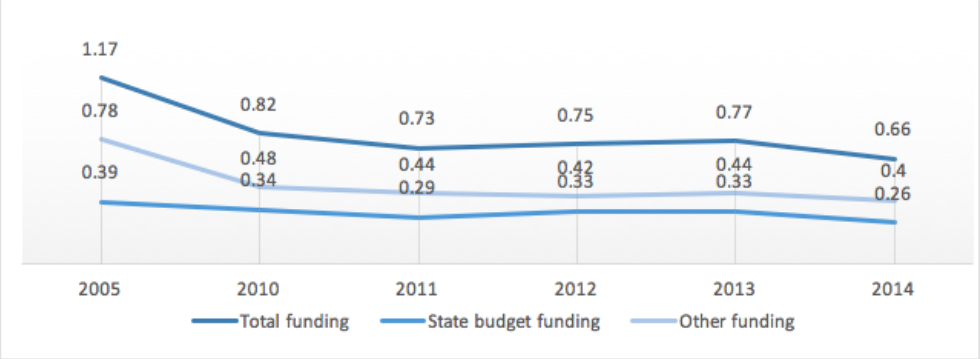

Figure 4: Gross domestic expenditure on R&D (GERD) / GDP, 2005 – 2014 (Source = OECD)

The successive crises of the economy in the late 2000s caused depreciation of the national currency, the Ukrainian hryvnia (UAH), and then the 2013-2015 Euromaidan Revolution followed by war have had a negative impact on R&D funding. In the budget of Ukraine for 2016, allocations for S&T support for the military-industrial complex have significantly increased due to the military conflict in the occupied eastern Ukrainian territory. As a consequence, ***the budget for R&D decreased***. State funding of R&D has fluctuated over the past decade. The government funded directly 39.3% of the whole expenditure for R&D in 2014[49]. The rest was funded by other national sources (20.9%), foreign funding (19.8%) and private funds (18.7%) (see Figures 5 and 6).

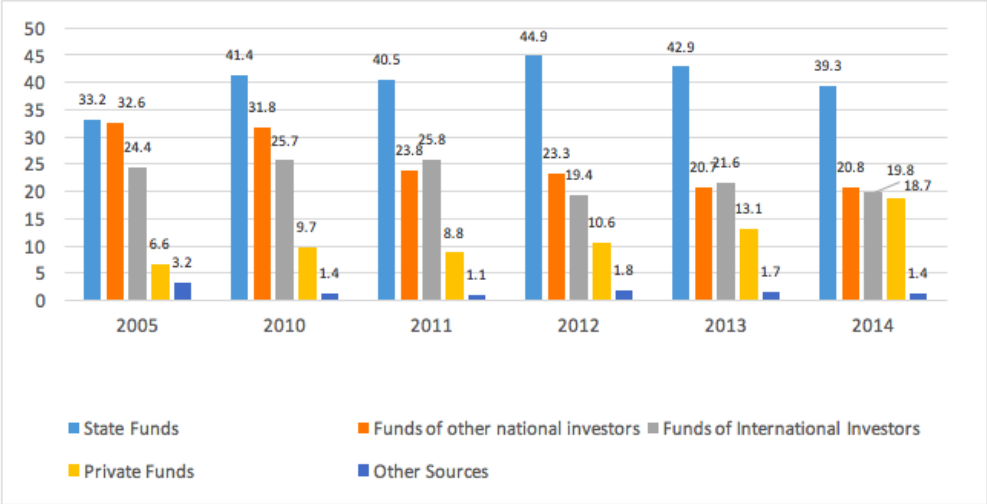

Figure 5: Percentages of R&D funding by funding source
Source: MESU Self-Assessment Report

In terms of private funding sources, the Business Enterprise Sector in 2013 consumed 55.3% of GERD, while the governmental sector consumed 38.6% and the higher education sector 6.2%.[50] This high share of R&D consumption by the Business Enterprise Sector, however, should not be overrated, because its contribution to R&D funding has dropped since 2003 (36%). It hit a low of 26% in 2009 when international prices for steel slumped, forcing the metallurgy and machine-building industries to reduce wages and to lay off workers and when gas supplies by Russia were

[48] This information was provided by MESU as a feedback on the draft final PSF Peer Review Report on 9 November 2016.

[49] Presentation of Dr. Strikha, Deputy Minister, MESU, given in September 2016 in Kyiv at the JRC Smart Specialisation Event; http://s3platform.jrc.ec.europa.eu/documents/20182/185795/jrc.pdf/0055d43b-41c6-4e61-bf98-bf00b545a993

[50] UNESCO Science Report 2015.

suspended due to a dispute over Ukraine's natural gas debt in January 2009. Since then the financial contribution of the Business Enterprise Sector to GERD has stagnated (29% in 2013).

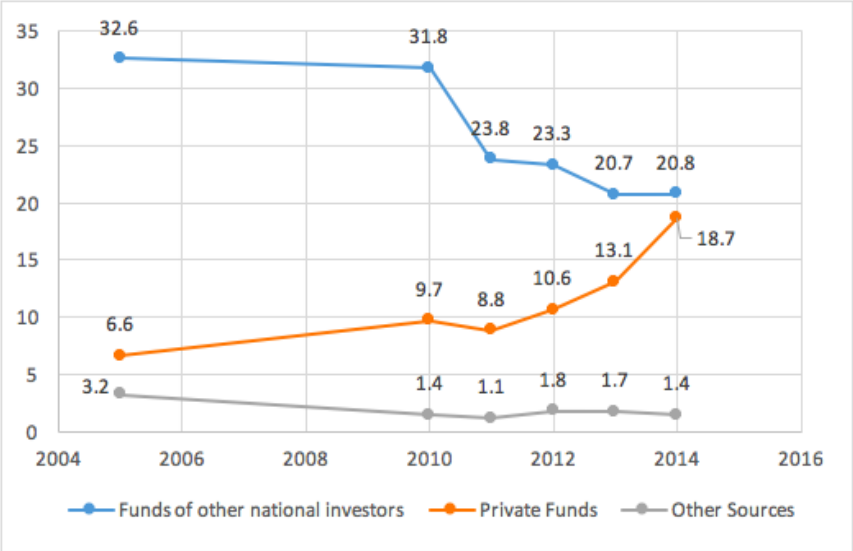

Figure 6: Percentage of other and private funding of Ukrainian R&D (2005-2015)
Source: MESU Self-Assessment Report

In 2014, however, the private funding (in current prices) increased compared to 2013 by 5.6% of the total R&D expenditure in Ukraine. It does show that ***private funding could have an important role in the future as the state funding further decreases, but it does not have the capacity to counterbalance public reductions in the short and medium term***. The reason for this negative perspective is the specific structure of the Ukrainian economy, where two thirds of business spending on R&D is concentrated in machine-building, an industry which has seen its contribution to the national economy contract since independence in 1991. Because of the crisis with Russia (which has been the main customer for machine-building products of Ukraine until now), it is assumed that this industry will further decline.

The share of foreign funding in R&D in Ukraine is at a high level of about 25% of GERD in 2010-2013, but has dropped[51], not at least due to the political and economic instability since 2011 and the recent military conflict. In 2005, this share was 24.8%, and in 2014 was 19.8 %[52]. However, this share of foreign investments in Ukrainian R&D is still relatively high compared to the other Eastern Partnership (EaP) countries. In order to attract foreign investments, the Ukrainian state offers certain measures to protect foreign investments against future changes in legislation. Among these is the possibility for non-native investors to register their assets with state authorities to enjoy guarantees for foreign investment for a certain period of time after the investment has been made.[53]

In particular, in 2016 MESU has focused on the increase of the state budget dedicated to R&D in current, but not constant prices[54], including basic funding of the institutions; grants for nationally funded projects; financial support for research infrastructure both in universities and state research institutes; establishment of a special support mechanism for young researchers to stay in or to return to the country; evaluation and validation of state research institutions and universities (currently an evaluation of all research preforming organisation in Ukraine is under way); financial support for accession to R&D databases (i.e. Scopus, Web of Science, etc.); and the establishment of the National Research Foundation of Ukraine.[55]

Ukraine has adopted many initiatives in the past, some of them as special laws. However, ***implementation has been uneven, due to the lack of necessary follow-up steps to give concrete expression to high-level objectives (including the provision of financial***

[51] UNESCO Science report towards 2030 (2015): http://unesdoc.unesco.org/images/0023/002354/235406e.pdf, p.334 : accessed on 15 April 2016.

[52] Source: Ministry of Education and Science of Ukraine

[53] http://usa.mfa.gov.ua/en/ukraine-us/trade/Investment+Opportunities+in+Ukraine : accessed on 29 April 2016.

[54] This could rather result overall in a declining budget.

[55] Source: Department of Scientific and Technical Development of MESU

resources), the political situation following the war in 2014 and the decrease in state funds for research and innovation.[56,57]

2.4 Scientific and innovation performance in Ukraine

In 2014, the number of publications prepared by the R&D actors in Ukraine was 327,900. Out of the total number of publications, 179,700 were articles in professional scientific magazines; 33,800 were printed in magazines included in international databases; 15,200 textbooks and manuals; and 6,600 individual monographs. According to the Scopus database, Ukraine ranked 46th among 229 countries (see Figure 18). According to Hirsch index (h-index) in 2014, Ukraine was ranked 45 among 229 countries.

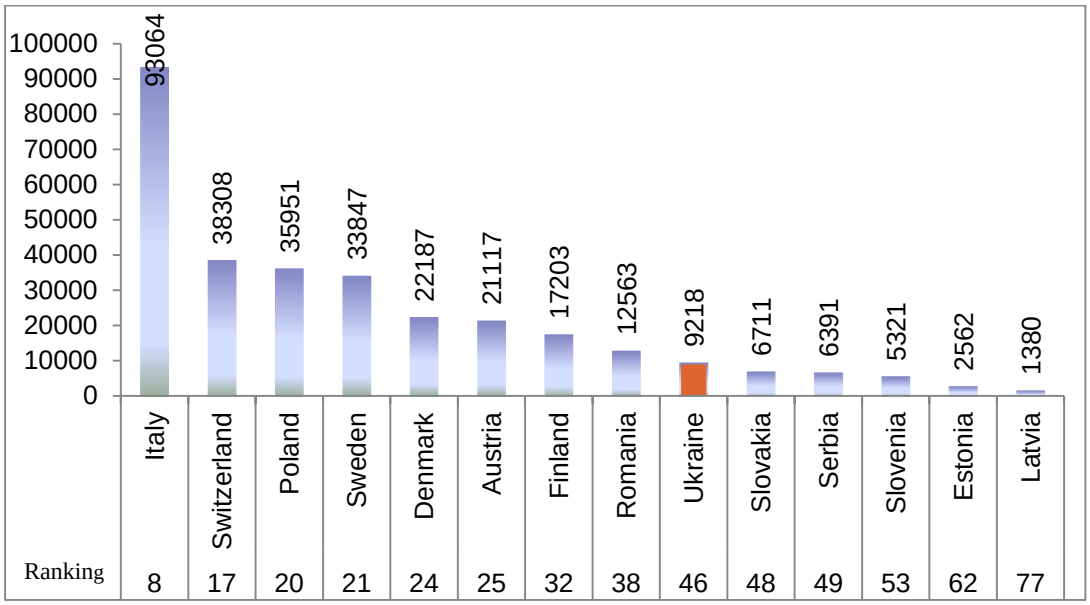

Figure 7: Publication activity of Ukraine

Source: Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016

An important indicator used for assessing science-industry relations is the number of ***public-private co-publications*** by million population. This often indicates the level of knowledge-based cooperation between academic and business R&D of a given country. The higher the indicator is, the higher is this sort of knowledge-based inter-sector cooperation. While the EU average between 2008 and 2014 fluctuates quite heavily between 34.1 in 2008 and 33.9 in 2014 with a peak as high as 41.6 in 2011 and a low in 2014, the Ukrainian time data series is ***stable, but at a very low level***. It shows 1.0 in 2014 with a peak of 1.5 in 2010 and a low of 0.9 in 2013. Among the countries covered by the IUS/EIS similar low recent levels can only be found in Latvia, Turkey, the Former Yugoslav Republic of Macedonia, Montenegro, Bosnia and Herzegovina, Albania, Moldova and – India (which hints to an influence of size effects). The countries with the highest number of public-private co-publications by million populations in 2014 are Switzerland (217.6),[58] Iceland (187.3), Denmark (143.5) and Sweden (107.8). Russia has a low value of 1.7 in 2014 and the EU cohesion countries are usually varying at higher levels (e.g. Bulgaria 2.1 in 2014; Czech Republic: 13.8; Hungary 23.2; Poland: 3.7; Romania 2.6).[59]

The ***international scientific co-publications*** per million population are taken as a proxy for the international openness and connectedness of the domestic research communities with their fellows from abroad. Also with respect to this indicator, Ukraine shows a ***rather low, but steadily increasing*** performance ranging from 40.1 in 2005 to 59.4 in 2014. By comparison, Russia shows 76.3 in 2014; Moldova 56.8; Turkey 75.1; Slovakia 372.4; Romania 163.7; Poland 235.2; Hungary

[56] UNECE: https://www.unece.org/fileadmin/DAM/ceci/publications/icp7.pdf : accessed on 15 April 2016.

[57] Ministry of Education and Science, Department of International Cooperation.

[58] The highest number actually has Liechtenstein (727.2), but is not taken here for comparison because of its size.

[59] These data are taken from CWTS.

398.1; Czech Republic 610.0; and Bulgaria 175.4. The top performers in 2014 are Switzerland (2,743.2), Iceland (2,364.3), Denmark (1,889.5), Sweden (1,670.2) and Norway (1,527.2) [60].

Ukraine's overall scientific publication output amounts to 94,135 publications for the period 2003-2013.[61] Out of these, 31,695 publications involve at least one author affiliated in Ukraine and at least one affiliated in another country. Consequently, the share of international co-publications in Ukraine's overall publication output is 33.46%, which is comparatively low. In 21,378 of Ukraine's co-publications published in the observed time span, at least one EU28/AC author is involved. Therefore, around 22.6% of Ukraine's overall publications and 67.45% of all Ukraine's international co-publications are published with an author affiliated in an EU28/AC country (see Fig. 8).

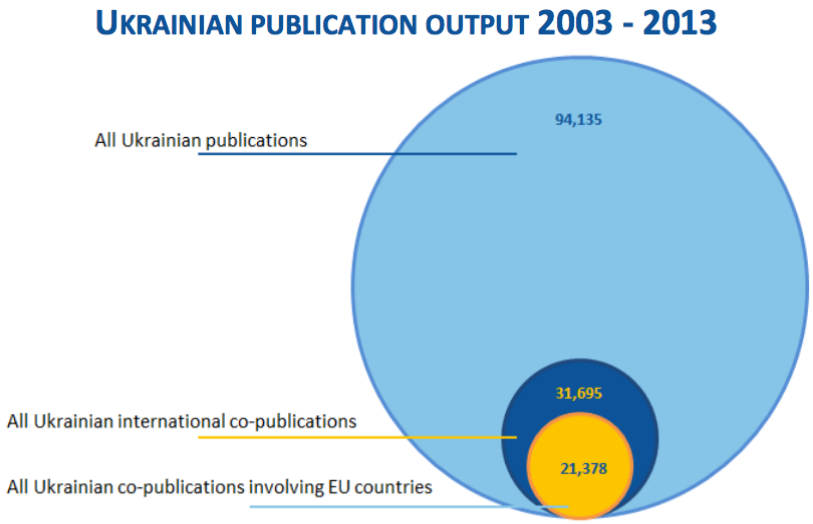

Figure 8: Ukraine's publications, international co-publications and EU28/AC co-publications
Source: WoS and Scopus

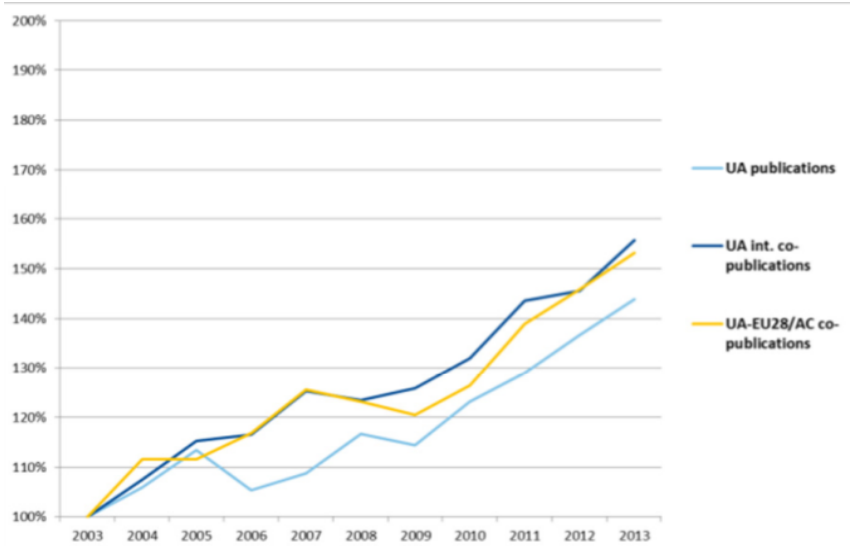

Figure 9: Growth rates over time of Ukrainian publications, co-publications and EU28/AC co-publications, 2003-2013; Source: WoS and Scopus

Ukraine's annual ***output of co-publications is growing slightly faster***. In Figure 9 the annual output of 2003 is taken as benchmark for the following years, indicating 100% as the initial value. Whereas until 2009 there have been periodic slight decreases in the annual output from one year to another, from 2009 onwards the numbers of Ukrainian (co-)publications have steadily increased.

[60] Date are taken from CWTS, see RIO Background Report – Peer Review of the Ukrainian Research and Innovation System under the Horizon 2020 Policy Support Facility. https://rio.jrc.ec.europa.eu/en/policy-support-facility/peer-review-ukrainian-research-and-innovation-system; accessed on 4 November 2016.

[61] Based on the unified data from both Thomson Reuter's *Web of Science* and Elsevier's *Scopus* databases. As reported in the Deliverable 2.20, EU-Ukrainian co-publication analysis including emerging trends, funded under grant agreement no 311839 (BILAT-UKR*AINA) by the European Union's Seventh Framework Programme for research, technological development and demonstration.

Although the ***observable increase of Ukraine's (co-)publications follows a global trend***, overall worldwide annual scientific output in 2013 nearly doubled compared to the output in 2003 (around 84% more publications worldwide in 2013 than in 2003 [Source: Scopus]) and thus was growing faster than for Ukraine. This means that the ***internationalisation speed of Ukraine remains below the global average***. However, it needs to be taken into account that the overall R&D personnel in Ukraine significantly decreased in this period.

Germany, followed closely by Russia and the USA, are the countries with most co-publications with Ukrainian authors. Ukraine's co-publications involving authors from Italy, Spain, Switzerland, South Korea, Czech Republic, Austria, Belgium, Mexico, China or Finland have more than 350 different authors involved on average.

Co-publications within individual scientific fields show different trends. ***The largest number of co-publications is observed in the scientific area of Physics & Astronomy*** (42.02% of all Ukrainian international co-publications), which is, compared to many other countries[62], a particularly high share. Enabling & Strategic Technologies is the field with the second highest EU28/AC co-publication share of 12.03%. Chemistry, which ranks fifth in the overall Ukrainian publication count (9.58%), is the research field with the third most co-publications, with a share of 10.62% (all) respectively 10.47% (EU28/AC). Mathematics & Statistics is on the fourth place: for Ukrainian EU28/AC co-publications (6.48%) the share is higher than for Ukrainian overall co-publications (5.76%) and slightly higher than for Ukrainian publications (6.11%). The annual output of UA-EU28/AC co-publications in Information & Communication Technologies is growing particularly strong: the output in 2013 is more than five times higher as in 2003. The output in the field of Economics & Business grew tenfold in the same period. In Clinical Medicine, Biology, Engineering, and Mathematics & Statistics, the annual output roughly doubled from 2003 to 2013. For most of the other research fields, the annual growth of UA-EU28/AC co-publications is steady but rather low with yearly deviations and might be too low to be measured on a yearly basis.

Scientific focus in co-publication activities echoes the specialisation of Ukraine. According to the Specialisation Index[63] ***Ukraine is considered highly specialised in Physics and Astronomy, Materials Science and Chemistry, and specialised in Engineering, Mathematics and Earth and Planetary Sciences*** as well (between 2003-2013). It is similar to the world average in the fields of Computer Sciences, Chemical Engineering and Energy. All other fields have an S.I. below 1 which indicates an 'under-specialisation' in these fields. By comparing Ukraine's S.I. in 2003 and 2013 one can see that the specialisation of Ukraine in the fields of Mathematics, Earth and Planetary Sciences, Energy and Economics, Econometrics and Finance is growing considerably stronger from 2003 to 2013.

In bibliometrics, the impact of scholarly works is typically approximated by the number of citations a published work receives.[64] In 2003-2013, ***the average citation of a publication involving at least one author from Ukraine was 3.7***, i.e. each publication has been cited on average 3.7 times. The number of citations of publications that were solely authored by Ukrainian authors is quite low, or about 1.39 times. Works co-authored with at least one author from a foreign country are cited on average 8.24 times. Works co-authored with at least one author from EU28/AC are cited 9.48 times on average, i.e. 15% more often than all international co-publications involving at least one Ukrainian author on average.

Ukraine shows regularly low shares in the available time series from 2002 to 2013 when it comes to the number of scientific publications ***among the 10% most cited publications*** worldwide as a percentage of the total scientific publications of the country. Based on CWTS findings Ukraine[65] ranged around 3% (2002: 3.4%; 2013: 3.1%), with a negative trend from 2008

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[62] E.g. the share of Physics & Astronomy in international co-publications of countries within the Danube Region is considerably slower; e.g. for Austria the share is 13.08%, for Bulgaria 25.67%, Czech Republic 20.79%, Hungary 18.18%, Romania 22.98% or for Slovakia 22.74%. Smaller countries have even to some extent lower shares e.g. Albania has a share of 3.46%, Bosnia and Herzegovina has a share of 6.24%. (cf. Lampert et al. (2015)) This is also true for many other countries.

63 The S.I. = the share (%) of publications of region x (Ukraine) in field Y divided through the share (%) of world publications in field Y. A S.I. > 1 indicates that region X is specialized in field Y. A S.I. < 1 indicates an 'under-specialisation' of region X in field Y; a S.I. = 1 indicates that region X is similar to the world average in field Y. (UNESCO, 2005).

[64] The impact in terms of average citations may vary greatly between scientific fields, which is why any such comparison should be made cautiously. A comparison within the same field but between different countries and/or over time is more plausible. A limitation to take note of is that the average citations for fields with few publications should not be taken at face value because they tend to fluctuate widely, e.g. if there is only one publication that has been cited 40 times and, later on, there is another one in the same field that has just 2 citations, the average citation drops from 40 to 21. Thus it may be sensible to exclude such cases.

[65] Data from CWTS were provided by the European Commission.

(3.1%) to 2012 (2.2%). The EU average vacillates between 9.8% in 2002 and 10.5% in 2012, depicting a positive upwards trend. The Ukrainian performance lies below all EU cohesion countries (e.g. Bulgaria 2013: 3.5%; Czech Republic: 7.3%; Hungary: 6.5%; Poland: 5.0%; Romania 4.7%; Slovakia 5.5%) but also below Turkey (2013: 4.8%) and Russia (3.3%). Among all countries analysed for the IUS/EIS, Ukraine only surpasses the performance level of Albania.

Patent statistics provide major proxies for assessing the technological development of a country. According to WIPO data (World Intellectual Property Organisation), ***Ukraine demonstrates a relatively high patent activity***. In 2012[66] filing of applications for industrial property rights (IPRs) (which can serve as an indicator for the national industrial performance) remained stable compared to previous years. 65.3% applications were filed for trademarks on goods and services; 20.8% applications on utility models; 10.1% for inventions; and 3.8% on industrial design.[67] ***The industrialised regions of Ukraine play the most important role in terms of patent activities****:* The analysis of the distribution of the total number of applications for inventions and utility models by regions in 2012 indicates that more than 76% of applications were submitted by enterprises and organisations located in the industrialised regions of Vinnytsia, Dnipro, Donetsk, Luhansk, Lviv, Odessa, Kharkiv and Kyiv.

Patenting across sectors differs considerably. Many patent applications are made in the 'performing operations and transport' sector, while the textiles and paper sector shows very few patent applications. The Ukrainian chemistry and metallurgy sector is relatively more prominent in the national patent application portfolio than at international level. Physics plays a much larger role in Ukraine's PCT (Patent Cooperation Treaty) output than in its national patent output. Also electricity is a field with more prominence in PCT patents than in nationally filed patents in Ukraine. Most PCT filed applications from Ukraine were made in the mechanical engineering sector (320, representing 28.4% of the total national share in PCT filed applications). Ukraine's PCT output shows a stronger concentration on electrical engineering (share of 19.5% in PCT filed applications compared to a share of 9.2% in national filed ones) and less focus on instruments compared to its national filed applications (share of 21.3% in national filed applications compared to 12.9% in PCT filed ones). Concerning the specialisation grades in Ukraine's PCT applications, audio-visual technology, digital communication and computer technology (all from the electrical engineering sector) are relatively important within its total portfolio.

2.5 Quality of human resources and infrastructure

The availability and quality of human capacity is crucial in the development of research and innovation both in the public and private sectors. Ukraine inherited a relatively ***well developed education system*** from the Soviet era, which still preserves some positive features with an emphasis on mathematics and natural sciences at school level. However, serious concerns have arisen as to the quality of S&T education since the early 1990s. In particular, schools and vocational schools lack technical equipment. Curricula are still based on Soviet-style patterns and teaching approaches and have to be continuously adapted to new requirements. Teachers receive low salaries, which causes high levels of corruption, both in primary and secondary schools as well as tertiary institutions.

Although the Ukrainian education system appears to be chronically underfinanced[68], almost all major indicators such as share of public expenditures for education in % of GDP or in % of the public budget show Ukraine in a comparatively favourable position.[69] This contradiction may be partially explained by the relatively low absolute financial allocation, which might not be sufficient to maintain the comprehensive system of education in a country as big as Ukraine. It could indicate inefficiencies within the system too. For instance, in elementary schools about 600 teaching hours are taught per school year, which is 100-200 teaching hours less than in the majority of European countries.

University enrolment in Ukraine is very high. ***Around 80% of 19-25 year-olds Ukrainians are enrolled in universities***.[70] With 2.35m students, Ukraine belongs to the group of five countries of the European Higher Education Area (EHEA), which together represent slightly more than 54% of

[66] The State Intellectual Property Service of Ukraine; last available data.

[67] Self-assessment report: Scientific and Technological Sphere of Ukraine, MESU, 2016, p.33

[68] https://www.liportal.de/ukraine/gesellschaft/#c4543 : accessed on 6 May 2016.

[69] http://www.kooperation-international.de/buf/ukraine/bildungs-forschungs-und-innovationslandschaft/bildungslandschaft.html : accessed on 6 May 2016.

[70] UNESCO Science Report 2015.

the total tertiary student population in the EHEA.[71] Most university students in Ukraine aim to receive a Master's degree. The fraction of students enrolled at ISCED 6 level, which are programmes that lead directly to the award of an advanced research qualification (e.g. PhD), is considerably lower in Ukraine (1.52%) than overall in the EHEA (2.7%), which indicates a rather low interest to pursue a scientific career.

According to the Bologna Report 2015, the ***unemployment ratio of people aged 20-34 with higher education attainment in Ukraine is slightly higher*** (8.0%) than for people of the same age cohort with medium educational attainment (6.7%), albeit unemployment rates for both are at a comparatively low level. Additionally, unemployment of people aged 20-34 with higher education attainment increased faster during 2008 and 2013 in Ukraine (+4.9%) than for people of the same age cohort with medium educational attainment (+1.2%), which indicates a limited absorption capacity of the Ukrainian economy for persons with tertiary education attainment. In this respect, however, Ukraine is not an exception within the EHEA. The labour force with tertiary education was 36% in Ukraine during 2009-2012.[72]

Ukraine belongs to the group of countries with the ***highest share of over-qualification*** (32.9%), defined as the percentage of young people with tertiary education occupying a job position which is not traditionally regarded as necessitating a tertiary qualification (i.e. occupation level 4 to 9 according to the International Standard Classification of Occupations [ISCO]). Other countries with the highest over-qualification rates (above 30%) in the EHEA were Albania (45%), Cyprus (39.7%), Spain (38.8%), Ireland (36.9%), Turkey (35.2%), Greece (34.1%), and Bulgaria (33.3%).[73] This indicates that the ***absorption capacity of the Ukrainian economy for highly-educated individuals is limited.***

The labour market for researchers in general is not very dynamic, although the total number of doctors of science and of candidates of sciences is growing in Ukraine. Only 20.6% of this growing number of doctors and candidates of science were involved in R&D as their primary job task in 2011.[74] ***New positions for recruiting researchers are few and the number of researchers has been consistently declining in Ukraine since the 1990s***. In 2005-2011, fewer than 50 researchers with scientific degrees emigrated from the country annually.[75] At the same time, however, approximately 1,000 researchers had long-term visits abroad every year and more than one quarter of them stayed longer than one year in foreign countries. To attract young scientists, special state stipends were increased two- to four-fold in the last few years. The same holds true for state awards for advancement in science which support the most talented specialists and which should stimulate their work within the country.[76] There is also hardly any influx from foreign researchers. Although foreigners could compete for positions in Ukrainian research institutes and universities, language is often a barrier; the general tax regulations disadvantages employment of foreigners, and the relatively low salary is unattractive.[77]

The number of personnel at Ukrainian research institutions is 109,636[78] of whom 53.5% are researchers (as for 2014, without Crimea), 45.8% of these are women.[79] By head counting[80] 65,641 researchers are working in Ukraine in 2013. Of these, 16,512 are working in the field of natural sciences, 27,571 in engineering sciences, 4,200 in medical sciences, 5,289 in agricultural sciences, 4,644 in social sciences and 2,078 in humanities.[81] Contrary to the global trends, there is a ***continued reduction in the total number of staff employed in research and development.*** Since 2005 the number of employees of scientific organisations in Ukraine decreased by 35.7%, including researchers – per 31.1% (Figure 10).

The over-ageing of research personnel in Ukraine is evident. The average age of doctors of science is more than 61 years and that of candidates of science more than 53.[82].The average age

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[71] Bologna Process Implementation Report 2015.

[72] UNESCO Science Report 2015.

[73] Ibid.

[74] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[75] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[76] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[77] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[78] According to the State Committee of Statistics of Ukraine.

[79] http://www.increast.eu/en/194.php: accessed on 4 May 2016.

[80] In Ukraine statistical difficulties occur in calculating full-time equivalents of researchers.

[81] UNESCO Science Report 2015.

[82] UNESCO Science Report 2015.

of researchers has been growing by one year every three years in the last decade.[83] This could lead to a slightly better labour market for younger researchers in the future if the system of research funding does not further shrink. The average salary in Ukrainian research institutes and universities was around €600 per month before the most recent crisis, but dropped in real terms due to the collapse of the national currency in 2014 and 2015***. In addition to the low salary, the poor state of research infrastructure makes the working conditions for researchers unattractive.***

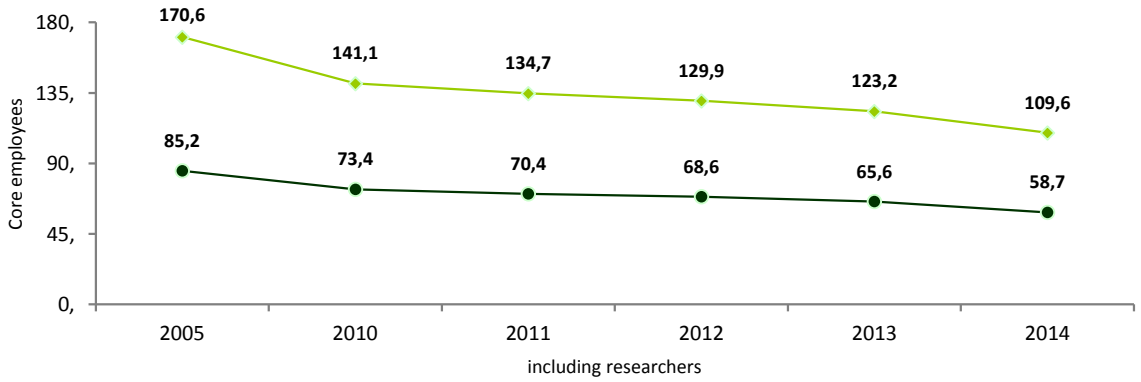

Figure 10: Changes in the number of employees of scientific organisations in Ukraine, 2005-2014 (in thousands of people); Source: Self-Assessment Report of MESU

As a heritage from the Soviet Union era, Ukraine accommodated nearly 20% of the experimental facilities of the USSR including nuclear reactors, astronomic observatories, and ships for marine research, but a substantial part of this infrastructure was lost during independence. Today, the ***research infrastructure facilities for Ukrainian researchers are overall outdated***, since financial resources to renew research equipment have been very low. According to Yegorov (2013) the *"problem developed over many years and has now reached such proportions that neither quick nor inexpensive solutions are feasible".*[84] However, ***Ukraine still has a few R&D infrastructures in operation which are, although insufficiently funded, internationally recognised***. Most of these are located at different institutes of the Academy of Sciences of Ukraine. 15 Ukrainian research entities are included in the European Research Infrastructure Observatory.

2.6 Internationalisation of STI

International R&D cooperation is becoming more and more important in Ukraine. Cross-border cooperation with the European Union and with its Member States (MS) bilaterally forms one of the pillars of the Ukrainian international R&D cooperation. Since its independence in 1991, Ukraine has strived to open up its national research system towards the international research community. In the early 2000s and, especially, since Russia interfered on Ukraine's territory in 2014, Ukraine shifted its interest towards the EU.

One of the main priorities for Ukraine's international R&D cooperation is the ***integration in the European Research Area (ERA)***[85]. This is fostered by multilateral and bilateral cooperation with the EU and its Member States. According to data from 2014, 25 intergovernmental agreements on S&T cooperation between Ukraine and EU MS and countries associated (AC) to Horizon 2020 are in effect. These cooperation partners are (in alphabetical order) [86]

- EU MS: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, The Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain;
- AC to H2020: FYROM, Moldova, Turkey.

The number of grants received for research work from international funds in 2014 decreased by 12.2% compared to 2013. In addition, 4,513 individual scholars used international grants, which is 11.2% less than in 2013 (see Figure 11).

[83] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine.

[84] Yegorov, I. (2013): ERAWATCH Country Reports 2012: Ukraine, p. 27.

[85] http://ec.europa.eu/research/era/index_en.htm : accessed on 2 May 2016.

[86] Erich Rathske: "Comparative Analysis of EU MS/AC policies and programmes towards Ukraine", Deliverable 1.5 in the frame of BILAT-UKR*AINA project, 2014, p. 13.

Weaknesses were mainly found on the side of finances and governance, because the budgetary situation in Ukraine for national R&D as well as international R&D cooperation was unstable and Ukraine faced serious re-organisation efforts on its governance level during the last few years.

NASU is one of the most active organisations in international R&D cooperation. It concluded more than 110 bilateral agreements with more than 50 countries in the world. Most of these agreements are signed with other National Academies of Sciences (such as those of Austria, Bulgaria, Germany, Poland, Romania etc.) In 2012 most joint projects in the framework of bilateral inter-academy activities were executed with Poland, France, Hungary, Slovakia and the Czech Republic.

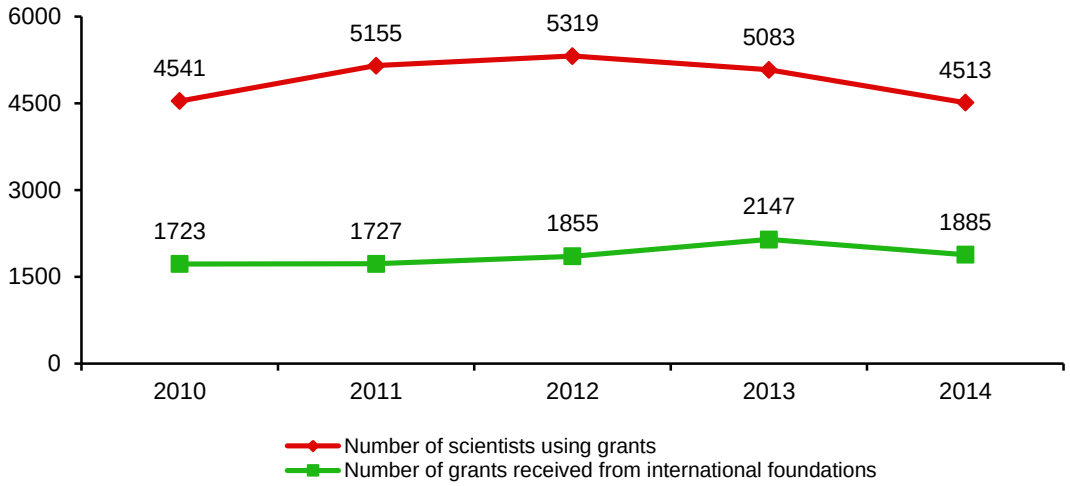

Figure 11: The dynamics of cooperation with international funds

Ukraine is a third country within the Eastern Partnership and the only country in this region with whom a separate ***Science and Technology Cooperation Agreement was signed already in 2002 with the European Commission*** (in force since 2003). Under the terms of this agreement, the Joint Science & Technology Cooperation Committee (JSTCC) was established. In the frame of Joint Committee meetings, both sides provide up-to-date information on current developments in research and innovation policy and related programmes in the EU and Ukraine, respectively.

There are several EU programmes supporting the RTI cooperation between the Union and Ukraine, including:[87]

- FP7 – Seventh Framework Programme for Research and Innovation (closed; some projects are still running);
- HORIZON 2020 – Framework Programme for Research and Innovation (succeeding FP7 and currently running);
- Erasmus Mundus;
- Tempus;
- Jean Monnet Programme under the Lifelong Learning Programme;
- INSC and INOGATE – both funded through the European Neighbourhood and Partnership Instrument (ENPI);
- Cross-Border-Cooperation Programmes – funded by ENPI;
- Central Europe Programme – as part of the European Trans-regional Cooperation Programmes.

The ***association to Horizon 2020 on 20 March 2015 was an important milestone in the EU-Ukrainian RTI cooperation***. Moreover, in 2016 Ukraine signed a treaty on associating to the Euroatom programme. This development demonstrates the current political will to establish Ukraine's future together with the EU. This association to Horizon 2020 was the first full association of Ukraine to any of the EU framework programmes. The success rate (successful applications or participations in applications) of Ukrainian researchers in FP7 was 19.5%. 155 grant agreements were signed, involving 215 participants from Ukraine to whom €30.9m of European funding from

[87] Olena Melnyk, Olena Koval: Progress Report on monitoring of Ukraine participation in FP7 and Horizon 2020, p.6, 2015, Deliverable 2.18 in BILAT-UKR*AINA project.

FP7 were allocated. In FP7 Ukraine ranked 7th among all third countries both in number of participations and in budget share[88] and was most active (based on signed grant agreements)[89] in the areas of environment (16), transport (15), INCO (International Cooperation) (15), Marie Skłodowska-Curie Actions (15), and nanotechnologies (13).

Until 10 October 2016, 61 proposals involving Ukrainian research organisations were selected for funding. The budget allocated to these Ukrainian research organisations was €11.5m.[90] According to data from the RI-Links2UA project (cut-off date in May 2016), ***the success rate in terms of participations dropped significantly to around 10% in Horizon 2020, which is below the average EU/AC-success rate of 13%.*** The success rate of proposals coordinated by Ukrainian parties was then only 4%, which indicates a problem in terms of quality and/or in handling Horizon 2020 adequately. Only 3 successful coordinators from Ukraine were recorded until May 2016.[91]

In addition to the EU programmes, Ukrainian research institutions and universities cooperate with international organisations and foundations, such as CERN, NATO, US Civilian Research and Development, Joint Institute for Nuclear Research (JINR), the International Committee on Space Research (COSPAR), the Executive Council of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the International Union of Academies of Humanities and Social Sciences (IUA) and the Pan-European Federation of Academies of Sciences (ALLEA).

In Ukraine***, international mobility of researchers is mainly stimulated through international projects, schemes and exchange programmes***. Since 2011, MESU runs a state mobility programme promoting the education and training of students and post-graduate students as well as internships for scientific and pedagogical staff.[92] The European Commission supports a wide range of external policy activities aimed at enhancing cooperation in higher education between the EU and third countries. Activities in this field are mainly subsumed under the Erasmus Mundus programme.[93] Whereas it aims to intensify cooperation between EU and third country higher education institutions, the Tempus programme[94] is dedicated to modernising the higher education sector in third countries by supporting its alignment to the Bologna goals. In both of the programmes Ukraine is an active member and eligible to apply for funding. The Tempus programme helped facilitate the internationalisation of Ukrainian higher education institutions and contributed to the initiation of several new research projects and exchange programmes.

[88] Ibid.

[89] Ibid., p.9

[90] This information was provided by MESU as feedback on the draft final PSF Peer Review Report on 9 November 2016..

[91] Data taken from RI-Links2UA project: Statistics and Analyses of Ukrainian Participation in Horizon 2020. Frist draft, based on 241 concluded calls, Warsaw/Vienna, September 2016.

[92] Olena Koval, Vadym Yashenkov et al.: Overview of the internationalisation of Ukraine in RTDI including recent trends and developments, Policy Brief in BILAT-UKR*AINA project, 2012.

[93] http://eacea.ec.europa.eu/erasmus_mundus/ : accessed on 2 May 2016.

[94] http://eacea.ec.europa.eu/tempus/ : accessed on 2 May 2016.

3. RECOMMENDATIONS TO RAISE QUALITY AND RELEVANCE OF THE SCIENCE BASE

The PSF Panel is strongly convinced that Ukraine may lose its connectivity to leading international progress in STI if the reform process, triggered and based on the new Law of Scientific and Technical Activity, does not advance with highest attention and support from both the side of policy makers as well as from the side of heads of research institutes and universities as well as the faculty.

It will not be enough to consider transformation only as top down pushed by the new Law; transformation needs to take place also within the research performing organisations. The autonomy of universities needs to be intrinsically practiced. At both NASU and universities, low performing research units should be closed; management and administrative procedures must be simplified and made more efficient.

Much can be done by the research organisations and the universities themselves. The top management must listen to its staff and establish reform committees and start working! Some of the best institutes and research units are dying a slow death, because funding is wrongly allocated based on proportional cuts. Decisions need to be taken quickly to save the best groups. Collaboration, partnerships, and when relevant mergers should be developed between research units of various affiliations in order to avoid duplication, create synergies and to ensure better international visibility. Perspectives need to be created for the available human talent.

There is no doubt that the available budget is nothing more than a survival budget prolonging a survival mode which runs short. Therefore budgetary allocation needs to be effectively increased; but the dramatic financial situation must not be used as a permanent excuse for not moving forward in the sphere of autonomous decision-making and change management.

The recommendations highlighted here are deemed necessary and fundamental by the PSF Panel for the overall quality and relevance-oriented reform process of S&T in Ukraine. Most of these recommendations are of immediate nature, realising that the implementation of the new Law on Scientific and Technical Activity will need time and that its implementation is unfortunately already delayed. The PSF Panel underscores that the time to act is now.

Therefore, ***the Ministry of Education & Science [MESU] is advised to publish an action plan [including time schedule] for the implementation of the Law in the first quarter of 2017 by taking the core messages and recommendations of the PSF Panel into account.*** Special emphasis should be put on the National Board on the Development of S&T and the National Research Foundation.

The new Law should be used to radically start reforming along the following lines, which are in detail further elaborated in the forthcoming recommendations:

- Make the S&T system more efficient through introducing a strong competitive research funding pillar in Ukraine;
- Identify across-government national reform priorities, whose processes of attainment in the field of S&T should be promoted, guided, supervised and monitored by the National Board on the Development of S&T in Ukraine;
- Re-orient NASU to become more responsive to the needs of society and business;
- Further stimulate the engagement of universities in academic research;
- Encourage linkages and structural partnerships between research units of NASU, other research organisations and universities;
- Ensure a strong enough pool of talent for safeguarding the future of research in Ukraine (both in qualitative and quantitative terms);
- Safeguard the public S&T budget is not further reduced (in nominal or real terms) in the next years but is rather steadily increased to contribute to the 1.7% target stipulated by the Law on Scientific and Technical Activity within the next 10 years.

3.1 Promoting change and reform through a strong mandate of the National Board on the Development of S&T

Recommendation 1: The National Board on the Development of S&T should work strategically in reforming and re-orienting the system of S&T in Ukraine on the basis of jointly defined priorities with all involved stakeholders, such as the Ministry of Education and Science, the future National Research Foundation and the National Academy of Sciences.

The re-orientation of the S&T system of Ukraine towards higher effectiveness and a much stronger innovation focus and the necessary radical reforms, which are needed for this, require a strong guidance, supervision and monitoring from an independent Board, which feels responsible towards defining a challenging reform agenda in consultation with important stakeholders. Substantial follow-ups of political announcements have been major shortcomings in the field of STI in Ukraine during many years. The Board has – inter alia – the difficult task to demand adequate policy interventions and actions from all involved stakeholders, including MESU and the National Academy of Ukraine (NASU).

The PSF Panel acknowledges the respective articles concerning the National Board on the Development of S&T in the new Law on Scientific and Technical Activity. It further considers the operationalization of the Board as an important milestone in reforming the system of STI in Ukraine. However, ***the National Board on the Development of S&T[95] must be in a position to be politically influential and to produce strategic intelligence.*** To secure political strength, the Board must receive strong political backing and commitment.

Moreover, ***the Board should be assisted by a well-equipped secretariat staffed with subject-matter experts***. In order to do its work substantially, the Board should have also budgetary means at its disposal to set up working groups and to involve additional subject matter experts, and – if necessary – to subcontract experts even if they are not civil servants (see Recommendation 25). Budget for the secretariat should ideally be secured in 2016.

The Board should focus its short-term agenda (next 2 years) on several important activities to radically re-orient the system of STI in Ukraine. These activities include:

- First of all and most importantly, ***decide on the distribution of funding between institutional research funding and competitive project-based research funding***. The Panel recommends that 60% be allocated to institutional research funding and 40% to competitive research funding. The Boards should clearly establish a transparent action-oriented roadmap on how to reach these proportions within 5 to 7 years, including in the present perspective of a constant budget scenario (see more on this under Recommendation 2). The 60:40 financial calculation should be made on the basis of Ukraine's complete public state research funding, including funds for NASU and research financed by other ministries.
- ***Introduce a comprehensive national socio-economic priority setting process***, which includes the business and the civil society sectors to address relevant business and social innovation aspects (see Box 1). The aim is to derive the relevant national research priorities from the identified overall national priorities by taking into account the existing scientific excellence according to world standards and the need to maintain the nation's broad knowledge absorption capacity. The identification of both national overall priorities and national research priorities should be based on the entanglement of various approaches such as short- and midterm foresight exercises, smart specialisation and other analysis and consultation formats. The PSF Panel noted that Ukraine conducted some prioritisation exercises in the past, but such exercises frequently did not lead to transformation or follow-up. Thus, the PSF Panel advises the National Board to regularly monitor the implementation of its conclusions, advices etc. Furthermore, the PSF Panel is of the strong opinion that the identified national research priorities must correspond with and directly contribute to the overall national priorities, which should support the transformation of Ukraine towards an innovation-oriented economy and society. The identified research priorities should also be used for international research cooperation.
- ***Re-orient the STI systems towards innovation.*** R&D in Ukraine should be based on "excellence" in terms of world-class science and on "excellent science for innovation" especially in engineering and natural sciences. Adequate exchange and consultation

[95] The Board is proposed by the new Law on Scientific and Technical Activity.

formats with the business and civil society sector in Ukraine need to be introduced. Institutionalised participation of the business sector in the National Board on the Development of S&T is advocated (see Recommendation 24).

- Set up a system to ***continuously monitor the development of STI policies*** in Ukraine and introduce a full-fledged evaluation culture and system for research and innovation policy. The Board should have the capacity to monitor the reform process of Ukraine in the field of S&T and also to request evaluations of institutions on a regular basis. All introduced research and/or innovation instruments, regulations, programmes and other measures should be compulsory evaluated. Ex-ante impact assessment of new policy interventions is strongly advised. Existing European tools for monitoring the development of research and innovation, such as the European Innovation Scoreboard (previously the Innovation Union Scoreboard), should be actively used. The PSF Panel also takes note that the Board is obliged to prepare an annual monitoring report on the state of S&T in Ukraine. Such report should without any doubt be demanded and secured.

The Board is perceived as deliberate consensus-making mechanism which should build its recommendations and activities on jointly defined priorities to serve the whole of the Ukrainian STI system. Trust-building among the participants is of major importance. Individual interests (e.g. due to affiliation to a certain organisation) should be subordinated to a jointly shared agenda with few compromises. A strong consensus among the Board members should be maintained for this.

Box 1

Inspiring Practice

Prioritization in the Netherlands, Flanders and Ireland

The **Top Sector policy in the Netherlands** adopted in 2011 was the result of both a top-down and bottom-up identification process of priority sectors for knowledge-based development. The government identified 9 broad sectors, including Agriculture and Food; Chemicals; Creative Industry; Energy; High Tech; Horticulture and Propagation Materials; Life sciences and health; Logistics; and Water. The strategy has been further implemented through an interactive policy process, whereby the government, businesses and knowledge institutes together identified strengths, needs and opportunities linked to innovation for each sector identified as priority for the country. 'Top Knowledge & Innovation Consortiums' were created in each sector, and each was tasked to prepare precise policy agendas based on analyses and consultations within their field of activity. The mandate was to build on scientific excellence while developing innovative solutions for societal problems. The design of sector-specific instruments was based on a bottom-up approach. This resulted in "Innovation contracts" for each sector, which cover a range of policy fields such as research, education, environment, etc., and are renewed regularly. The Innovation contracts mention amounts for both public and private investments in R&D and provide detail on the allocation of resources.

The 2011 established **New Industrial Policy in Flanders** aims at directing economic policies towards the support of innovation in growth markets: it focuses on specialised clusters, each of them benefitting from a customised policy. Those strategic domains are: 1. Sustainable chemistry; 2. Specialised manufacturing solutions; 3. Personalised cure and care; 4.Value-added logistics; 5. Specialised agro-food; 6. Integrated building-environment-energy cluster; 7. New ICT-platforms.

Like for the Netherlands the more detailed definition of priorities under those areas is the task of partnerships, the "Innovation Steering groups", who are responsible for the development of mid-term innovation strategies to address the main societal challenges and for the elaboration of a roadmap for the valorisation of innovation in their domain. They include experts from scientific fields as well as business experts. The process is geared towards a European and international positioning by means of the process of roadmapping.

The **National Research Prioritisation Exercise conducted in Ireland** in 2012 lasted 18 months and included extensive studies as well as stakeholder consultations. Stakeholders groups were formed with leading roles from people from industry; international experts were also involved. Priorities were selected on the basis of: research excellence, economic relevance and response to societal challenges. The exercise led to the identification of 14 priority areas and 6 underpinning/enabling technologies on the basis of existing strengths of the enterprise and public research bases and on opportunities that exist in terms of the global market place. Implementation was subsequently outsourced to relevant actors. Implementation is driven by detailed Action Plans for each priority area, developed by a government appointed group, chaired by the Minister for Research and Innovation and the Prioritisation Action Group.

Lessons learned:

- The identification of priorities for research and innovation requires the joint participation of stakeholders from the public research and the business sectors.
- The implementation of targeted policies needs the continuous involvement of stakeholders in order to ensure that policies are responsive to the specific needs of each sector.
- Such a process will trigger cross-government coordination across several policy domains.

3.2 Raising quality and relevance of S&T through competitive research funding

Recommendation 2: The National Research Foundation should become a strong change-maker and champion reforms in the STI system of Ukraine, notably through a stepwise strong increase in the competitive funding of research projects

The Ukrainian research system lacks a comprehensive approach towards competitive R&D funding. Competition is regarded as a necessity to increase quality, to create critical mass through the formation of bottom-up "critical mass of excellence" consisting of the best combinations of researchers from different research organisations and to combat fragmentation and sub-critical activities. The new Law on Scientific and Technical Activity positions the National Research Foundation (NRF) as a central and crucial element in modernising and reforming the system of S&T funding in Ukraine, thanks to the introduction of a system of competitive research funding. The PSF Panel favours that the NRF should exclusively and competitively fund research projects, may they be fundamental or applied. The NRF should abstain from providing institutional funding. The NRF should focus its funding activities on excellence in research and its relevance both vis-a-vis the national priority areas and the broad science base. The PSF Panel strongly suggests to the Government of Ukraine to mobilise substantial extra funds from the state budget to support the activities of the NRF.

The PSF Panel considers it as very important that NRF works from its inception along internationally inspired practices and in an autonomous way in terms of its operations outside daily interference from politics with the ultimate objective to raise the quality and relevance of research in Ukraine.

The NRF needs for its funding obligations substantial budget, which can come from the following sources:

1. To reach the 1.7% financing target stipulated by the Law requires extra budget allocations in addition to the present level of S&T funding. The necessary budget increases should first of all be deposited to the NRF for running competitive calls for RTI proposals – this must be an absolute priority. There is no doubt that the NRF requires substantial extra budget allocations, and this is crucially necessary for making the NRF operational.
2. The budget of the State Fund for Basic Research should be transferred to the NRF and the State Fund should be dissolved.
3. 50% of the competitive funding for R&D projects of the universities, which is currently directly distributed by MESU, should be transferred to the NRF to restock the budget for open competitive calls for R&D proposals (see our explanation under Recommendation 5 as regards the other 50%).
4. Only in cases where no substantial extra budget can be allocated (point 1 above), it is suggested to transfer as a 4th source also 50% of the competitive funding for projects, which NASU directly distributed under its authority and autonomy during the last years on average, to the NRF to restock the budget for open competitive calls for R&D proposals. The PSF Panel, however, would see this as an infringement to reach the 1.7% goal stipulated by the Law and takes note that this would be against the spirit of Art. 48.

The PSF Panel noted the exemplary way in which MESU implemented fair principles and processes of research funding allocation to the university sector in Ukraine. The knowledge of this practice should be made accessible and communicated to the NRF.

The PSF Panel suggests a stepwise increase of the competitive component within the entire public research funding up to 20% in 2018; 30% in 2020; and 40% in 2022. This approach should also generate the development of qualitatively sufficient absorption capacities in Ukraine for this kind of funding.

The leadership of the autonomous NRF should be responsible for formulating its policies taking into account the advices of the National Board and the strategic considerations of the Government. These policies deal with issues as important as:

- A balance between the competitive budgets allocated for priority areas and the budgets for the broad, thematically open science base. The latter should address in particular humanities, social sciences, natural sciences, life sciences and e-sciences. Corresponding to the idea of rather long-term fundamental research and rather short-term applied research, the NRF budget should be allocated into a budget line for open, possibly permanent calls without thematic definition and a budget line for targeted priority areas with focus on contributions to specific problem solving.
- The consideration of those national priority areas on whose support the NRF can be an important stakeholder based on the guidelines and recommendations prepared by the National Board on the Development of S&T in Ukraine (see recommendation 1).
- The selection of which "categories" of researchers and teams of researchers can submit research proposals. In this regard the PSF Panel holds a strong opinion that competitive research funding in Ukraine should also strongly stimulate and support interaction and cooperation between research institutes and universities as well as other stakeholders (including industry and the service sector). The PSF Panel advises that all research groups in universities and research institutes irrespectively of their affiliation should be eligible to compete for research projects granted by the NRF. This includes NASU institutes as well.
- At the level of project proposals, it should be made clear which cost categories can be funded. The PSF Panel advises to fund primarily personnel costs (especially salaries of pre-doc and post-docs; for persons with fixed contracts one could consider the idea of some kind of premium), travel costs, conference costs as well as research equipment and consumables related to the research project under scrutiny.
- The definition of procedures for the evaluation of project proposals and the administrative conditions once proposals are selected for funding. Scientific communities and governments all over the world expect their national funding agencies to have fair and transparent ex-ante evaluation procedures for project applications in place. The National Board should encourage NRF to seek international experience in setting up the organisation and the procedures for research funding, including the use of international reviewers and review panels (see Recommendations 3 and 4).

Finally, the PSF Panel suggests the Minister of MESU to act as political budget authority for the NRF.

Box 2

Definition

Institutional and competitive research funding

Institutional funding may take different forms with different basis for calculation, but is usually based on lump-sum allocation, or as budget-line allocation, according to the level of autonomy granted to the public research performing organisation (PRO). Generally, institutional funding comes without conditions to fund, although a more recent trend is to introduce some performance-based or quality-based mechanisms in order to enhance the competition between organisations and their accountability. Institutional funding is usually attributed to research organisations (PROs, HEIs) for funding their running activities and, usually, for an unlimited period of time (the annual amount might vary). It is usually not earmarked to specific activities and to organisational subunits, but the internal allocation is left to the performing organisation. A typical example of institutional funding is block transfer to the Academy of Sciences of Ukraine or Higher Education Institutions, which in most European countries comprises the largest part of their budgets and is allocated in the form of a lump sum.[96]

Competitive research funding is defined as project funding based on competitive processes, on the basis of applications submitted in response to notifications or calls for tenders managed by a

[96] Lepori, Benninghoff, Jongbloed, Salerno and Slipersaeter 2007.

funding agency (e.g. ERC, NRF, DFG), with evaluation using different types of peer-review processes.[97] The rationale for competitive research funding is to improve the research performance and a more efficient use of the funding resources, by selecting the best research groups, promoting some subject or research themes, supporting structural changes in the modes of knowledge production, improving the cooperation and competition between research groups.[98]

Recommendation 3: The National Research Foundation should be internationally supervised and assisted to guarantee higher accountability and transparency

The role and performance of any institution in a system must be checked periodically. The NRF in Ukraine – just like any other public research funding body – should be no exception, especially given its fundamental role in introducing a substantial competitive research funding pillar in Ukraine.

The PSF Panel suggests that a temporarily implemented advisory board responsible for supervision and assistance, consisting of administrators from international sister organisations, such as the DFG (Germany), NWO (The Netherlands), SNSF (Switzerland), ERC (Europe) etc., should regularly supervise the grant review procedures of the NRF. As part of the review, feedback from scientists who have submitted proposals should be collected and considered. The supervision reports on the reality of review procedures should be communicated to the National Board and the scientific community in Ukraine together with the pertinent conclusions of the NRF Board. The NRF should be put in a position to work in English and to translate the most important documents into English (see also Recommendation 4).

By employing such procedures, a strong signal can be sent to both the Ukrainian and international research communities that the NRF works in a transparent and professional way. To secure professional procedures along international standards facilitates trust. This is especially important in an environment which is unfortunately not completely free from allegations of opaqueness and nepotism.

The implementation of this policy option should fall primarily under the autonomy of the NRF in consultation with the National Board on the Development of S&T.

There are good role models of public national agencies for research funding in many countries. The National Science Foundation of the United States (NSF) and the Deutsche Forschungsgemeinschaft of Germany (DFG) are examples of independent funding institutions which are not involved in research themselves (see Box 3).

Box 3

Inspiring Practice

DFG – The German Research Foundation

The Deutsche Forschungsgesellschaft (DFG, German Research Foundation) is the largest research funding organisation in Germany that supports research projects financially and thereby facilitates the collaboration among researchers. In addition, it provides scientific advice for parliaments and other public institutions.

In order to fulfil its tasks in an appropriate manner, complex processes are necessary, e.g. the review process for the funding applications, the selection of qualified reviewers or the development of the application process. The application is a multi-stage process. Thereby the application will first be checked for formal correctness. If all requirements are met, the application will be assessed by carefully selected peer reviewers, which ensures a certain standard of quality. The board of reviewers compares and assesses all applications within the particular subject to make a funding

[97] Definitions are taken from the ‚Handbook for data collection and indicators production', 4th draft (18 May 2015), authored by B. Lepori and produced under the PREF project (Analysis of national public research funding).

[98] Geuna, 2001; Braun, 2003.

recommendation. After a formal recheck, the final funding decision in made by the DFG's Joint Committee. The Head of Office informs the applicant about the decision and the level of funding.

In order to facilitate the application process, DFG provides information (programme guidelines, application forms) and ensures the completeness of all necessary information by respecting the rules for good scientific practice. These rules apply to all applicants and scientific institutions to avoid scientific misconduct.

Recommendation 4: An international peer review system for projects should be introduced to support the excellence and internalisation of Ukrainian science

Scientometric studies have clearly shown that Ukraine is less involved in international exchange and cooperation in the field of science and research than countries of comparable potential and pretence (see Section 2.4).

An enhanced use of English as worldwide common scientific lingua franca would contribute to overcome the relative isolation of certain research communities in Ukraine. This would also avoid scientific inbreeding. Moreover, the enhanced use of English and stepwise improvement of the standard of Ukrainian research proposals and projects would not only open up the Ukrainian system of research towards international cooperation but also contribute to strengthening its competitiveness and increase the likelihood to successfully compete for European funding.

The PSF Panel suggests implementing research proposal writing, proposal submission and review procedures in English language (starting with projects above a certain financial threshold) in order to prepare the Ukrainian scientific community for international competitive research procedures. To avoid scientific inbreeding, the National Research Foundation (NRF) should also increasingly use peer reviewers from outside of Ukraine.

To improve the prevailing low command of English among many Ukrainian researchers, in-house service trainings at research organisations should be implemented. International mobility and an increased publication of articles in English should be promoted (see Recommendation 11).

The implementation of such a recommendation falls under the operative autonomy of the NRF. It should be supported by accompanying legal acts, which enable the use of English for submission and evaluation of proposals.

In order to facilitate the introduction of an international peer review system, the NRF should make use of cooperation agreements with other Eastern Partnership countries but also establish agreements with research funding agencies from the EU or other scientifically leading countries.

3.3 Enhancing R&D at Universities and Increasing Autonomy

Recommendation 5: Research universities should be identified in a post-factum approach over five years on the basis of transparent international standards

Ukraine has a limited tradition of research across its huge higher education sector. However, interaction between teaching and research is seen as beneficial for the quality of these missions of universities. Instead, the higher education sector in Ukraine is overwhelmingly focussed on teaching, while research is mostly conducted in the Academy of Sciences. This separation is harmful for the Ukrainian STI system. Any university should in principle have the possibility as well as the resources for research activities. However, the intensity and the extent of research conducted in a university may vary for very different reasons. Countries choose different approaches to their university system. Some, for example, choose to develop universities with specific profiles, e.g. profiles related to the local economy (e.g. universities of applied sciences) or profiles focusing on certain multi-disciplinary topics or on the presence of some world leading research groups. Also for Ukraine it will be useful to re-orient existing universities in a way to unfold different profiles related to specificities of the region they are located in.

Beyond that, the introduction of the concept of research universities is important as research universities can contribute massively to societal and economic development if well designed and well-organised. Research universities focus strongly on research, which, however, does not mean that they neglect teaching and the training of PhDs. Their achievements are documented by relevant international publications and involvement in international research networks.

The PSF Panel understands that a number of universities in Ukraine were already declared as research universities. The PSF Panel, however, is of the opinion that it is too early to attach financial consequences to the status of a research university in Ukraine, since the level of research across the universities in Ukraine is too uneven and in general too volatile. Universities, regardless of their affiliation to any ministry, should have the opportunity to develop their research potential over time before the research university landscape is cemented and institutional funding is allocated to a selected group of universities. The PSF Panel advises that the status of a research university must be earned, not granted upfront, and that it should not automatically last indefinitely.

Instead, the PSF Panel advocates a post-factum identification of research universities. The PSF Panel suggests a period of 5 years when research universities could be identified based on transparent criteria taking good international practice into account. MESU should install a committee with national and international experts to define the exact criteria which will help to identify universities entitled to hold the status of a research university on an ex-post factum basis. This includes examining, for instance, the number of international publications and citations, the international prestige of certain research groups, the extent of successful participation in Horizon 2020 projects and other substantial international projects, the extent of resources competitively attracted from the new National Research Foundation, other types of third-party funding (e.g. contracted research especially from the business sector) and similar achievements.

To facilitate this process of further developing traceable research trajectories at universities as well as to promote the development of critical R&D mass, the PSF Panel advises to fund research at universities during a transition period over the next five years through an institutional lump sum allocation solely dedicated to R&D.[99] This is to be done before the status of a research university will be granted to a few Ukrainian public universities with all financial consequences which are included. After this transition period, the then nominated research universities should receive R&D funds through a new funding algorithm.

To finance this institutional transition grant, MESU should transfer on an annual basis 50% of the research funding (which it so far has competitively allocated to R&D projects of universities) into this institutional lump sum. The volume of this institutional R&D budget dedicated to the universities should be calculated on the average competitive R&D project funding, which each university has competitively received through MESU over the preceding 5 years.

A pre-condition for this institutional allocation is the drafting of a strategic R&D development plan by each university seeking to apply for this competitive pot of money. This strategic R&D development plan needs to be approved by MESU. No public university should be ex-ante excluded from application if they received some competitive R&D project funding during the last five years. The strategic R&D development plan must include a strategic vision, a detailed research prioritisation plan with thorough justifications in terms of available human resources and scientific infrastructure as well as a detailed roadmap for R&D development along the identified few priorities for the next five years. The implementation of the strategic R&D development plan falls completely under the autonomy of each university. The implementation of the Roadmap, however, should be checked by MESU after three years.

The consequence of the fact that 50% of the research funding that MESU distributes competitively to universities up to now is transferred into an institutional lump sum for R&D and that the other 50% of the research funding is channelled into the NRF (see Recommendation 2) leads to a new situation in which MESU is relieved from acting as a funding agency. Instead it can re-focus its work on strategic policy making.

As an accompanying regulatory change, universities – which are not designed as pure educational or training universities – should introduce research as an obligation in all new employment contracts and should be encouraged to modify also existing working contracts to include the dimension of research. Universities will also have to react in providing appropriate conditions and incentives for researchers involved in "third mission" activities (see Box 4).

[99] After settling the text of the PSF Peer Review Report, the PSF Panel was informed by MESU about a Roadmap to strengthen R&D at universities, adopted on 26 October 2016. Since this Roadmap Process, which includes a number of complex options, has just started and will probably need fine-tuning which takes some time, the PSF Panel alternatively sticks to its more streamlined suggestion as presented in Recommendation 5.

Box 4

Definition

Third mission activities of universities

In a modern world, universities have three missions to play. Their first, and more traditional, mission is education: universities prepare students for professional life by ensuring they master the corpus of knowledge relevant to their discipline. Their second mission is research: universities engage in research activities pushing forward the frontiers of knowledge. Carrying out this second mission ensures that education is nurtured by direct access to the latest state of knowledge in each discipline. The "third mission" of universities, also referred to as "societal engagement" or "service to society" is a more recent idea, which refers to their activities benefitting society in a wider sense.

Universities' third mission activities can be seen as extensions of their original first two missions, namely:

1. Linked to the Education mission: universities diffuse knowledge in society through further education and lifelong learning courses, targeting other target groups than traditional students: professionals in need of updating or complementing their skills and competences; retired people willing to engage in the study of topics meeting their own interests; pupils for which an early confrontation with the world of science is thought to be beneficial for their general education; or the wider society through science communication activities taking the shape of "Science weeks" or "Open laboratories" aiming at popularizing science and raising its attractiveness for the young generation and the wide public, etc.
2. Linked to the Research mission: in the innovation sphere, universities are engaged in commercialisation of their research results through a variety of activities such as: cooperative projects with companies with a goal of supporting innovation in companies; contract research for companies; licensing of university research results; support to establishment of spin-off companies exploiting university research (this can involve establishment of science parks, venture capital funds, etc.). In other spheres than innovation strictly speaking, university researchers, professors and students are engaged in supporting wider society needs through: expert work and scientific advice provided to public bodies and authorities (e.g. on climate change issues); participation in media debates on societal issues; etc.

This translates into a phenomenon where universities are engaged in a variety of initiatives and structures which extend beyond the public science and academic spheres: universities are part of competitiveness poles or clusters structures and initiatives, which aim at fostering public-private cooperation around innovation; they are part of official advisory bodies such as Science and Technology Councils aiming at supporting the formation of policies, etc. This phenomenon also has an impact on funding sources for universities, which are widened beyond the traditional sources for funding the first and second mission: these include private money, and public money devoted to cooperative or societal projects.

The extent to which universities are able to perform their third mission depends on:

- Their fields of specialisation and the connection of these to society needs.
- The internal rules which allow for, and promote these types of activities: introduction of third mission criteria in rewards, incentives and career development paths and in the organisation of work, as traditional assessment criteria such as academic publications are not sufficient for this purpose; appropriate intellectual property rules allowing for research exploitation outside of university walls; openness to trans-disciplinary work which is often necessary for conducting "third mission" activities.
- The overall strategy of university authority a as well as the existence and performance of internal structures supporting these activities, such as technology transfer offices and research management offices.

Box 5

Inspiring Practice

Country experiences for strengthening research at universities

There are many experiences from other countries to strengthen research at universities. In Germany, for instance, the Federal Ministry of Education and Research (BMBF) and the Ministries of the "Länder" (i.e. regions) conduct a competitive "excellence initiative" under which universities are invited to submit proposals. The aim is to strengthen German universities and to make them more attractive.

The initiative consisted of three lines: graduate schools to promote young scientists; clusters of excellence to promote excellence science; and future projects to extend university research in selected lines. A first round of the excellence initiative was implemented in 2005 and a second round in 2011 until 2016. The selection procedure was conducted by the Council of Science (Wissenschaftsrat) and the German National Science Foundation (Deutsche Forschungsgemeinschaft). This procedure led to 45 graduate schools, 43 excellence clusters and 11 future projects being sponsored between 2012 and 2016.

In a new round of the initiative, all universities can apply implying that some formerly selected universities may not necessarily be in the set of excellence universities again. The excellence initiative had substantial impact on German universities as most institutions started internal reflection processes on their profile and on the quality of their research.

In the United States, a large number of excellent universities are financed from private sponsors, but there are also a large number of excellent state-financed universities. Researchers from both types of universities can receive funds from the National Science Foundation (NSF). In this model the majority of research universities have been very stable over a long period of time. Nevertheless, the precise rank of the universities did change over time such that they are continuously forced to renew their effort over and over again.

Lessons-learned:

- The quality of university research can be increased by a country-wide initiative putting emphasis on scientific excellence.
- Excellence initiative can induce universities to sharpen their profiles.
- The set of the universities of excellence in a country may vary over time.

Recommendation 6: A process of profiling and merging of universities should be induced to avoid "mushrooming" and improve impact and critical mass

Ukraine has about 300 organisations calling themselves higher education institutions; however, many of them are devoted to a narrow subset of disciplines. Around 20 universities are located in Kyiv only.

Not at least because of the predicted shrinking number of student enrolments, it seems in the medium term unavoidable to re-structure and re-dimension the higher education system in Ukraine. To prevent a further 'mushrooming' of higher education institutions in Ukraine, which would also make the overall governance and quality assurance within the higher education sector highly complex, two approaches are suggested: one is to introduce strategic mergers of existing universities to establish critical masses. The second approach is to strategically work on distinct profiles for universities to make them distinguishable from each other in terms of their missions, functions and roles. These two approaches can also be combined.

Publications from the European University Association (EUA) indicate that the "merger" and "profiling" of universities is on the agenda in quite a number of European countries (see Box 6). The PSF Panel wishes to draw the attention of the Ukrainian authorities also on the issue of the quantity and quality of higher education institutions in Ukraine and to carefully start to induce and elaborate a process of merging universities and/or on shaping the profiles of existing universities. The Panel advises to draw on the available expertise accumulated by the EUA.

Box 6

Inspiring Practice

Re-structuring of the higher education and research system in Denmark

Denmark went through an extensive wave of university and institute mergers in 2006, most of which were inaugurated on 1 January 2007. New universities were established on the basis of mergers between universities and between universities and government research institutes: 25 universities and research institutions were reduced through merger to 8 universities and three research institutions. The purpose of the mergers was to integrate research into the universities, connecting it better with education and other research, while outsourcing investigative and regulative functions to other agencies. As a result, the major part of the publicly supported R&D now takes place at the universities. It also aimed to strengthen the sector in the international setting. The question of university profiles did not exist as a key issue for the mergers at the time of the merger process but it did in certain ways act as a change driver.

The mergers had a clear top-down approach when in the winter of 2006 the Danish government announced its desire to see voluntary mergers between universities and governmental research institutes. The universities were to report their response, including preferred partners, to the government within a couple of months. An intensive exploration began of who could possibly partner with whom. Some were essentially positive about merging while others resisted and some refused. Rectors and university board chairs met and negotiated. In April, the universities reported back to the government. Further discussions followed between the government and the universities as well as the institutions concerned, and a preliminary outcome was presented in June. The respective institutions were told to keep discussing and preparing for a merger with their chosen partners, and to report back again to the government in September. A formal governmental decision regarding the mergers was taken in October, and the mergers took place from 1 January 2007, with some exceptions (for instance, the Danish Pedagogical University merged with Aarhus University later in 2007; and a few smaller units were merged at later stages).

During the University Evaluation in 2009 the effects of the mergers were not yet fully materialised. Some years ago the changes seemed to have caused organisational overload and weak integration of the institutes. Today, however, experts often link the good research performance of Danish universities partly with its mergers (as well as other changes in the system).

Lessons learned[100]:

- Any merger needs external support (including financial), i.e. high political support as well as support from stakeholders in the surrounding region, both from business and politics.
- The process speed must be considered. A short preparation phase requires a longer phase of 'post-merger healing'; too long of a preparation phase may put certain questions on hold.
- In some cases a re-organisation of the new institution is likely to happen after the merger, or after a few years.
- For democratic and collegial reasons it is important to involve staff and at least to some extent also students in the merger process.

Recommendation 7: All research organisations of the Academies of Science and universities should be entitled to their own discretionary use of acquired third party funding

Commitment for scientific fundraising should be seen as a driver for excellence and competitiveness. Investments in research, particularly related also to the so called 'third mission' of universities (see Recommendation 5), should be regarded as an incentive for active researchers and their organisations. (e.g. for paying additional salary premiums or for procuring research infrastructure or for establishing institutional support structures on a basis of strategic R&D development plans).

Therefore, the PSF Panel recommends that surplus budget generated by research institutes and universities (e.g. through third party financing, consultancy work, contracts with industry etc.) should not be given back to the treasury, but rather the use of surpluses generated through third party funding and financing should fall under the autonomy of the research institutes and universities. This also implies that all 'third mission' activities should be channelled through a research institute and/or universities where the researchers are located instead of it being individual private activities of researchers (unless, of course, this is allowed by their employer).

[100] *For more information, see:*

Aagaard & Schneider (2013). Relationships between policy, funding and academic performance — Examination of a Danish success story. In Hinze & Lottmann (eds.). Proceedings of 18th International Conference on Science and Technology Indicators, pp. 19-28.

Melin, G. (2015) University merge processes. In R.M.O. Pritchard et al. (Eds.), *Diversity and Excellence in Higher Education*, pp. 31-51. Sense Publishers.

Peer review of the Danish Research and Innovation System: Strengthening innovation performance (2012).

In this context universities should be enabled and empowered to operate hard currency accounts, which is a necessity for successful engagement in European projects, in particular as coordinators of such projects.

MESU should establish such a regulation together with the Ministry of Finance. Several EU Member States have introduced autonomous budgeting and financing elements within their public research sector which can be used as inspiration for an adequate Ukrainian solution.

3.4 Raising the efficiency and the contribution of the Academy of Science of Ukraine

Recommendation 8: The National Academy of Sciences of Ukraine should streamline its current profile and concentrate its priority focus

In these times of economic crises and dramatic brain drain Ukraine needs the intellectual and creative brainpower of the National Academies of Sciences of Ukraine. The members of the Academies are among the "best and brightest scientists" in the country. Among all Academies, the National Academy of Science of Ukraine (NASU) has a special responsibility. NASU receives about 50% of the public money for R&D. In these circumstances it is necessary to pro-actively open the window to society and to convince the public that the organisation is serious in delivering "value for money". That in itself will not be easy. Already in a 'frozen' financial situation the decision of the Presidency of NASU to put more efforts in national priority areas or to enter new research fields will have as a consequence the reduction or even termination of activities in other fields/areas. This may include the ultimate termination of institutes which are not performing well. In any case, the troublesome financial situation is no excuse for inertia in the sphere of decision-making for supporting the internationally outstanding in-house research groups and for raising the efficiency of the administration.

NASU sees as one of its primary tasks to support the progress of Ukrainian economic development. In the coming period the government will [again] decide – in consultation with the stakeholders [among them NASU] – to concentrate its economic drivers in areas like ICT, new materials, high tech instruments, food/agriculture etc. The PSF Panel advises NASU to make explicit how the research activities of its institutes will contribute to innovative progress in these national priority areas and report annually about the results. There is also a need to define more targeted niches within these broad fields where Ukraine holds promising assets (see Recommendation 24). This does, however, not mean that NASU should refrain from conducting fundamental research, but also in terms of fundamental research priority-setting is strongly advised.

The addressee of this policy option is the strategic authority of NASU. Such a strategic re-orientation should not be done in isolation but in close coordination with the National Board on the Development of Science & Technology in Ukraine, also including interactions with actors outside of the science sector.

By the end of 2017, the Presidency of NASU should communicate a strategic plan for each of the various priority areas selected by NASU, defining the corresponding research lines, the amount of manpower, the institutes involved, impacts already achieved and the collaborating national and international partners or networks. MESU is requested to demand this strategic plan from NASU, which should also serve as discussion input to the priority identification process which should be exercised by the National Board on S&T (see Recommendation 1). NASU is prompted to document how it structures and supports its identified priority areas, e.g. through shifting budgets to these areas from under-performing areas or non-priority areas, in yearly progress reports drafted by the Presidium of NASU and delivered to the government of Ukraine.

Recommendation 9: The Academy of Science of Ukraine should make its institutes' organisation more effective through regular independent evaluation exercises

NASU is the dominant research organisation in the country and comparable in its aims with organisations like Max Planck Gesellschaft [Germany], CNRS [France], Austrian Academy of Sciences etc. Organisations responsible for national research institutes organise periodic evaluations according to international standards to enable learning, strategic decision-making and to demonstrate accountability and legitimacy by assessing the quality, relevance, usefulness, efficiency and efficacy of its work and the work of its institutes. NASU has decided to explore an approach oriented on procedures applied by the Leibniz Association [Germany].

The PSF Panel is of the opinion that NASU should take the results of the ex-post evaluation of the performance of its institutes seriously into account and to focus its decision-making strongly on the conclusions of the international panel. These conclusions have to deal with the future strategic significance of an institute both for the exploration of new scientific frontiers and for the socio-economic impact of the research.

Currently, however, only a selected number of NASU research institutes have been evaluated along the adapted Leibniz model. The PSF Panel urges NASU to evaluate ALL research institutes and research groups within the next four to five years maximum. This evaluation should lead to a process of concentration along a basic decision on strategic re-orientation (see Recommendation 8) and a continuous improvement and increasing competitiveness of the research undertaken under the umbrella of NASU. The evaluation cycle should be repeated every 5 to 7 years.

Those institutes and research groups which perform far below the Academy's benchmark should be terminated and the freed budgets should be invested in the best performing research groups and the most pressing upcoming challenges. The percentage of institutes and research groups to be closed down is assumed to be in the range of 10% to 15%.

Since the evaluation is a step-by-step process, it is suggested to evaluate firstly those institutes and research groups which are considered to be significant in terms of the priority setting and profiling process of NASU which is recommended by the PSF Panel (see Recommendation 8). NASU should produce an operational document on how to organise and implement the external evaluation within the next 4 years. This document should include an explanation and logical order on when to evaluate which institutes and research groups.

The results of the evaluation should be communicated to the National Board and the Government of Ukraine. These results (or lack of them in case these are not presented) should be taken into account in preparing the request of NASU for the next year.

This policy option falls under the autonomous decision-making of NASU. The necessary strategic re-orientation based on the evaluation results should, however, not be done in isolation but in close interaction with the National Board on the Development of Science & Technology in Ukraine.

Recommendation 10: The Academy of Sciences of Ukraine is advised to initiate several science communication activities

NASU is also a "Learned Society" and in this capacity it is the preeminent organisation to stimulate the necessary public awareness for the importance of science for tackling societal problems, wealth creation and cultural heritage. What science can tell about facts, insights – even scientific controversies – to the general public and to decision makers becomes more and more important. Topics could be: Alzheimer, climate change, resistance against antibiotics, big data, global population growth, etc.

A lack of wider public recognition of the importance of science, research and innovation for a better society and economy in Ukraine is a big hurdle for the governmental action in support to the research and innovation system. Allocating scarce public money, which already faces fierce competition, to this domain requires the support of society as a whole, beyond the small fraction of people directly involved in science and research. Advocating the restoration of "the prestige of science" and improving the status of researchers are not likely to be met favourably in the wider society if this is not accompanied by demonstration of the "value of science and research for the people". Good intentions and well prepared proposals will be blocked at Parliamentary level if the society is not prepared to see these investments as vital for the country.

It is notoriously difficult to change mentalities inherited from past systems, but the power of demonstration effects and positive role models has been used in many countries, especially targeting the younger part of the population, to help nurture such gradual evolution.

Therefore, the PSF Panel advises NASU to enhance in its autonomous capacity as a "Learned Society" several science communication activities (like symposia, TV specials, etc.) to strengthen its "science for society" nexus.

Recommendation 11: The Academy of Sciences of Ukraine should broaden the diversity of its Human Capital, with particular focus on age and gender balance

In order to introduce more dynamism and a broader diversity of views and in general more societal relevance, many academies have started activities to reduce the average age of the members, to increase the number of female members and to restrict membership periods of the Board/Presidency to active/younger members. Given NASU's skewed distribution in terms of age and gender, especially but not only in its highest decision-making bodies, such changes are considered especially relevant for NASU.

The PSF Panel advises NASU to reflect international developments aimed at diversifying human capital structures within large research organisations and to act accordingly. NASU should set the target that the members of the Presidium, which carry out management positions, are younger than 70/67 years of age (male/female) and that the percentage of female members is more than 25%.

In addition to such interventions which target the Presidium, the PSF Panel suggests to introduce in general more diversity in NASU's human capital structure. This refers also to the composition of different bodies and panels as well as to the composition of research teams in all institutes. It would be worthwhile to consider the European Charter for Researchers in this respect.

This policy option falls under the autonomous decision-making of NASU. The PSF Panel acknowledges the measures already introduced by NASU, such as (i) that also extraordinary members of the Academy can become members of the Presidium, which automatically leads to more diversity or (ii) that the number of terms at office is reduced to two. Further measures, however, are deemed to be necessary.

Recommendation 12: The Academy of Sciences of Ukraine and universities should promote publications in international journals and downsize in-house publishing

Excellence in public research activities goes along with a wide diffusion of research results in acknowledged professional international journals. Ukrainian scientists tend to rely too much on publishing in Ukrainian and Russian which de facto prevents diffusion on a global scale and international research cooperation. The PSF Panel advises universities and NASU to promote the use of English in publications and to introduce this element in the criteria for individual and institutional assessments. Articles and books in Ukrainian should be allowed in relevant scientific areas in which they are the natural vehicle of transmission, such as Literature, Cultural Studies, History, etc.

In addition, the world of scientific publications faces the introduction of new business models. The Internet facilitates completely new ways of communication between scientists all around the world. Open access journals appear and open data are strongly discussed. This drastically undermines the value of articles in journals that are not widely available, and sometimes only edited for the prestige of a few influential researchers, often in irrelevant fields, if evaluated against the priorities of the country.

As a consequence, NASU and the universities should downsize their publishing-house activities by safeguarding only those scientific journals that have a competitive impact factor. Preference should be given to those which are edited in English.

3.5 Raising the efficiency of other research performing organisations through institutional reforms

Recommendation 13: The Sectoral Academies of Science should be modernised drawing on the transformation model of the National Academy of Science of Ukraine

One could imagine discussions about how NASU and the Sectoral Academies of Sciences could be positioned vis-a-vis ministries and whether new organisational structures of the science system are desirable. However, Ukraine is currently in a very difficult situation and cannot afford wasting time and energy. Everything that is presented about NASU in this report is – with possibly slight modifications per Academy – also applicable to the Sectoral Academies.

The PSF Panel acknowledges autonomous reforms to modernise Sectoral Academies such as the one conducted by the State Academy of Agriculture and Ecology of Ukraine. In addition to such

efforts, the PSF Panel suggests to transform the existing Sectoral Academies of Sciences along the recommendations directed to the national Academy of Sciences of Ukraine (NASU). This refers especially to the previous Recommendations 7, 8, 9, 10, 11 and 12.

Recommendation 14: The institutes in the sphere of MESU and other ministries should be evaluated and – depending on the obtained results of these assessments – restructured or dissolved

The system of research in Ukraine is highly fragmented. This holds also true for the institutes which are directly subsumed under MESU. Some of these institutes appear to operate without strong external accountability. Some are operating more successfully than others and for some it seems questionable if their core operations are research-based and/or efficiently policy oriented. Also the system of state financing of these institutes is rather opaque and lacks transparent regulations.

The PSF Panel is therefore of the opinion, that MESU should only be directly responsible for mission, strategy, management and financing of those institutes which directly serve the political tasks of the ministry by providing relevant intelligence, evidence and/or operational support. To assess whether such functions are truly performed in an efficient and effective manner by the institutes in the sphere of MESU, these institutes should be comprehensively evaluated.

Those institutes whose performance is weak should be either reformed or terminated. For those institutes which are performing well but which do not fulfil a support function for MESU, the PSF Panel considers two options for disentanglement, which should be based on a serious SWOT analysis of the institutes and should be decided in consultation with them and not as a top-down decision by the Ministry:

1. Integration of suitable research institutes into appropriate universities.
2. Integration of suitable research institutes into (institutes of) the National Academy of Sciences of Ukraine or the Sectoral Academies of Science if appropriate.

Depending on the choice(s) of integration selected, the receiving organisations themselves should be put in a position to strategically supervise, finance, control and (externally) evaluate these newly integrated research institutes. After a certain period of consolidation, which should be based on some kind of performance agreements, the institutes should be again evaluated. Institutes which do not pass the evaluation should be either dissolved or radically re-structured.

In order to find out which combinations might be most promising, institutes should be incentivised to start projects, possibly with universities, NASU institutes or other partner organisations through participating in competitive funding endeavours, organised for instance by the National Research Foundation. This will help to see which relevant combinations emerge.

Taking note that in addition several other research institutes are directly under the authority of other Ministries in Ukraine, the PSF Panel proposes to extend this procedure in the mid-term also to these other research institutes.

Box 7

Inspiring Practice

Lithuania's experience in dealing with research institutes

There have been many changes in the research and innovation landscape of Lithuania since its independence from the Soviet Union in 1991. Decisions on restructuring, changes in the R&D funding, and setting of research priorities were based on evaluation of science – often involving not only national but also international expert groups. The need (especially on a regular basis) for such evaluations was understood at the very beginning of transformation. One of such decisions was in relation to the restructuring of the network of research institutes and universities, which happened in several phases. Certain restructuring took place in the early days but did not produce too many expected outcomes. In 2000–2001, stronger actions were taken to merge the higher education sector with research institutions. After the adoption of the 2009 Law on Higher Education and Research, the research institute landscape was further restructured.

During the 1990s, the group of industrial research institutions, including Soviet-type branch institutes, gradually faded away; 29 of former Soviet research institutions were transformed into state research institutes (guaranteed state budget financing); 13 research institutions became

departmental scientific institutes that on contractual basis received project-based funds from the ministries; another 6 became part of higher education institutions. In addition, there are 9 non-state research institutes. Many of the former institutes of higher education were reorganised into universities.

The research institutes cover a broad range of research fields and play a role in various national research strategies and policies. Nevertheless, the objectives of advancing modernisation and achieving better performing HEI institutions still seem to be hampered by the highly fragmented structure of the HEI and research institute sectors. The sub-critical size of many research units impedes the setting of strategic research priorities at the institutional level.

Lessons learned[101]:

- Given the fact that the national science and research systems and agendas in the countries of former Soviet Union were largely linked to the overall structure and agenda, it is inevitable that changes are needed once the old system is no longer there.
- Transformation within the network of research institutes can be beneficial to build up research potential within universities and for dealing with issues of sub-critical size of research groups.
- The longer the fragmentation stays in the research and innovation system, the heavier the financial burden on the public resources will be in the long-term and the higher is the potential loss in strengthening the capacity of research.
- Restructuring should be based on strong evidence and unbiased assessment of research and innovation strengths and future research and innovation potentials of existing research institutes (as well as individual research units within them).

3.6 Developing talent and capacity

Recommendation 15: Research careers should be stimulated through a mix of policy instruments , such as increase in salaries, exchange programmes or awards

One of the most urgent concerns of Ukraine is not to lose furthermore large numbers of human talents. Ukraine has suffered from internal and external brain drain of researchers that might have otherwise served as high-potential individuals to build up and sustain the country's STI system and the knowledge economy.

The PSF Panel is of the opinion that a mix of policy instruments should be implemented to safeguard the scientific human capital base and to make Ukraine an attractive location for young researchers within the global research market.

A relevant policy mix also has to include salary-related elements. First, the PSF Panel suggests a general increase of the salaries for researchers. MESU should together with the Ministry of Finance and the universities implement a new salary scheme for faculty staff that takes their research activities and outputs into account.

The PSF Panel also would welcome a number of support measures being discussed, including:

- a possible extension of presidential and governmental programmes for exchange of young scientists with other countries
- a review of the award system for "outstanding research in Ukraine" with the objective to promote excellence.

[101] For more information, see:

Kristapsons, J., Martinson, H. and Dagyte, I. (2004). Baltic R&D Systems in Transition: Experiences and Future Prospects, Riga: Zinatne. http://www.lza.lv/csts/Baltic_R&D_Systems.pdf.

Martinson, H., and T. Raim (2001). Strategic Approach versus Spontaneity in Restructuring the R&D System in a Small Country. In: Government Laboratories – Transition and Transformation. NATO Science Series 4: Science and Technology Policy – Vol.34.

OECD (2016), OECD Reviews of Innovation Policy: Lithuania 2016, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264259089-en

Recommendation 16: Research administration should become leaner, ensure less red tape and get rid of inefficiencies and corruption

The management and administration of universities and research organisations as well as within MESU should be professionalised. Administration is necessary to assure the proper functioning of an organisation according to the rules of the organisation's environment and the rules the organisation has given to itself. However, the PSF Panel learned about examples of substantial inefficiencies, delays and unnecessary work leading to frustration and demotivation.

The PSF Panel recommends to thoroughly scrutinise administration processes by including the perspectives of the end-users and simplifying those processes which are unnecessary, cumbersome and inflated.

By anticipating the many reform challenges that the Ukrainian research and innovation system faces, the staff from (research) administrations from the research performing organisations as well as MESU must become trained and responsive to organise reform processes in an efficient, deliberative and acknowledging manner. Inflated administration structures need to be streamlined.

Therefore, the PSF Panel favours that the administrative staff of universities and research institutes receive training, job shadowing and mentoring in order to learn and get to know more efficient management and administration systems of other European STI landscapes. Such trainings should increase the understanding of a modern and lean concept of administration and deal with ideas of simplifying, re-structuring and organising administrations vis-à-vis the envisaged reform processes. For this purpose, collaboration should be established or further developed with pertinent university associations, leagues (such as LERU), confederations or organisations that are familiar with excellence in research management for research institutions.

Since MESU is at top of the system, the PSF Panel also believes that MESU administrators should receive capacity-building training for being more prepared and responsive for the new reform challenges to come. This is of particular importance because MESU administrators will have substantial influence on the further development of the Ukrainian research and innovation system, and, in particular, on the destiny of organisations such as universities and individuals working thereunder.

This recommendation addresses the responsible units for human resource development within MESU, the universities as well as the non-university research organisations including NASU. MESU should provide incentives for the different institutions addressed by this recommendation to set up adequate simplification plans with corresponding Human Resource Development plans and to be able to implement them in a five-year period.

Even when regulations become less burdensome and administrative procedures are diminished to a necessary extent, a fundamental change of the system takes time since individuals have to learn to adapt and to use new opportunities. The culture of organisations as well as the self-concept of individuals in organisations changes only slowly. In this respect, management training would also contribute to cultural change of the administration.

The PSF Panel heard also views during its official visit that there are serious examples within the Ukrainian system of science, research and innovation related to corruption. For example, the PSF Panel was informed about isolated stories that students in some cases pay to receive academic degrees; PhDs bribe their professors to be able to finish their PhDs; or when professors even bribe rectors to stay in their jobs. For the OECD, the anti-corruption reform in Ukraine has been an important topic.[102] The report discusses prevention of corruption and integrity of public service as very important fields for Ukrainian administration to develop. In its report from 2015, the OECD advocated among other measures to establish a National Anti-Corruption Bureau and a specialised anti-corruption prosecutor's office. The OECD report lists a number of recommendations for the integrity of public service (page 86 and 87, overview) in general. From the point of view of the PSF Panel the suggested list of recommendations also applies to administrations in the field of research and innovation such as MESU, universities, NASU and any other institutes' administrations.

MESU should communicate to stakeholders, especially the younger generation, to report cases of corruption and misuse and to make them public. The PSF Panel urges MESU to address issues of corruption and misuse vigorously.

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[102] https://www.oecd.org/daf/anti-bribery/Ukraine-Round-3-Monitoring-Report-ENG.pdf, accessed on 2 July, 2016.

Box 8

Definition

The principles of subsidiary and budgeting in administration

A useful general point of departure for organising governance structures is the subsidiarity principle that stipulates that decisions should be taken at the lowest possible level in an organisation in order to assure that the best level of information is available on the issue to be decided. Clearly, in any administrative system there have to be elements of control to prevent corruption. Controls have to be organised efficiently.

Generally, most universities in OECD countries are organised around the principle of budgeting, i.e. allocation of resources, e.g. positions and /or money to subunits, typically faculties, in order to allow them to achieve best results out of a given input of resources. The principle of budgeting goes along with rules, e.g. defining wages of scientists as well as wage limits for various categories, defining rules for scientists' travel, etc.

It should also be clear that having control over a budget means taking responsibility and accountability for certain tasks.

4. RECOMMENDATION TO OPEN UP THE RESEARCH AND INNOVATION SYSTEM TO THE WORLD AND TO ENHANCE INTERNATIONAL COLLABORATION

This chapter presents several recommendations which are considered important by the PSF Panel to open up Ukrainian research and innovation to the world and to contribute to the improvement of the system of research and innovation in through international cooperation at several levels and through several policy instruments. An important aspect in this regard has been the association of Ukraine to Horizon 2020, which should be further strategically and operationally capitalised upon.

The focus in this chapter is on policy learning from inspiring international practices to improve the domestic system of STI, specifically by introducing structures and incentives for further internationalising research at institutional and individual levels and prioritising international collaboration in domains of strategic importance.

4.1 Increasing participation in European research

Recommendation 17: The opportunities offered by Horizon 2020 should be reaped through adequate accompanying support measures and initiatives

To make optimum use of the association to Horizon 2020, the PSF Panel recommends implementing a number of concrete accompanying support measures and initiatives (see Box 9):

1. Set up a dedicated and well-staffed unit in MESU dealing with Horizon 2020 and ERA integration, which could be run by competent experts from MESU, but potentially also by MEDT and NASU. This unit should coordinate shared European STI agendas across ministries and sectors. The unit should work closely with the network of the NCPs in order to retain cooperation in the process.
2. MESU should establish a liaison office in Brussels to facilitate communication and exchange with relevant stakeholders located there. Such an office or representation should also serve as a bridge between the European level, EU Member States and Ukraine. The IGLO network in Brussels (Informal Group of RTD Liaison Offices)[103] could be approached to learn important information on what to consider and how to make optimum use of such a relatively costly infrastructure.
3. Unify the existing NCP networks into one professional, powerful and united National Contact Point (NCP) system for Horizon 2020 and other European RTI programmes and initiatives in Ukraine. Horizon 2020-related bodies, such as NCPs or Programme Committee delegates, can be important human resources to provide both operational and strategic advice on how to make the best use of Horizon 2020. The NCP system in Ukraine currently suffers from unclear duplication. An NCP system of the Ministry of Education and Science (MESU) operates aside an NCP system operated under the umbrella of the National Academy of Sciences of Ukraine (NASU). It is important that the delegates to the 14 strategic configurations of the Programme Committee are firmly embedded in national research and innovation policy making and policy delivery, and that they retain close connection to the NCP system to minimise information asymmetries, establish critical mass, speak with one voice and reduce transaction costs.
4. Establish a knowledgeable system of delegates to the Programme Committee of Horizon 2020 with the so-called 14 configurations preferably in connection and/or strong alignment with the NCP network (see point 3 above). Although several issues (such as the work connected with multilateral initiatives) are often prepared and executed outside the influence of the Programme Committees, these Committees are an important bridge between the European and the national level. They assist (and control) the EC in implementing Horizon 2020.[104] An essential part of their work should be encouraging discussions on strategic planning and on ensuring links to nationally funded activities. They also can provide opinions on the Work Programmes (with the exception of the ERC and the JRC). The members of Programme Committees are delegates of national governments.

[103] See http://www.iglortd.org

[104] Regulation (EU) No 182/2011 of the European Parliament and of the Council of 16 February 2011 laying down the rules and general principles concerning mechanisms for control by Member States of the Commission's exercise of implementing powers.

They can be assisted by external experts. Programme Committee meetings are organised by the European Commission and usually take place 3 to 4 times a year.

5. Regularly monitor participation in Horizon 2020. Programme Committee delegates have access to the eCORDA database of the European Commission and should carefully monitor and analyse how the participation of Ukrainian organisations in Horizon 2020 applications and funded projects is structured and how it develops.
6. Establish and incentivise learning cycles on the use of Horizon 2020 (i) at the level of government (ministry, top-down responsibility, but inclusive and multi-actor-centred) to design policies (see Recommendation 22); (ii) at the level of the NRF to implement policies which do not contradict European developments but rather enhance or complement them; (iii) at the NCP level to deliver best information and advice on how to successfully participate and use Horizon 2020; and (iv) at the level of research organisations and innovative companies to ensure that they are responsive and prepare their internal structures for a smooth participation in Horizon 2020 and other relevant European programmes, and that they act with a strategic approach towards Horizon 2020 (e.g. creation of a responsive environment for ERC grantees, use of RISE, TEAMING etc.).
7. Establish responsive and adequately performing administrations at universities and research organisations in order to reduce problems in participating in Horizon 2020. This requires an anticipation of the administrative precautions which come along with successful Horizon 2020 engagement (see Recommendation 16).
8. Launch national programmes to support Horizon 2020 participation, e.g. similar to the Momentum Programme of the Hungarian Academy of Sciences or the Polish "Pact for Horizon", including research proposal preparation grants, normative recognition vis-à-vis research career advancements or the award of the status of a research university. Funding for research proposal preparation can facilitate the inclusion of Ukrainian researchers by partially reducing the transaction costs associated with preparing a Horizon 2020 project (participation).
9. Participate in multilateral European initiatives including selected Joint Programming Initiatives or ERA-NETs. However, participation in multilateral initiatives (MULLATs) like for instance JPIs,[105] ERA-NETs[106] or JTIs[107] should be carefully and strategically considered. MULLATs often receive funding from national sides and Horizon 2020. Thus, participation of researchers depends on the participation and the contribution of an EU Member State or a country associated to Horizon 2020 (AC) in a specific MULLAT. Personnel capacities in terms of administration and researchers are necessary to capitalise MULLATs. It is therefore important to be well organised. It would be beneficial if participation in MULLATs is based on a national agenda, represented by nationally well embedded actors who have sufficient resources available.
10. Foster engagement in strategically important European material and immaterial research infrastructure initiatives (see more details in Recommendation 19).

Most of the activities recommended above fall under the authority of MESU. However, coordination with the National Board on the Development of S&T and with other ministries and stakeholders is also encouraged. This relates also to the nomination of delegates to the Programme Committees.

Both MESU and the National Board should engage a broad spectrum of domestic organisations to propel the opportunities provided under Horizon 2020 to generate shared ownership. Additionally, MESU and the National Board should secure good relations with regard to domestic sector policies as well as raise the awareness of domestic sector policies for research and innovation, and should make best use of returning national experts from Brussels. Programme Committee delegates should be involved in pre-meetings and alliances with other MS/AC to prepare agenda-setting.

[105] JPI is a coordination mechanism for national research programmes to contribute to solving societal challenges.

[106] ERA-nets are structures to coordinate the implementation of transnational calls financed through national budget.

[107] JTI's are dedicated organisational structure formulating research calls along the demand of industries.

Box 9

Inspiring Practice

The importance of active presence in Brussels

Brussels is the capital of EU-level policy making, networking and intelligence in the research and innovation sphere. Therefore, EU Member States (and to a large extent many Horizon 2020 Associated Countries) actively develop their presence in Brussels on many levels and through various formations[108]:

- Legislative and strategic matters of the European Research Area (ERA), the research framework programmes (currently Horizon 2020) and international STI agreements are discussed in the **Competitiveness Council**. The preparatory body for the Council meetings is the **Research Working Party**, comprised of research attaches seated in the Member States' Permanent Representations.
- The European Research Area and Innovation Committee (**ERAC**) and the other **ERA-related groups** are strategic policy advisory committees. Usually policy makers or senior experts are delegated from the national administrations; therefore, the meetings provide opportunities for mutual policy learning on EU and national level developments.
- The research framework programme Horizon 2020 is implemented by the European Commission. Strategic planning and monitoring of the programme is assisted by 14 **Programme Committees**, the members of which are delegates and experts of national governments. Note that in many cases the function of the programme committee members is closely related to the network of **National Contact Points** (NCPs, which is the main structure to provide guidance, practical information and assistance on all aspects of participation in Horizon 2020).
- Many Member States (but usually not the governments themselves directly) maintain **liaison offices** in Brussels, which act as interface between the national scientific communities and the European institutions, disseminate advice on how to access funding programmes, facilitate networking with European partners, and also help the representation of national stakeholders in the EU.
- There are **associations** of national or regional organisations, which are effective in gathering information at an early stage for future programmes and policies, and also provide discussion forums for sharing best practices and developing and promoting common positions in research and development. Probably the most influential among these are the Informal Group of RTD Liaison Offices and the European Regions Research and Innovation Network.

Lessons learned:

- An enhanced presence in Brussels is helpful to ensure active participation in Horizon 2020 as well as in EU-level policy making. It also can effectively support the internationalisation of the national innovation system.

Recommendation 18: Ukraine should become a member of COST and provide incentives for increased participation of its STI community in EUREKA

To overcome its relatively marginal position in the field of European research and innovation, the PSF Panel is of the opinion that Ukraine should explore membership in COST, the longest-running European framework supporting trans-national cooperation among researchers, engineers and scholars across Europe. COST is a unique opportunity for researchers to jointly develop their own ideas and new initiatives across all fields in science and technology, including social sciences and humanities, through pan-European networking of nationally funded research activities. COST strongly supports the mobility of researchers across Europe.

[108] More information:
- https://era.gv.at/object/document/1919/attach/COM_ERAC_RTD_Inventory_ERA_groups.pdf
- http://www.consilium.europa.eu/en/council-eu/preparatory-bodies/european-research-area-innovation-committee/
- http://www.iglortd.org/
- http://errin.eu/

COST complements the activities of the EU Framework Programmes by constituting a "bridge" towards the scientific communities of the COST Inclusiveness Target Countries, to which Ukraine would also belong. With its strong focus on enhancing the participation of COST Inclusiveness Target Countries within running and new COST actions, COST explicitly contributes to the 'Spreading Excellence and Widening Participation' Horizon 2020 goal.[109]

Moreover, to enhance its low participation in EUREKA, financial incentives for innovative companies which successfully participate in this publicly-funded, intergovernmental network, in which Ukraine is a member state since 2006, should be explored. This would facilitate the international out- and in-reach of Ukrainian companies at the European technology frontier.

EUREKA is a leading open platform for international cooperation in innovation. It is present in over 40 countries and is the only initiative of its kind committed to the 'bottom-up' principle ensuring that any R&D project with a good business plan receives support, independent of its technological nature or the type of organisations involved.

The exploration of COST membership falls under the authority of MESU. To incentivise the participation of innovative Ukrainian companies in EUREKA the PSF Panel suggests considering to hand the managing authority over to the Ministry of Economic Development and Trade.

Recommendation 19: Opportunities for international STI exposure, especially for junior and middle-career researchers, should be assured based on their contribution to research advancement

There is an obvious need for Ukraine to increase cooperation with Europe and the rest of the world, but also to enhance research cooperation within the country. One way to acquire international experience is to participate in international conferences or projects.

The PSF Panel is of the opinion that opportunities for researchers from Ukraine to gain international experience are insufficient, especially for junior and middle-career researchers. Opportunities to attend international conferences abroad and to visit international research partners should not be concentrated on a few individuals within universities or research institutions. When funds for international activities are scarce, this usually prevents PhD candidates, post-docs and middle-career researchers to gain experience in international research communities. From a long-term economic point of view, it makes sense to allocate more money to young researchers, as they are the ones who will shape the future of research in Ukraine.

MESU should be responsible to define a way to operationalise and monitor this recommendation. The collected information can also be used as part of the research performance evaluation of a university or a research institute.

The leadership of universities and research institutes (including NASU) should be made responsible to establish a travel budget fund and ensure that in particular young people may access it. The PSF Panel indicated in Recommendation 2 that projects honoured by the NRF should have a line for international travel in their budget.

Recommendation 20: Access to national and international scientific infrastructures should be improved

Researchers both from academia and business need to have access to modern research infrastructures to have the possibility to conduct cutting-edge research. In several scientific disciplines this is considered to be a *sine qua non* condition. Access to research infrastructure is especially important for (i) young researchers as part of their scientific education and early career consolidation and (ii) for companies which usually cannot afford – also due to capacity problems – their own measuring and testing equipment or other research equipment. Such access is important for companies to develop new products and/or to test (and improve) the compliance of their products vis-à-vis technical and business standards and regulatory requirements of foreign markets.

[109] See MIRRIS Policy Brief on COST, https://www.zsi.at/de/object/news/4206; accessed on 20 July 2016.

The PSF Panel sees the need to provide better equipment as well as access to (domestic and international) scientific infrastructure, especially for young researchers. Moreover, the Panel believes that national research infrastructures should also become accessible for companies registered in Ukraine.

MESU should seek to establish beneficial agreements with European research infrastructures and should secure necessary budgets, also from the EU through the so called INFRAIA calls launched under Horizon 2020 as well as from international sources, that allow Ukrainian researchers to have access to these research infrastructures and to conduct research there together with their fellow peers from other countries. Such a scheme should include a substantial quota for young scientists as well as contractual relations to prevent further brain drain.

4.2 Enhancing research quality by using the expertise of the Ukrainian diaspora

Recommendation 21: Cooperation with the scientific diaspora should be increased in order to exploit its potential for Ukrainian STI

Ukraine has suffered emigration of researchers who might have served as high-potential individuals to build up the STI system and the knowledge economy.

The PSF Panel is of the opinion that an active approach towards the Ukrainian scientific diaspora is purposeful and necessary. This could be done through two basic approaches, which are both based on a thorough process to identify top researchers in the diaspora. First, an inviting and welcoming spirit should be created to engage the scientific diaspora in interacting and cooperating with local research teams. Second, a few outstanding researchers can be either selected on a competitive basis (see Box 10) or headhunted. They have to be financially sponsored to re-settle back in Ukraine or come to the country for a longer-term period (e.g. minimum of 3 years). Potential researchers should be chosen in a process of international peer evaluation organised by independent experts from non-Ukrainian research funding organisations such as ERC, or any other acknowledged research funding organisations, such as DFG or the National Science Foundation. They should be rewarded with favourable working conditions. It is advised to use also existing European instruments for this purpose.

The PSF Panel, however, believes that attracting individuals from the Ukrainian diaspora will be difficult in the current situation. Therefore, the Panel recommends primarily systematically addressing and 'exploiting' the potentials of the Ukrainian diaspora, because such interactions can also facilitate the necessary change of research culture. Not only homecoming experts but also partners from the diaspora abroad can be considered as "cells" of innovation in and for the Ukrainian STI landscape. If welcomed, they will also be instrumental in supporting further internationalisation of the national system by using the connections to foreign institutes in countries where these researchers from the diaspora are located.

MESU and the National Board on the Development of S&T should prepare an action plan on how to properly address and engage the Ukrainian research diaspora in the reform process and in research collaboration at the working level.

As a first step, a database on the Ukrainian diaspora should be established for active communication and outreach measures.

It is furthermore advised to use bilateral S&T agreements between Ukraine and other countries as a basis to prepare joint projects between domestic researchers and colleagues from the diaspora. Moreover, the Ukrainian diaspora should also be invited to participate together with local principal investigators in submitting proposals in competitive research funding schemes organised by the National Research Foundation.

Box 10

Inspiring Practice

Targeted programme of the Hungarian Academy of Sciences to alleviate brain drain

The Momentum Programme[110] of the Hungarian Academy of Sciences (HAS) aims at alleviating brain drain by attracting internationally acclaimed young scientists either from abroad, or keeping them in Hungary. Calls for applications have been published annually since 2009, and are open to promising young (typically under 38 years of age) researchers as well as leading researchers under 45. In the selection process, preference is given to researchers active abroad but wishing to return to Hungary (usually 20-30% of the successful applicants are repatriates). International excellence is sought within both categories: applications must be submitted in English, and the programme explicitly requires that successful applications to European Research Council (ERC) funding shall be targeted by the applicants within 3-5 years.

Successful applicants may establish research teams in host institutions (both within the HAS research network, or universities since 2011) to work on new research themes rather than promote existing ones. Annual funding for the teams is EUR 65.000 – 200.000 for 5 years. Around 10-15 new research teams are established every year (with the exception of 2012, when 37 Momentum grants were awarded). In total 121 research teams (68 in HAS institutes and 53 in universities) have been supported, and the programme's annual budget is around EUR 10-12 million in total since 2013.

The performance of a research team is evaluated thoroughly after 3 years, and as a result the grant can be terminated or continued. For successful research teams (only for those operating in HAS institutes) there is even the possibility to be finalized, i.e. their annual financing is permanently added to the institutional financing of the host institute. Experience with the Momentum programme shows that it effectively contributes to a dynamic renewal of the research institutions which host the fellow, and that researcher mobility is promoted.

Lessons learned:

- To alleviate brain drain, not just researchers already abroad should be targeted
- Managing one's own research ideas and establishing independent research teams is an important milestone in one's career, and therefore an effective incentive for young scientists to stay/return home
- Even small scale programmes promoting excellence, mobility and new research themes have considerable modernising effects on the institutional level as well

4.3 Policy learning and strategic decision-making

Recommendation 22: The association to Horizon 2020 should also be used as a source for policy learning

The association agreement signed between the EU and Ukraine has shown Ukraine's willingness to move along the path of internationalisation of research. Success and failure of Horizon 2020 participation is not only an issue of the quality of researchers (in many ways) and their structural embedding, with sufficient provision of relevant information and advice to individual researchers (usually done by NCPs), but it is also an issue of how national STI policy is ready and capable to address and exploit the possibilities offered by Horizon 2020 and ERA with new governance approaches.

The PSF Panel encourages Ukraine to consider Horizon 2020 not just as a powerful source of funding for (public-private) research partnerships, but also as a source for policy learning. This necessitates active participation of Ukrainian high level experts in several bodies, foremost ERAC (European Research Area and Innovation Committee) which advises the Council, the Commission and EU Member States on the full spectrum of research and innovation issues in the framework of the governance of the European Research Area. In ERAC a representative of each associated country is invited as observer. They have the same speaking rights as participants from the EU Member States. If a vote concerns a document that has any bearing on the Associated Countries,

[110] More information: http://mta.hu/english/lendulet-momentum-programme-106053

the views of their representatives shall be heard before the vote is taken. Representatives of Associated Countries can also participate in ERA groups and ad-hoc Working Groups.

The PSF Panel considers it important that Ukraine follows closely the activities of the European Research Area (ERA)-related groups and aspires for policy learning with and from them. Ukrainian RTI policy makers should start preparing a pragmatic national ERA roadmap to compare the different legal, thematic and operational approaches between Ukraine and the EU Member States in terms of the pertinent ERA dimensions and to reflect a strategic alignment. The order of alignment could be based on a "strategic cost-benefit approach".

Opportunities triggered by the European level through Horizon 2020 or ERA should be used to generate policy spill-overs to enhance the national agenda (e.g. new agenda of competitive funding policy; institutional [funding] regulations by anchoring European issues in performance contracts with universities; strategic orientation of important stakeholders) and for the best combination of national and European policies. This is for instance attained by strategic participation in European multilateral initiatives (e.g. JPIs or JTIs; see Recommendation 16).

This recommendation is addressed to MESU and the National Board on the Development of S&T.

Recommendation 23: International collaboration efforts in STI should be aligned with national priorities and strategie

The current science and technology cooperation agreements tend to be highly general and thus scarcely aligned with national strategies and priorities, which is partly also caused by different interests of the partner countries. Since the association of Ukraine to Horizon 2020, the cooperation between researchers from Ukraine with European Union Member States and other countries associated to Horizon 2020 is served on a broad competitive basis. Putting increased priority on those fields where Ukraine holds more promising assets and competences would help reinforcing Ukrainian nodes of excellence which are well connected to foreign actors specialised in the same field.

Therefore, the PSF Panel recommends discussing a more strategic alignment of internationalisation policies with national priorities and strategies. This relates to all uni-, bi- and multilateral levels. As regards bilateral science and technology cooperation, the existing agreements should concentrate on a few key partners in the midterm. In the short run, however, existing bilateral agreements with EU partners should, if possible, be jointly transformed into instruments that incentivise the creation of tri- and multilateral research consortia to prepare the ground for further submissions under Horizon 2020. In addition, such agreements should also be capitalised, if possible, to forward horizontal priority concerns such as raising public awareness of science and innovation.

This recommendation falls under the authority of MESU based on consultation with the National Board on the Development of S&T. However, also the Ministry of Economic Development and Trade (which promotes high-tech industries) and NASU, which also has several agreements, should be involved. Several steps can be made with this regard, namely:

- A review (or quality check) of various existing bi- or multilateral agreements should be made to draw a picture of who on the national level is involved and the results brought through these agreements.
- Decide on the challenges to be addressed and the priorities to be set based on the deliberations of the National Board on the Development of S&T.
- Design the future programmes in collaboration with different partners in Ukraine.

5. RECOMMENDATIONS TO BUILD A CONDUCIVE FRAMEWORK FOR AN INNOVATION-DRIVEN ECONOMY IN UKRAINE

As highlighted in the PSF Panel's core messages, Ukraine needs to innovate its ways to growth, which requires a cross-government effort involving the intellectual, material and financial assets of the country. Therefore, Ukraine should place science, research and innovation high on its national policy agenda. The country should develop a cross-governmental Research and Innovation Strategy and corresponding instruments aimed to facilitate economic growth and societal wellbeing by acknowledging the importance and exploiting the potential of science, research and innovation.

The PSF Panel believes that the importance of innovation in a broad sense, both for the economic and the social development of the country should be better promoted, valorised and actively taken up by research stakeholders.

In this Chapter the PSF Panel proposes recommendations to guide the transformation of the research system towards innovation. These policy recommendations address two levels: the governance level (section 5.1) and the instrumental level (section 5.2) to operationalise innovation policy objectives connected to the system of research.

The PSF Panel is convinced that innovation is much more than the successful commercial exploitation of results of research coming from the public sector. To flourish, innovation needs many more elements than the availability of good and relevant research. Many innovations emerge without a link to formal research activities. In other words, research in some sectors of the economy is neither necessary nor sufficient to generate innovation. Therefore, the Ukrainian government should take a broad-based view of innovation, where not all inputs come from the science sector and where not all results obtained in the private sector are based on technology transfer from the science sector and the exploitation of research results. Given the current situation of the Ukrainian economy (characterised by a weak "demand side"), a too narrow focus on science-for-innovation, although doubtlessly a strategically important and central element of the whole innovation picture, is unlikely to be successful.

The promotion of non-technology-based innovation and of innovation that is not derived from the exploitation of public research is a subject that is beyond the scope of the Peer Review Panel's mandate. It remains, however, an important issue to be considered by the Ukrainian government in view of developing a broader base for innovation, and hence more impact on economic competitiveness and growth in the country.

As regards the forthcoming Law on Innovation, the Panel favours that the new Law will not be overregulated, but remains workable by providing space for bottom-up and top-down interaction involving all relevant stakeholders in order to provide solid foundations for an innovation policy for Ukraine.

5.1 Putting innovation high on the political agenda

Recommendation 24: Elaborate a cross-governmental Innovation Strategy and Action plan focusing on priority domains for science- and technology-based innovation

Innovation is widely acknowledged to be the most important driving force for economic growth, yet Ukraine's economy is still very much dependent on exploitation of natural resources and low-tech activities. There is a need to reach a government-wide consensus on the importance and the pervasive role of innovation for all sectors of life in Ukraine. This requires a dedicated space and cooperation mechanism where all Ministries can communicate their views and exchange with others on the best ways to integrate innovation into their priorities and action. This will help address the current fragmentation, resulting in a lack of consensus across the Ukrainian government on what innovation is and how it can benefit Ukrainian economy and society. In particular:

- The **Ministry of Education and Science** emphasizes innovation as the valorisation of results from scientific and research activities carried out in public research organisations, into the private sector (cfr. Law on Scientific Research and Development Activities);
- The **Ministry of Economic Development and Trade** sees innovation mainly under the auspices of support to start-ups, in particular in ICT applications (cfr. the High-Tech Strategy of Ministry of Economic Development and Trade);

- There is no evidence that other **line Ministries** (including Health, Environment, Agriculture, Youth and Sports, etc.) see their remit as encompassing innovation promotion;
- The **Ministry of Finance** oversees the State budget preparation on an annual basis, under very tight constraints. In this process, there is insufficient information on the returns on public investments in research and innovation, which would support a view that those expenses are long-term investments rather than short-term expenditures;
- The **National Academy of Sciences of Ukraine** should be also committed to contribute to innovation generation in the Ukrainian economy (see Recommendation 8).

While the first two angles have merits on their own, they are not sufficient to support the deployment of "open innovation" in Ukraine, namely innovation which derives from cooperation between many actors: companies, research institutions of all types, users, NGOs, civil society, and public authorities (an "innovation ecosystem"). Government's role should be to enable and support this ecosystem through the appropriate policy instruments.

In particular, possibilities for public-private partnerships around innovation are highly restricted in Ukraine: promoting this falls in between the competences of Ministries of Education and Science and of Economic Development and Trade. Other Ministries also have a potentially important role through redirecting their action where possible in more innovation–friendly modes, incorporating innovation in public procurement and acting as first customers of innovations. Cross-government coordination of innovation policy and strategy is essential, and should also open up more budgetary lines for the promotion of innovation (rather than restricting the discussion around the "science and research" budgets).

In other words, innovation is a "homeless policy" in Ukraine and there is a need to create a "home" for it at cabinet level. There are many inspiring examples from EU Member States that have followed this route of creating new mechanisms to support cross-governmental action for innovation. Such an arrangement will work better than the current situation where synergies between policy action by, respectively, the Minister of Education and Science and the Minister of Economy and Trade, are not promoted.

Therefore, the PSF Panel recommends to the Cabinet of Ministers of Ukraine to develop a National Innovation Strategy, based on the work of the National Board and its working groups. It should aim to identify the overall role of innovation for development in Ukraine, assess the present situation highlighting assets and constraints for Ukraine as an innovation-driven economy, and present ways forward in terms of priorities for supporting innovation. Priorities should include both thematic priorities (such as raising awareness of innovation in SMEs, improving access to innovation finance, etc.) and the domains where Ukraine holds the most promising assets for innovation-based development (see Box 11 and 12). The Strategy should include an Action Plan that translates the broad directions into operational instruments, indicating goals and responsibilities for each of them (funding, implementation) and highlighting the priority fields. Attracting private funds for innovation should constitute an important component of this Strategy. This work should be supported by international experts where possible.

Box 11

Inspiring Practice

Mix between "horizontal" and "vertical" priorities in Catalonia

Research and innovation strategies should rely on the identification of priorities on which policies should concentrate in order to ensure maximum leverage. Two types of priorities for research and innovation can be distinguished:

"Horizontal" priorities targeting functions of the research and innovation system, such as: developing science-industry links; improving conditions for knowledge-based start-ups; fostering skills and competences for the system, etc.;

"Vertical" priorities targeting activity domains in which the country holds specific strengths both in economic and in research terms, thus offering good prospects for innovation-based development (e.g. advanced medical equipment, marine energy technologies, etc.).

The smart specialisation strategy conducted in Catalonia in 2013 has four pillars. The first two target "vertical" priorities while the last one concerns "horizontal" priorities for a better functioning of the innovation ecosystem.

Pillar 1 Leading sectors: the aim is to enhance the competitiveness of the business fabric by improving the efficiency of production processes, promoting internationalisation and reorienting established sectors towards activities with greater added value. Seven leading sectors are identified in the strategy: 1. Food; 2. Energy and resources; 3. Industrial systems; 4. Design-based industries; 5. Industries based on sustainable mobility; 6. Health industries; 7. Cultural and experience-based industries;

Pillar 2 Emerging activities: the aim is to promote new emerging economic activities through research, creativity and innovation in order to create and exploit new market niches, such as: mobile applications, printed electronics and biomass;

Pillar 3 Cross-cutting technologies: the aim is to consolidate Catalonia as a European knowledge hub and to connect the country's technological and creative capabilities with existing and emerging sectors in the territory;

Pillar 4 Innovation environment: the aim is to make global improvements to the Catalan system of innovation, improving the competitiveness of companies, particularly SMEs, and orienting public policies towards the promotion of innovation, internationalisation and entrepreneurship. This pillar covers elements from other policy domains: training and education, infrastructure, organisational and managerial competences, as well as the quality of the innovation support eco-system.

Lessons learned:

Priorities in research and innovation strategies should target both generic bottlenecks in the innovation system as well as focus on those areas of activity where the greatest potential exists for contribution to socio-economic development.

Box 12

Inspiring Practice

Criteria for the definition of research and innovation priorities in Ireland

The prioritisation exercise carried out in Ireland used four high-level criteria:

1. The priority area is associated with a large global market or markets in which Irish-based enterprises already compete or can realistically compete;

2. Publicly performed R&D in Ireland is required to exploit the priority area and will complement private sector research and innovation in Ireland;

3. Ireland has built or is building (objectively measured) strengths in research disciplines relevant to the priority area;

4. The priority area represents an appropriate approach to a recognised national challenge and/or a global challenge to which Ireland should respond.

Lessons learned:

Prioritisation of research and innovation strategies should simultaneously include criteria relating to research excellence, economic potential, interaction between research and economy and relevance for society.

Recommendation 25: Ensure representation of the Ministry of Economic Development and Trade and innovation actors in the National Board on the Development of S&T

The National Board of Ukraine on the Development of Science and Technology addresses issues relevant for the improvement and upgrading of the public science sector. It is geared at fostering better organisation, more effectiveness and more cooperation within that sector. Its composition reflects the diversity of components of the public science sector. Its main remit is to prepare proposals in view of raising the quality, sustainability, efficiency and effectiveness of the public science sector. There is a risk that effectiveness is seen by this Board exclusively under the angle of "excellence of science". However, in the Law on Scientific and Technical Activity, the Board has also in its remit a responsibility to "prepare proposals regarding mechanisms of commercialisation of scientific research findings jointly with representatives of actual and financial sectors of economy and other interested parties" (art.20.7.13). The PSF Panel has in subchapter 3.1 clearly indicated that the National Board should focus its short-term agenda on a few important activities to radically

re-orient and speed-up the system of S&I in Ukraine in order to ensure not only better quality but also more relevance for public research. Innovation is thus a key element in these agenda items for the National Board.

The incorporation of representatives of economic policy and innovation actors in this Board aims at addressing the fragmentation between different categories of stakeholders in the national research and innovation system, by bringing them together to discuss the best and most realistic options for driving Ukraine towards a knowledge-based economy.

Therefore, the PSF Panel recommends having a high-level representative of the Ministry of Economic Development and Trade with a permanent seat in the Administrative Committee of the National Board on the Development of S&T. His/her role would be to bring the perspective from the economic sector into the discussions of the National Board, which is complementary to the views of the public research sector.

Additionally, all relevant constituents of the Innovation Ecosystem should be represented in this Administrative Committee. This possibility should be fully exploited by providing seats (perhaps on a rotating basis) to a variety of structures which are playing a role in innovation support (incubators, business support agencies, business accelerators, NGOs devoted to innovation, venture capital funds, etc.).

This recommendation is addressed to the stakeholders in charge of nominating the members of the Administrative Committee of the National Board on the Development of S&T.

Recommendation 26: Establish a permanent working group on innovation together with consultative processes under the National Board on the Development of S&T

Well-founded proposals on all matters relevant to the promotion of innovation in the productive sector (which includes primary industries, the industrial production sector and the services sector) need to be made available in order to progress towards the design of a Ukrainian Innovation Strategy. Within the current restriction of innovation seen from the angle of "research exploitation", the main and immediate task of an "Innovation" working group under the National Board is to prepare proposals with respect to "relevance of science".

To prepare its decisions in the field of innovation, the PSF Panel recommends that the National Board on the Development of S&T should make full use of its legal possibility to establish working groups and expert committees (Art.20.14). Specifically, the PSF Panel suggests that a permanent working group is created to cover the innovation issue. This working group should include, beyond Board members, representatives from the variety of actors playing a role in the innovation ecosystem (see Box 13): companies (large and small, domestic and foreign, new and established), intermediaries and NGOs in charge of innovation promotion (science and technology parks, innovation centres, etc.), innovation funders (venture capital, etc.) and technology transfer offices from universities and research institutions.

The PSF Panel has notably identified the following barriers, which provide a starting point for the identification of priority issues for the working group.

1. **Barriers on the "supply-side":** the deplorable state of the scientific infrastructure, lack of incentives for public research organisations to get involved in innovation-related activities, despite the possibility open for researchers to be engaged in business and expert activities (Article 6 of the Law), i.e. absence of a "third mission" assigned to public research organisations. Lack of entrepreneurship and innovation culture in public research sector. Leaking of research results in foreign countries where exploitation is taking place in more attractive conditions.
2. **Barriers on the "demand side":** insufficient interest in research activities from the side of the economic actors, as most domestic companies are active in sectors that are not research-intensive or knowledge-based. Lack of awareness and capacities of SMEs to undertake innovation, and need to reinforce managerial competences in start-ups established by scientists and technicians. Lack of visibility and understanding of potential in Ukrainian public research organisations from the side of companies. Public authorities not ready to use scientific and technology development results in their field (e.g. acting as "first buyer of innovation").
3. **Barriers at the interface between "supply" and "demand":** little experience in national public-private partnerships for innovation, where innovation is jointly created by researchers in the public sector and companies working in shared projects (including also

projects with an international dimension). Absence of formal and effective channels to convey messages from industry with respect to expectations from the science and education sector.

4. **Lack of prioritisation:** given severe State budget restrictions, there is a need to concentrate public support on those activities where Ukrainian research and competence base can best contribute to innovation in the private sector. This is the best approach to secure the attraction of private funds into innovation. Currently, an agreement on such activities does not exist in Ukraine. Undertaking such a prioritisation exercise starts with an identification of strengths and weaknesses of the innovation ecosystem supported by robust and independent evidence; continues with the mobilisation of key innovation actors (mix of public and private) to help obtain a view on paths for modernisation and transformation of the economic fabric; and ends up with the adoption of priorities which shape the orientation of policies (in line with the smart specialisation approach currently discussed in Ukraine).

This recommendation is directed to the National Board on the Development of S&T.

Box 13

Inspiring Practices

Consultative processes for the adoption of innovation strategies

The adoption of the **Denmark Plan for Growth 2020** adopted in 2013 relied in the involvement of key system actors in the following way:

- At national level: the government has established "Growth teams" in each of the 8 areas selected in the Growth Plan. They gather all relevant actors, present recommendations and the government develops growth plans on this basis for each growth area: Blue Denmark (maritime and related industries); Creative industries–design; Water, bio and environmental options; Health and welfare; Tourism and experience economy; Energy and climate; Food; ICT and digital growth.
- At regional level: the Growth Forums (partnership agreements including a wide range of regional stakeholders) elaborate their priorities based on evidence in the form of a multiplicity of analyses and SWOT analyses of the regions.

A Forum gathering both regional and national actors exists: the Danish Growth Council. It aims at ensuring good coordination between the two levels of governance in Denmark. It includes high level representatives of the national and regional authorities as well as representatives from the innovation community. At the operational level, the link between the national and regional strategies is orchestrated in growth partnerships agreements, in which the focus areas and actions of national and regional authorities are agreed upon.

The **Hungarian National Research Development and Innovation Office,** established in 2015, has been given responsibility to run a consultation platform that will monitor the implementation process and encourage feedback on the national innovation strategy. In developing the strategy many opinions have been collected on how to make the knowledge economy more sustainable, and how to achieve the highest levels of societal benefits through leverage effects. Discrepancies between market demand for research, development and innovation and current capabilities at universities, research institutions, knowledge transfer bodies and business R&D units, have been identified through the consultations. The consultation programme included an online survey on priorities and planning (with almost 700 questionnaires). Strategy documents have been available for online consultation and comments that resulted in more than 3,400 registered users. Finally, a series of workshops have been held in 19 counties involving almost 1,300 participants, who have worked together to define regional specialisation goals and emerging R&I opportunities (taken from: http://s3platform.jrc.ec.europa.eu).

In Catalonia, the involvement of key innovation actors was already achieved at the time of adoption of the **Catalan Agreement on Research and Innovation** in 2008. The further involvement of these actors in the smart specialisation strategy in Catalonia was ensured by public consultations, which led to final revision of the strategy. One major innovation of the strategy is the establishment of RIS3CAT communities. Those are *"voluntary associations of companies and stakeholders in the Catalan R&I system that work in coincident sectors and cooperate to incorporate R&I into production activities in the leading sectors.*

As active stakeholders in the Catalan innovation ecosystem, they ensure the participation of companies and stakeholders from the system in defining, monitoring and evaluating the priorities for R&I programmes." [111] RIS3CAT communities are selected by open calls for proposals, implement agendas for the economic transformation of production activities through the incorporation of R&I. Within the sectors they represent, the members of the communities must generate critical mass and be representative and multidisciplinary, as well as featuring considerable private sector involvement. The role of these communities is to promote medium- and long-term action programmes to develop joint R&D&I projects based on the detection of common opportunities and needs that are key to the economic transformation of the production fabric.

Lessons learned:

- Robust and implementable strategies need the endorsement of a wide range of stakeholders. It is important to involve them at an early stage, and continuously during the formulation and implementation of strategies.
- The regional dimension should also be incorporated in public consultations to ensure wide dissemination of innovation practices all around the country.

5.2 Supporting innovation with concrete instruments, programmes and schemes

Recommendation 27: Realistic and effective innovation policy instruments should be identified

Ukraine has very few instruments to support innovation, and the effectiveness of those in existence is rated unfavourably. The traditional policy response to the science-industry gap in Ukraine is the establishment of technology parks. Panel interviews pointed towards implementation problems and lack of effectiveness of this type of instrument in the past. Science parks are also present but there is seemingly no independent evaluation of them. Recent initiatives are concentrated into one element of the innovation support ecosystem: support to start-ups. The "High Tech Office" project funded by the World Bank (through a loan) provides a first blueprint for a model of integrated support (incubators/accelerators) for high-tech start-ups, including finance and coaching. Other initiatives in this field also exist and lessons learned from them could be used to further build up this type of support.

Despite strong public budget constraints, the PSF Panel recommends that Ukraine should establish and allocate public money to a range of innovation support instruments, programmes and schemes, which are necessary for innovation to flourish. This expenditure should be thought of as a national investment rather than a budgetary expense. A portfolio of instruments, programmes and schemes should be established with the help of foreign expertise and with due attention paid to transparent selection procedures and built-in monitoring and evaluation mechanisms to ensure their effectiveness. Co-funding from private sources should be included in the instruments when relevant, so as to increase the overall resources for innovation.

Establishing a full portfolio of innovation support instruments, programmes and schemes is a long term endeavour: in the short term, it is necessary to start this process by defining instruments with limited budgetary implications and rapid and visible results ("quick wins"), to nurture positive demonstration effects. In the following three recommendations, the introduction of three specific innovation support instruments is suggested. They are far from being sufficient to constitute a relevant policy mix for innovation in Ukraine, but they can help reach the goal of demonstrating the relevance of paying more attention to innovation.

These include:

- Innovation vouchers (see Recommendation 28)
- Science-industry mobility schemes (see Recommendation 29)
- Collaborative projects between public research organisations and industry (see Recommendation 30).

Potential warning by the PSF Panel:

[111] http://www.catalonia.com/en/newsletter_news/newsletter/issue6/ris3cat.jsp

Innovation support instruments like these are also under risk to become misused in terms of corruption. This is especially true for instruments and projects which involve considerable budgets. Therefore, it is absolutely necessary that the project implementation is closely monitored and regularly audited by the body responsible for the implementation of such instruments. In addition, the PSF Panel suggests for larger instruments and projects to establish during a pilot phase an ex-post reviewing process conducted by an international committee and an ex-post auditing of an international public accountant firm.

Note by the PSF Panel:

In the medium or long term, other elements of an innovation support system, which are necessary to create favourable conditions for innovation, should also receive consideration by Ukrainian authorities and progressively be put on the policy agenda and implemented:

- Regarding the "supply side", the following could be done to raise the incentives for researchers in public organisations to integrate the commercialisation dimension into their research:
    - Review and change of employment contracts to integrate research and research exploitation as duties;
    - (Networks of) Technology Transfer Offices established at both universities and Academies of Science, possibly with joint offices to avoid fragmentation and duplication and to create critical mass, and also incorporating a regional dimension when relevant;
    - Students placement schemes in industry.
- Regarding the "demand side", the following could be done to support companies to undertake R&D and innovation activities:
    - Grants or reimbursable advances for R&D and innovation projects;
    - Small business research initiative (SBRI), which obliges each ministry to earmark a part of its budget for innovation in SMEs (see Box 14);
    - Seed funding for "innovation managers" in SMEs;
    - Government guarantees for venture capital funds;
    - Internationalisation vouchers to promote the marketing of Ukrainian products abroad and to facilitate penetration of foreign markets by domestic companies;
    - Innovation advisory services for SMEs;
    - Support to emerging clusters and networks of companies around new and promising activities.
- Concerning collaboration between public research and companies, different incentives could be developed:
    - Innovation vouchers to support companies accessing resources at public research organisations (including universities);
    - Grant schemes for research or innovation projects conducted by public-private partnerships. These should be concentrated in the priority areas for innovation;
    - Mobility schemes favouring exchanges of researchers and joint work between public and private actors;
    - Engagement campaigns for attracting young talent (apprenticeships in research organisations and innovative companies, reach out to schools);
    - Engagement of industry in the development of courses at HEIs.
- The development of an innovation culture is another important element to support a well-functioning innovation system. Various types of support initiatives may be implemented, such as:
    - Innovation prizes for new and established companies;
    - Innovation promotion campaigns at schools;
    - Popularisation of science activities which help demonstrate the value of science and research to a wide public;
    - Entrepreneurship promotion initiatives and courses.

Providing advice on the design of a portfolio of innovation support instruments (currently limited to science- and technology-driven innovation) falls under the remit of the National Board on the Development of S&T.

For all standard components of innovation support systems, there are good practices and caveats to be learned from experience in EU Member States, which can serve as inspiration for Ukraine. The establishment of new innovation support instruments should include clear targets, means to monitor achievements and assess value-added of public intervention, as well as exit mechanisms for those instruments that cannot demonstrate effectiveness.

Experiences from existing pilot (and often donor-funded) projects in Ukraine should be capitalised upon when developing new schemes (e.g. the UNINI project[112], aiming to develop and support SMEs and start-ups with innovative business ideas, with support from Norway; the Sikorsky Challenge[113] for the promotion of entrepreneurship and high-tech start-ups, with support from Israel, etc.).

Box 14

Inspiring Practice

Procurement reform – United Kingdom

With an annual spend of £230bn, UK public sector procurement has the potential to create significant business and growth opportunities through increased participation for small and medium-sized enterprises (SMEs), as well as improving the public sector's access to SMEs' creativity and innovation; there are many good examples of small suppliers delivering significant benefits to the public sector through their greater innovation and at a comparatively lower cost base than large, incumbent government contractors.

Government policy and reforms have done much to increase innovation and growth using the buying power of the public sector. Lean procurement methods have stripped out unnecessary waste from the procurement process and reduced timescales delivering benefits to public authorities and the businesses that bid for and win contracts. A new "single market" for public procurement ensures a simple and consistent approach to procurement across all public sector authorities so that SMEs can gain better and more direct access. These reforms act as a deregulatory measure to remove excessive burdens on small suppliers and make the procurement process faster, more transparent and less bureaucratic.

Summary of reforms:

- Pre-Qualification; eliminating the use of PQQs for low value contracts, mandating a core PQQ with standard questions for high value contracts, and allowing suppliers to provide PQQ data only once.
- Transparency: ensuring all new contract opportunities and contract awards are advertised online on a £230bn 'Single Market' (Contracts Finder) and the public sector reports its performance on spend with SMEs and centrally negotiated deals.
- Payment and finance: ensuring contractors pay their suppliers on time; consideration of whether performance bonds can be an unnecessary barrier for SMEs, and encouraging the use of e-invoicing in the public sector.

Small Business Research Initiative (SBRI)

SBRI enables government departments to connect with technology organisations, finding innovative solutions to specific public sector challenges and needs. It aims to use the power of government procurement to accelerate technology development, supporting projects through the stages of feasibility and prototyping which are typically hard to fund. SBRI offers an excellent opportunity for businesses, especially early stage companies, to develop and demonstrate technology, supported by an intelligent lead customer.

SBRI employs a simple structured process. Typically, competitions are structured in two phases:

In phase 1 the scientific, technical and commercial feasibility of the proposed project is scrutinised. The results of Phase 1 determine whether the solution should go further to Phase 2, not all projects will progress to Phase 2.

[112] http://unini.cc
[113] http://www.sikorskychallenge.com

The principal R&D effort takes place in Phase 2, which aims to produce a well-defined prototype. At the end of Phase 2 it is intended that what has been developed will be manufactured and marketed as a way of fulfilling requirements.

Lessons learned:

Ukraine has already made progress in this area, building on the success of the Prozorro platform, which provides an ideal basis for similar policies in Ukraine, there is potential for procurement to be a powerful driver of innovation and growth in the country.

Recommendation 28: Innovation vouchers for internationalization and validation of innovation activities for companies should be introduced

To be successful, companies need to innovate. Innovation was historically not a major focus in countries which made the transformation from a centrally planned economy into a market economy. Therefore, countries such as Ukraine face major challenges to introduce and build innovation ecosystems. The stakeholders in these newly arising innovation ecosystems cannot look back to a long history of innovation activities. As in Ukraine today, stakeholders did not have the chance to "practice" innovation and accumulate experiences. Therefore, it seems wise to connect the Ukrainian innovation ecosystem very early with EU countries.

The PSF Panel puts emphasis not only on connecting Ukrainian universities and research institutions with their international counterparts but also on Ukrainian innovative companies being trained to operate in international innovative markets. In international context Ukrainian firms will be required to develop and improve high quality innovative products.

Therefore, the PSF Panel suggests introducing innovation vouchers for internationalisation and validation of innovations to support Ukrainian firms to enter attractive foreign markets with strong innovation competition (see Box15). Vouchers focusing on internationalisation and validation are a rather new policy instrument. This type of voucher is particularly attractive for countries that seek to be more closely integrated in terms of research and economics into large and attractive innovation markets.

The basic idea is that Ukrainian companies compete for vouchers. The voucher finances a part of the cost for internationalisation by validating the company's innovative products in the context of a foreign market. The key point is to foster the commercialization potential of new ideas for products, technologies, or services in international markets. The administration of the vouchers and the organisation of the competition between the firms should be organised by a Ukrainian authority. However, the selection process of the companies that have applied for a voucher should be delegated to a research institution outside Ukraine; for example, located in the innovation market Ukraine wants to target. This could possibly be one or a number of countries in the EU. The reason for delegation of the selection decision is that the foreign research institution can better assess the probability of success of Ukrainian firms and their future potential in the foreign innovation market.

Following this procedure, the Ukrainian firm will learn about the internationalisation process and about the cooperation with foreign research institutions thereby establishing standards for the cooperation between firms and research institutions at home.

Furthermore, the foreign research institution should be obliged to connect the firm to research institutions and universities in the innovation market to provide experience for the Ukrainian firm in the innovation market of the foreign country. As a next step a connection should be developed between research partners in foreign innovation market as well Ukrainian research partners. That could ultimately lead to a strong research base of a successful innovative Ukrainian firm being active in Ukraine and abroad.

On the whole, such a policy instrument would fit well with internationalisation of research institutions and universities and the corresponding recommendations of the PSF Panel. Adding vouchers for internationalisation would allow a faster development of the Ukrainian innovation landscape because multiple actors – researchers and innovative entrepreneurs – are addressed.

Box 15

Inspiring Practice

The Polish Programme of Internationalisation Vouchers

An example for an internationalisation voucher scheme is the GO_GLOBAL.PL programme of the National Centre for Research and Development (NCBIR)[114] in Poland. It aims at supporting the validation of the commercialisation potential of the R&D results of companies with medium or high technology intensity (start-ups, spinoffs, SMEs). The NCBIR offers grants to enable selected companies to prepare for international market entry. NCBIR has partnerships with many accelerators and research organisations operating accelerators in different countries to promote the internationalisation of Polish companies. These accelerator operating organisations have signed an agreement with NCBR. Among them are organisations from European countries such as Fraunhofer Center for International Management and Knowledge Economy in Germany, Instituto Superior para el Desarrollo del Internet in Spain and Accelerace in Denmark.

The NCBIR grants per project a maximum of roughly EUR 37.000. Companies must contribute with 15% of the total of eligible costs. The projects should last maximum 6 months. The programme started in 2015 and has already gone through three rounds.

The voucher instrument fulfils several targets: (a) the innovative Polish company internationalises into new markets making it grow and being more independent of the Polish market; (b) the innovative Polish company gets connected to the foreign research scene, can thereby adapt and improve its product for non-Polish markets; (c) more international cooperation is likely as Polish firms learn how to act and move in international markets, e.g. future projects may involve the Polish company as well as Polish and foreign researchers and also a foreign partner company.

Lessons learned:

- Internationalisation vouchers can substantially push the integration of innovation landscapes.
- Innovative companies may achieve substantial economic success by developing innovative products and services early on in international markets. Thereby the companies' competitiveness as well as the economic basis of the country is strengthened.
- Successful international companies could be used as good examples in the innovation economy.

Recommendation 29: Science-industry mobility schemes should be established

Currently a large gap exists between applied research activities in the public research sector and companies in Ukraine. A few companies know where and how to access relevant competences and sources in the public research sector but most do not. Especially those companies which lack internal resources to conduct applied research or innovation activities face difficulties and/or are reluctant to contact possible partners in the public research sphere. Mobility schemes can help companies to access these competences in a pragmatic way. Mobility of people is arguably an effective way to create linkages as this involves a direct confrontation with the differences in strategies, needs and working conditions in public versus private organisations. Knowledge from public research activities is not only codified in publications, it is also embedded in a tacit form in human beings. Mobility helps to foster the process of knowledge exchange between the two separated worlds.

Therefore, the PSF Panel recommends the implementation of a pilot science-industry mobility scheme in Ukraine, in view of promoting cooperation between public research organisations and innovative businesses. Such a scheme provides incentives for researchers in the public sector to get involved in activities in companies. This adds industry-based training to the competences of the researcher and reinforces the capacity of companies for research-based innovation. The scheme generally takes the form of a State subsidy for 1 to 2 years to public researchers (generally recently graduated people) wishing to develop a research project in partnership with a company, which is also contributing with private funds. The researcher is based simultaneously in the two environments (company and research organisation) and shares his/her time between the two places. Some schemes also provide some funding for the researchers' laboratory. This proposal focuses on mobility towards existing companies, in other countries there are variations of this

[114] http://www.ncbr.gov.pl/en/

scheme which target start-ups (providing funding for public researchers willing to establish a company based on research results).

According to the experience with such schemes in Europe, a key success criterion is attracting the researcher in the company, thereby reinforcing the capacity of companies to conduct research-based innovation, and maintaining and developing linkages with public laboratories for future projects.

This type of scheme can rather easily be implemented in Ukraine in a pilot phase by providing a limited number of grants to well-targeted individuals presenting a credible proposal of cooperation with private and public partners demonstrating strong commitment to the project. Budgetary implications for the State are limited and additional money is to be provided by the company benefitting from the work of the researcher.

As with the innovation voucher, the establishment of a science-industry mobility scheme potentially falls under both domains of competence of the Ministry of Education and Science and of the Ministry of Economic Development and Trade and should be consulted and programmed by a dedicated working group of the National Board. Various models of mobility schemes are in place in European countries, some with a long history, and many benefit from evaluations, which can help to shed light of the most appropriate variation of the scheme for Ukraine. It is necessary to evaluate the implementation of the first round of grants after a first period of 3-5 years, before upscaling the scheme taking into account lessons learnt from the pilot phase.

Recommendation 30: Cooperative projects between the public research sector and industry should be supported

There are no financial incentives in Ukraine to support collaborative research between public research institutions and companies. However, enhancing such collaboration is likely to bring several types of benefits to the Ukrainian research and innovation system:

- Helping public research institutions to better assess the relevance of their research for the economy, and subsequently re-orient their applied research activities to better serve the needs of the country;
- Creating synergies between the type of knowledge developed in companies and in public research laboratories which would serve the development of innovative products or processes;
- Reducing financial risk for companies while undertaking research activities, by sharing part of it with the public sector;
- Progressively reconciling the timescale and mode of operation of public research organisations and companies in order to facilitate joint work.

Therefore, the PSF Panel recommends the establishment of a new funding mechanism to support cooperative research projects shared between public research institutions and companies. This would involve grants to consortia formed between actors from the two sides, with the objective to jointly develop innovations based on the exploitation of research results by the company. Funding is distributed between the partners in the consortium and companies are expected to provide co-funding. This type of funding is usually allocated on the basis of a clearly defined project of a duration of approximately 1 to 3 years. The consortia should have developed clear Intellectual Property agreement for the research project. This type of funding should be open to all public research actors and companies, without distinction according to affiliation or other criteria. The key criteria for awarding the grants are: quality of the proposal and quality of the partnership. The award of grants should be subject to a selection procedure involving independent experts.

The budgetary size of such a programme is higher than the two other schemes proposed above, which is a problem in the current tight budgetary situation of Ukraine. A pragmatic way to go forward with such an idea in the short term is to concentrate the funds on a limited number of experimental projects (in the order of 5 projects) which are consistent with the priority domains for research and innovation in Ukraine.

Funding cooperative projects should be seen as a first step towards a longer term goal of creating more structural partnerships of the type of "Ukrainian competence centres". Competence centres gather on a structural basis the top actors from both the public and the private sphere, which cooperate on new technology-based developments. They benefit from government support on a longer term basis (up to 10 years) and are subject to serious performance evaluations. While the concept of competence centres seems not attainable in the current fragmented context of Ukraine,

the successful realisation of more limited cooperation on a competitively funded project basis may pave the way towards such more ambitious initiatives.

The establishment of a programme to support cooperative projects potentially falls under both domains of competence of the Ministry of Education and Science and of the Ministry of Economic Development and Trade. It should be consulted on and programmed by a dedicated working group of the National Board. Additionally, the supported projects should correspond to areas of need and potential as identified through the work of the National Board.

As with the other two proposal outlines above, the power of demonstration effects and positive role models created thanks to cooperative research should also be fully exploited to create the basis for a more interlinked innovation system in Ukraine.

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LIST OF ACRONYMS

AC	Countries Associated to Horizon 2020
ALLEA	Pan-European Federation of Academies of Sciences
CERN	European Organisation for Nuclear Research
CNRS	Centre National de la Recherche Scientifique
COSPAR	International Committee on Space Research
COST	"Cooperation in Science and Technology" is the longest-running European framework supporting trans-national cooperation among researchers, engineers and scholars across Europe
DFG	Deutsche Forschungsgemeinschaft (German Research Organisation)
DG	Directorate General
EaP	Eastern Partnership
EHEA	European Higher Education Area
ENPI	European Neighbourhood and Partnership Instrument
ERC	European Research Council
ESFRI	European Strategy Forum on Research Infrastructures
ERA	European Research Area
ERAC	European Research Area and Innovation Committee
ERA-NET	European Research Area Network
EUA	European University Association
EUREKA	Intergovernmental organisation for pan-European research and development funding and coordination
EU28/AC	28 Member States of the European Union and Countries Associated to Horizon 2020
EU MS	European Union Member States
FDI	Foreign Direct Investments
FP7	7th European Framework Programme for RTD
FYROM	Former Yugoslav Republic of Macedonia
GDP	Gross Domestic Product
GERD	General Expenditures on R&D
HORIZON 2020	The 8th European Framework Programme for R&I
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
ISCED	International Standard Classification of Education
IUA	International Union of Academies of Humanities and Social Sciences
IUS/EIS	Innovation Union Scoreboard|European Innovation Scoreboard
JINR	Joint Institute for Nuclear Research
JRC	Joint Research Centre
JSTCC	Joint Science & Technology Cooperation Committee
JPI	Coordination mechanism for national research programmes to contribute to solving societal challenges.
JTI	Joint Technology Initiative
LERU	League of European Research Universities
MEDT	Ministry of Economic Development and Trade of Ukraine

MESU	Ministry of Education and Science of Ukraine
MULLAT	Multilateral Initiatives
NASU	National Academy of Sciences of Ukraine
NATO	North Atlantic Treaty Organisation
NCBRI	National Center for Research and Development (Poland)
NCP	National Contact Point
NGO	Non-Governmental Organisation
NRF	National Research Foundation
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PSF	Horizon 2020 Policy Support Facility
R&D	Research and Development
R&I	Research and Innovation
RISE	Research and Innovation Staff Exchange Programme under Horizon 2020
RTD	Research and Technological Development
S&T	Science and Technology
SBRI	Small Business and Research Initiative
SME	Small and Medium sized Enterprises
STI	Science, Technological development and Innovation
TEAMING	Instrument to team up with institutions from all over Europe under Horiyon 2020
UAH	Ukrainian Hryvnia
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WIPO	World Intellectual Property Organisation
WoS	Web of Science

LIST OF BOXES

LIST OF FIGURES

A ‘Policy Support Facility’ (PSF) has been set up by the Directorate-General for Research & Innovation (DG RTD) of the European Commission under the European Framework Programme for Research & Innovation ‘Horizon 2020’, in order to support Member States and associated countries in reforming their national science, technology and innovation systems.

The Peer Review of the Ukrainian Research and Innovation system was carried out between May and November 2016 by a dedicated PSF Panel, consisting of nine independent experts and national peers. The Ukrainian national authorities expressed a strong political commitment to this exercise.

The PSF Panel arrived at seven Policy Messages highlighted upfront in the report. The report explains the rationale supporting each of those policy statements and discusses the 30 specific recommendations, clustered into thematic areas. Case studies from other countries supplement the narrative by presenting good practice examples that could facilitate the implementation of the recommendations.

It is the country’s responsibility to ensure the follow-up to the Peer Review as well as the potential implementation of its recommendations through concrete reforms.

Studies and reports

Publications Office