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NEW CHALLENGES FOR STI POLICY FROM THE INTERNATIONALIZATION OF R&D: THE CASE OF RUSSIAN-GERMAN R&D COOPERATION

BASIC RESEARCH PROGRAM

WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY, INNOVATION
WP BRP 02/STI/2012

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NEW CHALLENGES FOR STI POLICY FROM THE INTERNATIONALIZATION OF R&D: THE CASE OF RUSSIAN-GERMAN R&D COOPERATION[2]

Over the last two decades national policy makers drew special attention to the implementation of policy tools which foster international cooperation in the fields of science, technology, and innovation. In this paper, we look at cases of Russian-German collaboration to examine the initiatives of the Russian government aimed at stimulating the innovation activity of domestic corporations and small and medium enterprises. The data derived from the interviews with companies' leaders show positive effects of bilateral innovative projects on the overall business performance alongside with major barriers hindering international cooperation. To overcome these barriers we provide specific suggestions relevant to the recently developed Russian Innovation Strategy 2020. [3]

JEL Classification: O30, O31, O32, O38, F23.
Keywords: science, technology, and innovation policy; small innovative enterprise; state-owned enterprise; international cooperation.

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[2] A preliminary version of this paper was partially published in Russian in Foresight-Russia journal (Gershman M., Kuznetsova T. (2012) Osobennosti uchastiya malikh predpriyatii v mezhdunarodnoi nauchno-tekhnicheskoi kooperatsii: opyt rossiisko-germanskikh kontaktov [Specificities of Involving Small Enterprises into International S&T Co-operation: Evidence from the Linkages between Russia and Germany]. Foresight-Russia, vol. 6, no 3, pp. 51–61).

[3] Acknowledgements: The author would like to thank Dr. Tatiana Kuznetsova for her advice and input during the preparation of this paper.
This study has been funded partly by the International Bureau of the German Federal Ministry of Education and Science (Internationales Büro des Bundesministerium für Bildung und Forschung, BMBF) under the grant contract 'R&D Globalization and R&D Cooperation between German and Russian Enterprises' ("F&E Globalisierung und F&E Kooperationen zwischen deutschen und russischen Unternehmen"). The project was conducted in cooperation with Prof. Dr. Alexander Gerybadze (Hohenheim University) and Dr. Christoph Grenzmann (Science Statistic Consulting Grenzmann).

1. Introduction

A significant shift in the development of national innovation systems occurred during the last two decades. The dominant classical approach, based on the central role of domestic economies, was followed by more broad concepts (Freeman, 2002). Economic globalization has to a large extent redefined the role of national innovation systems and forced policy-makers to adapt innovation policy tools to the international context (Borras et al., 2009). Another major trend was the transition from linear innovation models to the concepts of 'open innovation' (Chesborough, 2003, 2006) and networking at the cross-country level (OECD, 2008). The idea of the multiplication of the innovation potential of networks' actors lies at the heart of these approaches. Strong linkages between partners provide access to unique resources and improve knowledge and technology transfer as a whole (Powell, Grodal, 2005). This is the major reason why successful enterprises all over the world has become increasingly involved in international collaboration activities.

Science, technology and innovation (STI) cooperation in the business enterprise sector is essentially associated with large and strong domestic corporations, which are frequently multinational enterprises (MNEs). In developed economies they play an important role in R&D performance. In 2010 the overall R&D investments of the 1400 largest companies – most of them from the European Union, the US, and Japan – were equal to 456 billion euro, that is nearly 50% of global R&D spending (The EU Industrial R&D, 2011; Grueber and Studt, 2011).[4] On the other hand, big corporations are major subjects of the innovation systems in the developing world. In particular, the technological success of Asian countries (Japan, Taiwan, and South Korea) is to a large extent a matter of the existence of large domestic conglomerate firms combined with active government policy (Amsden, 1989; Fagerberg et al., 2010). The presence of a high proportion of state-owned enterprises (SOEs) constitutes a particular feature of developing economies (for instance, China, Korea and Russia). In these countries SOEs have been much stimulated by the government in order to become more competitive on the global market. It has resulted in the rise of genuine international technological leaders such as Samsung, LG and Hyundai in Korea and Huawei and ZTE in China. As far as Russia is concerned, the only domestic corporations which compete in the international innovation arena (Gazprom and Lukoil) are from gas and oil sector.[5] However, over the last two years the Russian

[4] In 2007 R&D spending of the 20 largest MNEs (including Toyota, General Motors, Pfizer, Nokia) accounted for 13.1% of global R&D investments (Jaruzelski and Dehoff, 2008).

[5] In the Ranking of the top 1000 non-EU companies by level of R&D investment Gazprom and Lukoil ranked 108th and 482th, respectively (European Union, 2011).

government has been stimulating the largest SOEs to strengthen their innovation capabilities and international STI performance. The latter will form the focus of this paper.

Other important actors of global innovation chains are small and medium enterprises (SMEs), which clearly contribute to economic growth and increase the competitiveness of domestic markets by creating new jobs (Audretsch, 2009; OECD, 2012; Siegel et al., 2003). In rapidly growing industries (information and communication technologies (ICT), automotive industry, pharmaceuticals) SMEs produce ideas which are subsequently integrated into new products and then purchased by larger companies (OECD, 2006a).

At the same time, SMEs appear to be the least protected entities in innovation systems in terms of the availability of investments and loans, which innovation activities obviously require. It is worth noting that interest rates for SMEs sometimes exceed those for large companies (OECD, 2012). Such obstacles not only negatively affect their ability to develop but also challenge their survival (Blanchflower and Oswald, 1998; World Bank, 2010).

However, over the last 20 years public priorities have been significantly reconsidered and switched towards SMEs support. Thus, in the United Kingdom small innovative enterprises are provided with public R&D contracts in couple with public procurement of their innovative products; Netherlands has recently established 'innovation vouchers' for SMEs; and specific tax and social incentives are implemented in France. South Korea has expanded financial support for this type of enterprise by allowing the use of intellectual property (IP) rights as a form of loan guarantee, and has also established several publicly funded programs (World Bank, 2010).

In developed countries the state tends to support SMEs not only in the early stages of their growth but also while commercializing products and entering the global market. The key supporting tools for these purposes are consulting services, education, financing marketing campaigns and activities related to intellectual property protection (OECD, 2006a, 2007). The engagement in trade associations, technological clusters, and specific cooperation programmes are also of much significance. The latter has only recently appeared in the Russian context. In this paper we look at one such public STI cooperation programme for small enterprises (BMBF / FASIE programme), which has recently been established between Russia and Germany.

2. Russian-German relations

Germany is a major partner of Russia in trade and economic relations:

- Its share in Russia's foreign trade consistently remains at 8-9% (Russia's share in Germany's trade turnover is 2.5%).
- Investments in Russia reached almost 8.5 billion euro in 2010.[6]
- According to the Central Bank of Russia, Russian investments in the German economy account for nearly 5.5 billion euro. This figure is almost twice less when reported by Bundesbank, however Russia still remains the major foreign investor in the German economy among BRICS countries and takes the fifth place among non-European countries which invest in Germany.[7]
- The number of companies with German participation (which are represented in 80 out of the 83 Russian Federation regions) in 2011 exceeded 6000, demonstrating steady growth.[8]
- High-tech products clearly dominate in the structure of Russian imports from Germany. Machinery, equipment and vehicles account for about 60% of goods imported to Russia.[9]

These, and other aspects, make Germany one of Russia's key partners in industry and infrastructure modernisation, as well as the innovation sphere.

Russian-German cooperation over recent years has been characterized not only by extensive growth, but also by improving the quality of integration processes. Thus, Russian investments in Germany have become more technologically oriented, for example, the purchase of former Hitachi plant located at Bavarian Landshut by the Russian LED-producer Optogan, the acquisition of German oil refineries (Ruhr Oel) and the German shipyard Wadan Yards by Rosneft and Nordic Yards, respectively. At the same time, numerous German production facilities were established in Russia as well as training and R&D centres.

Therefore, Russian-German cooperation in the business sector is developing dynamically. However, there is a lack of data on STI cooperation between Russian and German companies.

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[6] Source: Germany. Review of trade relations with Russia (website of external economic data of the Ministry of economic development of the Russian Federation) http://www.ved.gov.ru .
[7] Source: GTAI – http://www.gtai.de
[8] Böhlmann J. New growth of number of German enterprises in Russia (website of Russian-German Chamber of commerce). http://russland.ahk.de/uploads/media/2011_01_13_deutscheUnternehmen_ru.pdf).
[9] Source: Rosstat (2011).

3. International STI cooperation of Russian SOEs

Innovation strategies of Russian SOEs represent one of the current policy tools of the Russian government aimed at stimulating innovative activities of major corporations. The initiative was launched in August 2010. The Government Commission on High Technologies and Innovations compiled a list of the 47 largest SOEs[10] whose overall share in the Russian industrial turnover, according to the Russian Ministry of Economic Development, was more than 20%.[11] These enterprises were obliged to develop and implement innovation strategies.

In addition, the Working Group on Private-Public Partnership Development in Innovation Sphere was formed which included representatives from the government, ministries, corporations, universities, and the Russian Academy of Sciences (RAS). This group was in charge of making tactical decisions regarding innovation strategies of SOEs, technology platforms, development institutions, public procurement for innovation (PPI). SOEs from the approved list had to annually report to the group on the progress of implementation of their innovation strategies.

The innovation strategies were developed in accordance with the official recommendations of the government. Most of them included the following strategic directions: new product development, modernization of equipment, commercialization of technologies, cooperation with universities, R&D institutions and SMEs, participation in Russian technology platforms, and international collaboration.

To shed light on specific experience of international R&D cooperation in the business sector, we examine innovation strategies of the largest Russian SOEs.[12] The results of this analysis are presented below. In addition, we illustrate them with two case-studies (Aeroflot Airlines and Russian Railways) to provide evidence that some of the Russian SOEs are strongly involved in international STI cooperation, although in a peculiar way.

The analysis of the innovation strategies showed that each company had included international STI activities in its mid-term implementation plan. Though the geographic scope of Russian SOEs' linkages is relatively wide, the most frequently mentioned countries are the USA, Germany, France, CIS countries, China, and South Korea. Several innovation projects with Italy, Japan, Canada, UK, and Northern and Eastern European countries have also been planned.

[10] 13 companies were added to the existing list in 2012.
[11] Over a third of these SOEs belong to the defence industry.
[12] The following analysis is based on the innovation strategies reports of 31 state-owned enterprises.

Since the main focus of our research is Russian-German STI cooperation, we examine specific data on cooperation projects with Germany. Such projects were included in the innovation strategies of 11 SOEs from mining, manufacturing and transport sectors (namely, Gazprom, AvtoVAZ, Aeroflot, Russian Railways, and several enterprises of the defence industry). Some examples are presented in Table 1.

Table 1. Examples of STI cooperation between Russian and foreign corporations (including German ones)

Russian SOE	**R&D partners**	**Form of cooperation**	**Project details**
Gazprom	Wintershall Holding AG (BASF subsidiary, Germany)	Joint venture with Gazprom mining Urengoi Ltd (Achimgaz)	Commercial mining and production of natural gas and condensate from the Achimov layers (since 2008)
	Statoil (Norway) Total SA (French Group)	Joint venture (Shtokman Development AG)	Development of the Shtokman offshore gas-condensate field (In August 2012 Statoil exited from the project)
	Royal Dutch Shell (Netherlands, Great Britain) Mitsui, Mitsubishi (Japan)	Joint venture (Sakhalin Energy)	The offshore extraction of hydrocarbons Sakhalin-2 (since 2006).
	Russian-German Energy Agency RUDEA (Germany)	Long-term agreement with Gazpromenergosberezhenie and JSC INTER RAO UES in the field of energy conservation and efficiency	Construction of new and reconstruction of existing boilers, generating stations, thermal and electrical networks, infrastructure facilities using advanced German technologies as well as Russian equipment, materials and services
AvtoVAZ	TRW Automotive Gmbh (Germany) Takata-Petri AG (Germany, Japan) Robert Bosch GmbH (Germany)	Agreement Protocol on technical cooperation	The projects with TRW Automotive Gmbh and Takata-Petri AG is related to automobile safety systems, and the project with Robert Bosch GmbH concerns engineering of ABS and ESP systems for LADA
Aeroflot Russian Airlines	Boeing (USA) Airbus (Europe)	Agreement	Purchase of aircraft, system components and equipment on a regular basis
	Flight simulator producers: CAE (Canada) RP Aero Systems (Great Britain)	Agreement	Purchase of flight simulators for Aeroflot Aviation School
	Lufthansa Technik (Germany)	Five-year contract (from 2009)	Technical support and maintenance of the Aeroflot aircraft

	Suppliers of IT solutions: Lufthansa Systems (Germany) SAP (Germany)	Long-term agreement	Optimization of finance, implementation of ERP systems
Russian Railways	Siemens (Germany)	Joint venture (Ural locomotives)	Joint production of electric trains and electric freight locomotives; collaboration in engineering
	Alstom (France)	Joint venture (TRTrans)	Production of electric passenger trains
	Tatravagonka (Slovakia)	Joint venture with Transmaschholding (Transmasch)	Production of flat wagons for carrying large-tonnage containers and production of multifunctional covered trucks of new type
	Bombardier (Canada)	Joint venture (ELTEZA)	Production of systems of railroad automation and telemechanics
	Finmeccanica (Italy)	Memorandum of understanding and roadmap	Modernization of automatic train control systems
	MTU Friedrichshafen GmbH (Germany)	Joint venture with Transmaschholding	Production of diesel engines of new generation
	Knorr-Bremse (Germany)	Joint venture with Freight Two (a subsidiary of Russian Railways)	Manufacturing and maintenance of brake equipment for locomotives and other rail transport

Source: ISSEK/HSE

3.1 Joint ventures

Russian-German STI cooperation often occurs in the form of a joint venture which contributes to more successful adaptation of foreign technologies to Russian SOE's production. Typically, it takes at least a year to launch joint production. Several years later, after technologies have been adapted in one department, they diffuse throughout the corporation. For example, in 2003 Gazprom mining Urengoi Ltd (Gazprom daughter company) and Wintershall Holding AG established a joint venture Achimgaz. Commercial mining and production of natural gas and condensate from the Achimov layers started only

five years later. In 2010 the decision was made to construct 20 new wells. The experience gained is currently being adapted to implement similar projects in other deposits of Gazprom.

The same model is used to deal with large scale projects involving several foreign enterprises. One such project ('Sakhalin-2') was initiated in 2006 by Gazprom, Royal Dutch Shell, Mitsui, and Mitsubishi and is related to offshore extraction of hydrocarbons. In 2010 the project reached its full capacity (9.6 million tons of liquefied natural gas (LNG) per year). Now the companies engaged in this project plan to increase its transport capacity to meet the growing demand for LNG and oil. Another one, which aimed to develop the Shtokman offshore gas-condensate field jointly with Norwegian company Statoil and French group Total SA, was temporarily stopped in August 2012 due to large project costs.

3.2 The upgrade of physical infrastructure

A common model of Russian-German STI cooperation implies a contribution of German companies to the modernization of physical infrastructure of Russian corporations. Usually it comes to providing engineering services or delivering and maintaining high-tech equipment. Thus, in late 2010 a long-term agreement on energy conservation and efficiency was signed between Gazpromenergosberezhenie, INTER RAO UES and the Russian-German Energy Agency (RUDEA). The agreement provides for construction of new and reconstruction of existing boilers, generating stations, thermal and electrical networks, and infrastructure facilities using advanced German technologies and Russian equipment, materials and services.

Another example is the Russian car manufacturer AvtoVAZ which in 2011 conducted several high-tech projects with the world's leading high-tech companies, including German ones: Bosch, Siemens, ANVIS, BASF. The projects with TRW Automotive Gmbh and Takata-Petri AG were related to automobile safety systems, while the project with Robert Bosch GmbH concerned engineering of ABS and ESP systems for LADA. By 2017 AvtoVAZ plans to invest nearly 136 million euro in the development of innovative technologies for automobile manufacturing. This includes engineering and production of new and improved engine units and automobile systems in collaboration with German partners (Bosch, ANVIS, Hella) and automotive industry players from other countries.

3.3 Cooperative R&D

Most Russian SOEs appeared to be uninvolved in the cooperative R&D with German companies and research organizations. These activities were not directly

mentioned in their innovation strategies. Thus, the only data that we obtained from the interviews with representatives of Russian Railways concerned large engineering and joint production projects launched by the company in partnership with Siemens (see below).

The official data on international collaboration within Russian technology platforms[13] in which some SOEs take part may constitute an additional source of information on joint R&D projects.

3.4 Selected case studies of STI cooperation of Russian SOEs

To provide more detailed information on Russian-German cooperation in STI sphere, specific cases involving Russian Railways and Aeroflot (the companies which showed much activity in this area) are described below.

a) Aeroflot

Aeroflot – Russian Airlines is Russia's largest air carrier with total revenue of 3.4 billion euro in 2011. The company owns a number of regional carriers: Dzhetallians East, Vladivostok Avia, Sakhalin Airlines, Orenburg Airlines, and Russia Airlines. As one of the major transport SOEs, Aeroflot has its own innovation strategy. In 2011 the overall expenditures on innovative projects[14] amounted to nearly 800 million euro, or 23% of the company's revenue. Expenditure on high-tech equipment clearly dominates among the implemented technological innovations.

As a part of its innovation strategy Aeroflot purchases modern aircrafts from leading foreign aircraft manufacturers Boeing and Airbus. Apart from that, the company established partnerships with Western flight simulator producers – Canadian CAE and British RP Aero Systems. In the near future the Aeroflot aviation school will buy a full-flight simulator CAE for Airbus A330.

The Russian air carrier also pays much attention to organizational innovation which is typical for a service company. This mainly refers to ICT, safety of flights, and quality of provided service. Cooperation in this field also involves German suppliers of IT solutions for air transportation. For example, in 2010 Aeroflot became the first Russian airline to implement an integrated platform for optimization of financial processes, Sirax AirFinance, developed by Lufthansa Systems. In the IT field Aeroflot has a long-term cooperation agreement with German IT-integrator SAP concerning the implementation of ERP systems. According to CEO Advisor for Innovative Development Andrei Polozov-

[13] The initial list of 27 technology platforms involving research and technology organizations, universities, corporations, and SMEs was established in April 2011 by the decision of the Government Commission on High Technologies and Innovations. In February 2012 this list was expanded to include 30 technology platforms.

[14] That is, projects which include technological, organizational, or marketing innovations.

Yablonsky, *"Cooperation with German companies is carried out without any problems, business issues are discussed during negotiations."*

Regarding internal R&D, Aeroflot carries out research and holds patents on several unique technologies for improving the safety of flights. These include mobile canine complexes (which are already available on certain European markets), anti-icing fluids of new generation, and other technologies.

Aeroflot is a member of the Russian technology platform 'Aviation mobility and aviation technologies'. In 2011 the company joined the Supervisory Board of the platform and now manages the 'Effective air transportation' directorate.

b) Russian railways

Russian Railways, the world's largest transport company, is another example of Russian corporation closely collaborating with German and other foreign enterprises. The company provides freight and passenger transport. In 2011 the number of company's employees was over 1 million, and its revenue reached 33 billion euro. Russian Railways provides about 80-85% of freight transport in the country, not counting pipeline transportation. The long mileage of railways in the Russian Federation (85 thousand km) requires regular modernization of railway infrastructure. This is one of the reasons for why the company has a large Innovation Centre and is strongly engaged in public innovation activities. It is also deeply involved in technology cooperation with foreign partners such as Siemens (Germany), Alstom (France), Tatravagonka (Slovakia), Bombardier (Canada), Finmeccanica (Italy).

The head of Russian Railways Innovation Centre, Alexander Korchagin, argues that *«the latest negotiations with the European partners on purchase and localization of production of passenger trains in Russia have not been easy»*. However, good relations between the governments of Russia and Germany and the history of collaboration with Siemens AG (on the production of the high-speed train Sapsan) have contributed to the final decision: in 2009 Russian Railways and Siemens signed a contract for the purchase of 38 new German-produced trains for the Olympic Games in Sochi. By 2014 Russian Railways are planning to purchase 16 Siemens trains manufactured in Russia with the level of localization of production of at least 35%, and by 2017 this figure should reach 80%. For this purpose the joint venture Ural locomotives was established by the Russian group Sinara and Siemens AG in 2011 in Verhniaya Pyshma (Russia). Later on, an engineering centre was opened which was responsible for technological innovations and technology transfer.

The representatives of Russian Railways emphasize that all foreign trains they purchase require technological adaptation to Russian standards and weather conditions, which implies cooperative R&D. Such an adaptation of mounted wheels of Sapsan to winter conditions was carried out jointly with Siemens (Russian Railways and Siemens registered 26 joint patents while working on the Sapsan train).

Another area of R&D cooperation with Siemens is the production of electric freight locomotives at the Ural plant of railway engineering. In 2010 the first prototype was assembled, and in 2011 Russian Railways purchased 11 new locomotives. Passenger electric trains with similar engine system are now produced at the Novocherkassk plant in cooperation with Alstom.

In 2011 Russian Railways initiated a new government programme to support the manufacturing of diesel engines of new generation. In 2012 the company placed an order with JSC Transmashholding to supply 10 Russian-produced diesel locomotives equipped with diesel engines of MTU Friedrichshafen GmbH (Germany). By the end of 2015 it is planned to establish an engineering centre to develop a new design of diesel engines and manage the whole production cycle of diesel engines in Russia.

There are other German companies involved in technological cooperation with Russian Railways. For example, the manufacturer of brake systems Knorr-Bremse and JSC Freight Two (a subsidiary of Russian Railways) are planning to create a joint venture to manufacture and maintain brake equipment for locomotives and other rail transport.

Russian Railways is also implementing the project on the development of ‘smart stations’ which include a set of automatized life support and engineering systems. The company plans to use the experience of Deutsche Bahn in developing such smart stations.

Another initiative of the company concerns the construction of a separate high-speed line from Moscow to St. Petersburg. A tender for this work was announced by Russian Railways in the beginning of 2012. The competition involves different countries, including China and South Korea, but Germany, as mentioned by Alexander Korchagin, would be most preferred outcome.

The two case studies examined above represent a rather common model of international STI cooperation through technology upgrade. However, very few Russian SOEs obtain new knowledge and technologies through international collaboration, and the number of companies who use high-end developments in the local production is even smaller. In this regard, the cases of Russian Railways and Aeroflot may be good examples for other Russian SOEs to follow.

4. Bilateral public funding – The BMBF / FASIE joint programme

4.1. Background

The second tool which we address in this paper is a bilateral public funding program. In contrast with SOEs' innovation strategies initiative this policy targets small innovative enterprises from Russia and Germany. It is widely known that Russia and especially Germany support small high-tech business, but Russian segment of these firms is still very narrow (Gokhberg and Kuznetsova, 2009). The share of SMEs implementing technological innovation hovers around 5% and significantly varies in different industries. Thus, in manufacturing of medical equipment the figure is 17%, whereas in pharmaceuticals and electronics production the share stands around 22-23%.[15] Since positive outcomes of the innovation activities of small enterprises are to a large extent determined by the quality of their linkages and involvement in international STI collaboration (Ahvenharju et al., 2006; European Commission, 2010), public support for the development of Russian-foreign STI cooperation is of high importance.[16] Hence, our main purpose here was to look at one of the bilateral public funding programs in order to identify weak points in national STI policy that could be improved by the Russian government.

Intended to support Russian-German scientific cooperation, the Russian-German programme was implemented in 2008 by the International Bureau of the Federal Ministry of Education, Science, Research and Technology of Germany (BMBF) and the Russian Foundation for Assistance to Small Innovative Enterprise (FASIE). Overall, four calls for joint Russian-German research projects have been made. The purpose of these calls was to support Russian-German projects aimed at developing priority technologies. Between 2008 and 2010 over 150 applications were received; only 50 were approved for funding.[17]

As it is stated in the bilateral agreement, FASIE finances SMEs from Russia, whereas BMBF supports a consortium of participants from Germany (the German part should be presented by at least two applicants: a small business and an academic / research organization). One of the conditions of the programme is that companies must cover half of the project costs with their own resources. The duration of such projects is usually 18-24 months. The amount of funding allocated by FASIE is up to 4 million roubles.

The analysis given below is based on data from a survey involving 10 Russian innovative SMEs funded within the BMBF / FASIE programme in 2008-2010 (Table 2).

[15] Source: Rosstat (2012).
[16] The implementation of such public policies has been suggested by experts while working on Russia's new strategy of social-economic development for 2020 (Strategy 2020), (Gokhberg and Kuznetsova, 2011).
[17] Source: FASIE website http://www.fasie.ru/

Table 2. Russian innovative SMEs funded within the BMBF / FASIE joint program in 2008-2010, which took part in the survey

№	Company name	City	Industry	Year of funding
1	GIDRAN	Moscow	Engineering	2008 and 2010
2	Nanostructured Glass Technology	Saratov	Nanotechnology	2008
3	Aeroservice	Koltsovo	Engineering (air-conditioning systems)	2009
4	Crystal	Korolev	Engineering (energy)	2009
5	Medotel	Moscow	Healthcare (medical diagnostics technologies)	2010
6	R&D Enterprise "DNA-Technology"	Moscow	Healthcare (DNA-diagnostics technologies)	2010
7	High Technologies R&D Centre	Kazan	Nanotechnology	2009 and 2010
8	Geoenergetika	Kaluga	Engineering	2010
9	Biospec	Moscow	Healthcare (video diagnostics technologies)	2010
10	VEK-21	Moscow	ICT, Engineering	2009

Source: ISSEK/HSE

The enterprises were located in different Russian cities (Moscow, Korolev, Saratov, Kaluga, Koltsovo, and Kazan) and belonged to the industries where Russian-German cooperation is highly active (medical equipment and services, engineering, ICT, and nanotechnology). The data was collected through semi-structured in-depth interviews with the small enterprises' CEOs. The interview guide contained questions which referred to companies' main economic activities; results of the FASIE funded projects; experiences of international STI cooperation; and major barriers hindering R&D and innovation performance.

In order to collect additional data, several German companies from pharmaceuticals, construction and chemical sectors were interviewed (Knauf, Henkel, STADA CIS, Bayer AG, Evonik Industries AG). Some of them have been cooperating with Russian enterprises and research institutions for several years, and now plan to expand their innovation activities in Russia.

4.2. The results of the survey of Russian small enterprises funded within the BMBF/FASIE programme

4.2.1. Incentives for international cooperation

During the interviews the respondents were asked questions concerning incentives for STI cooperation with Germans. The main incentive for Russian small enterprises

appeared to be an opportunity to enter European markets which is difficult to do on one's own. According to several interviewees, Europeans are quite wary when a purely Russian company, without any Western support or cooperative ties with Western countries, tries to enter a European market.

Another advantage of German R&D organisations is modern equipment. Some Russian CEOs from the healthcare industry find this factor rather important for achieving positive scientific results. Hence, German healthcare companies often do analytical work, which implies modelling and calculations, while Russian partners conduct applied research and development. Such cooperation scheme was common for several Russian SMEs in healthcare and other sectors.

"- Do they [Germans] have advanced equipment? – Oh yes, state of the art stuff, we can only dream about such things" (manager of Russian-German nanotechnology project)

Frequently the attractiveness of working with German companies comes from its strong R&D skills. For that reason High-Technology R&D Centre, Ltd – a small enterprise established by Kazan National Research and Technological University – contacted Dresden Technological University. This contact resulted in a joint project on nanomodification of sheet materials.

Regarding the motives for German companies to work with Russian enterprises, the respondents suggest that Germans are also interested in Russian science. Interestingly, some of the CEOs believe that Russian applied science keeps going mostly in small enterprises directly or indirectly related to the RAS. Usually employees of these small firms also have jobs at the RAS research institutions.

Some respondents agree that the European research system is less oriented towards the commercialisation of R&D results than, for example, the American one with its powerful infrastructure designed to promote innovations (Silicon Valley, for example). This makes German companies look for partners capable of achieving applied R&D results and transforming them into end products. In this regard, Russia is a good collaborator since it can produce high-level scientific results at relatively low cost.

Finally, the Russian market has still many free niches, and this also attracts German companies which use joint R&D projects as 'feelers' for exploring new market opportunities.

4.2.2. Barriers hindering cooperation

Perhaps, the most important question in the survey concerned barriers hindering international STI cooperation.

One of the key problems facing both Russian small enterprises and German companies operating in Russia is customs barriers. This is most relevant to innovative enterprises which work with materials, substances, components and parts for high-tech equipment.[18] In particular, firms have to pay customs duties for importing materials and components while ready-made equipment (medical, automotive) may sometimes be imported duty-free. Such a customs regime, on the one hand, limits the manufacturing capabilities of Russian enterprises, and on the other it decreases the motivation of German companies to locate production facilities in Russia. Customs barriers are also associated with problems of a bureaucratic nature (redundant forms to fill in, long waits for approval) which often result in experimental prototypes being 'blocked' by customs officials.

"We had a project once (related to electronics), well, we could neither import nor export certain parts. So customs just get in the way" (CEO of a small company producing medical equipment)

Another problem is related to patenting R&D results abroad. According to some respondents, this problem derives from the mistrust towards Russian companies which is the result of the high level of corruption in the country. For that reason, European patent agencies may significantly delay expert evaluation of applications, and even refuse to register IP rights. Therefore, the respondents believe that the only reliable way to protect their inventions abroad is to file patent applications with foreign partners (for joint ownership). Some surveyed small companies opted for that strategy also because they find the procedure for international registration of IP rights cumbersome and expensive. According to the respondents, they could certainly use government support for that purpose.

"Since it is hard to get a foreign patent in Russia we are planning to file patent applications jointly with our foreign partners" (CEO of a small healthcare firm)

A significant barrier hindering innovation activities of Russian small enterprises is public procurement legislation. According to the respondents, it slows down the implementation of Russian scientific developments and does not allow domestic companies to compete with foreign enterprises even in Russia. It is widely known that commercialization of technologies requires substantial resources (to launch mass production, marketing and sales) which small enterprises usually lack. Hence, public procurement for innovation could become an effective tool to support innovative SMEs. However, this has not happen as, for example, in China where such a policy was carried out intentionally. Moreover, the respondents describe Russian policy as 'absurd': the government allocates public funds to finance R&D projects but at the next stages of the

[18] We would note that a large number of Russian innovative companies (e.g. working in medical industry) not only develop technologies but also produce hardware.

process Russian innovations are not supported. Instead, public institutions and enterprises prefer to buy foreign-made products with similar functionality, comparable price and quality.[19] Such government policy essentially leaves small enterprises on their own; they have to find investors themselves, which is a difficult task in Russia. At the same time, Russian developments are copied by foreign competitors. Thus, a technology identical to the cargo management and monitoring system developed by Vek-21, Ltd, which did not get early government support, was soon implemented by Lufthansa Cargo.

"The current situation is absurd: government spends a lot of money on R&D but it doesn't procure Russian innovative products. How should we compete with Western companies?" (CEO of a small enterprise producing medical diagnostics equipment)

"While we are looking for an investor, foreign companies are already using our technologies" (CEO of a small ICT enterprise)

Accepting the need for competition in public procurement, certain Russian CEOs believe that domestic manufacturers should be supported through special PPI tools. Such programmes would contribute to transformation of R&D results into innovations, increase the overall demand for Russian-made products, and help to get feedback from users. Public procurement seems to be important also because Russian small enterprises currently have almost no competitive advantages over foreign companies in terms of pricing policy. Although some Russian products have the same functionality as Western-made analogues, it is very hard for Russian small enterprises to reduce production costs. There is a shortage of skilled technical and engineering personnel, the costs of such labour is comparable to European costs, and most electronic components are imported from abroad.

Among other general problems associated with public innovation policy, lack of tools for promotion of Russian-made products was also noted. This results in a low level of consumer loyalty. Here it may be useful to follow the Chinese example: for many years China has been investing in promoting 'Made in PRC' and 'Made in China' brands, and now has achieved positive results (Fan, 2006). The Russian government has not yet done anything of the sort though these issues have been continually discussed at various government levels. A related problem mentioned by the respondents is lack of engineering and production infrastructure in Russia. While in Western countries such services are often outsourced, Russian innovative companies have not been well integrated in global production chains so far.

The respondents also mentioned certain industry-specific problems. As an example, healthcare industry is subject to quite rigid government regulation. For instance, new diagnostic techniques cannot be introduced to the market before they are registered. By

[19] In formal compliance with the public procurement law which implies the use of competitive procedures.

that time market opportunities might be lost, or innovations might be copied by competitors. In Germany, a license of medical practice allows doctors to use new diagnostic systems at their own responsibility which is insured. In Russia, if a doctor acts in accordance with official regulations, he will not be formally liable for consequences.[20]

4.2.3. Establishing initial contacts

Most of the interviewees underline the importance of establishing initial contact with foreign partners. One of the relevant mechanisms to start cooperation is through international exhibitions, fairs, and conferences. For example, the CEO of Crystal, Ltd met his future German partner at a trade fair.[21] That acquaintance subsequently helped the Russian enterprise to enter foreign market and establish contacts with world's largest car makers (Porsche, BMW, Audi, etc.).

A less common way to find foreign partners is the so-called 'direct search'. A good example is Gidran, Ltd, whose managers went to Germany in the 1990s specifically to look for a firm interested in the distribution and adaptation of pumping equipment in Russia. At the moment this small enterprise is in the process of adapting German ground water purification equipment to Russian environmental conditions.

Many international contacts in the STI sphere are made through 'old connections' in which case a former compatriot now settled abroad serves as a contact person for the foreign side. That is the way Aeroservice, Ltd, Medotel, Ltd, and Nanostructured Glass Technologies, Ltd established their contacts in Germany.

«There're lots of guys who left Russia a long time ago; we mostly work with groups like that» (CEO of a small engineering enterprise)

4.2.4. Government support of STI cooperation

The respondents suggest that the efficiency of international STI cooperation could be increased by such means as simplification and acceleration of customs procedures, duty relief schemes for imported components and materials, zero R&D taxes, simplification of administrative procedures. According to several managers, cancellation of visa requirements would definitely benefit international cooperation between countries. Some of the CEOs suggest that the database of foreign STI partners should be extended and

[20] Certain Russian experts believe that Federal Law of 10.03.2006 N 323-FZ 'On health protection of citizens of the Russian Federation' substantially limits the potential of medical liability insurance. An alternative bill which contributes to solving this problem shall be approved in 2013 (Kondratyuk, 2012).

[21] The scientific production association Crystal, Ltd produces thermoelectric cooling and generator (Peltier) modules for cars. The company won the BMBF/FASIE programme call in 2009.

made more accessible. That would allow to substantially increase the number of international contacts.

Many small enterprises funded by the FASIE are involved in other government initiatives aimed to support science and innovation. The firms participate in the federal targeted programmes of the Russian Ministry of Education and Science, as well as in regional programmes, and establish contacts with Russian development institutions. However, the respondents were unable to name particular public policy tools to support and promote Russian-German STI cooperation (apart from the BMBF / FASIE programme); only one of them took part in a research programme implemented by the Goethe Foundation.

Apart from cooperation policies, some respondents characterized other public mechanisms to support and promote R&D and innovation. Thus, the CEO of a company – resident at the Novosibirsk industrial park highly assesses the 'Development of high-technology industrial parks in the Russian Federation' programme [22]. According to him, it was simple enough to obtain a small research grant within the programme, and reporting requirements were also quite easy to meet. Moreover, this programme allowed the company to get a soft loan to establish a physicochemical lab which became an 'R&D contractor' not just for the company but also for other research teams.

Several interviewees mentioned the Skolkovo Tech in various contexts. On the one hand, the government policy of funding Skolkovo is perceived by the CEOs rather sceptically due to unclear management structure and non-transparent funding system.

"(About Skolkovo) They say it themselves: "We're onboard an aircraft, and we're attaching the wings as we fly" (CEO of a small healthcare firm)

On the other hand, Skolkovo is seen as one of the few policy tools that could promote and support Russian innovative businesses. To a large extent this is due to Skolkovo's cooperation with the Massachusetts Institute of Technology (MIT), the world's leader in R&D and innovation. A good management practice of the Skolkovo Tech is the division of labour between researchers and entrepreneurs. This was achieved by establishing specialised structures in the university responsible for commercialisation of R&D results including mass production, marketing and sales.

"Scientists are not supposed to be selling, they're supposed to create something patentable, get the patent and then sell the license – on their own or with somebody's help" (CEO of a small enterprise – resident at Skolkovo)

[22] The RF Government Regulation of 10.03.2006 N 328-r (as amended on 27.12.2010) 'On the Government Programme 'Development of high-technology industrial parks in the Russian Federation'.

The respondents also have varying opinions about the so-called 'mega-grants'[23] – a rather new STI policy tool implemented by the Russian government in 2010 in order to attract the world's leading scientists to Russia. While the main goal of this public policy is regarded as positive important, the rules and procedures for the calls are seen as opaque.

CEOs are sceptical in their assessment of the Federal Law of 02.08.2009 N 217-FZ, which allowed Russian universities and research institutions to establish small innovative enterprises. They believe that instead of producing innovations most of those enterprises would rather 'write reports' to the Ministry of Education and Science.

4.2.5. Assessment of the FASIE support

Most of the respondents positively assess the FASIE activities. They agree that its work is beneficial and the selection of call winners is fair. In general, the FASIE support is perceived as extremely useful even if R&D does not result in commercially viable products. It was also noted that most of the projects funded by the FASIE usually do generate clear results which are easy to transform into innovations.

"The Foundation is the first example of an adequate approach to assessing applications" (CEO of a small electronics enterprise)

At the same time, the respondents note certain problems. One of them is excessive reporting which takes a lot of time. Another one is the quality of expert evaluation of call applications which may be improved by involving foreign experts. Another issue mentioned was the need for a wider publicity for the FASIE calls in order to extend the pool of potential participants.

The role of the FASIE in the system of public development institutions was also discussed. Some respondents believe that the FASIE should define its role more clearly and make the goals of its calls more transparent. Obviously, the average size of grants allocated by the Foundation covers only a portion of the R&D costs but certainly not the whole innovation process. In this context the FASIE requirement to cover half of the project costs seems rather unreasonable to the CEOs.[24] Finally, according to some of the respondents, the government should allocate additional funds to support commercialisation of successful innovative products (to provide an 'innovation lift').

"There must be a system, and the Foundation must be very clear about where it is and what it can do in its field" (CEO of a small healthcare enterprise)

[23] The RF Ministry of Education and Science Regulation of 09.04.2010 N 220 'On attracting leading scientists to work at Russian universities'.

[24] Some Federal targeted programmes of the Russian Federation Ministry of Science and Education contain similar requirement.

4.2.6. The perspective of German companies

As mentioned earlier, the survey also involved German companies engaged in STI activities in Russia. It turned out that their cooperation with Russian small innovative enterprises is not developed enough, and it only exists in a few industries. Possibly this is due to the small sample size, although the overall trend seems to be true. German companies with STI activities in Russia do not see much benefit in cooperating with Russian small firms. They also note a shortage of promising projects and technologies. Even in such a dynamic industry as pharmaceuticals there is a lack of Russian R&D products attractive for investments and commercialisation. R&D skills are still mostly concentrated in research organisations established during the Soviet period. Lack of communication tools for STI cooperation also hampers this process to a certain extent.

"We have been approached by small firms offering their R&D products, but it was nothing new, so we were not interested" (Director for development of a German pharmaceutical corporation)

At the same time, the surveyed German companies do intend to expand their innovation activities in Russia. Some of them even plan to establish divisions responsible for R&D and innovation. The main partners of German companies in this field are usually research institutions and universities (mostly in staff training). The latter, according to some respondents, have recently started to get substantial support from the government, and are trying to make the most out of it.

"Universities have ideas, they have recently got resources from the government, they try to use them, and, thank God, they're not completely estranged from the market" (R&D director of a German chemical corporation)

Among economic and political problems which affect R&D activities of German companies in Russia the most important is the intellectual property protection. Companies spend a lot of time negotiating with Russian R&D organisations on relevant issues. Some respondents suggest that it is high time to introduce specific tools which would raise personal responsibility for crimes in this area, as well as more efficient arbitration mechanisms for such conflicts.

"Suppose we work with a third party on developing a product; who would put his hand into the fire and guarantee that somebody from that team wouldn't go to work for another company after a while and take our results along? Answer: nobody" (R&D director of a German company producing construction materials)

Dealing with customs is also important for German companies, especially the long time it takes to get customs clearance, redundant customs documents, and high costs of such services.

Other common problems associated with doing business in Russia include unreliable suppliers, underdeveloped logistics, and administrative pressure on businesses. Besides, Russian certification system has a serious drawback of not being harmonised with

international standards. This results in spending extra time and money to complete re-certification procedures in Russia.

In Annex 1 we provide additional data on particular projects of the small enterprises funded within the BMBF/FASIE program. **Annex 2** contains summaries of interviews with managers of German companies engaged in STI activities in Russia.

5. Conclusions and policy implications

In this paper we looked at different cases of Russian-German STI cooperation within two recent government policy tools: innovation strategies of Russian SOEs and the Russian-German funding program which targets small innovative enterprises. Below we provide the main conclusions and implications for policy making.

Most of the Russian SOEs which implement innovation strategies are involved in international STI cooperation. They collaborate with German and other foreign companies, typically with large and well-known ones. At the same time, the ongoing projects are often concerned with technological modernization and the procurement of high technology equipment. Some Russian corporations (Russian Railways and Gazprom, for instance) implement large-scale projects which provide for gradual localization of high-tech production in Russia. For this purpose joint ventures are usually established. Cooperative R&D between Russian SOEs and foreign companies and research institutions are rare when compared to technological modernization projects. Thus, the 'open innovation' model in terms of international cooperative R&D is not appropriate for Russian SOEs so far.

It is hard to estimate to what extent the innovation strategies of SOEs contribute to the development of new international linkages in the STI field since this tool is still rather new (the innovation strategies were implemented only in 2011). However, no special emphasis has been made by the government until now on what steps Russian SOEs should take in order to increase the efficiency of international STI relations. It is probably one of the reasons why most of the innovation strategies of SOEs are locally oriented and do not involve many foreign actors. Therefore, while policy making in this particular area remains uncertain there is just a slim chance that Russian SOEs will significantly modify their business strategies with regard to international cooperation in the R&D and innovation field.

The second part of the survey, dedicated to small innovative enterprises, showed that even such 'small-scale' policy tools as the BMBF / FASIE programme can be very

effective. Only one cooperative R&D project in the survey sample was not successful while many of the current projects funded in 2010 have good market prospects. Besides, most of the interviewees believe that the international programme is useful and effective both in terms of project results and opportunities to access foreign markets. The latter turns out to be the main incentive for Russian small enterprises to take part in the programme besides getting additional funding. Other appealing factors for Russians are the high quality of German research equipment and their strong scientific expertise in certain research fields.

German companies, according to Russian respondents, are attracted by the relatively low cost of Russian R&D combined with strong research skills in several areas, and by opportunities to develop applied solutions and technologies that can be quickly transformed into end products. The Russian market with its many free niches also attracts German companies.

The analysis of the BMBF/FASIE programme revealed a number of barriers hindering international STI cooperation. These provide a basis for further improvement of the existing policy tools. Below we provide a policy-mix consisting of three main sections: provision of funding and benefits, improvement of innovation infrastructure, and specific framework conditions.

a) Provision of funding and benefits:

- *Introduction of new international STI cooperation programmes (similar to the BMBF/FASIE programme).* New and existing programmes should involve a larger number of innovative enterprises. Project funding should be gradually increased since the current project budget is hardly enough to cover R&D costs.
- *Development of various Russian-foreign mechanisms to provide funding and loans to innovative SMEs.* Since Russian SMEs usually have limited financial resources, specific funding instruments should be developed (for example, provision of low interest rate loans from the state). A good example is the Russian-German foundation for assistance to SME's high-tech innovative and energy-efficiency projects, established by Russian Vnesheconombank and German Kreditanstalt für Wiederaufbau.
- *Duty relief schemes for imports of materials and components for STI activities, including Russian-based foreign-owned production facilities.* This is critical to Russian innovative SMEs dealing with the manufacturing of medical equipment and other high-tech machinery since high import tariffs on materials and components increase production costs. The same problem affects foreign producers doing business in

Russia: localization of production facilities becomes less profitable for them because of the high costs of imported equipment and components.

- *Extension of the policy mix and benefits provided for Skolkovo residents to cover other successful Russian science and industrial parks, special economic zones of technology-innovative type, science towns, and innovative clusters*. Over recent years a large innovation infrastructure has been created in Russia. The Russian government funds Skolkovo, while residents at successful science parks and special zones, which cooperate with foreign partners, are operating under worse conditions. Incentives for this group of enterprises might be reconsidered in order to grow a larger number of internationally competitive innovative start-ups.

b) Improvement of innovation infrastructure:

- *Development of consulting infrastructure to support foreign companies with innovation activities in Russia.* Foreign enterprises which start R&D or innovation activities in Russia should recognize the specificities of Russian legislation as well as rights provided by federal and regional laws. They would also be well advised to take into consideration the cultural dimension, namely soft skills, of their Russian counterparts. The relevant consulting infrastructure does not exist at the moment.
- *Development of infrastructure to allow quick registration of IP rights abroad including assistance to Russian and joint Russian-foreign small innovative enterprises.* Many Russian innovative SMEs experience problems with patenting abroad. They usually find this procedure expensive and complicated. While the average number of patent applications filed by 'patent active' Russian small enterprises is rather high (nearly 3 applications per year), only 9% of them apply for patents abroad.[25] The current situation would be improved by creating an infrastructure to allow Russian firms to more easily enter the global market.
- *Development of specific structures to support commercialisation of STI results.* This survey shows that Russian firms are quite successful in collaborating with German partners in R&D and innovation. However, the cooperation processes between the countries are often being slowed down at the commercialization stage. Lack of financial resources forces Russian enterprises to look for investors, and this is not easy in Russia. While doing such a search a company may lose its competitive advantage, since a new product may be copied by a competitor or the overall demand may decline. Therefore, there is a need for public support of commercialization of innovative

[25] Source: HSE (2012).

products and services through the system of public procurement (specific procurement programmes for Russian innovative SMEs, for instance).

c) Specific framework conditions:

Much attention should be paid to the adjustment of specific framework conditions. Many of the suggestions listed below have already been planned in the Russian Government Strategy 'Innovative Russia 2020'. The most critical tools to improve international STI cooperation, in our view, are the following:

- *streamlining technology import procedures;*
- *improving mechanisms for IP protection and enforcement (including the establishment of new IP courts);*
- *simplification of immigration laws related to highly skilled foreign professionals employed in Russia;*
- *allowing domestic manufacturers to introduce their products to the market assuming full responsibility for them, on the basis of declaration rather than certification;*
- *simplification and streamlining of certification procedures to bring them in line with international quality standards;*
- *development of professional associations of Russian suppliers.*

In conclusion, it is worth noting that many of the above mentioned suggestions may become compulsory for the Russian government as well as for local producers in the light of Russia's accession to the World Trade Organization (WTO).[26] The effects it may have on the Russian economy are multiple-valued: some sectors (such as steel manufacturing) may benefit from the decrease in production costs while the others (agriculture, aviation, automobile manufacturing, and consumer goods) will face strong competition from abroad. However, major advantages should be revenue growth for Russian exporting industries and foreign direct investment inflows to the Russian economy.

Referring to international STI cooperation, current framework conditions will begin to gradually improve because of Russia's WTO accession. In particular, international rules of standardization and certification will come into effect. This should deliver foreign producers in Russia from the necessity of following additional certification procedures. Other positive effects may derive from the implementation of the international pre-qualification system of producers. This procedure, on the one hand, will be a serious challenge for Russian enterprises that do not meet international standards (for example, in quality management, safety, and environmental safety). On the other hand, such pre-

[26] In 2012 Russia has finally joined the World Trade Organization (WTO) after a 19-year process of negotiations.

qualification system may become a powerful incentive for Russian producers: it will contribute to filtering out weak actors and establishing a pool of strong suppliers able to act within global production chains. At the moment, many foreign automobile producers (e.g., Volkswagen, Ford) have to look for reliable Russian suppliers of automotive components, which is usually not an easy task.

Duty relief for imports of high-tech equipment may also have different consequences. Such policy would foster R&D and technological modernization of Russian enterprises and public research organizations, but at the same time government protection of Russian producers of similar equipment may be required.

Annex 1. Case studies of Russian innovative SMEs' cooperation with German companies in the framework of the BMBF / FASIE programme

Company Overview	*Overview of the project funded*	*The results achieved*	*Market prospects*
Gidran, Ltd (http://www.gidran-ptf.ru) was founded in 1999. It specialises in engineering services in the field of groundwater treatment. Its key foreign partner is Danish company Grundfos – a world's leader in pumping equipment.	The aim of the project is adaptation of a German groundwater treatment technology to the Russian environment (in the Khabarovsk area). Dresden University of Technology is Gidran's partner in this project. On the Russian side the leading scientists from the Moscow State University (Faculty of Geology), Far Eastern Branch of the Russian Academy of Sciences, and the Kurchatov institute are involved in the research. The completion of the project is scheduled for 2013.	The project is currently at the testing phase. The first stage of testing (for 2 wells) was successful. In May 2011 the starting complex of treatment facilities was put into operation in Khabarovsk. It has significantly increased the capacity of head treatment facilities. In 2012 the company plans to launch the technology for another 12 wells in Khabarovsk. In case of success the supply of clean drinking water to the city will become possible.	If all tests will be successful, the technology would be in great demand both on domestic and foreign markets, and particularly in China.
VEK-21, Ltd (http://wisenetlab.ru/) was founded in 2009 by the graduates of Moscow State Institute of Electronics and Mathematics (MIEM). It specialises in offering new technological solutions in the IT field. The current company products are mainly based on R&D which has been conducted in MIEM in recent years. VEK-21, Ltd is an official partner of Low Power RF Solutions NXP Semiconductors. Under this partnership the company has become an accredited Training Centre for Microelectronics. VEK-21 regularly participates in international exhibitions,	The project of VEK-21 and Fraunhofer IML is aimed at developing an integrated information-analytical system for cargo management and monitoring of goods transportation, based on the concept of 'Internet of Things'. This concept assumes the use of a special controller (with an inbuilt energy converter) for each managed object, and the development of an information system for managing material flows. VEK-21 was responsible for research and development of information	The technology allows to monitor the status of goods in real time. One of the key features of this technology is the possibility to use alternative power sources from the existing industrial infrastructure. The technology was registered as a utility model. The application for a joint patent in Germany has been filed recently.	The company is now searching for partners to commercialize the technology. On the Russian market the technology may be in demand by logistics and freight companies.

which allow to significantly expand the network of foreign partners.	technology systems, while German partners conducted the analytical part of the project.		
Nanostructured Glass Technology, Ltd performs R&D in optics and biophotonics. The company is affiliated to the Department of Optics and Biophotonics of the Saratov State University.	The purpose of the joint research project was to develop an optical fibre for transferring femto-second impulses. The Russian side was responsible for the development of the fibre, and the German partners provided instrumentation and measurement support.	The project is seen as successful since the planned results have been obtained. The resulting product is a glass fibre with specific optical properties which can be used to make biological sensors. These sensors, in turn, are used to determine the toxicity of pathogenic environment (cholera, tuberculosis, etc.) based on the indications of the optical spectrum. During the joint research project partners have also identified possibilities for using fibres as biological sensors, optical spectrum transformers, etc.	The developed glass fibres are supplied to the Russian Research Institute for Plague Control «Microbe» (Saratov) which makes biological sensors at its own production facility. The company is also developing a technology to determine the level of sugar in the blood. According to the head of the company, this will be a small portable device (similar to the famous «Accu-Chek Performa Nano», but based on a completely different principle). Another area of company's work is food quality testing.
Crystal, Ltd (http://crystalltherm.com/ru/index.html) specialises in R&D in thermoelectricity, specifically in conversion of thermal energy into electrical energy and vice versa. The company makes materials based on bismuth telluride solid solutions, and Bi_2Te_3 thermoelectric elements (so called «pellets» or «dice»). Crystal performs the whole production cycle, from R&D to mass production.	The joint project with German Quick-Ohm Küpper & Co. GmbH funded by FASIE in 2009 aimed to develop the Peltier modules with the increased density of heat flow.	Crystal improved the properties of the material used for the development of the module, and designed the module itself. Then it was handed over to the German side which successfully placed it on the market.	The patent on the material used in the design of the module is owned by Crystal. The company also maintains other patents, in particular a joint patent with Panasonic. According to the CEO, other technologies developed by the firm also have a big market potential.

Medotel, Ltd was established by the Institute for Aterosclerosis Research of the RAS and is managed by its director who has been engaged in R&D in this field for over 30 years. The company is also a resident at Skolkovo.	The project is being implemented jointly with the Faculty of Medicine of the Heidelberg University. The objective is to develop an efficient drug for inflammatory processes which can be used to cure various diseases.	The project has not been finished yet. However, R&D were carried out successfully.	According to the CEO, the developed technology has no analogues on the global market. The company has its own production facility, thus, manufacturing of the product would not be difficult. However, mass production may be a problem since it requires significant investments. Another problem is patent protection of the drug made of natural compounds. It is also not easy for the company to find an investor because of the long-term return on investment due to low cost of the drug.
DNA Technology, Inc. (http://www.dna-technology.ru/) was established in 1993. The company develops clinical laboratory diagnostic techniques based on molecular genetic techniques. It includes the diagnostics of such serious diseases as parodontosis and periodontitis. The company's team consists of the leading experts from two key Russian R&D centres: the State Research Centre of the Institute for High Energy Physics and the State Research Centre of the Immunology Institute of the Federal Medical-Biological Agency.	The purpose of the project (the German partner was Labor Dr. Bauermeister & Co.) was the development of diagnostic technology including special-purpose consumables.	The company developed a new toolkit for diagnosing parodontosis and periodontitis.	At the moment German partners are the only buyers of the technology. In Russia the product is still being registered. It takes a long time due to specific features of the Russian laws.
Biospec, Inc. (http://www.biospec.ru/) performs R&D in biomedicine. The	The project implies basic and applied research of the interaction between	The project is scheduled for completion in October, 2012. The	The project has a high market potential: the developed technology

company develops treatments, diagnostic systems, and medical equipment for treating various diseases (in particular cancer and skin diseases) with the use of nanotechnology.	photo-active aluminium nanoparticles, cells and bio-tissues, as well as the development of a prototype of the equipment to apply this technique. Biospec is responsible for the development aspects while the German partner (the Institute of Laser Technologies in Medicine of the Ulm University) explores the interaction between nanoparticles at the cell level.	participants have already obtained preliminary results. IP rights will be registered at a later stage.	allows to surpass the 'industrial' standards for treating skin diseases, both cancerous and non-cancerous. The company intends to register the project results with the help of German partners (joint patent) since obtaining an international patent in Russia involves a number of technical, administrative and financial difficulties. After securing the IP rights, Biospec intends to sell manufacturing licenses and technologies. The company estimates that the new technique will become common practice in 2-3 years' time.
Geoenergetika, Ltd (http://geoen.ru/) develops and implements durable antifriction mineral coatings for friction pairs in machine parts and mechanisms, in power engineering, machinery manufacturing, shipbuilding and manufacturing.	The company collaborated with the German Federal Institute for Materials Research and Testing – a leading European research centre in tribo-engineering and tribology. The project was a purely applied one. Its objective was to use the technology of creation of friction pairs' surfaces (developed by Geoenergetika) in order to solve a number of relevant industrial problems. An incentive to undertake this project was the artificial increase of tungsten prices by China – tungsten being the most common metal to make durable coatings. Thus the main effect of the new technology was, on the one	According to the CEO, the project was successful because it resulted in the development of a technology which replaced tungsten. Now the technology is being tested. The completion of the project is scheduled for December, 2012.	The IP rights on the developed technology belong to Geoenergetika. Currently the company is planning to license the new coating manufacturing technology. The CEO argues that potential market is large. It involves power engineering, engineering and shipbuilding enterprises. According to German partners, no similar applied research has ever been conducted in Germany; analysis of the German market confirmed the absence of competition in this area.

	hand, less deterioration of friction pairs, and on the other, the reduction of costs due to the use of alternative materials. The German partners' role was to provide R&D support, and to facilitate the introduction of the technology to German and European markets.		
High-Technology R&D Centre, Ltd is a small enterprise established by Kazan National Research and Technological University. The company performs R&D in aircraft construction, engineering, and construction (folded structures).	The objective of the project is the development of nano-modified sheet materials to improve the mechanical properties of folded structures of multi-layered panels.	Cooperation with the Dresden Technological University allowed the High-Technology R&D Centre to create a 'lucky' design of wedge-shaped folded filler. The German colleagues developed the engineering model and conducted a number of complex computations (power characteristics, compression module). The project has not been completed yet. The target material has been created and is being analysed at the moment; operational characteristics are now better than at the previous phase.	The weakness of the first stage of the project was that the forms and fillers designed by the High-Technology R&D Centre were not used in real-life constructions where more simple folded blocks were implemented. Now the operational characteristics are being improved. Some of the materials have already been patented; soon the company intends to start commercialisation of the project results.
Aeroservice, Ltd (http://www.sibairservice.ru/) is resident at the Novosibirsk industrial park. The company specialises in the development and manufacturing of integrated air purification and disinfection systems. The company's products allow to clean the air from harmful microorganisms, and then	The aim of the research was to identify materials which, on the one hand, would ensure adequate efficiency in terms of capturing bio-spray while on the other, would serve as a photocatalyst carrier. This would offer an alternative way of deactivating	The company's assessment of the project results is rather ambiguous. On the one hand, they acquired valuable experience, extended the range of their scientific interests, and found solutions which have been used in other research projects. Yet, despite the adequately designed	The side effect discovered in the course of the applied research does not allow to commercialise the technology. However, the company is implementing other projects using alternative air purification technologies, which are commercially successful. In terms of

eliminate them from the filters' surfaces. The equipment manufactured by the company is knowledge-intensive. It matches modern technological requirements and standards, and ensures maximum efficiency with minimum power consumption. At this stage, the main customers are healthcare organisations.	microorganisms on filter surfaces. The German partners from the Friedrich-Alexander Institute had experience and competence in the area of calculating particles' trajectories, in particular for porous materials. Thus, they were responsible for the analytical component of the project (development of analytical model to narrow the search range for required filtering materials). Aeroservice was responsible for the experimental component (testing the models developed by the German colleagues).	model, a side effect was registered at the testing stage, which did not allow commercialisation of the developed technology. In particular, toxic intermediate products (formaldehydes) exuded during catalytic oxidation of organic materials.	efficiency/safety/power consumption/running costs ratio, the company products are unrivalled in the world. In 2011 the company's turnover amounted to 500 million roubles (just for manufactured equipment). The company is entering foreign markets. So far it is Eastern Europe, Slovakia and the CIS countries, but next year Aeroservice is starting to sell its products in Western European countries (maybe in Germany where they already have contacts).

Annex 2. Summaries of interviews with managers of German companies engaged in STI activities in Russia

Company name	Specialisation	STI activities	Cooperation with Russian R&D organisations
Knauf Operates in Russia since 1993	One of the best-known foreign manufacturers of construction materials, a developer of dry construction, insulation and finishing construction mixes solutions. Knauf's business in Russia constitutes a full production cycle, from mining/making raw materials (gypsum and cardboard) to manufacturing and selling completed products.	Knauf's R&D are conducted at the main R&D centre in Germany. In Russia the company's STI activities so far were insignificant, but in the near future Knauf is planning to establish a specialised division to coordinate all the company's R&D and innovation activities in the CIS countries. In the framework of developing innovation activities in Russia, the company plans to establish its own testing centres provided with state of the art equipment. Knauf's technological innovations are mostly connected with improving production processes. The company has an efficient system for applying successful innovation experience at other Knauf enterprises – 'innovation catalyst' (Tucker, 2006).	Since 2009 the company is successfully engaged in educational activities in Russia, including the highly developed system of regional training centres based at secondary vocational training institutions and universities. These centres are established in various forms (training, resource sharing, consulting); they have different resources, and different forms of partnership with the host training institutions. The company's cooperation with the RF Ministry of Education and Science resulted in development of a new Russian Federal standard for basic vocational training "Dry Construction Master" (the RF Ministry of Education and Science order № 364 of 16.04.2010 'On approval and introduction of the state educational standard for basic vocational training, profession 270802.08 'Dry Construction Master'). The company's main partners are the Moscow State Construction University and the South Urals State University. In particular, in Moscow the company has established a laboratory at the university, equipped to match the most advanced standards, to conduct joint R&D work.
Henkel	Henkel is one of the most innovative European companies. In Russia Henkel is active in four areas: industrial glues, consumer glues, cosmetics (professional and consumer), and cleaning products.	The management of the company's R&D division is located at the firm's Dusseldorf headquarters. R&D labs are located at production facilities in Europe (Ireland, Germany, Italy, etc.), in the USA, etc. R&D in Russia are not very large-scale, and are mostly aimed at adapting the existing technologies to match local customers'	The company's cooperation with Russian R&D organisations is limited to its specialisation areas (e.g. joint projects with the RAS Institute of Mineralogy, Geochemistry and Crystal Chemistry and Rare Elements on assessment of phosphate layer structure, with D.I. Mendeleyev All-Russian Metrology Institute, one of the best-equipped Russian R&D institutes, etc.).

		requirements. Despite the fact that the company has production facilities in Russia (in Leningrad Region, Engels, Perm, etc.), Russian R&D centres are not yet used at their full capacity. Every year Henkel holds an international innovation competition for students, 'Henkel Innovation Challenge', open to student teams from 14 countries including Russia. The contestants develop a concept for one of the company brands or an innovative technology; the winner team gets a special prize and is offered fellowship positions at Henkel, with subsequent full employment prospects.	Cooperation with universities is aimed at staff training. The company maintains contacts with Russian D.I. Mendeleyev University of Chemical Technology, Moscow State University of Fine Chemical Technologies, etc.
STADA CIS	STADA Arzneimittel AG is one of the largest pharmaceutical companies, and the world leader in generics production. STADA CIS is a Russian holding, part of the international group of companies comprising leading Russian pharmaceutical firms such as NIZHPHARM, MAKIZ-PHARMA and Chemopharm.	The company has two R&D labs in Russia employing about 100 researchers. STADA CIS's R&D are mostly aimed at adapting and improving existing drugs; the company's business model is based on identifying promising pharmaceuticals and their subsequent commercialisation through efficient product portfolio management.	The company successfully cooperates with Russian small innovative firms, R&D institutions and universities, looking for and promoting promising Russian designs and products.
Bayer AG	Bayer AG is one of the largest chemical and pharmaceutical concerns. All major divisions of the company are represented in Russia: Bayer HealthCare, Bayer CropScience (plant protection technologies), Bayer MaterialScience (polymeric and	The company's R&D expenditures in 2011 amounted to 2.9 billion euros (8 % of the total sales). This made Bayer the 8th in The 2011 EU Industrial R&D Investment Scoreboard (http://iri.jrc.es/research/scoreboard_2011.htm). In Russia Bayer does not yet have its own	Cooperation with Russian R&D organisations started in the 1990s, and now continues in the following main areas: polymeric chemistry, composite materials, development and optimisation of technologies, organic synthesis. The company's partners include the RAS R&D organisations and Russian universities (such as Tomsk State University, Tomsk Polytechnic

	other materials, etc.). Bayer Technology Services (which is another division of the concern) provides engineering services to members of the concern and to other enterprises.	R&D centre, but given favourable corporate and external socio-economic situation, this remains a possibility.	Institute (technical university), etc.), and chemical companies. Bayer has established long-term contacts with Russian small innovative enterprises such as Berachem, Ltd (chemical synthesis), PiM Invest, Inc. (chemistry of fluorine-organic compounds), etc.
Evonik Industries AG	Evonik Industries is a creative industrial group of companies, one of the leaders in the special chemistry field. Evonik's key specialisation areas include high-technology polymers, inorganic materials, food, health care, consumer goods, coatings and additives. Evonik is a global concern: in 2011 more than 70% of the revenues were generated from sales outside Germany.	In 2011 the company's revenues from sales of innovative products amounted to about 1.9 billion euros, while the R&D budget grew by 8% compared with 2010 (to 365 million euros). The company's R&D work is decentralised, to closely match requirements of regional markets. The global R&D network includes over 35 divisions which employ 2,400 researchers. R&D divisions maintain close contacts with marketing services, to ensure efficient response to emerging demand. The company's technological innovations include lithium-ion batteries, membrane gas separation modules, lightweight construction materials, nanoparticles, solar power technological solutions, etc.	The company is present on the Russian market since the late 19 century; Degussa (since 2007 Evonik) products were very popular among Soviet industrial enterprises. The company has own production facilities in Russia (e.g. Plexiglas® extrusion acrylic plates factory in Podolsk). In 2014 a Biolys® installation is scheduled to start production in the Rostov Region. In the R&D area, the company cooperates with M. Lomonosov Moscow State University, with St. Petersburg and Novosibirsk research institutes in such fields as development of new catalyst systems, organic synthesis, biotechnology and process technologies. R&D cooperation with Russian industrial enterprises remains insignificant so far, but the company does not exclude its activities in this field in the future.

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