BILAT-RUS-Advanced

STI Priority Setting in the EU Countries and the Russian Federation: Best Practices

BILAT-RUS-Advanced project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under grant agreement no 311836.

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The publication was prepared in the scope of the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration Activities "Advancement of the Bilateral Partnership in Scientific Research and Innovation with the Russian Federation".

The paper presents an analysis of best practices in STI priority setting in the EU member states (UK, Germany, and Finland) and in the Russian Federation; compares priority systems adopted by various European countries; and identifies prospective subject areas for further development of international cooperation.

The materials included in the publication will help public authorities, companies, R&D organisations, universities, technology platforms, innovative territorial clusters, and other organisations to identify priority development areas, subject fields, and critical technologies.

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Introduction

Present-day research activities are growing in scale, have inter-disciplinary nature and global coverage; their impact on global innovation-based development is also increasing. Despite significant growth of R&D expenditures in developed countries, no single one of them is capable of conducting fully-fledged research covering the whole range of subject areas. Therefore setting sound priorities for science, technology, and innovation (STI) activities becomes particularly important, since they determine the prospects not only for scientific, but also socio-economic development.

Most developed countries have been working on setting STI priorities for quite some time, the latter providing the basis of their STI policies. The focus is put on dealing with strategic socio-economic development objectives, efficient exploitation of national competitive advantages, and concentrating on application of particularly efficient innovative technologies.

A major result of this work is lists of priority STI development areas and critical technologies, which require top-priority support. These may comprise targeted, thematic, or functional priorities reflected in various strategic documents (e.g. strategies, white papers, policy papers, memorandums, etc.). National-level priorities usually attract the most attention and are implemented using various STI policy tools.

In many European countries (UK, Germany, Finland, France, etc.) decisions to support specific STI areas are based on results of foresight studies conducted by public organisations, research centres, universities, and consulting firms. Such studies identify global STI development prospects, assess the country's competitive advantages and impacts of previously implemented R&D and innovation support programmes. Along with governments, results of such studies are actively applied in making management decisions by other stakeholder groups, such as the real sector companies and R&D organisations.

The Russian Federation also has significant experience of identifying priority development areas and making lists of critical technologies [Shashnov, Pozniak, 2011; Sokolov, 2007]. The first such lists were officially approved in 1996 and have been repeatedly updated since then.

The priorities are identified on the basis of the long-term science and technology foresight [Gokhberg, 2016].

A large number of projects on assessing STI development prospects and the efficiency of technological development in particularly important areas are implemented on the European Union level. E.g. significant EU-level STI priority setting experience was accumulated in the course of developing and implementing a series of Framework Programmes for Research, Technological Development and Demonstration [Gutnikova et al, 2014]. The European Technology Watch programme [Mrakotsky-Kolm, Soderlind, 2009] is also oriented towards the early identification of emerging technologies, and analysing their impact on key markets. The programme is aimed at both detecting important emerging technologies and services, and identifying steps to be taken to promote their development in European countries.

The European Commission implements programmes and publishes reports presenting results of the studies of global technologies with a potential to affect future development of economy and society, to prepare STI policy recommendations for the European Parliament. For a decade, the ERAWATCH programme has been contributing to meeting data requirements of decision-makers and the broad research community[1].

After the launch of Horizon 2020 programme, a new resource was applied for the same purpose: the Research and Innovation Observatory (RIO) / Horizon 2020 Policy Support Facility [European Commission, 2015a], which provides pertinent up-to-date information on and analysis of relevant mechanisms, organisations, and programmes, on the European, national, and regional levels. This contributes to further development of the European Research Area [European Commission, 2015b] through the identification of relevant practical steps and improved coordination of STI activities.

[1] See http://erawatch.jrc.ec.europa.eu/ for more.

Examples of best European and Russian practices show that STI priorities are set in the context of designing long-term sustainable socio-economic development strategies, to support accomplishment of major national or international socio-economic objectives.

National S&T priorities create a basis for mutually benefitial cooperation allowing researchers from different countries to share their experience and enlarge the spectrum of their research activities [Kotsemir et al., 2015].

The new Europe 2020 strategy [European Commission (2010)] is currently being implemented by the EU, pursuing the following ambitious goals: increasing employment and promoting innovation; improving the quality of education; poverty reduction and social integration; dealing with climate change, the lack of energy and other resources. Seven major initiatives were proposed to accomplish these objectives, including one in the STI sphere (Innovation Union) [European Commission, 2015c].

The Innovation Union initiative is aimed at improving access to R&D funding in Europe, to help transform innovative ideas into products and services thus promoting economic growth and job creation. The course towards eliminating barriers hindering private investments in research, development and innovation was taken, by creating an actually working European Research Area focused on innovation, aimed primarily at meeting major societal challenges identified in the Europe 2020 strategy. All social layers and regions are expected to be involved in the innovation-based development process (including social innovations and smart regional specialisation).
The whole R&D and innovation chain should become better coordinated and more stable, from generating original scientific ideas to bringing end products to markets.

The new European Horizon 2020 Research and Innovation Framework Programme [European Commission, 2011] launched in 2014 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. It has integrated the EU framework programmes on promoting R&D, competitiveness and innovation. Results of various foresight studies of STI development prospects were actively applied to develop the previous and the current framework programmes. Horizon 2020 also provides for a strategic foresight study to specify the programme's strategic priorities and plan their implementation [European Forum on Forward Looking Activities, 2015, a,b].

Analysis of best international STI priority setting practices reveals that methodologies and mechanisms for selecting and implementing high-priority fields, major areas and critical technologies are constantly being improved to match new global and national-level challenges. In recent years a clear trend has emerged towards systemic objective setting and extending the range of information sources, including long-term S&T foresight studies and various combinations of quantitative and qualitative techniques [Meissner, Gokhberg, Sokolov, 2013].

The main objective of this brochure is to present a review of best STI priority setting practices in the EU countries and the Russian Federation; compare sets of priorities adopted by various European countries; and identify promising subject areas for further enhancement of international cooperation.

1

STI priority setting and implementation in the EU

1.1.

EU-level priority setting procedures

On the political level, priorities in the European Union are set through consultations between the European Commission, the European Parliament, and the European Council, involving a wide range of stakeholders from all EU member states.

As the executive organ of the EU, the European Commission plays a leading role in priority setting. The European Commission represented by its Directorate General for Research and Innovation drafts initial proposals on sets of priorities.

The following criteria are taken into account in the course of thematic priority setting [BILAT-USA, 2010]:

- Contribution to EU policy objectives: sustainable economic growth, dynamic and competitive knowledge-based economy etc.;
- European research potential: research in thematic domains with strong potential for excellent research and technological development and for disseminating and converting the results into social and economic benefits;
- European added value: a strong need for additional public funding and for such intervention to be at a European level.

The results of various foresight studies commissioned by the European Commission are actively applied in priority setting [European Union, 2010], e.g. a special study was conducted to set research priorities for food-related issues (see box 1).

The draft priorities are submitted to the European Parliament and the European Council where they are subjected to several rounds of debates with participation of various committees, commissions, and expert groups representing all European institutes. In parallel, the European Commission holds extensive consultations to discuss

BOX 1

Healthy future: four research priorities for healthy foods and diets
[European Commission, 2015d]

The foresight study was conducted by the European Commission's Joint Research Centre, commissioned by the Directorate General for Research and Innovation. The project was focused on European consumers and various factors affecting their food habits and preferences, e.g. life style, nature of work, supply of food, and economic situation. The objective of the study was to help politicians set the agenda and identify relevant research priorities. The results are expected to help set research priorities to fund in the scope of the Horizon 2020 programme, and can be used by interested parties to organise further discussions on the future of nutrition.

the draft proposals with other European Research Area stakeholders such as national and regional government agencies responsible for promotion of research and innovation, representatives of science and business communities, and civil society.

After participants of debates come to an agreement, the materials are submitted to the European Parliament for final approval, and prepared for adoption by the European Council. Overall political priorities are subsequently specified by Programme Committees through annual work programmes, on the basis of which calls for proposals of R&D projects are organised. Programme Committees comprise representatives of the EU member states, which allows to take into account their specific interests in pan-European programmes.

1.2.

The 7th Framework Programme's priorities

Between 2007 and 2013, the EU implemented the 7th Framework Programme of the European Community for Research, Technological Development and Demonstration Activities, with two main strategic objectives:

- to strengthen the scientific and technological base of European industry;to encourage its international competitiveness, while promoting research that supports EU policies.

The programme was designed to accelerate economic growth and increase Europe's economic competitiveness, by investing in knowledge, innovation, and human capital. Compared with the previous framework programmes, the 7th Framework Programme (FP7) had the following new elements [European Commission, 2015e]:

- stronger emphasis on priority research areas, as opposed to "tools";
- significantly more simple implementation procedures;
- increased attention to industry's demand for research, on the basis of the specially designed scheme "Technology Platforms and Joint Technology Initiatives";
- establishment of the European Research Council to fund advanced European basic research;
- international cooperation in all FP7 areas;
- establishing Regions of Knowledge – regional networks of R&D centres whose potential is not limited by national borders;
- promoting private investments in promising R&D areas;
- opportunity to share financial risks.

Priority thematic areas for FP7-funded research covered major areas of knowledge with a potential to contribute to sustainable economic development of the EU and meeting major social challenges, in accordance with the Lisbon strategy.

International cooperation was supported by the following instruments:

- Collaborative Research – a major part and the core of the EU-provided research funding.
- Technological Platforms & Joint Technological Initiatives, comprising applied research in priority areas.
- Coordination of National Research Programmes outside the Community.
- International cooperation with countries – non-EU members (third countries) in ten priority thematic areas.

"Cooperation" supported research actions in the following thematic areas:

- Health
- Food, agriculture and biotechnology
- Information and communication technology
- Nanoscience, Nanotechnologies, Materials and new Production Technologies
- Energy
- Environment (including Climate Change)
- Transport (including Aeronautics)
- Socio-economic Sciences and Humanities
- Security
- Space

Each area was divided into more detailed high-priority fields (see box 2).

Specific thematic fields were identified in the annual work programmes, for which calls for proposals (project tenders) were organised.

BOX 2

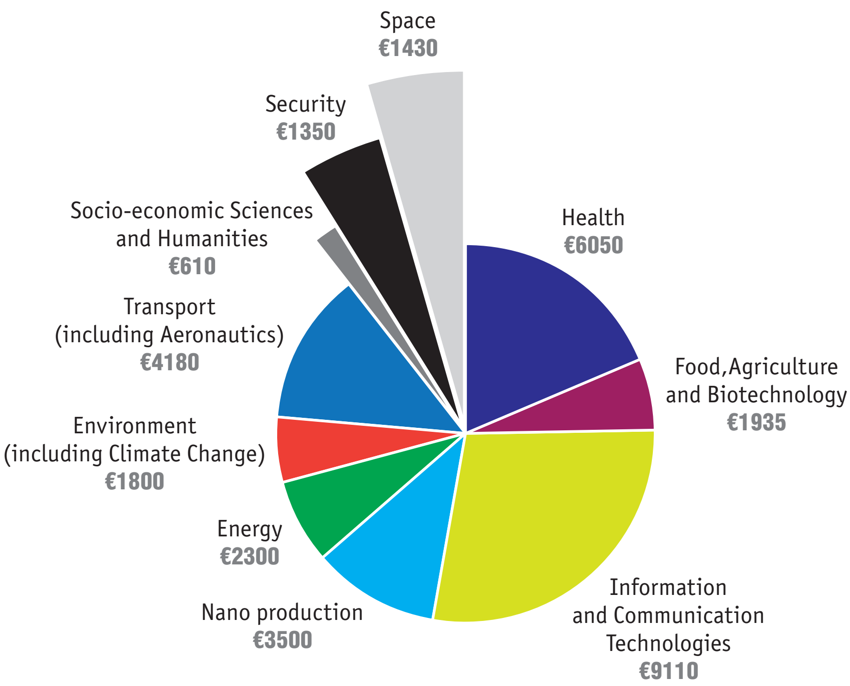
The Health thematic area (budget €6.05 billion) provided for research projects on the following topics:

- **Biotechnology, generic tools and technologies for human health**
  - High-throughput research
  - Detection, diagnosis and monitoring
  - Innovative therapeutic approaches and inventions
  - Prediction of suitability, safety and efficacy of therapies
- **Translating research for human health**
  - Integration of biological data and processes
  - Research on the brain and related diseases, human development and ageing
  - Translational research in infectious diseases (HIV/AIDS, malaria, tuberculosis, SARS, avian influenza)
  - Translational research in major diseases: cancer, cardiovascular disease, diabetes/obesity, rare diseases, other chronic diseases including rheumatoid diseases, arthritis and muscoskeletal diseases
- **Optimising the delivery of healthcare to European citizens**
  - Translation of clinical outcome into clinical practice
  - Quality, efficiency and solidarity of health care systems including transitional health care systems and home care strategies
  - Enhanced disease prevention and better use of medicines
  - Appropriate use of new health therapies and technologies

The FP7 Cooperation programme's budget was in excess of €32 billion. Its allocation between various thematic areas is shown in figure 1 below.

ICT, Transport, and Health were the obvious leaders.

Fig. 1. **Cooperation programme's budget broken down by priority thematic areas** *(million €)*



1.3.

Horizon 2020 priorities

As of 1 January, 2014 the EU implements the new Research and Innovation Framework Programme Horizon 2020 focused on highly efficient technologies – eco-, nano-, bio-, and info-technologies applied to deal with major socio-economic issues (green energy, transport, climate change, and ageing population).

The following aspects were defined as starting points: Human Potential, Research Programmes and Infrastructures, Sharing Knowledge, and International S&T Cooperation.

Further development of the European Research Area is expected to help overcome barriers between:

- countries (by setting up multinational consortia involving researchers from all countries of the world);
- different organisation types – universities, R&D centres, commercial and private enterprises (including small and medium ones) and large companies;
- various research areas;
- national funding organisations, which should promote exchanges of information, knowledge, technologies, and scientists.

Keeping in mind that the bulk of research and innovation funding comes from individual EU member states, the need to establish closer links between national tools, business initiatives, and the new European programme was noted. The Horizon 2020 actions are also expected to be more closely coordinated with the Strategic Energy Technologies Plan [European Commission, 2015f], the ICT Joint Technology Initiatives [European Commission, 2015g], and Strategic Transport Technology Plan [European Commission, 2015h], which is currently being developed.

2020

The Horizon 2020 programme takes into account problems and drawbacks identified through the assessment of previous Framework Programmes for S&T development, the Competition and Innovation Programme, and projects of the European Institute of Innovation and Technology. Their major weakness was judged to be insufficient coordination with the EU member states' national funding agencies. Overcoming this issue would contribute to stepping up efficiency of funded activities, avoid duplication and fragmenting, reduce administrative barriers, and simplify project calls procedures.

The new framework programme is expected to establish more transparent links between declared objectives and actions, and reduce the number of funding mechanisms.

To optimise the available resources, the EU R&D funding structure was significantly changed, bringing together three previously independent funding sources: the Framework Programme for Research and Technological Development, the Competitiveness and Innovation Framework Programme, and the European Institute of Innovation and Technology [The European Institute of Innovation and Technology, 2015].

Another objective of the programme is extending participation of particular organisation types (e.g. SMEs) and researcher groups (e.g. females from new EU member states, third country scientists). Horizon 2020 is expected to bring scientific discoveries closer to the actual demand for innovative products, and help meeting global challenges.

The Horizon 2020 Framework Programme has three core priorities:

- *Excellent Science* aims to reinforce and extend the excellence of the Union's science base and to consolidate the European Research Area in order to make the Union's research and innovation system more competitive on a global scale
- *Industrial Leadership* aims to speed up development of the technologies and innovations that will underpin tomorrow's businesses and help innovative European SMEs to grow into world leaders;

- *Societal challenges* responds directly to the policy priorities and societal challenges identified in the Europe 2020 strategy and aims to stimulate the critical mass of research and innovation efforts needed to achieve Union's policy goals. This approach covers not just technological but also social innovations.

Another major component is the Joint Research Centre's (JRC) *Non-Nuclear Energy Research Programme* [European Commission, 2015i].

The Horizon 2020 budget for 2014-2020 is earmarked at €80 billion (in 2011 prices).

The Excellent Science section of the Horizon 2020 programme (budget €24,4 billion) includes grants by the European Research Council (€13 billion) [European Commission, 2015j], Marie Sklodowska-Curie Actions (€6,1 billion) [European Commission, 2015k], Future and Emerging Technologies (€2,6 billion), Research Infrastructures (€2,6 billion) [European Commission, 2015l].

The Industrial Leadership section (budget €18 billion) promotes investments in research and innovation in key emerging and industrial technologies taking into account their multidisciplinary aspects (Leadership in Enabling and Industrial Technologies: budget €13,5 billion), such as Information and Communication Technologies; Micro- and Nanoelectronics, Photonics; Nanotechnology and Advanced Materials; Biotechnology; Advanced Manufacturing Processes; and Space.

An important aspect of the Horizon 2020 programme is achieving leadership in Enabling and Industrial Technologies (LEIT), by supporting innovation in various sectors of the economy. Specifically, the programme assigns a high priority to increasing European competencies in development and application of key enabling technologies (KETs), in particular in such areas as nanotechnology, advanced next-generation materials, advanced production technologies, and biotechnology.

Two other areas of the Industrial Leadership section are attracting private and venture capital to fund research and innovation (Access to Risk Finance, budget €2,8 billion), and supporting innovation in SMEs (budget €616 million).

The Euratom programme's budget is €1,6 billion.

The Societal Challenges section (total funding €31,7 billion) addresses such issues as increasing efficiency of research and innovation activities in the following areas:

- Health, Demographic Change and Wellbeing (budget €8 billion);
- Food Security, Sustainable Agriculture and Forestry, Marine and Maritime and Inland Water Research, and Bioeconomy (budget €4 billion);
- Secure, Clean and Efficient Energy (budget €5,7 billion);
- Smart, Green and Integrated Transport Systems (budget €6,8 billion);
- Climate Action, Environment, Resource-Efficient and Raw Materials (budget €3 billion);
- Europe in a Changing World - Inclusive, Innovative and Reflective Societies (budget €1,3 billion);
- Secure societies - protecting freedom and security of Europe and its citizens (budget €1,7 billion);
- Science for and with Society (budget €0,5 billion).

Regarding top-level priorities, Horizon 2020 maintains strong continuity with the priorities of the previous Framework Programme, though it should be noted that the new wording is more practical and more precisely aimed at dealing with the most acute of the present-day global challenges.

The top-level priorities are broken down into specific thematic subject areas (see Box 3).

BOX 3

Priority activities for the Information and Communication Technologies subject area

- **A new generation of components and systems**
  - Smart cyber-physical systems
  - Optical wireless networks
- **Advanced Computing**
  - Reduced energy consumption and customisation
- **Future Internet**
  - Internet of things
  - Cybersecurity and trustworthy ICT
- **Content technologies and information management**
  - Technologies for creative industries and convergent processes
- **Robotics**
- **Micro- and nano-electronic technologies, photonics**
  - Basic micro- and nanoelectronic technologies
  - Key enabling ICTs

2

Priority setting and implementation in European countries and Russia

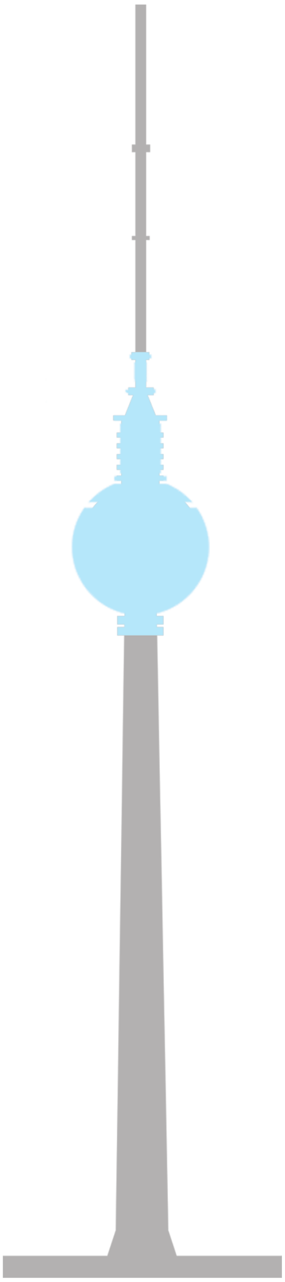
Along with pan-European priorities, the EU member states maintain their own national-level priority systems which directly reflect their specific S&T landscape, challenges to and needs of the national socio-economic development. To illustrate possible approaches to priority setting, and to compare various priority systems we have chosen Germany and the UK – leading EU economies which pay considerable attention to supporting development of the STI sphere.

The following scheme was adopted to analyse STI priority setting and implementation in the above countries and in Russia:

- context and participants of the priority setting process;
- priorities and documents (strategies, white papers, critical technologies, priority areas, etc.);
- priority setting methodologies and procedures;
- implementation of thematic priorities (basic research programmes, thematic and industry-specific programmes, etc.).

2.1.

Germany



Context and participants of the priority setting process

On the federal level, the Ministry of Education and Research [Federal Ministry of Education and Research, 2015] is responsible for shaping research policy while the Federal Ministry for Economic Affairs and Energy [Federal Ministry Economic Affairs and Energy, 2015] supervises development of innovation and technology policy and supports the development of the Eastern German States with special programmes. Other ministries also provide support to R&D in areas of their responsibility.

Setting priorities for its science, technology and innovation (STI) policy, the German Federal Ministry of Education and Research actively applies participative approach which allows for the collection and consideration proposals by various participants of the national innovation system.

The Ministry of Education and Research has an Advisory Board comprised of more than 20 experts – members of academia and the business community. The board participates in development and implementation of national high-technology development strategy, and prepares recommendations on strengthening Germany's competitiveness in high-technology markets. Various support measures are also provided to R&D activities on the federal lands' level. The German parliament has the Commission of Experts on Research and Innovation (members are appointed by the Chancellor of Germany). The commission provides advisory support on research policy issues and regularly conducts expert evaluation of advanced research and innovation projects, and of Germany's overall S&T development level.

Priorities and documents (strategies, white papers, critical technologies, priority areas, etc.)

The main directions of the S&T and innovation policy are set in the German High-Tech Strategy [Federal Ministry of Education and Research, 2014]. They are aimed at creating new markets, stepping up cooperation between science and industry, and providing a wide range of support to innovation activities using various new tools.

The strategy identifies the following areas which pose the biggest challenges for the economy and society:

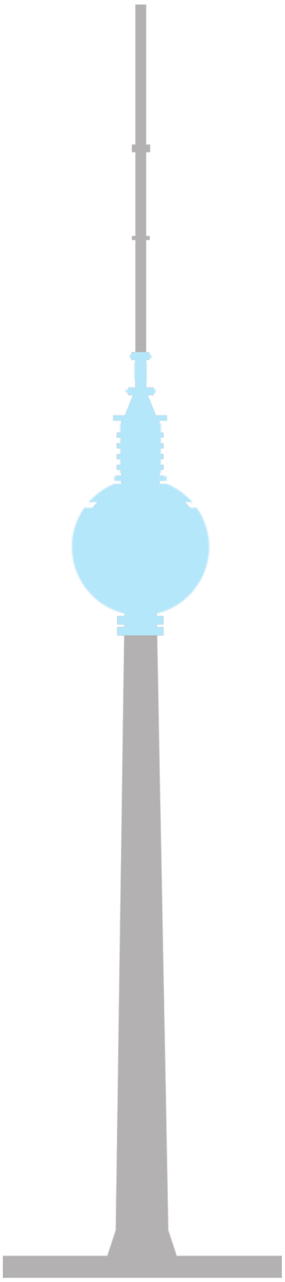
- climate, energy;
- health care, food;
- mobility;
- security;
- communications.

To meet these challenges, the following research field are suggested for priority development:

- Digital economy and society
- Sustainable economy and energy
- Innovative world of work
- Civil security
- Healthy living
- Intelligent mobility

This strategy is coordinated with the Europe 2020 strategy regarding implementation of national and European R&D programmes and it aims to provide matching funds to European programmes.

At the beginning of 2012, the federal government published the High-Tech Strategy 2020 Action Plan, which identified ten “Future Projects” of particular social importance [European Commission, 2015o].



Priority areas for implementing these projects include the following:

- CO_2-neutral, energy-efficient and climate-adapted cities
- Intelligent energy generation systems
- Renewable energy resources as an alternative to oil
- Combating illness with personalised medicine
- Improving health through targeted preventive measures and nutrition
- Independent living for senior citizens
- Sustainable mobility
- Secure identities
- Internet-based services for the economy
- Industrie 4.0 (4th-generation industry)

The plan was adopted by the federal government to coordinate the various ministries' policies and initiatives and to combine the efforts of academia and the business sector, specifically in the following areas: environment protection, energy, health care and healthy nutrition, mobility, communications, and security.

Germany also implements programmes and initiatives to support specific S&T development areas and industries: ICT 2020 [Bundesministerium fьr Bildung und Forschung, 2015]; Framework biotechnology development programme [Federal Ministry of Education and Research, 2015b]; 6th Energy Research Programme of the Federal Government [Federal Ministry of Economics and Technology, 2011], etc.

Strategies and initiatives to support S&T development are also implemented on the Landers' (State) level, to reflect their region-specific features – e.g. Bavarian Research and Innovation Strategy, Hessen's LOEWE initiative to foster development of scientific and economic excellence, etc.

Furthermore, priorities are set by the German Science and Research Organisations, Max-Planck Society, Fraunhofer Society, Helmholtz Society, Leibnitz-Society which involve more than 100 research institutions in Germany. All associations formulate research strategies and coordinate STI priorities regularly with federal and regional ministries.

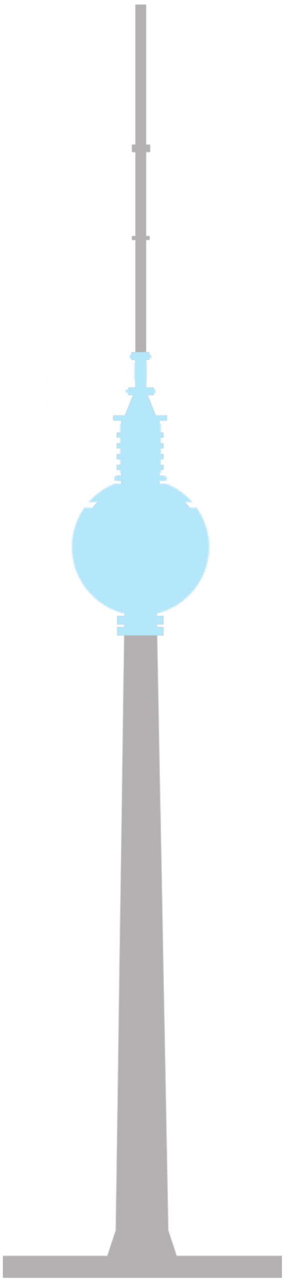
Priority setting methodologies and procedures

The most important strategic tool for identifying the economy's and society's future R&D needs is the BMBF Foresight Programme [Federal Ministry of Education and Research, 2015e]. In the framework of these studies future development prospects are analysed, using a 15-year horizon. The results help to set the agenda and priorities for the national research and innovation policy. These studies are commissioned by the Federal Ministry of Education and Research, and are typically conducted by a consortium comprised of several research organisations. In the course of the foresight study the consortium's leader involves experts from the Federal Ministry of Education and Research, other relevant government agencies and other stakeholders, including representatives of universities, R&D centres, and companies. Technology assessment is carried out with the parliamentary office "Technology Assessment Bureau", affiliated with the Karlsruhe Institute of Technology (KIT).

Since 2010, Germany has been implementing an ongoing structured foresight study (with a four-year cycle) which includes two interconnected stages, during which S&T development prospects are analysed through integrated research of global trends, high-technology-related risks, prospective products, etc., to identify and assess the S&T sector's potential to meet emerging economic and social needs. This approach implies the active application of various expert-based procedures involving local and international experts.

The foresight study identifies major "prospective trends", assesses their consequences and prepares recommendations to help make relevant decisions. Information about anticipated trends and challenges is widely disseminated among all relevant stakeholders including politicians, members of executive agencies, industry, academia, and general public, to inform them about prospective needs and more important technologies.

The results are applied to prepare various strategic documents and initiatives which are developed by the Ministry of Education and Research, Ministry for Economic Affairs and Energy, and other relevant government agencies. Results of the foresight projects may also be applied by regional (federal lands') ministries, private sector companies, and other stakeholders providing support to the R&D sector. Currently foresight studies' results are primarily oriented towards the further development of the foresight process, and supporting its newest format – the High-Tech Strategy 2020.



Implementation of thematic priorities (basic research programmes, thematic and industry-specific programmes, etc.)

In Germany, thematic R&D programmes serve as the main STI policy implementation tool. The Federal Ministry of Education and Research supervises most of these programmes, while the Ministry for Economic Affairs and Energy is responsible for R&D programmes on energy, transport, and space. Ecology, environmental protection, and nuclear safety research are the domain of the federal ministry, which bears the same name. Similarly, issues related to R&D on food quality, agriculture, and consumer protection are supervised by the Federal Ministry of Food, Agriculture and Consumer Protection.

Thematic programmes are designed in line with priorities set in the High-Tech Strategy 2020 for relevant technology areas. E.g. the BioEconomy 2030 programme is aimed at strengthening the competitiveness of German biotech industry, and concentrates on balanced nutrition and climate change. The integrated programme ICT 2020 specifies the following priority areas for strategic research and development: ICT in Complex Systems; New Business Processes and Production Technologies; Internet of Things and Services.

These programmes determine the German economy's future technological potential and competitiveness, so they are supported by the government and the private sector at all levels – including financial support for the development of major technologies, the establishment of innovation alliances and strategic partnerships. Specific programmes to support R&D in relevant priority areas are funded through a system of tenders. All programmes and tools are regularly adjusted, and if necessary updated.

Länder programmes are aimed at creating research and innovation clusters to support high-tech development on the regional level.

2.2.

UK

Context and participants of the priority setting process

The Department for Business, Innovation and Skills (BIS) is primarily responsible for shaping science, technology and innovation (STI) policy in the UK. In setting and implementing its strategic priorities the department is assisted by a wide network of committees, councils, and advisory groups, on the government, departmental, and parliamentary levels. These include Technology Strategy Board (since August, 2014 – Innovate UK), Higher Education Funding Council for England (HEFCE), Council for Science and Technology, Research Councils, etc. The Council for Science and Technology consults the prime minister and government ministers on strategic aspects of STI policy, and provides information and analysis support for making decisions aimed at maintaining a high level of British research and development activities.

The Parliamentary Office of Science and Technology (POST) and the Parliamentary and Scientific Committee (PSC) also contribute to shaping STI policies.

Priorities and documents (strategies, white papers, critical technologies, priority areas, etc.)

Medium- and long-term national S&T development priorities are set in the UK Innovation and Research Strategy for Growth 2011[Department for Business, Innovation and Skills, 2011a]. Its objective is to increase the UK's potential to accelerate commercialisation of emerging technologies, and to facilitate creation of relevant value chains.

The strategy determines subject areas and sectors for priority S&T development:

- life sciences;
- high added value production;
- nanotechnology;
- computer technologies.

Key innovative technologies identified as priority investment areas include the following:

- synthetic biology;
- energy-efficient computing;
- energy storage;
- graphene-based materials.

In 2012, the UK started implementing the new Industrial Strategy aimed primarily at developing technologies, skills, funding mechanisms, and partnership between academia and business [Department for Business, Innovation and Skills, 2012]. The strategy identifies eleven high-priority sectors and industries (which either have already reached top international level or are likely to do so), for which the government jointly with relevant industries have designed specific strategies to support their further efficient development through long-term investments. The Strategy for the UK Life Sciences (2011) [Department for Business, Innovation and Skills, 2011b], the Nuclear Industrial Strategy: the UK's Nuclear Future [Department for Business, Innovation and Skills, 2013a], the Agricultural Technologies Strategy (2013) [Department for Business, Innovation and Skills, 2013b], etc. These strategies set development objectives for relevant sectors (areas), identify the most promising technologies and steps to be taken to accomplish appropriate objectives.

The aforementioned Industrial Strategy and its Implementation Plan also identifies eight "great technologies" where the UK has potential to become a world leader [Department for Business, Innovation and Skills, 2014]:

- Big data and energy-efficient computing;
- Satellites and commercial applications of space;
- Robotics and autonomous systems;
- Synthetic biology;
- Regenerative medicine;
- Agriscience;
- Advanced materials and nanotechnology;
- Energy and its storage.

The following S&T areas were selected for priority support in the medium term [Innovate UK, 2014]:

- graphene;
- energy-efficient computing;
- new visualisation technologies;
- quantum technologies;
- synthetic biology;
- technologies which do not require animal testing;
- energy storage.

A full list of foresight and horizon scanning projects, documents and reports is available at the website of the Government Office for Science [Government Office for Science, 2015].

Priority setting methodologies and procedures

STI development priorities are set by the government through a process of broad public debates and consensus building, involving all relevant participants of the national science and innovation system. In priority setting, the government relies on the results of various foresight studies, the results obtained by the Horizon Scanning Centre, and on consultations conducted in the course of strategy development.

Currently the UK Foresight Programme – a major data source for setting STI priorities – promotes projects either on key research issues (such as flood risk management), or S&T areas with a potential to have major practical impact (e.g. spectral characteristic of electromagnetic radiation).

The starting point of a project may be either a key subject area where impressive results and potential solutions have already been obtained, or a prospective field for which potential practical applications and technologies need to be identified and/or elucidated. There are two criteria for the selection of topics: "Problem-oriented" topics requested by different departments (ministries) – such as Obesity, Infectious Diseases, Flood and Coastal Defence . Promising areas with potentials for exploitation – such as Cognitive systems, Exploiting Electromagnetic Spectrum etc.

Programme participants analyse the potential of specific technologies in the scope of various independent projects[1] (e.g. Cyber Security and Crime Prevention, Cognitive Systems, etc.). The projects are put together through a consultative process with participation of members of the R&D community, government agencies, research councils and other stakeholders.

Completed projects include Future Flooding (2004), which served as the basis for national Making Space for Water (2006) and Tackling Obesity (2007) strategies. The latter was subsequently developed into a new inter-departmental national strategy Healthy Weight, Healthy Lives (2008). There were other projects, which have significantly affected the government policy-shaping process[2].

Each such project is independent, but the British government takes steps to bring them together again under the auspices of the Horizon Scanning Centre's S&T Secretariat.

The Horizon Scanning Centre implements short-term projects on specific issues with 10-15 year horizons. The obtained results are applied by various government ministries and other agencies in policy shaping.

All in all, the UK foresight projects generate detailed information that is sufficient for proposing alternative approaches and steps for further discussion and development of strategies to meet key challenges, and make political decisions to produce relevant strategic documents.

Implementation of thematic priorities (basic research programmes, thematic and industry-specific programmes, etc.)

The implementation of established priorities is supported by research councils, the provision of joint public-private funding to institutes (centres) operating in industries and sectors identified as high-priority ones in the Industrial Strategy, and through other mechanisms.

Research councils develop R&D programmes in line with higher-level strategic documents. Relevant programmes set more detailed priorities, which are implemented via R&D projects and other support

[1] See http://www.bis.gov.uk for more.

[2] See www.foresight.gov.uk for more.

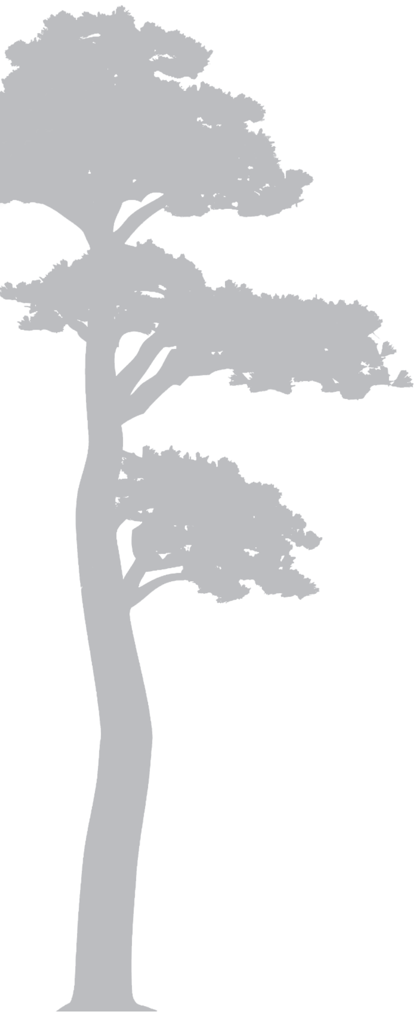
tools. Every year research councils invest about 3 billion pounds in research in medical and biological sciences, astronomy, physics, chemistry, mechanical engineering, ecology, economics, social science, and humanities.

In the scope of the Industrial Strategy, the most significant have been the joint public-private investments into the Aerospace Technology Institute (2 billion pounds), the Advanced Propulsion Centre (1 billion pounds), and centres for agricultural innovation and support of agritech companies (160 million pounds). The Industrial Strategy also provides for public investments into the eight key interdisciplinary technologies mentioned above, for which the country has advanced R&D results, technological and industrial facilities.

Also, in the scope of each priority area the so-called Catapult Centres have been established, to provide access to necessary equipment and technologies for joint use with staff of other participating companies and laboratories. Eight such centres are currently operating: Cell Therapy, Digital, Energy Systems, Future Cities, High Value Manufacturing, Offshore Renewable Energy, Satellite Applications, Transport Systems.

2.3.

Finland



Context and participants of the priority setting process

Finnish innovation and research system includes the following stakeholders: the Parliament, the National Government, the Research and Innovation Council, the Ministry of Education, Science and Culture, the Ministry of Employment and the Economy, other ministries, the Academy of Finland, R&D funding agencies, Tekes, Sitra, etc.

S&T priority setting happens on many levels and in many organisations. The government, academia, the industries and companies are performing their priority setting activities in various contexts. In Finland, the government keenly follows OECD STI policy discussions. "The OECD Model" also has political influences on the selection of S&T priorities in Finland.

At the Academy of Finland there are four research councils, which participate in priority setting: Research Council for Biosciences and Environment, Research Council for Culture and Society, Research Council for Natural Sciences and Engineering, Research Council for Health. Each of them carries out the Academy's tasks within their respective fields. The Finnish Government appoints a chair and a maximum of ten members for each research council for a three-year term. Care is taken to ensure that the research councils represent high-quality, versatile scientific expertise. Before appointing the members, the Ministry of Education, Science and Culture considers universities, government research institutes, public authorities and corporate bodies representing research and development, as well as major scientific societies and science academies.

The role of Tekes is to be central player in the Finnish innovation system. The Ministry of Employment and the Economy has set three targets for Tekes operations until 2014. These targets are: increasing innovation capabilities, growth and renewal of business productivity, social and environmental wellbeing. Impacts on society, business activities and research are evaluated.

Priorities and documents (strategies, white papers, critical technologies, priority areas, etc.)

There are many strategic documents relevant for priority setting in S&T in Finland. According to Research and Innovation Council of Finland, key development areas of R&D policy are: (1) A radical reform of the higher education system, (2) promoting the exploitation and impact of R&I results and (3) strengthening new sources of growth, intellectual capital and entrepreneurship. Other key targets for development are (1) the improvement of the overall knowledge base of the population and selective support for cutting-edge skills, (2) the reform of the public sector and closer cross-administrative cooperation and (3) the adequacy and targeting of R&D funding.

Some thematic areas are mentioned in the government programme and Tekes documents such as the Proposal for Finland's National Innovation Strategy [Ministry of Employment and the Economy, 2008]; Government Strategy to Promote Cleantech Business in Finland [Ministry of Employment and the Economy, 2014]; Sustainable Growth from the Bioeconomy; the Finnish Bioeconomy Strategy [Ministry of Employment and the Economy, 2014]; Tekes Strategy [Tekes, 2014]; The Impact of Tekes and Innovation Activities [Tekes, 2015]. These are e.g., health and well-being, bioeconomy, diversity of nature and ecosystems, energy efficient building, restoration, the Baltic Sea, etc.

Priority setting methodologies and procedures

Finland has broad networks for foresight research. The Sitra Foundation established in 2006 as was the National Foresight Network; since 2015, the foundation coordinates the foresight network jointly with the Prime Minister's Office [National Foresight Network, 2015]. The network's goal is to provide adequate information about new challenges facing Finland and about related opportunities to all stakeholders – to discuss and analyse them, and incorporate them in decision making on various government levels. The foresight network receives practical support from the Government Foresight Group, which promotes the application of the results in strategic decision making in the STI sphere. The network is comprised of representatives of government ministries and other agencies, regional councils, universities, private companies, and research centres. It is an open network, in which participants can set up other specialised 'targeted networks' to meet their own needs. Close cooperation between members of various organisations when implementing foresight programmes is supposed to significantly increase their efficiency and promote the application of their results, thanks to better opportunities for planning their applications early on.

Typically, S&T evaluations are based on (1) expert panel evaluations and on (2) the principles of multi-criteria decision-making. The methodology and procedures for priority setting are illustrated by the activities of Academy of Finland and Tekes.

A starting point for all Academy of Finland funding is that a project must benefit Finnish research, society or international cooperation in order to be funded. The Academy of Finland allocates funding on a competitive basis to the best researchers and research teams and to the most promising young researchers in order to support them in carrying out scientifically ambitious projects. High-level international peer review is a key tool for identifying the best and most promising projects. The review process does not include the opportunity for giving counter-criticism to reviewers.

The decisions of the panels are typically final. All preliminary review reports are available to the panel members before or at the meeting. The panel reviews all applications assigned to it and prepares one joint review on each application, based on discussions and the preliminary reviews.

In selecting scientifically top-level projects to fund, the Academy of Finland applies five main criteria: (1) scientific quality and innovativeness of the research plan, (2) competence of the applicant/research team, (3) feasibility of the research plan, (4) cooperation contacts for the research and (5) significance of the research project for the promotion of professional careers in research and researchers' training. The international evaluation panel evaluates these five main scientific criteria.

When making funding decisions, the Academy of Finland also pays attention to other science policy objectives (developing creative research environments, advancing multi- and interdisciplinary research, supporting the internationalisation of research, etc.).

There is hard evidence that Tekes contributes greatly to business growth. The prioritisation of S&T policy is based on impact assessments and evaluations. Typically, evaluations include many approaches and methods. There are priorities for Tekes programmes and themes, but also priorities for quality of R&D projects. Tekes programmes focus on topical and clearly defined issues, and offer funding and expert services. The programmes enable companies and public research units to develop new businesses and competences, participate in international networking and contribute to developments in the field.

In the final evaluation of Tekes in 2012, the following evaluation platform was used: (1) desk research, (2) a survey given to Tekes customers and non-customers, (3) an organisational assessment of Tekes based on self-assessments and interviews with Tekes employees, (4) interviews with stakeholders outside of Tekes from policymakers, intermediaries, research centers and businesses, (5) an international comparison of the innovation support networks in three countries including an assessment of the Finnish R&D internationalisation strategies and (6) four focus groups with experts, including an international focus group [Van der Veen et al, 2012]. Tekes also performs various programme evaluations.

Another interesting S&T procedure is the Technology Barometer. It measures Finland's techno-scientific competence and its performance capacity based on the level of its economic and societal development. The indicator-based section of the Technology Barometer compares Finland's development to that of selected reference countries. The selected target countries are compared in terms of four dimensions, which the report identifies as (1) information society, (2) knowledge society, (3) knowledge-value society, and (4) society based on sustainable development. The Technology Barometer provides vital information for decision making in relation to key reference countries in S&T policy.

Implementation of thematic priorities (basic research programmes, thematic and industry-specific programmes, etc.)

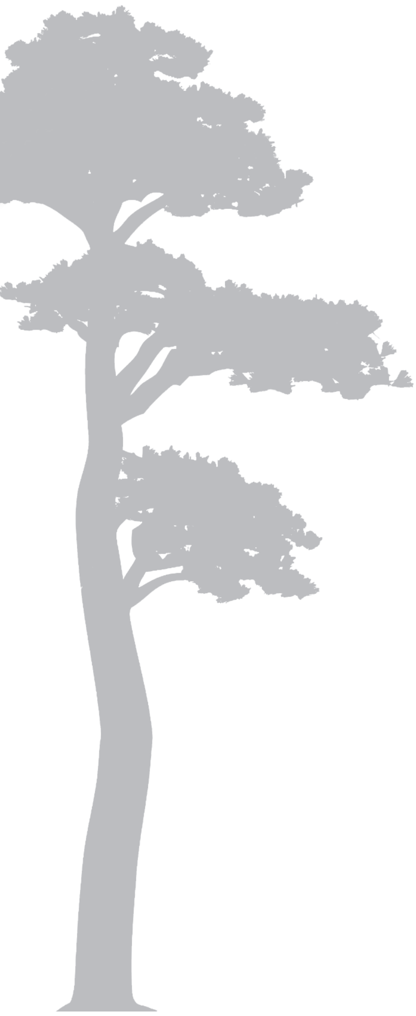
The main mechanisms of priority implementation are decision-making processes based on impact assessments and evaluations. Evaluations are typically focused on key institutions and organisations of the Finnish innovation system. The main political mechanisms are government programmes, principles of Horizon 2020 programme and incentive systems of universities and other research institutions.

2.3 Finland

The key target of S&T policy in Finland has been “the search for scientific excellence”. There are continuous monitoring activities and evaluation mechanisms that are regularly implemented. Various evaluations have had a strong emphasis on policy learning and policy implementation, which means that an active involvement of the stakeholders and national experts is typically a critical element for meeting the STI goals and priorities.

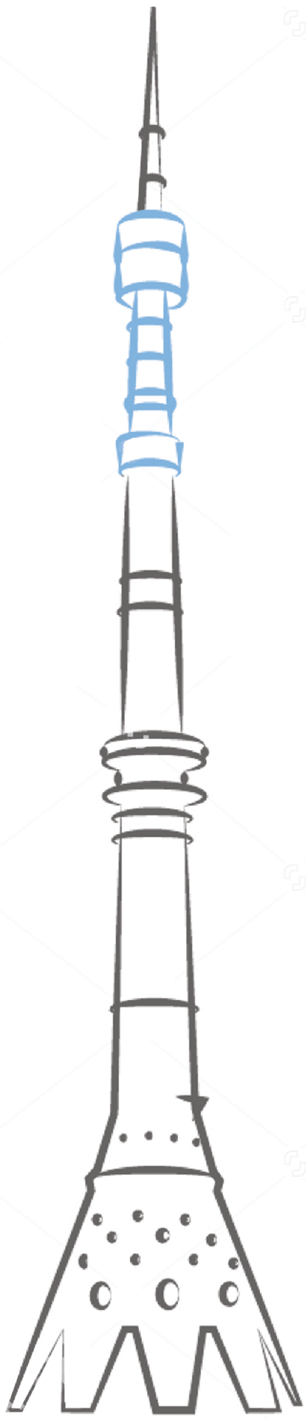
Many policy documents recommend broad STI policy, decentralised governance structures, policy planning, experimentation and agility. There are only few exceptions from these priority settings.

Please refer to the review prepared in the scope of the BILAT-USA project for analysis of S&T priority setting systems of other EU member states [BILAT-USA, 2010].



2.4.

Russian Federation



Context and participants of the priority setting process

During the last decade, Russia has accumulated significant experience in priority setting and identifying critical technologies. This work has been considerably stepped up after 2003, when the RF Ministry of Education and Science started to regularly commission studies to design lists of priority S&T development areas and critical technologies. Based on results of the studies conducted in 2004-2005, following discussions and endorsement by relevant ministries, new lists of priority S&T development areas and critical technologies were approved by Russian presidential decree (№ Pr-843 of 21 April 2006). The lists were then updated by the Ministry of Education and Science in 2009-2010, following which the current versions were approved by presidential decree № 899 of 7 July, 2011.

In 2013, the National S&T Foresight System was established in Russia, to support the prospective needs of the economy including the manufacturing sector, taking into account the development of key production technologies. Studies to identify socio-economic and S&T development areas particularly important to Russia in the medium to long term are conducted in the framework of this system. Strategic planning is supervised by the Inter-Departmental Commission on Technology Foresight of the Presidential Council for Economic Modernisation and Innovative Development's Presidium.

At the federal level, the Russian Ministry of Education and Science is responsible for S&T priority setting. For specific industries, this is performed by relevant federal executive authorities. Additionally, regional executive agencies design development strategies for Russian regions, which may indicate key R&D areas where the region's leading production and research facilities should concentrate their efforts.

Priorities and documents (strategies, white papers, critical technologies, priority areas, etc.)

Key documents of the recently established National S&T Foresight System comprise the following:

- Russian Long-Term S&T Foresight;
- Lists of priority S&T development areas and critical technologies for the Russian Federation.

Whereas the first document sets the general framework for S&T development, the second identifies the most important inter-industry (inter-disciplinary) subject areas with potential for making the biggest contribution to accelerating economic growth, ensuring national security and increasing the country's competitiveness.

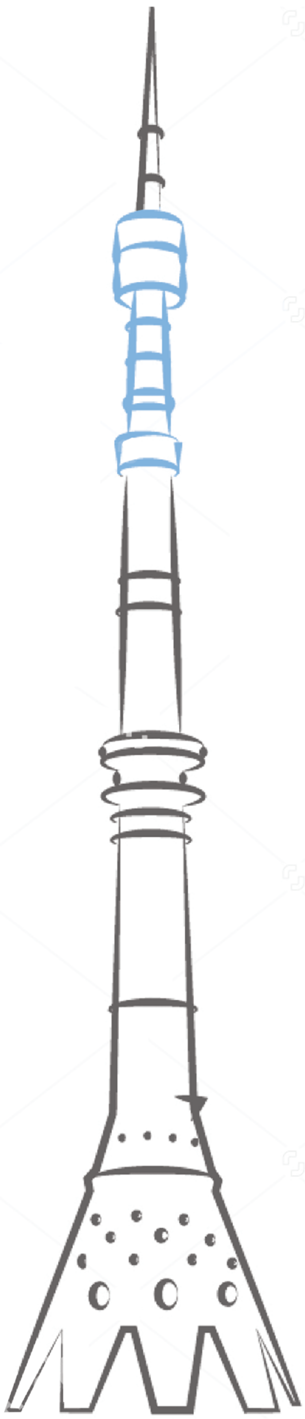
These lists were first adopted in 1996 (comprising 7 priority S&T development areas and 70 critical technologies); since 2002 they are approved by the Russian president. The lists were updated in 2002 and 2006. The current version was approved in 2011 and comprises 6 civil priority development areas and 26 critical technologies:

Energy efficiency, energy saving, nuclear energy

- Basic power electrical engineering technologies;
- Nuclear power engineering, nuclear fuel cycle, safe nuclear waste and depleted nuclear fuel disposal;
- Efficient organic fuel-based energy production and conversion technologies,
- New renewable energy sources, including hydrogen energy;
- Efficient energy transmission, distribution, and usage systems.

Life sciences

- Biocatalytic, biosynthetic and biosensor technologies;
- Genome, proteome, and postgenome technologies;
- Cellular technologies;
- Bioengineering technologies;
- Reducing negative impact of socially significant diseases;
- Biomedical and veterinary technologies;



Information and telecommunication systems

- Access to broadband multimedia services;
- Technologies and software for the distribution of high-performance computational systems;
- Electronic components bases and energy-efficient lighting devices;
- Information, management, navigation systems;

Nanosystems

- Computer modelling of nanomaterials, nanodevices, and nanotechnologies;
- Production and processing of construction nanomaterials;
- Production and processing of functional nanomaterials;
- Diagnostics of nanomaterials and nanodevices;
- Nanodevices and microsystem devices;
- Nano-, bio-, information and cognitive technologies.

Transport and space systems

- High-speed transport systems and smart control systems for new transport types
- Next-generation space-rocket and transport vehicles;

Efficient environmental management

- Monitoring and forecasting environmental trends; preventing and managing environmental pollution;
- Preventing and managing natural and anthropogenic emergencies;
- Searching, prospecting, developing natural resource deposits, and mining technologies.

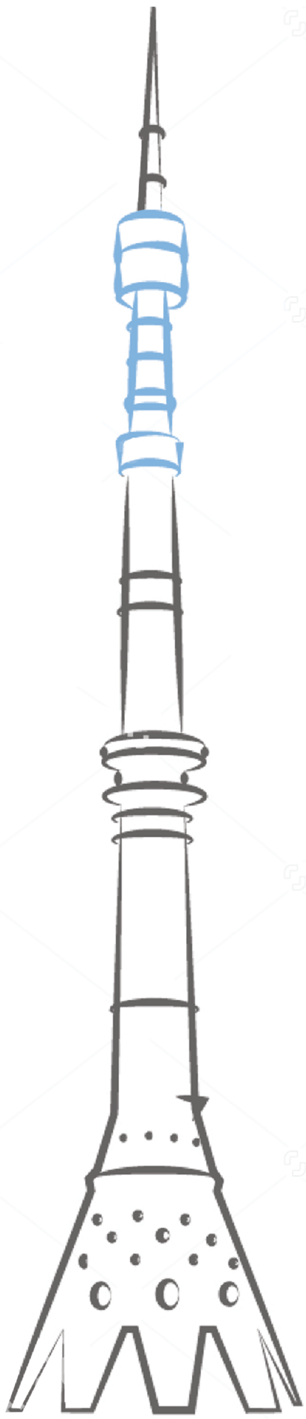
In addition to the federal-level critical technologies, several ministries have developed industry-specific lists of critical technologies – e.g. for the energy and health sectors.

Certain priority development thematic areas and industries are specified in Russian federal government programmes – the key tool for allocating government budget funds. R&D is mainly funded through the following programmes:

- Russian Federal Space Programme for 2006-2015
- "Research and Development in Priority Areas of the Russian S&T Complex for 2014-2020", which includes the Federal Targeted Programme "Research and Development in Priority Areas of the Russian S&T Complex for 2014-2020"
- Development of Civil Aviation Technologies in Russia in 2002-2010 and until 2015
- Development of Russian Spaceports in 2006-2015
- Development of Civilian Maritime Vessels and Equipment in 2009-2016
- Development of Electronic Components Base and Radioelectronics in 2008-2015
- Thematic area "Production of Next-Generation Diesel Engines and Components in the Russian Federation in 2011-2015"
- Next-Generation Nuclear Energy Technologies in 2010-2015 and Until 2020
- Development of Pharmaceutical and Medical Industries in the Russian Federation Until 2020 and in the Subsequent Period
- Support, Development and Application of the GLONASS System in 2010-2020
- Development of Russian Transport System in 2010-2020
- Federal Targeted Programme "Development of Education in 2011-2015"
- "Development of the Russian Water Sector in 2012-2020"
- Nuclear and Radiation Security in 2008 and Until 2015
- National Chemical and Biological Security System of the Russian Federation (2015-2020)
- Increasing Road Safety in 2013-2020

Another tool for supporting research in Russia is research foundations. For example, the Russian Science Foundation provides grants to finance basic and exploratory research in the following priority subject areas [Russian Science Foundation, 2015]:

- New technologies for the production and processing of heavy oils;
- New approaches to combating infectious diseases;



- Prospective manufacturing technologies;
- Inter-ethnic relations and ethno-social processes. Analysis of international and Russian experience. Reasons for conflicts and mechanisms for anticipating, preventing and managing them;
- Prospective industrial biotechnologies;
- Electrochemical and thermoelectrical technologies for power engineering;
- Smart technologies for robotics and mechatronic systems;
- Reducing risks and managing consequences of natural and anthropogenic disasters;
- Restorative, regenerative, and adaptive medicine;
- Prospective quantum communications and computing;
- New agritechnologies for managing the main sections of trophic chain to optimise the Russian population's diet;
- Neural technologies and cognitive research.

Priority setting methodologies and procedures

In 2014-2015, the Russian Ministry of Education and Science organised work on updating the current lists of priority S&T development areas and critical technologies. In the course of the new cycle of research the focus was put on both increasing science's contributions to economic and social development by dealing with the most relevant objectives, and the practical application of results that were obtained in the identified priority areas. Priorities were updated taking into account the goals set by the national authorities, and the opinions of the expert community.

The following basic principles were applied to update the lists of priority S&T areas and critical technologies:

- focus on accomplishing major socio-economic objectives;
- ten-year time horizon;
- scope for making use of national competitive advantages (territory, reserves of natural resources, etc.);
- concentrating on three most important selection criteria: the contribution to economic growth (including import substitution of mass-market products), meeting societal challenges, and ensuring technological security;

- taking into account global scientific, technological and innovation development trends;
- assessing availability of required resources (funds, human potential, facilities and equipment, previously obtained R&D results, etc.);
- setting a limited number of essential S&T priorities on which to concentrate the available resources;
- establishing links with STI policy tools.

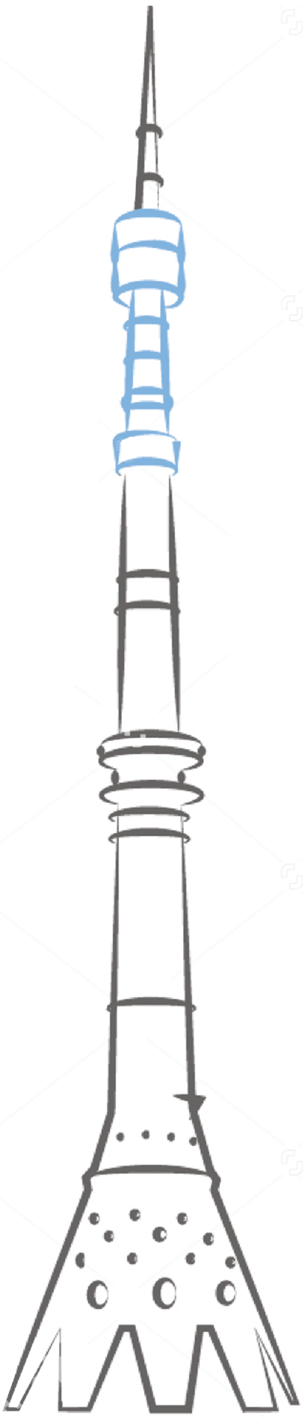
A special Interdepartmental Working Group (IWG) was established to coordinate the work, which included representatives of federal executive authorities, the Presidential Administration, the Russian Academy of Sciences, development institutes, leading national R&D and production centres and universities. The IWG developed a methodology for updating the lists, and priority selection criteria. Nine expert groups were formed for thematic areas, comprising leading professionals in relevant fields representing the government, scientific and business communities. Members of the IWG and thematic working groups took part in a series of expert discussions, surveys, and in-depth interviews.

The information required to compose lists of critical technologies primarily comes from the Russian S&T Foresight 2030, approved by the RF Prime Minister, № DM-P8-5 of 3 January, 2014 [Gokhberg (ed.), 2016]; the current lists of critical technologies and priority S&T development areas (approved by the RF presidential decree of 7 July, 2011 № 899); results of monitoring their implementation; critical technologies' passports; and other strategic documents and forecasts (such as Russian presidential address to the Federal Assembly; the Russian presidential decrees; national RF programmes; national, industry-specific, and regional development strategies; forecasts and analytics prepared by technology platforms, etc.).

Following the analysis of these materials (more than 60 documents altogether), a list of socio-economic objectives was composed, highly important for Russia generally and for particular industries and regions, and with a high potential for contribution that science and technology could realistically make in accomplishing them. The final list was made with participation of federal executive authorities, which included about 80 objectives.

Based on the S&T Foresight results, experts identified the most important prospective innovative products (services) and their consumer properties, which could support accomplishing these objectives. Particular attention was paid to critically important products (without which the objective could not be accomplished).

For the above products, list of technologies required for their manufacture was composed, to overcome "bottlenecks" and ensure the necessary consumer properties. The experts have also assessed potential for developing and applying these technologies in Russia, and considered possible risks and limitations. Similar technological solutions were grouped into critical technologies and assessed in terms of their potential contribution to making major prospective innovative products (providing services).



Priority S&T development areas were identified taking into account the updated list of critical technologies and their composition. The priority areas included horizontal ones (i.e. with a wide range of applications and reflecting global S&T development trends), and specific thematic areas particularly important for the country.

The joint effort of federal executive authorities, the IWG, the expert working groups, and broad expert community resulted in identifying eight civilian priority S&T development areas:

1. Bioindustry, bioresources, and food security
2. Biomedicine and quality of life
3. Efficient environmental management and ecological security
4. Information and communication technologies and information security
5. Next-generation materials and production technologies
6. Secure and efficient energy
7. Space equipment and systems
8. Transport vehicles and systems

A list comprised of 25 critical technologies was composed for the selected priority S&T areas – those with the highest potential contribution to accomplishing major national socio-economic objectives, and to innovation-based technological development of the country. The lists were agreed with all relevant federal executive authorities, and Russian Academy of Science provided the basis for the draft presidential decree.

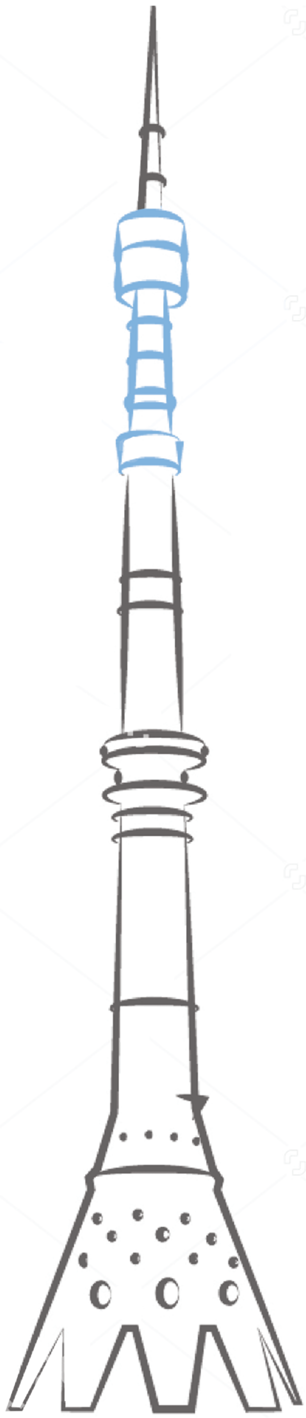
Implementation of thematic priorities (basic research programmes, thematic and industry-specific programmes, etc.)

Lists of priority S&T areas and critical technologies are among the key STI policy mechanisms applied by federal authorities, development institutes, R&D and production organisations, and other participants of the national innovation system (among other things) for the following purposes:

- shaping medium- and long-term socio-economic, innovation, and S&T policy;
- developing, implementing, and adjusting industry-level national strategic planning documents and national programmes, including federal targeted S&T development programmes;
- composing lists of industry-specific critical technologies;
- developing and adjusting regional-level strategic planning documents, including regional development programmes;
- operational activities associated with organising calls for proposals (project tenders) by development institutes and support foundations;
- designing and adjusting innovation-based development programmes for companies with public participation, strategic research programmes for technology platforms, and development programmes for innovative territorial clusters.

R&D conducted in the framework of priority S&T development areas and critical technologies are supported through national and federal targeted programmes; the key tool is the federal targeted programme "R&D in Priority Development Areas for the Russian S&T Complex in 2014-2020" (supervisor – the Russian Ministry of Education and Science) (the previous programme covered the period between 2007-2013). The programme's budget is envisaged at almost 240 billion roubles (82% to be allocated out of the federal budget). The programme covers applied research and development in priority S&T areas, the development of R&D infrastructure, facilities and equipment, and supporting international projects, including in the framework of cooperation with the EU member states.

Another mechanism for developing priority S&T areas and critical technologies is providing tax breaks and other benefits for conducting



relevant R&D. Detailed description of critical technologies has formed the basis of the list of tax-deductible R&D.

The Russian Ministry of Education and Science annually monitors the development of priority S&T areas and critical technologies; the relevant data are collected through official statistical surveys and from accounting documents. The monitoring covers federal executive authorities, the Russian Academy of Sciences, technology platforms, innovative territorial clusters, foundations supporting science, technology and innovation, various organisations active in science and innovation, and other participants of the national innovation system. The data collected in the course of the monitoring subsequently can be applied to update the lists of priority S&T areas and critical technologies. Analytical reports on R&D results are submitted to the RF government.

According to the monitoring data, Russian R&D expenditures have significantly increased in recent years. Overall national internal R&D expenditures in 2014 amounted to $43,4 billion, out of which $29,5 billion USD (67,9%) was spent on R&D in civil priority S&T areas and critical technologies [Higher School of Economics, 2016].

R&D expenditures are distributed between priority S&T areas as follows (in 2014):

- Transport and Space Systems ($10,6 billion);
- Energy Efficiency, Energy Saving, Nuclear Energy ($4,3 billion);
- Information and Telecommunication Systems ($3,6 billion);
- Efficient Environmental Management ($2,1 billion);
- Life Sciences ($1,8 billion);
- Nanosystems ($1,2 billion).

Most of the funds allocated for civilian priority S&T development areas went to “Transport and Space Systems” and “Energy Efficiency, Energy Saving, Nuclear Energy” – due to implementation of major infrastructural projects and relevant departmental programmes.

An analysis of European and Russian experience of S&T priority setting reveals that methodologies and mechanisms for their identification and implementation are constantly being improved to meet new global challenges and development trends.

3

EU-Russia cooperation in priority STI development areas

3.1.

STI cooperation experience

EU-RUSIA

S&T cooperation between the European Union, its Member States, and the Russian Federation has a long history and covers practically all scientific disciplines and technology areas. Research areas pursued by the EU and Russia complement each other.

One of the best examples of Russia – EU STI cooperation is Russian scientists' participation in the EU framework programmes on S&T development. It has been steadily increasing for the last 15 years. Russia became the largest and most successful in group of third countries. This was particularly evident in the 6th (2002-2006) and 7th (2007-2013) Framework Programmes – both in terms of received funding and the number of participating scientists. E.g. in the FP7 Russian researchers participated in more than 350 projects (thematic areas ICT, Health, Biotechnology and Food Safety, Energy, Transport, etc.). In December 2012, 463 Russian scientists were receiving funding through 291 grants, the total EU contribution amounting to €63 million (Russian co-funding was €40 million).

At the end of 2013, 459 Russian organisations participated in 298 projects with the total funding in excess of €2 billion, €1,3 billion of which have been provided by the EU. The overall budget of Russian participants of these projects amounted to €103 million, with €64 million provided by the EU. These are the biggest figures among third countries – participants of the Framework Programme. Priority cooperation areas included air transport, space, ICT, energy, nano-technologies, health, and research infrastructures.

A key area for developing Russian-EU S&T cooperation is setting up research infrastructure, specifically the major Mega Science infrastructural projects. Russia and the EU closely cooperate in the framework of such initiatives as the European X-Ray Free Electron Laser (XFEL), the Facility for Antiproton and Ion Research (FAIR), the International Thermonuclear Experimental Reactor (ITER), the European Organisation for Nuclear Research (CERN), etc.

Noticeable progress has been achieved in researchers' mobility. On 9 April 2010, the Russian government approved the regulation "On measures to attract leading scientists into Russian universities and research institutions of state Academies of Sciences". "Mega-grants" are allocated through tenders to fund research headed by leading scientists at Russian universities and R&D organisations. Three such tenders have been organised so far; more than 100 foreign scientists received funding, 33 of them EU citizens. Cooperation is also developing in the framework of grants allocated by the European Research Council, and through Marie Sklodowska-Curie Actions for Russian scientists.

The ERA.Net RUS project has been implemented since 2009 in order to integrate Russia in the European Research Area through the coordination of S&T programmes of the EU Member States, associated countries, and Russia [ERA.Net Rus, 2015a]. ERA.Net RUS became the first project in the history of Russia – EU S&T cooperation in the scope of which funding agencies from various countries hold joint calls for proposals in a multilateral format (as opposed to individual bilateral agreements) [European Commission, 2015m].

3.2.

Similar EU and Russian priorities is the basis for strategic partnership

EU-RUSSIA

Despite a certain diversity of approaches to setting S&T priorities in the EU countries and Russia, their top-level priorities are very much similar to each other. Structured top-level STI development priorities of the EU, UK, Germany, and Russia are presented in table 1 below.

All developed countries conduct research in areas reflecting major global S&T development trends, which affect their future competitiveness. In most of the European countries strategic S&T development areas include nanotechnology and next-generation materials, information and communication technologies, advanced production processes, energy, transport, space systems, life sciences, and biotechnology.

Depending on countries' research potential and available resources, they select more precisely defined technology fields within priority S&T development areas (e.g. critical, key, enabling technologies) to be supported ahead of all others. This is the level where differences between countries' approaches to STI priority setting are the most pronounced. The level of funding and other resources allocated in order to support specific S&T development areas also indicate the country's STI priorities.

Concentrating resources in the above areas allows for the promotion of further development of existing technologies and the creation of new technologies required to deal with major social challenges, accelerate economic growth, and increase competitiveness of partner countries.

An important objective is to identify areas where potential partner countries not only have a significant research potential but also would be interested in cooperation – because one could expect a substantial synergy from joining forces in such fields.

Table 1. Thematic STI priorities of the EU countries and Russia

Research areas	European Union (Horizon 2020: the EU Framework Programme for Research and Innovation)	UK (Eight great technologies, UK)	Germany (The High-Tech Strategy 2020)	Russian Federation (List of priority S&T areas and critical technologies, approved in 2011)	Russian Federation (Draft list of priority S&T areas and critical technologies, 2015)
Industrial Leadership	Advanced manufacturing processes				Next-generation materials and production technologies
Next-generation nanotechnology and advanced materials	Nanotechnology	Advanced materials and nanotechnology		Nanosystems	Next-generation materials and production technologies
ICT	ICT	Big data and energy-efficient computing	Information economy and society	Information and telecommunication systems	Information and communication technologies and systems
		Robotics and autonomous systems			
Life sciences	Biotechnology	Synthetic biology	Healthy life	Life sciences	Bioindustry, bioresources, food security
	Health, demographic change and wellbeing	Regenerative medicine			Biomedicine and quality of life
	Food security, agriculture, forestry, water ecosystems, and bioeconomy				

(continued)

Research areas	European Union (Horizon 2020: the EU Framework Programme for Research and Innovation)	UK (Eight great technologies, UK)	Germany (The High-Tech Strategy 2020)	Russian Federation (List of priority S&T areas and critical technologies, approved in 2011)	Russian Federation (Draft list of priority S&T areas and critical technologies, 2015)
Energy	Secure, clean and efficient energy	Energy and its storage	Sustainable economy and energy	Energy efficiency, energy saving, nuclear energy	Secure and efficient energy
Efficient resource management, climate impact	Food security, agriculture, forestry, water ecosystems, and bioeconomy	Agriscience		Efficient environmental management	Efficient environmental management and ecological security
	Efficient resource management, climate impact, natural resources				
Transport	Green, smart transport		Smart mobility	Transport and space systems	Transport vehicles and systems
Space	Space	Satellites and commercial applications of space		Transport and space systems	Spacecraft and space systems

National STI priority setting systems also differ in terms of their coverage (scope), and focus on particular major socio-economic problems.

3.3.

Identifying priority subject areas for mutually beneficial, efficient cooperation

EU-RUSIA

In 2014, a new stage in Russia – EU partnership began, which includes implementation of such major programmes as Horizon 2020 – the EU Framework Programme for Research and Innovation, and the Russian National Programme “Development of Science and Technology in 2013-2020”.

The Horizon 2020 roadmap for Russia describes Russia as a major partner. The Horizon 2020 work programme for 2014-2015 mentions the following priority areas:

- air transport;
- information and communication technologies;
- research infrastructures.

Russia participated in numerous research projects funded through FP7 covering various aspects of designing new high-speed aircraft, such as the application of composite materials, noise insulation, increased safety, improved quality of service, and standardisation. Russia is a leader in solving complex mathematical and software problems, so joint projects are planned in mathematical modelling and development of parallel programming algorithms, nanosystems, and photonics. Joining Russian and EU forces in such areas as health also seems desirable, especially taking into account relevant global challenges (the Global Research Collaboration for Infectious Disease Preparedness (GloPID-R) programme).

Currently the Russian Ministry of Education and Science, in line with the milestones of the State Programme “Development of Science and Technology in 2013-2020”, identified 12 priority research areas in the scope of the Horizon 2020 work programme for 2014-2015. Each area comprises specific thematic fields to support research in.

In particular, the supported areas include the following:

- Food security (3 thematic fields where calls for proposals will be organised);
- Innovative bioeconomy (4 thematic fields);
- Biotechnology (2 thematic fields);
- Nanotechnology, new materials, production (2 thematic fields);
- Low-carbon energy (9 thematic fields);
- Smart cities and townships (2 thematic fields);
- "Blue growth" based on marine resources (4 thematic fields);
- Low-carbon, resource-saving economy (1 thematic field);
- Water (2 thematic fields);
- ICT (9 thematic fields);
- Clear sky (55 thematic fields);
- Transport (4 thematic fields);
- Space (5 thematic fields).

Thematic fields to be supported in the framework of the ICT priority area are presented in Box 4 below.

BOX 4

Supported thematic fields in the ICT priority area:

- Reduced energy consumption and customisation
- Application of cloud computing for innovation-based development
- Big data research
- Advanced learning and teaching technologies
- Robotics
- Basic micro- and nanoelectronic technologies
- Key photonics technologies
- Internet of things and smart platforms
- Key enabling ICTs

Opportunities for cooperation in the scope of the Horizon 2020 programme are monitored and promoted by Joint EU-Russia Thematic Working Groups, in such areas as aviation technologies, energy, environment and climate change, food, agriculture, biotechnology, health, ICT, researchers' mobility, nanotechnology and materials, research infrastructures, and space [European Commission, 2014].

Cooperation with Russia is also initiated by individual EU Member States – participants in the ERA.Net projects; a number of such joint projects have been implemented jointly with Russian partners.

Two pilot multilateral calls for proposals have been organised in the scope of the ERA.Net RUS project in 2011 [ERA.Net RUS, 2012]: for Innovation Projects and S&T Projects. Funding was provided by relevant agencies from 11 countries – EU Member States, associated countries, and Russia (Russian Academy of Sciences, Russian Foundation for Basic Research, Russian Foundation for Humanities, Foundation for Assistance to Small Innovative Enterprises in S&T sphere). The total budget of the Innovation Projects call for proposals (52 applications were received, 11 projects funded) was €2,980,000, out of which the Russian side provided €1,500,000 [ERA.Net RUS, 2015b]. The total budget of the S&T Projects call (183 applications received, 31 projects funded) was €5,930,000, out of which the Russian side provided €1,300,000 [ERA.Net RUS, 2015c].

A foresight study was also conducted in the scope of the ERA.Net RUS project: "EU – Russia S&T and innovation cooperation", which allowed for the clarification and fine-timing of thematic areas for Russia – EU research cooperation. The study was conducted by the NRU HSE ISSEK jointly with the European Commission's Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS, Spain) and the Centre for Social Innovation (ZSI, Austria) [Sokolov et al., 2014]. The study comprised a number of working group discussions and a Delphi survey covering 7,000 respondents, and resulted in identification of thematic areas for S&T cooperation between Russia and the EU. Leading Russian and European experts participated in defining the subject areas for the joint call for proposals, including representatives of Russian funding agencies. This activity ensured that proposed research areas matched priority S&T development areas for the Russian Federation and the EU Horizon 2020 Framework Programme for Research and Innovation, and were in line with results of other Russian and European foresight studies, in particular Russian S&T Foresight 2030.

On the basis of the results of the above Delphi survey, the following important areas for Russia – EU S&T cooperation were identified:

- Heath, demography, wellbeing (selected by 55% of Russian respondents and 45% of the EU respondents).
- Secure, clean and efficient energy resources (20% and 25%, respectively).
- Climate change, efficient usage of resources and raw materials (11% and 14%).

Based on working group discussions, the following priority thematic areas for cooperation were identified: Medicine and Health, Nanotechnology, Climate Change, Social Sciences and Humanities (see Box 5).

BOX 5

Priority areas and thematic fields for cooperation

- **Nanotechnology**
  - Advanced nanosensors for application in health and environment protection
  - Designing and modelling new functional materials
  - Nanomaterials for making improved lighting devices
- **Climate Change**
  - Improving reliability of regional climate change forecasts
  - Assessing environmental impact of mining and transporting raw materials
  - Extreme natural phenomena and their environmental impact
- **Medicine and Health**
  - Molecular mechanism of human brain's functioning and pathologies
  - Regenerative medicine and biomaterials
  - New drugs to treat cancer, cardio-vascular, and infectious diseases
- **Social Sciences and Humanities**
  - Conflictology, identity, and historical memory issues
  - Demographic changes, migration, and migrants
  - Social cohesion and regional development challenges and opportunities

For each of the four areas roadmaps were developed. Project participants have also identified steps to extend the scope and improve the quality of joint work [Haegeman et al., 2015].

Ultimately, the international project consortium designed, with the help of foresight methodology, a development concept and action plan for Russia – EU MS/AC S&T cooperation.

The main outcome of the successful pilot calls for proposals organised in the framework of the ERA.Net RUS project was major extension of the international consortium of funding agencies from the EU member-states and associated countries, and increased investments in the call for proposals organised in the scope of the follow-up project, ERA.Net RUS Plus.

This project has been implemented since 2013, aimed at the further enhancement of STI cooperation between the EU member states, associated countries, and Russia. The main project objectives include coordination of the S&T development programmes of participant funding organisations, and implementation of the harmonised Russia – EU S&T cooperation programme developed in the scope of the ERA.Net RUS project to support Russia's efficient participation in Horizon 2020.

Thirty partners from 16 countries currently participate in the project, with total confirmed financial obligations of about €22,200,000. The European Commission agreed to provide a further €3,500,000. The extension of the ERA.Net RUS Plus project confirms efficiency of the model, according to which joint research projects are financed by funding agencies from the participating countries allocating the money to researchers from their own countries.

The projects selected for funding will receive €20 million – which makes ERA.Net RUS Plus the leading initiative of Russia – EU S&T cooperation. Three hundred applications have been submitted to the ERA.Net RUS Plus call for proposals.

Out of them, 45 projects were approved for funding in the Science and Technology area (priority subject fields Nanotechnology, Medicine and Health, Environment Protection and Climate Change), and 18 projects in the Innovation area.

Another priority area for Russia – EU S&T cooperation is joint construction and exploitation of global research Mega Science infrastructures. An example is the new joint Russia – EU three-year cooperation programme to establish world-level Mega Science class research facilities “Connecting Russian and European Measures for Large-scale Research Infrastructures” (CREMLIN) [NRC Kurchatov Institute, 2015] launched in 2015. It is jointly coordinated by the Kurchatov Institute and the Deutsches Elektronen-Synchrotron Centre (DESY). Other participants include the RAS Institute of Crystallography, the RAS Institute of Applied Physics, the Budker Institute of Nuclear Physics, the Joint Institute for Nuclear Research (Dubna), the Institut Laue-Langevin, Laboratory Interactions, Dynamique et Lasers (LIDyL), CERN, the European X-Ray Free Electron Laser (XFEL), and the European Synchrotron Radiation Facility (ESRF).

The programme has three major goals: enhancing research cooperation between scientists on the basis of Russian mega-facilities and European research infrastructure, including e-infrastructure and big data management; developing common research policy on the basis of the CREMLIN recommendations and foresight studies of strategies and prospects; and establishing an efficient platform to exchange the results of all Mega Science-class projects, support mutual learning and the exchange of experience.

The Kurchatov Institute National Research Centre participates in neutron research at the high-beam reactor PIK [NRC Kurchatov Institute, 2015, 2015b], and in joint photonics research at the synchrotron radiation source facility ISSI-4. There are plans to conduct joint heavy ion physics research at the Nuclotron-based Ion Collider (NICA) facility [Daily Electronic Newspaper. File-RF, 2015], research using high-power lasers at the Extreme Light Infrastructure Laser Research Centre (ELI), and research using the lepton collider at the C-Tau Factory in Novosibirsk and the IGNITOR Tokamak.

The Strategic Forum for International Science and Technology Cooperation (SFIC) also participates in setting STI priorities [European Commission, 2015n]; it is a consulting organisation established by the EU member-states and the European Commission to promote European partnership and international S&T cooperation. The EU member states and the European Commission are full members of the forum, associated countries have observer status. The SFIC participants exchange information and consult with each other to identify mutual priorities for international S&T cooperation, and coordinate their positions regarding third countries.

In 2014, the SFIC started developing a roadmap for implementation of the EU MS/AC – Russia Strategic Research and Innovation Agenda (SRIA), with Russian participation. This initiative was supported despite the unstable political situation because there were no obstacles at the technical procedures stage.

In October 2014, a working group meeting was held in Berlin to discuss internationalisation of research and cooperation with Russia ("Internationalisation of the European Research Area: Towards a Common European Approach in STI Cooperation with Russia"). Particular attention was paid to organising joint work in the current difficult situation, specifically plans for 2015 and establishing the platform EU-MS/Russia Strategic Research and Innovation Agenda (SRIA), which is supposed to extend the range of objectives, priorities, and tools for the foreseeable future.

Conclusion

A major feature of the current stage of global S&T and socio-economic development is the rapid acceleration of new technologies' commercialisation, combined with reduced life cycle of products. Accordingly, all industrially developed countries are taking steps to support sustainable development and efficient utilisation of their competitive advantages, especially concerning practical application of technologies to produce innovative products and services.

Setting viable S&T development priorities through the comprehensive assessment of their expected contribution to achieving sustainable socio-economic development and improving competitive positions becomes a key aspect of shaping long-term STI policy.

In recent years, this approach was adopted by most countries including EU member-states and Russia. Identifying STI priorities becomes increasingly relevant on the supranational level as well. A good example is the EU framework programmes for research, technology development, demonstration activities, and since 2014 also innovation, which for a long time were used as a tool to set STI development priorities.

In most of the developed countries, and on the EU level, STI priority setting systems are based on results of general or focused foresight studies covering major S&T development areas. In recent years, this trend became even stronger. E.g. the Horizon 2020 priorities are expected to be updated using the approach currently being developed by the European Forum on Forward-Looking Activities [European Forum on Forward Looking Activities, 2015]. A major feature of the latest round of STI priority setting activity in the Russian Federation was the fact that it was conducted in the framework of the National Technology Foresight System, taking into account the results of the Russian S&T Foresight 2030 study [Gokhberg, 2016].

Worthy of note are the significant similarities between priorities, which determine key STI development areas in the EU countries and Russia. This certainly can be seen as a major factor contributing to sustainable long-term partnership between them. Furthermore, the recent experience of the EU – Russia cooperation shows that it is developing through projects that are being implemented precisely in the high-priority subject areas, whose results are expected to have significant economic and social impact.

Therefore, the objective to design common approaches to creating a priority setting system for the European Union – Russia S&T cooperation becomes increasingly relevant. At the same time, it should be kept in mind that cooperation areas with a potential to not only join forces but produce significant synergies in the process would be of particular interest.

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