Seventh Framework Programme

Information and Communication Technologies

Coordination and Support Actions (Supporting)

Project title:	**Linking R&D Strategies, Foresight and Stimulation of EU-Russia Cooperation in Nanoelectronics Technology**
Project Acronym:	**EU-RU.NET**
Grant agreement no.:	**257511**
Type of funding scheme:	**Coordination and support actions (supporting)**

Deliverable number:	D5.7, D5.8 and D5.9
Deliverable title:	Strategy, Foresight and Roadmap for EU-Russia Scientific and Technological Cooperation in Nanoelectronics
Dissemination level:	PU
Scheduled delivery date:	Month 26
Actual delivery date:	July 2012
Author(s):	R. Vardapetian
Approved by:	Consortium
Short summary	The deliverable summarises the main achievements of the project and presents the future prospects of EU-Russia cooperation in nanoelectronics technology.

Strategy, Foresight and Roadmap for EU-Russia Scientific and Technological Cooperation in Nanoelectronics

Foreword

This document (shortly - Strategy) is based on recommendations from the Strategy Experts Group SEG set up in the frame of EU's Coordination and Support Action Project "*Linking Strategies, Foresight, and Stimulation of EU-Russia Cooperation in Nanoelectronics Technology*". Project acronym: EU-RU.NET. Start of the project: 1 May 2010; end of the project: 30 June 2012.

The group was appointed by the Steering Committee of EU-RU.NET in response to the initiative taken by the EU (IST Call 5) in an effort to strengthen scientific and technological cooperation with Russian Federation, and in particular, in Nanoelectronics Technology.

EU-Russia research collaboration has long traditions and has increased rapidly in recent years, not least through the EU's Framework Programs for Research and Technological Development. This is a very favourable trend.

The EU-RU.NET Project targets strengthened cooperation between leading European and Russian scientists in the all-important field of Nanoelectronics Technology. Development of Nanoelectronics is an essential element for keeping European and Russian industries competitive at global level. This is in line with the EU strategy of deepening and broadening the international aspect of its S&T policy, an important part of which is cooperation with Russia.

Why Nanoelectronics matters? Information and communication technologies are transforming the way we live, learn and play, with hardware and software costs now representing more than one-quarter of our total expenses on services. And electronics equipment including safety, engine control and anti-pollution systems represents around 20% of the direct production cost of a family car, and even more for high-end vehicles. The worldwide electronics industry now generates more added value than any other manufacturing sector. An annual market in excess of €800 billion means it is bigger even than the global automotive industry. Microelectronics manufacturers and related equipment and materials suppliers represent nearly 1% of global GDP with an average annual growth rate of 15%. And the many industries that depend on electronics – such as telecommunications, transportation, Internet services, consumer products, security and aerospace – have an overall weight several times higher at an estimated €5,000 billion. Electronics now accounts for some 30% of overall industrial investment. It is playing a vital role in the transformation of our society, with access to the Internet, mobility and e-commerce contributing to removing social and cultural barriers and to bringing every citizen into the information age, with direct benefits to welfare and the environment.

This Strategy covers research at academic institutions as well as industrial R&I. The contacts developed between industry and the world of academia in EU and Russia are enriching both sides, contributing to creative, innovative business and industry. This represents a potential for training and partnership for enterprises on both sides.

Bringing the measures described in this Strategy to fruition is a link to both Russia's government's and EU's campaigns to expand the internationalisation of research. Many of the world's most prominent research groups are located in Russia. Quality is at the heart of the collaboration this Strategy is designed to promote.

I would like to take this opportunity to thank the members of SEG and all others who have contributed to the preparation of this document.

Dr. Ruben Vardapetian
Coordinator of the EU-RU.NET Project
May-July 2012, Brussels - Moscow

Contents

SUMMARY

The EU-RU.NET Consortium hereby presents its Strategy for strengthening EU-Russia scientific and technological cooperation in nanoelectronics. Russia is an important partner for EU research collaboration. Contact with this country is a profoundly important part of EU's international research cooperation, and there is a significant potential for expanding this cooperation.

Nanoelectronics are at the heart of the industrial base of every advanced country. The present Strategy is intended to help ensure that European nanoelectronics research groups will be in an even better position to exploit the vast opportunities represented by Russia in research, technology and research-based economic development.

Moreover, it has been shown that research and development work should promote more innovation and result in a greater extent of commercialisation. International collaboration is essential for achieving such goals, and this Strategy is part of those efforts. Stepping up collaboration with Russia is not intended to come at the expense of collaboration with the EU's other international research cooperation; it will supplement and reinforce it.

Russia has traditionally played an important role in international research cooperation, especially in physics. One of the main explanations for this is that many prominent research groups are located in this country. Linguistic and cultural barriers have not prevented researchers from different countries coming to Russia for shorter and longer visits. Europe shares common interests with Russia in a number of disciplines including nanoelectronics. The level of interest in professional collaboration is reflected, for example, in the number of agreements between European and Russian institutions.

Increasing collaboration with Russia would open up new opportunities for EU researchers and research groups and would help improve the quality of EU research. Efforts must be made to ensure that collaboration and contacts with these groups will help to contribute to R&I-based economic development in EU, Associated Countries, and Russia.

Objectives and relevant subject areas

The Strategy is based on the recommendations of the Strategy Experts Group SEG comprised of experts from a broad range of EU and Russian organisations with long term experience in collaborative R&I and international project management.

The Strategy has three primary objectives, each supplemented by secondary objectives:

1. The Strategy will contribute to the long-term rise of R&I collaboration between EU and Russia in nanoelectronics.

- More EU researchers will spend time in Russia, and more researchers from Russia will have comparable stays in EU and Associated Countries.
- EU-Russia collaboration on R&I projects in nanoelectronics will be stepped up, bilaterally or through projects involving researchers from several countries.
- EU research and EU business and industry will receive more and faster access to results from research, knowledge and expertise from Russia.
- More scientists from Russia will have access to European nanoelectronics research facilities and infrastructure.

2. The Strategy will help enhance the quality of European and Russian research.

- More collaboration between EU and Russia will stimulate the revitalization of research in these countries, helping to improve the quality and efficiency of researcher training.
- Priority will be given to fields of research and groups that maintain high quality.

3. More R&I collaboration between EU and Russia will contribute to more knowledge-based economic development in EU and Russia.

- More partnerships in nanoelectronics and relevant fields will be set up for the purpose of innovation and innovation-based economic development.
- More people from EU (and respectively from Russian) research and industry, the authorities and others will be familiar with relevant groups for research and economic development in Russia (and respectively in EU) with a view to augmenting entrepreneurship in EU and Russia.

Quality must be the main criterion for EU-Russia cooperation in nanoelectronics. Projects shall be consistent with the priorities in the general research policy. Emphasis will be attached to the development and application of basic knowledge, as well as to innovation and value creation. The ranking of priorities must be further developed through collaboration between the parties involved.

Researchers and research institutions

The authors of this document express their hope that the Ministry of Education and Science (MES) of Russia and the EU's DG CONNECT will discuss, adjust and adopt the Strategy and accept special responsibility for its further follow-up and implementation. They may initiate measures encouraging research collaboration in nanoelectronics and mobility which, in principle, ought to be open to participation by third party states. Initiatives should also promote more collaboration and contacts within researcher training, and stimulate incoming mobility to Russia from the EU Member States and Associated Countries and *vice versa*. Further follow-up ought to emphasize more institutional support for research cooperation in nanoelectronics.

The Strategy calls for the establishment of university chairs that would be a visible, high-profile initiative for promoting EU-Russian collaboration. Such posts would help support and serve as bridgeheads for collaboration between EU and Russian research groups and institutions. Various alternatives for establishing such bridgeheads should be considered, i.e. part-time professorships at Russian and European institutions. Preferably, the establishment of such schemes would be reciprocal. This has to be examined in more detail, not least as regards expenses, funding, number and subject areas.

Industrial R&I collaboration

This Strategy also covers industrial R&I collaboration. The EU and the Russian authorities and their representatives ought to further develop the existing arenas for training and stimulate partnerships between Russian enterprises and enterprises in the EU Member States and Associated Countries, considering developing two-way commercialization channels. The main players on the Russian side here are MIKRON JSC and ANGSTREM, both in Zelenograd near Moscow.

The scope of the industrial research and innovation work that targets Russia in the EU Horizon2020 Framework Programme (2013-2020) should be exploited.

Funding

In the opinion of SEG, both Russian national and the EU budgets' total allocations to research collaboration between these two partners should be increased considerably in the years ahead. The SEG recommends that most of the allocations be granted through the Russia's Ministry of Education and Science, Ministry of Communication and Mass Media, and EU DG CONNECT budgets, and that sector-related allocations be made through the budgets of the various sectoral units.

CHAPTER 1 INTRODUCTION

The objective of this Strategy is to strengthen EU's scientific and technological cooperation with Russia. Expanding R&I collaboration with Russia will not take place at the expense of collaboration with the EU or other international research cooperation; it will rather supplement and reinforce it.

1.1 International research collaboration

Many dynamic Russian research groups have extensive contacts and collaboration with research groups in EU Member States and Associated Countries and participate actively in international research projects. In nanoelectronics, collaboration that extends beyond the country's borders is a prerequisite for maintaining vigorous research communities. Over the past two decades, Russia's international contacts and different types of participation in international R&I collaboration have increased substantially. Growing internationalization has also been an important political objective for research and education at Russian universities and education centres.

Contact and collaboration with strong international research communities is professionally enriching; it expands the horizons of researchers' own activities, creates new opportunities and contributes to professional revitalization. Accordingly, international collaboration is an important means for enhancing the quality of research. In "big science", i.e. research that calls for highly advanced equipment or special installations, such collaboration is a prerequisite.

In some EU countries R&I activities in nanoelectronics are very modest on a global scale. Through international participation, including with Russia, specialist groups and enterprises can gain access to knowledge based on research and innovation that would otherwise have been difficult to develop on their own. While the import of such knowledge is crucial, it cannot be viewed in isolation from the country's own potential contributions. High-quality domestic research is vital for successful participation in international knowledge development.

A large proportion of R&I cooperation in nanoelectronics between EU and Russia takes place directly between individual researchers and specialist groups, with little or no organizational affiliation or involvement. However, international R&I collaboration is becoming increasingly formalised and subject to agreements between institutions in different countries. Such collaboration may, for example, include exchange schemes, researcher training and stays for visiting researchers. More comprehensive formalized collaboration takes place through joint projects linked to special research programs and international cooperative organizations. The initiatives included in this Strategy are primarily stimuli and incentives. Support for major research projects must be based on special sources of funding.

1.2 About the Strategy

One of the main reasons for drawing up this Strategy is to enhance and intensify EU-Russia R&I cooperation in nanoelectronics technology. Closer collaboration will offer new opportunities for EU and Russian scientists. Russia is home to many of the world's leading research groups in a variety of disciplines. Ties between academia and industry in Russia are on increase, promising development of high productivity and innovative industry.

This Strategy primarily addresses research and innovation work, including R&I-based innovation and economic development, as well as researcher training. Higher education in general is not covered by the Strategy. Nonetheless, implementation will probably be relevant to and important for EU-Russia relations with regard to higher education, e.g. student exchange programs.

1.3 Spheres of activity

The Strategy is based on recommendations made by a broad-based SEG.

The Ministry of Education and Science of Russia bears the primary responsibility for basic research and has the ultimate responsibility for coordinating state-funded research. The MES of Russia maintains that research collaboration with EU must primarily be designed to generate added research-related value beyond that created through existing bilateral relations between Russia and separate EU States. The main focus should be on general instruments and measures that can enhance bilateral cooperation in nanoelectronics. Emphasis should be attached to fields in which EU and Russia have a special potential for additional collaboration.

In light of its strategic role, the EU DG CONNECT Unit "Nanoelectronics" has to bear special responsibility for the implementation of this Strategy. The responsible EU Officer must collaborate closely with the MES of Russia and other ministries involved, suggesting special target areas and devising relevant instruments. In this work a great deal of support might be provided by Europe's ENIAC Technology Platform and relevant Russian partners.

As far as industrial activities are concerned, the EU DG Enterprise and Industry as a key player for promoting cooperation between EU and Russian industry will have an especially important role in the implementation of the Strategy via collaboration with Russia's Ministry of Industry and Trade and Ministry of Communication and Mass Media. Other public bodies, notably the Russian Academy of Sciences should also contribute to the constructive follow-up of this Strategy in various sectors. The potential of the Russian ROSNANO Corporation shall be exploited as well.

The target groups for the Strategy are research communities at the countries' universities, state and private colleges, research institutions and enterprises. An effort to enhance R&I collaboration between EU and Russia in Nanoelectronics cannot be brought to fruition without their active participation. The aim of this Strategy is primarily to pave the way for such collaboration, so that opportunities and the potential can be realized, and thereby benefit research and R&I-based economic development both in the EU and Russia.

1.4 Evaluation

After the Strategy has been in place for some time, about three-five years, it should be evaluated. The evaluation will be essential for possible further follow-up and the choice of instruments. Decisions should be based on quantitative and qualitative factors alike.

Indicators chosen for this evaluation must provide information on key aspects of the Strategy. They must largely be related to the targets that have been set. Potentially useful indicators are, for instance:

- the progress of EU-Russia co-authorship in nanoelectronics articles
- the citation of EU-Russian articles, compared with other EU or/and Russian articles
- trans-border mobility
- doctoral-level education in Russia and EU Member States/Associated Countries
- patent cooperation between EU and Russia and other countries
- innovation cooperation between the EU enterprises and enterprises in Russia
- partnerships between enterprises in the EU and enterprises in Russia; joint companies

The choice of indicators must be specified in more detail, in accordance with the design and choice of instruments.

CHAPTER 2 EU-RUSSIA COOPERATION IN MICRO- AND NANOELECTRONICS

EU and Russian researchers have been cooperating for many years in a variety of scientific disciplines, taken on individual initiatives or based on inter-institutional or inter-governmental cooperation agreements. Supported by mutually beneficial legal agreements, Russia became an important partner for the EU organisations in EU's Framework Programmes. In addition to that, Russia has signed bilateral general agreements on cooperation in science and technology with almost every country in Europe.

As far as the EU's Sixth Framework Programme for Research & Technological Development (FP6) is concerned (2003-2006), Russia has been the most successful "third country" participant in terms of funding support from the European Commission and one of the most active third-country participants overall. For the totality of FP6 (2002-2006), more than 300 participants from Russia were involved in over 200 joint research projects in all thematic areas and sub-programmes of the FP6 worth over € 2 billion. In total the Russian Federation research entities obtained from the EC more than € 45 million.

Scientific publications are increasingly the result of collaboration across national borders. For European countries, the percentage of co-authorship with Russia steadily grows. In recent years, the number of joint articles with researchers in European countries has grown, largely because of research cooperation under the auspices of the EU's Framework Program and the extended European contacts in which this cooperation has resulted.

Experts from the EU-RU.NET Project participant organisation the State Research University Higher School of Economy in Moscow analyzed the trends in publication activity of Russian scientists, as well as the joint Russian-European publications in the field of nanoelectronics in the period from 2001 to 2011. Bibliometric analysis of a scientific activity allows to determine the dynamics of the number of publications, the parameters of international cooperation, and to identify organisations - leaders in the particular science and technology field.

The material for the study included data on publications indexed in Science Citation Database SCI of *Thomson Reuters*. Because "nanoelectronics" is an interdisciplinary field, the selection of articles for analysis was performed using keywords that reflect different aspects of this type of technology - from the physical principles and objects of nanoelectronics to various devices. Results of 12.600 publications of Russian authors were analysed - articles, notes, proceedings papers. The publication was considered Russian if at least one of the authors referred to a Russian organisation as the place of work.

Bibliometric analysis shows a steady positive trend in the number of Russian publications in the field of nanoelectronics: from 964 in 2001, to 1344 in 2011. Meantime, the share of Russian articles in the field of nanoelectronics, published in the international collaboration during 2001-2011, is 46.2% of the total, including 37.8% of publications in the preparation of which was attended by authors from Russia and the EU.

On average, for the given period, about 30% of the annual number of Russian publications is articles published in collaboration with foreign colleagues. Of these, 46.2% are joint articles in nanoelectronics and in 37.8% have at least one EU partner. This fact suggests a fairly high level of international cooperation in this area.

The dynamics of publications in nanoelectronics is shown in figure 1 below.

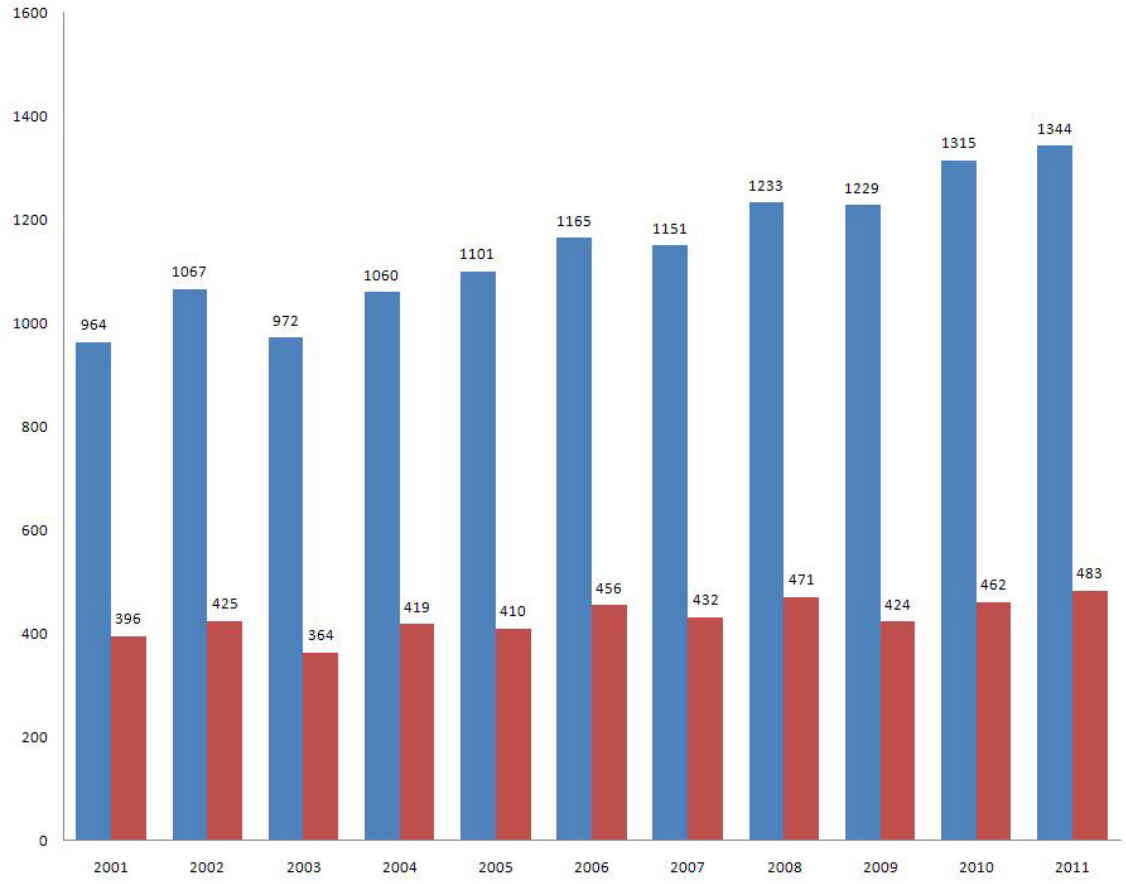


Figure1. Dynamics of Russian (blue columns) publications in nanoelectronics (2001 – 2011) and the publications with EU collaborators (red columns)

The next diagram (figure 2) reflects the level of cooperation of different EU member states with Russia in nanoelectronics (according to the number of joint publications). The most intensive in this field is cooperation with Germany (42.9% of Russian-European publications), France (18%), United Kingdom (10%), Sweden and Italy (8%), Poland (6%) and Netherlands (5.3%).

The leading foreign partners of Russian organisations (by the number of joint publications) in the field of nanoelectronics are the French National Centre for Scientific Research CNRS, the Technical University of Berlin, the Polish Academy of Sciences, the Dresden University of Technology, Universities Paris-6 and Paris-11, the Karlsruhe University and a few others.

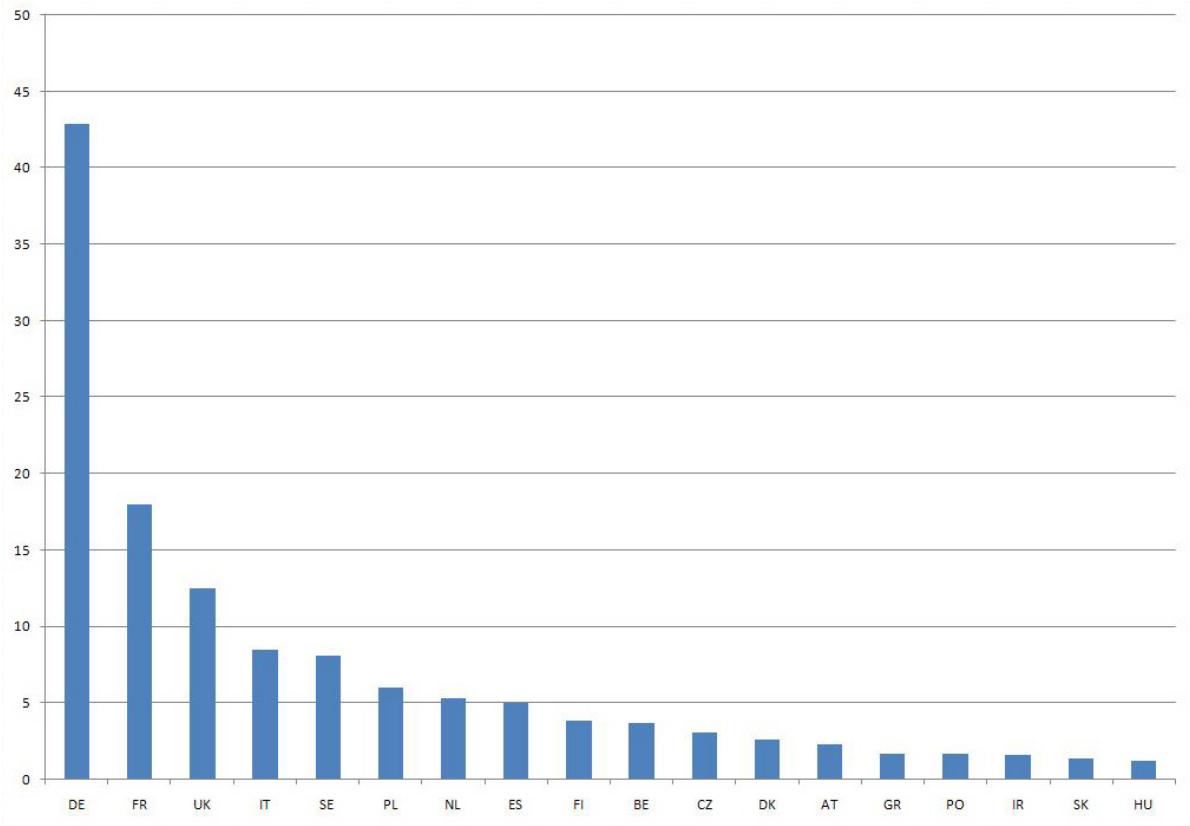


Figure 2: The distribution of EU Member States in joint Russian-European publications in nanoelectronics.

Finally, bibliometric analysis revealed Russian organisations with leading positions in the field of nanoelectronics. The top ten Russian organizations having the greatest number of publications on nanoelectronics in scientific journals indexed in the Web of Science databases are listed in the table 1 below.

Table 1: Ranking of Russian organisations – leaders in joint publications

Ranking	Organisation	No. publications
1.	Russian Academy of Sciences RAS	2128
	3. Ioffe Institute of RAS in St Petersburg	252
	6. Lebedev Physics Institute of RAS in Moscow (PhIAN)	95
	7. Landau Institute of theoretical Physics of RAS in Moscow	73
	9. St Petersburg Institute of Nuclear Physics of RAS	65
2.	Moscow Lomonosov University	534
4.	St Petersburg State University	206
5.	Joint Institute of Nuclear Research in Dubna	162
8.	Kazan State University	70
10.	Institute of Theoretical and Experimental Physics in Moscow	45

Representation and special initiatives in certain countries

Most European countries have their own designated representatives in Moscow who specialize in facilitating research collaboration. Moreover, organisations like French CNRS, German Fraunhofer Society, Italian CNR and some others have their branches in Moscow. However,

the science counsellors, or corresponding positions, are organized in different ways and the various countries have opted for different working methods.

The EU has a special delegation in Moscow that draws up regular reports on developments in Russian research policy.

The basics of this cooperation have been summarized in the "*Compendium on Science and Research cooperation between the European union and the Russian Federation*", published in 2009 by the Delegation of the European Commission to Russia. Its electronic version is available for downloads from the Delegation's site

http://ec.europa.eu/research/iscp/pdf/russia.pdf

Important background documents on EU-Russia cooperation include:

Agreement on Cooperation in Science and Technology between the European Community and the Government of the Russian Federation (1999)

Council Decision concerning the renewal of the Agreement on cooperation in science and technology between the Government of the Russian federation and the European Community (2009)

Agreement renewing the agreement on cooperation in science and technology between the Government of the Russian federation and the European Community (2003)

Roadmaps of four EU-Russia Common Spaces (including Roadmap for the Common Space of Research and Education including Cultural Aspects)

2.1 R&I-based economic development, innovation and patent cooperation

A patent is a form of intellectual property that consists of a set of exclusive rights granted by a sovereign state to an inventor or their assignee for a limited period of time in exchange for the public disclosure of an invention. The procedure for granting patents, the requirements placed on the patentee, and the extent of the exclusive rights vary widely between countries according to national laws and international agreements. The exclusive right granted to a patentee in most countries is the right to prevent others from making, using, selling, or distributing the patented invention without permission.

Under the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights, patents should be available in WTO member states for any invention, in all fields of technology, and the term of protection available should be a minimum of twenty years.

Europäisches Patentamt
European Patent Office
Office européen des brevets

The European Patent Office and Russia's Federal Service for Intellectual Property on November 17th 2010 launched a joint 500,000 Euro project aiming to make the two bodies' patent systems more compatible.

The main objective of this one-year project was to examine Russia's patent legislation and make recommendations on how to align it more closely with European legislation as well as to develop patent guidelines that can be used by patent examiners at the Federal Service for Intellectual Property, Patents and Trademarks (Rospatent). The project aimed also to streamline Russia's patent application, registration and

processing procedure to approximate them to the EU approach, and facilitate the teaching of intellectual property economics in Russia.

Earlier in September 2010 Rospatent and the U.S. Patent & Trademark Office PTO launched a one-year pilot program to fast-track each other's approved patent applications. Such "*Patent Prosecution Highway Programs*" allow patent offices to use each other's work to help process applications more quickly. The PTO's pilot program with Rospatent means that an applicant receiving a favorable ruling from one nation's patent office on at least one claim in an application may request that the corresponding application filed with the other nation be fast-tracked for examination.

Two patent applications have been filed as the result of the Pilot Projects carried out by the EU-RU.NET participants

2.2 EU Projects

During the last years EC DG CONNECT funded two Coordination and Support Action projects targeting cooperation between EU and Russia in micro- and nanoelectronics.

2.3 SEMIDEC

Stimulating Semiconductor Design Cooperation between Europe and Russia - **SEMIDEC** was an EU Support Action project (December 2009 — December 2011) aimed at stimulating cooperation between Europe and Russia in the design of semiconductor components and electronic miniaturised systems, in order to support Europe's leading position in integrated circuit product innovation. SEMIDEC aimed at developing cooperation in semiconductor design methods and tools that are relevant to the research priorities identified in the FP7 ICT Work Programme 2009 and ENIAC Strategic Research Agenda 2007. These research priorities included the following:

- Design of energy efficient electronic systems, and thermal effect aware design;
- Integration of heterogeneous functions: 3D, System-in-Package and Network-on-Chip;
- Methods for reuse of IP blocks, test and verification;
- Design platforms and interfaces for mixed/new technologies;
- New paradigms for design of reliable circuits with less reliable devices;
- Reliability-aware design including EMR/EMC requirements;
- Design for manufacturability taking into account increased variability of new processes;
- Better modelling of devices at all design levels into circuit/system design.

2.4 EU-RU.NET

This Strategy was developed in the frame of another EU project – **EU-RU.NET** (*Linking Strategies, Foresight and Stimulation of EU-Russia Cooperation in Nanoelectronics*

Technology; May 2010 — June 2012). It involved 5 EU and 5 Russian organisations as follows:

1. Fraunhofer Society (Germany)
2. Russian Academy of Sciences
3. French Commission for Atomic Energy and Alternative Energies
4. Moscow Lomonosov University
5. Italian Research Council
6. St Petersburg Electrotechnical University (LETI)
7. Interuniversity Microelectronics Centre IMEC (Belgium)
8. Scientific Research Center for Molecular Electronics and Mikron Factory (Russia)
9. European Centre for Knowledge and Technology Transfer (Belgium)
10. State University – Higher School of Economics (Russia)

In order to foster successful EU-Russia Cooperation in Nanoelectronics Technology, the project participants had set up four Working Groups of Experts as follows:

	WG1: End of the roadmap and beyond CMOS *Increasing process variability* *Innovative new metrology methods* *Nanotubes and graphene* *New device structures*
	WG2: System-on-Chip/System-in-Package *Heterogeneous integration*
	WG3: Manufacturing technologies including metrology applications
	WG4: Strategy for EU-Russia Cooperation in Nanoelectronics Technology

The Working Groups specified subjects for 12 collaborative R&D Pilot Trial projects in prospective areas. Not all of them took off successfully but the majority did; their analysis provided thoughts and helped drafting this document.

On 15 May 2012 during the SEMICON Russia2012 Conference in Moscow, a special EU-RU.NET Workshop was organised with the participation of a large number of EU and Russian scientists, many of them members of the SEG. Six most successful Pilot Projects were presented, followed by the panel discussion of the Strategy. The recommendations made during the Workshop were considered in this document.

The participants of the Pilot Projects reported over 60 scientific publications resulted from their study.

2.5 Dissemination and Exploitation beyond the EU-RU.NET Project

The EU-RU.NET Coordination and Support Action presented a unique opportunity to explore the possibilities and to strengthen cooperation in nanoelectronics. What's next? Answering this important question, the Participants developed the following dissemination and awareness rising plan to help to prolong the impact of the Project on the cooperation between Europe and Russia in Nanoelectronics Technologies:

1. Publication during 2012/13 of several scientific articles with results of some of the Pilot Projects carried out in the frame of EU-RU.NET in the Russian language journal "Russian Microelectronics".

2. Publication in the same Journal of the article "Linking Strategies, Foresight and Stimulation of EU-Russia Cooperation in Nanoelectronics Technologies", based on Project achievements.

Figure 1. The English language edition of the Journal "*Russian Microelectronics*"

3. Preparation of a document, summarising project achievements and recommendations, to be distributed among European Commission and Russian officials (GD INFSO, RAS, Ministry of Education and Science, ENIAC, others).

4. Preparation of an article in Russia's research community's newspaper "*Poisk*" presenting in a popular way the objectives and achievements of the Project.

5. Maintenance and regular update of the EU-RU.NET web site with information about forthcoming nanoelectronics events of mutual interest.

2.6 Other Success Stories

From 14 to 16 June 2011 a German-Russian Workshop "*Future Trends in Nanoelectronics*" was held in Jülich. The goal of the workshop was to strengthen the existing bilateral collaboration and to establish a German-Russian scientific network in the field of

nanoelectronics. Special emphasis was devoted to the contribution by students and young scientists on both countries.

Around 50 researchers from both countries attended the workshop. From Germany scientists from Jülich, Aachen, and Munich participated, while the Russian participants came from Moscow, Chernogolovka, Novosibirsk, Nishny Novgorod, and St Petersburg.

During the workshop current subjects in the field of nanoelectronics were discussed, i.e. the epitaxial growth of nanostructures, their transport properties, and their characterization. In addition, concepts of future device structures for nanoelectronic circuits were presented. Beside the scientific presentations possibilities to intensify the collaboration by bilateral or European projects were discussed. The EU-RU.NET Project was presented by the project coordinator. The Workshop was an event in the framework of the German-Russian Year of Education, Research and Innovation[1].

CHAPTER 3 LINKING STRATEGIES

During the recent years both EU and Russia have developed strategies reflecting the views on the future of nanoelectronics technologies in their countries. Defining goals of mutual interest and successfully linking strategies will open new gates for the fruitful EU-Russia cooperation in this all-important and challenging human endeavour.

3.1 ENIAC and the EU Strategy for Development of Nanoelectronics

ENIAC - European Nanoelectronics Initiative Advisory Council is a European Technology Platform for nanoelectronics.

The ENIAC Joint Undertaking (JU) is a Community body established for the implementation of the Joint Technology Initiative (JTI) on nanoelectronics, chartered to contribute to the implementation of the Seventh Framework Programme and the theme Information *and Communication Technologies* of the Specific Programme Cooperation. It has been set up for a period up to 31 December 2017.

The Council Regulation setting up the ENIAC Joint Undertaking was adopted on 20th December 2007. This document provides legal details on:

- the objectives, tasks and duration of the Joint Undertaking
- the accession rules and the structure of the Joint Undertaking
- the rules for the implementation of R&D activities
- the financial rules and the IP rules governing the ENIAC Joint Undertaking
- the rules for the funding of projects

ENIAC JU defines and implements a Research Agenda, notable by awarding funding to participants in selected projects following competitive calls for proposals, by promoting a public-private partnership, and by achieving synergy and coordination of European R&D efforts in the field on nanoelectronics.

The total funding for this R&D programme is estimated at about 3.3 Billion Euro.

The objectives of the ENIAC Joint Undertaking are outlined in the EU Council Regulation No 72/2008, Art. 2 and are as follows:

[1] http://www.deutsch-russische-partnerschaft.de/de/index.php

The ENIAC Joint Undertaking contributes to the implementation of the Seventh Framework Programme and the theme *Information and Communication Technologies* of the Specific Programme *Cooperation*. It will, in particular:

1. Define and implement a Research Agenda
2. Award funding to participants
3. Mobilise both public and private efforts to increase overall R&D investments
4. Achieve synergy and coordination of European R&D efforts
5. Promote the participation of SMEs

3.2 Russian Strategy for Development of Nanoelectronics

On 7th August 2007 the Minister of Industry and Energy of the Russian Federation signed the "Strategy for the development of electronic industry in Russia for the period up to 2025".

Expected results of the implementation of the Strategy, its target indicators are:

- implementation of the goals and objectives set by the President of the Russian Federation in the "Principles of Policy of the Russian Federation in the field of electronic components for the period up to 2010 and Beyond" as well as in national projects of the Russian Federation in the field of health, education, affordable housing and agriculture;
- increased ECB sales in domestic and foreign markets;
- reducing the level of technological backwardness of Russia in the field of ECB; meet the needs of the national economy in the modern home-made ECB and, consequently, increase the competitiveness of Russian products on the global and domestic markets;
- significant contribution to the solution of the problem of doubling GDP in ten years, as the industry has a significant multiplier effect in related fields;
- increased consumption of electronic goods by Russia's population.

The Goals and Objectives of the Strategies are:

1. Reforming the structure of the electronics industry, optimizing the methods and mechanisms of governance and public-private partnership.
2. Reconstruction and technical re-equipment of the electronic industry.
3. Develop a network of industrial and interdisciplinary microelectronic component design and "system on a chip" centres.
4. Priority development of technological and industrial base of solid-state and vacuum microwave electronics.
5. Priority development of design and production of radiation resistant and vacuum ECB.
6. Priority development of Microsystems engineering.
7. Priority development of microelectronics.
8. Priority development of nanoelectronics.
9. Priority development of electronic materials and structures.
10. The adoption of measures to significantly increase positions in the domestic market.
11. Taking action to change the existing legislation to ensure implementation of the activities of this Strategy

According to the Strategy, the development of Russia's electronics industry can be built around two options:

1. State ownership of electronics industry and centralized planning and management of organizations.

2. Public-private partnerships in the development of the industry, the expansion of all forms of international cooperation taking into account key interests of the state.

Analysing the first option, the Strategy resumes that the negative factors make the achievement of expected positive results for the industry very unrealistic.

Partnering with foreign business is in the second case is decisive, because it is foreign companies and organizations that are the global leaders in the field. Only they have the necessary technology and experience in organization of this type of production, as well as effective commercial exploitation.

The proposed in this case model of development is based on the principles of close cooperation between state and private businesses, including overseas. It allows the state to effectively combine the possibility of concentration of resources and the use of the different motivation preferences for private owners in order to bring results for the electronics industry.

Burden on the development budget can be greatly reduced by increasing funding from extra budgetary sources – organizations' own funds and of their foreign partners, commercial loans and investments.

However, the increase in extra budgetary funding for the development of industry cannot occur abruptly. Private investment in Russia's electronics industry in its present state will remain for a long time high risk. It is therefore necessary to establish partnerships between the state and the local investors with the involvement of reputable foreign partners under the state guarantees for such projects. Availability of a public partnership and a reliable technology partner is the key to achieving greater investor confidence and interest in such projects.

The Strategy resumes that the only realistic way is to develop a public-private partnership with the simultaneous expansion of forms of international cooperation, taking into account the key interests of the state.

Given the high potential level of science in Russia, the Strategy expects by the year 2025 significant development of international scientific cooperation and a breakthrough in new technologies, including nanotechnologies, bioelectronics, optoelectronics, quantum computers, etc.

3.4 Linking Strategies

The preceding chapters have described factors of importance for EU-Russia R&I collaboration in nanoelectronics, as well as the opportunities this cooperation represents for both sides. One of the principal objectives of this Strategy involves maintaining, revitalizing and further developing this collaboration in breadth and depth alike.

Primary objective 1

Linked Strategies will contribute to the long-term rise of R&I collaboration between EU and Russia.

Secondary objectives;

- More EU researchers and research recruits will spend time in Russia, and more researchers and research recruits from Russia will have comparable stays in EU and associated countries.
- EU-Russia collaboration on R&I projects in nanoelectronics will be stepped up, bilaterally or through projects involving researchers from several countries.
- EU research and EU business and industry will receive more and faster access to results from research, knowledge and expertise from Russia.
- More scientists from Russia will have access to the EU nanoelectronics research facilities and infrastructure.

Primary objective 2

Linked Strategies will help enhance the quality of European and Russian research.

Secondary objectives:

- More collaboration between EU and Russia will stimulate the revitalization of research in these countries, helping to improve the quality and efficiency of researcher training.
- Priority will be given to fields of research and groups that maintain high quality.

Primary objective 3

More R&I collaboration between EU and Russia will contribute to more knowledge-based economic development in EU and Russia.

Secondary objectives:

- More partnerships will be developed for the purpose of innovation and innovation-based economic development.
- More people from research, industry, the authorities and others will be familiar with relevant groups for research and economic development with a view to augmenting entrepreneurship in EU and Russia.

3.5 Potential areas of collaboration

More work should be done to determine which subjects or fields of nanoelectronics research should be given special priority. The Russian ministries, EU's DG CONNECT, ENIAC and other involved bodies, as well as the research communities themselves must play an active role in such a process. The following elements are to be central in all thematic priorities:

1. Quality is to be a main aspect of and criterion for programs and projects.
2. The target areas in this Strategy are to be consistent with the priorities in Russia's and EU's overall research policy.
3. Emphasis will be attached to the development and application of basic knowledge, as well as to innovation and value creation.
4. When possible, priority shall be given to the interdisciplinary research and innovation.

One important feature of the most prominent research communities is that they are attractive to international partners, and are able to attract highly-skilled researchers. Special emphasis should therefore be placed on the best research communities when implementing the Strategy. Russia has several national assets in relation to cooperation with EU, including the country's geographic placement, research infrastructure, highly skilled scientists, etc. These are fields in which Russia can make substantial contributions to cooperation with the EU Member States and Associated Countries in nanoelectronics.

CHAPTER 4 FORESIGHT AND COOPERATION ROADMAP

On top of a number of collaborative R&D pilot projects associated with EU-RU.NET, a Foresight study was carried out for the future of EU-Russia cooperation in Nanoelectronics Technology that was aimed at identifying the bottlenecks of cooperation and proposing improvements.

The results of the Foresight study presented below address the future prospects of EU-Russia cooperation in Nanoelectronics Technology.

The survey and all relevant calculations were implemented on the basis of the Delphi Online Survey System with the software developed in the project framework by participant State Research University - Higher School of Economics, Moscow.

4.1 Structure of the questionnaire

The questionnaire for the survey was prepared in Russian and English languages. The questions in both questionnaires were similar. It consisted of two parts referring accordingly to the Research and Development.

For these stages respondents were asked about:

- the level of research/development
- promising forms of cooperation between the EU and Russia
- factors hindering the development within the EU and Russia.

During the survey a desk research aimed at identification of the principal areas of application for nanoelectronics technology was organized. It was based on analysis of major sources of data available including publications and patent databases, Foresight studies performed in the field of nanoelectronics worldwide, and the Foresight study of nanotechnology markets performed by the Higher School of Economics.

The lists of promising products were discussed with experts engaged in implementation of EU-RU.Net project. On the basis of these discussions the following fields of nanoelectronics were identified to be considered within the Foresight study:

1. Materials:
    - for silicon technologies (4[2])
    - for non-silicon technologies (11)
2. Semiconductor computer elements:
    - for silicon technologies (4)
    - for non-silicon technologies (18)
3. Components:
    - for silicon technologies (2)
    - for non-silicon technologies (31)
4. Auxiliary systems (3)
5. Control and measuring devices (3)

Within these five areas 105 products have been identified. Among them respondents considered 79 products on the Russian side and 9 products on the EU side.

4.2 Survey results and analysis

General surveyed population was represented by Russian and European experts in nanoelectronics. The number of researchers filled in the Russian questionnaire was 16, for the English questionnaire there were 9 respondents (see figure 3 below).

[2] Numbers in the brackets indicate the number of promising products included in particular group.

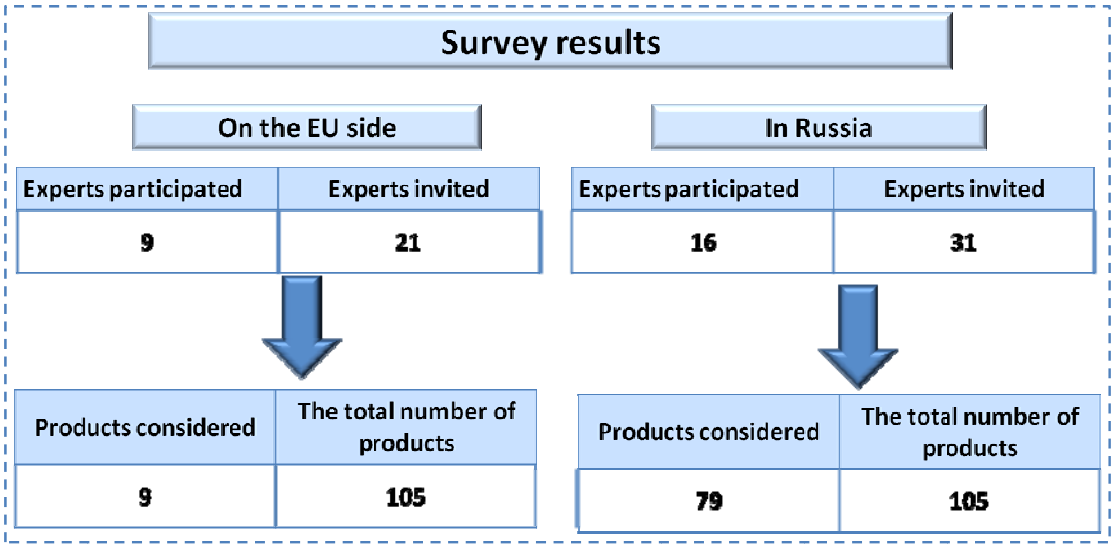


Fig.3. Survey results

4.3 Level of expertise

The distribution of respondents by field of expertise is presented in table 2**.**

Table 2: Level of expertise (respondents from Russia and the EU)

Products	Number of experts working in this field	Number of experts working in another field, but following the development of this field
Silicon carbide (Si-C)	1	4
Graphene	3	3
Polycrystalline silicon	3	3
Organic molecules with metallic nanoparticles	1	3
Polymers with nanoparticles	3	1
Heat-conducting nanosize and monatomic films based on fullerenes	0	2

Legend: green color indicates rather high level of expertise, orange color — rather low level of expertise.

The highest level of expertise was in the following two fields: Graphene and Polycrystalline silicon. The other areas were less covered by highly qualified experts responding the questionnaire.

4.4 Level of R&D

The prospects for R&D cooperation in different areas are presented in table 3.

Table 3: Cooperation at the stage of Research

№	Products	The level of Research in Russia	The level of Research in the EU	Prospects for cooperation
1.	Graphene	At the level of leading countries	At the level of leading countries	Positive
2.	Polycrystalline silicon	At the level of leading countries	At the level of leading countries	Positive
3.	Silicon carbide (Si-C)	At the level of leading countries	At the level of leading countries	Positive
4.	Organic molecules with metallic nanoparticles	Lags behind the leading countries	At the level of leading countries	To be further explored
5.	Polymers with nanoparticles	Lags behind the leading countries	At the level of leading countries	To be further explored
6.	Heat-conducting nanosize and monatomic films based on fullerenes	Lags behind the leading countries	At the level of leading countries	To be further explored

Legend: green color corresponds to high level of Research, orange color — rather low level of research.

The highest estimation of level of research (for both the EU and Russia) was given by the experts to three areas: Graphene, Polycrystalline silicon, Silicon carbide (Si-C). For these areas there might be organized joint EU-Russia projects that could be performed at the best level. For other areas the prospects for research should be considered more carefully and be focused on narrow areas of excellence within those fields. At the same time, the Russian scientific community could develop policy measures to bridge the gap between Russian researchers and global leaders in particular fields of nanoelectronics.

Table 4: Cooperation at the stage of Development

1	2	3	4	5
№	**Products**	**The level of Development in Russia**	**The level of Development in the EU**	**Prospects for cooperation**
1.	Graphene	Lags behind the leading countries, Research is almost non-existent	At the level of leading countries	To be further explored
2.	Polycrystalline silicon	Lags behind the leading countries	At the level of leading countries	To be further explored
3.	Silicon carbide (Si-C)	At the level of leading countries	At the level of leading countries	Positive
4.	Organic molecules with metallic nanoparticles	Lags behind the leading countries	At the level of leading countries	To be further explored
5.	Polymers with nanoparticles	Lags behind the leading countries, research is almost non-existent	At the level of leading countries	To be further explored
6.	Heat-conducting nanosize and monoatomic films based on fullerenes	Lags behind the leading countries	Lags behind the leading countries	Rather high

Legend: in the columns 3-4 green color indicates high level of Development, orange color — rather low level of Development. In column 5 the green color represents rather high prospects for EU-Russia cooperation.

For the development stage the positions of Russia were evaluated by the experts as less advanced. Only for the field of silicon carbide (Si-C) they were placed at the same level with the world leaders. An interesting outcome of the survey was for the field "Heat-conducting nanosize and monoatomic films based on fullerenes" where, despite of weak positions of both Russia and European countries, experts considered it as a highly promising area for collaboration efforts.

Table 5 R&D cooperation

1	2	3	4	5	6	7
№	**Products**	**The level of Research in Russia**	**The level of Development in Russia**	**The level of Research in the EU**	**The level of Development in the EU**	**Prospects for cooperation**
1.	Graphenes	At the level of leading countries	Lags behind the leading countries, Research is almost non-existent	At the level of leading countries	At the level of leading countries	**Rather low**
2.	Polycrystalline silicon	At the level of leading countries	Lags behind the leading countries	At the level of leading countries	At the level of leading countries	**Rather low**
3.	Silicon carbide (Si-C)	At the level of leading countries	At the level of leading countries	At the level of leading countries	At the level of leading countries	**Rather high**
4.	Organic molecules with metallic nanoparticles	Lags behind the leading countries	Lags behind the leading countries	At the level of leading countries	At the level of leading countries	**Low**
5.	Polymers with nanoparticles	Lags behind the leading countries; Research is almost non-existent	Lags behind the leading countries; Research is almost non-existent	At the level of leading countries	At the level of leading countries	**Low**
6.	Heat-conducting nanosize and monatomic films based on fullerenes	Lags behind the leading countries	Lags behind the leading countries	At the level of leading countries	Lags behind the leading countries	**Rather high**

Legend: in the columns 3-6 green color indicated high level of R&D, orange color — rather low level of R&D. In column 7 green color showed rather high prospects for cooperation between the EU and Russia, rose color — rather low prospects for cooperation; red color — low prospects for cooperation.

The overall estimates of prospects of EU-Russia R&D cooperation in nanoelectronics were rather uneven for different fields (table 5). The highest ones refer to "Silicon carbide (Si-C)" and "Polymers with nanoparticles", whereas the least promising areas in this respect are "Organic molecules with metallic nanoparticles" and "Polymers with nanoparticles". Although it does not mean that there are no prospects in these areas at all but just that the selection of cooperation areas should more careful and goal-oriented.

4.5 Promising forms of cooperation at the stage of Research and Development

During the preparation of the survey, the following list of the promising cooperation forms at the stage of Research was developed:

- Implementation of research projects and exchange of research materials and information.
- Organisation of workshops, symposia, conferences, exhibitions or other types of R&D related events.
- Trainings for researchers and experts, temporary placement in partner organizations.

The organisation of workshops, symposia, conferences, exhibitions or other types of R&D related events were indicated as the most promising forms at the stage of research for the major part of products in the field of nanoelectronics. Implementation of research projects and exchange of research materials and information were considered as the second most promising forms of cooperation at this stage.

The following forms of cooperation were picked up for the stage of Development:

- Establishment of research organizations, creation of joint research teams.
- Purchase and adoption of new technologies.
- Trainings for researchers and experts, temporary placement in partner organizations.
- Exchange of product samples.
- Implementation of technology projects, exchange of devices and research materials.
- Cooperation in the field of metrology and certification.

Trainings for researchers and experts, temporary placement in partner organisations were indicated as the most promising forms of cooperation at the stage of development for the major part of products in the field of nanoelectronics.

4.6 Factors hindering the cooperation at the R&D stage

The factors hindering the cooperation were mainly the same for the stage of research and for the stage of development. So these factors were integrated for the R&D stage and described as follows in the survey:

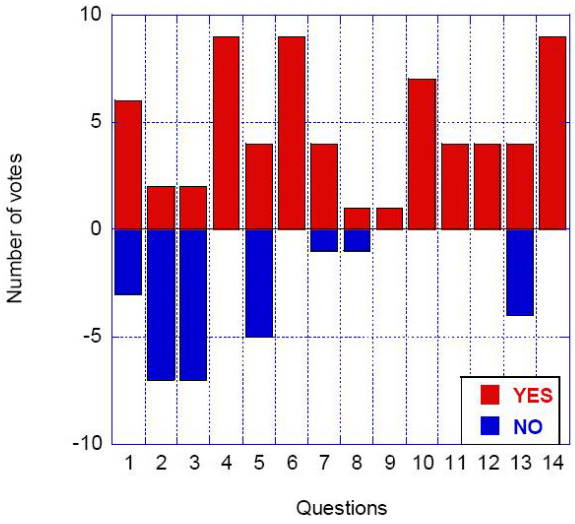
- Lack of financing from the European Commission and national governments.
- Shortage of human resources.
- Insufficient level of personnel professional training.
- Lack of modern research equipment.
- Underdeveloped R&D infrastructure.
- Insufficient protection of intellectual property rights.
- Lack of components and materials.

The survey results suggested that the lack of financing from the European Commission and national governments are the most urgent problems for cooperation between the EU and Russia at the R&D stage for the major part of products in the field of nanoelectronics. The second most important problem hampering cooperation between the EU and Russia was the shortage of human resources in Russia.

4.4 Pilot Trials Survey

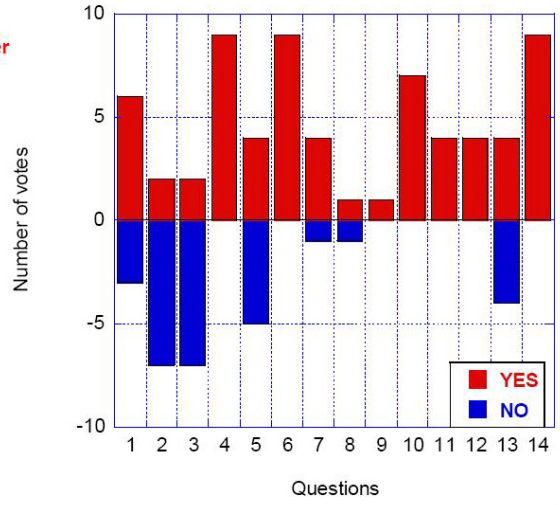
A parallel survey was carried out targeting the participants of the EU-RU.NET Pilot Projects. The questions asked and the responses are given in the table 6 below, while the table 7 highlights the responses with the most "yes" and "nos".

No	Question
1.	Did you know your European/Russian partners before the start of the EU-RU.NET Project?
2.	Would you have conducted this joint investigation if it were not for the EU-RU.NET Project?
3.	Have you had sufficient time to start and finish your Pilot Project?
4.	Are you intending to continue this joint investigation after the end of the EU-RU.NET Project?
5.	Were money/financial support a decisive issue in the success or failure of your Pilot Project?
	Mention max. 3 main outcomes of your Pilot Project?
6	a) New interesting contacts.
7	b) Joint publications.
8	c) Patent applications.
9	d) New EU Project proposals.
10	e) Strengthened bilateral cooperation
11	f) Better understanding of partners' environment.
12	g) More insight into partners' capabilities.
13	Has the need for getting a visa to Russia or the EU played a significant role in your Pilot Project?
14	Do you think there is a need for future Coordination and Support Actions like the EU-RU.NET Project?



4. Are you intending to continue this joint investigation after the end of the EU-RU.NET Project?
6. New interesting contacts.
14. Do you think there is a need for future Coordination and Support Actions like the EU-RU.NET Project?
10. Strengthened bilateral cooperation;
1. Did you know your European/Russian partners before the start of the EU-RU.NET Project?

2. Would you have conducted this joint investigation if it were not for the EU-RU.NET Project?
3. Have you had sufficient time to start and finish your Pilot Project?



Conclusions.

1. All participants have intention to continue collaboration because of new interesting contacts and strengthening of existing contacts. EU support is important.

2. Most of conducted collaborative researches wouldn't be possible without EU-RU.NET Project but the time was not sufficient (in the case of new contacts).

CHAPTER 5 INSTRUMENTS AND INITIATIVES

The Strategy should result in committed collaboration between nanoelectronics R&I groups in EU and Russia. The measures should also be open to participation from Third Party Countries. Supranational research collaboration may be organized in several different ways:

- Between individual researchers and research groups in different countries, based on shared professional interests. Such collaboration is not usually formalized to any great extent.
- Between research groups/institutions and enterprises, for example, in the form of project collaboration, mobility and stays for visiting researchers. This form of cooperation will ordinarily be based on agreements between institutions in different countries.
- Between research programs, separate internationalisation measures and special initiatives. Such collaboration poses further requirements for formalising cooperative relations.

The measures in this Strategy will largely be stimuli and incentives designed to enhance collaboration and contacts between EU and Russia. It may also be feasible to initiate funding of research projects. Support for major research projects should also be based on other national sources of funding.

5.1 Research scientists, fellowships and research institutions

International research cooperation ultimately rests on the willingness, ability and opportunities for contact and interaction between researchers from different countries. Hence one important element is to encourage such contact between individual researchers from Russia and Europe, ensuring that it is maintained and strengthened.

The mobility of researchers should go both ways. Not only should Russian researchers spend time in EU, but researchers from EU should be encouraged to spend shorter or longer periods of time in Russia.

Mobility and international cooperation is an integral part of a career in research. Those in recruitment positions, either doctoral or post-doctoral fellows, should establish contacts with international research groups that maintain high standards. As a general rule, research fellows should spend some time at an appropriate research institution in another country, or collaborate with well-qualified visiting foreign researchers at their own institutions. The conditions for such stays must be made attractive and practically feasible in order to ensure that more people will choose Russia as their destination.

A lengthy stay abroad should be a normal part of postdoctoral fellowships. That makes it especially important to ensure that post-doctoral fellows can spend time at EU's/Russia's research institutions, and efforts must be made to ensure that these research fellows have adequate facilities to return to Russia/EU. International research cooperation is becoming increasingly institutionalized. Institutional involvement implies binding social, financial and academic guarantees for the duration, and may result in greater breadth and better exploitation of the contacts and networks established.

Cooperation between institutions in nanoelectronics can be promoted through a variety of schemes. The Strategy recommends here establishment and development of bridgeheads as special contact points and prime movers for collaboration between institutions that can be an efficient policy instrument for increasing collaboration. They can be built up on the basis of

different models. They can be linked to special subjects or have a general sphere of activity. One model for such bridgeheads involves the establishment of special professorships – endowed professorships (chairs) at prominent EU and Russian universities. Endowed professorships should generally be directed at research and researcher training, providing stimuli for more high-level exchanges between EU and Russian research groups in disciplines linked to nanoelectronics. Part-time professorships are another possible alternative for developing more contact and collaboration.

The establishment of endowed professorships or part-time posts with prominent EU and Russian research groups should preferably be reciprocal.

The measures should be considered and studied in more detail, not least with a view to the choice of subjects and possible funding opportunities. The schemes eventually established should also be attractive to private EU and Russian stakeholders and funders.

5.2 Industrial R&I cooperation

EU and Russia continuously call for the enhancement and strengthening of links between industry and academia. U.S.A. with its long traditions in entrepreneurial culture which helped to boost productivity and install a strong spirit of innovation is the poster boy in both EU and Russia.

International collaboration is a key feature of the development of industrial R&I activities. EU and Russian grants to industrial R&I are intended to promote more innovation, build long-term competence and technology skills, enhance interaction between industry and R&I groups and increase participation in international cooperation. In connection with future allocations, particular attention should be devoted to the opportunities for enhancing R&I collaboration between EU and Russia in nanoelectronics.

The EU has a very open economy and depends on trade with other countries for developing knowledge and competence, as well as for commercial purposes. Through R&I collaboration with enterprises and research groups in other countries, EU's enterprises and research groups are able to develop knowledge that contributes to the development of Europe's knowledge economy.

There is a huge potential for developing industrial R&I-related collaboration between EU and Russia, both in terms of developing partnerships and as learning arenas.

The establishment of a double-sided "*commercialization channel*" for the EU and Russian nanoelectronics markets should also be considered more closely. Such measures could possibly comprise contact with R&I institutions, industrial networks and business development groups, capital, lobby and different IPR and regulatory agencies. The aim would be to ensure that ideas develop more commercial potential, both in Russia and in the EU. Good ideas and start-up companies originating at universities and having a commercial potential might also benefit from being introduced to an EU-Russia "*venture forum*". This might contribute to their professional and business-related development, and possibly result in access to capital, competence and markets.

The measures touch on several Russian ministries' and EC DGs' spheres of activity. These ministries and DGs will be responsible for the further follow-up of the measures. The aim is to better coordinate the various efforts during the further follow-up of the Strategy.

Knowledge and interest are important motives for collaborating across national borders. At a time of increasing globalization, interest in "old" partners has diminished. Russia and EU

have increasingly had to share the spotlight with other countries like USA, China, Japan, South Korea, India, and Brazil. This has had an impact on R&I.

Although there are traditions of European researchers working at Russian institutions, their knowledge about research in Russia and the opportunities that exist is relatively limited.

5.3 Funding and further follow-up of the strategy

This Strategy is based on the recommendations of a broad-based SEG. In the opinion of SEG, both the EU and Russian budget's total allocations to nanoelectronics research collaboration between Europe and Russia ought to be increased significantly in the years ahead. SEG also recommended that in Russia the majority of the allocations ought to be granted through the budget of the Ministry of Education and Science, and that additional sector-related allocations could be made through the budgets of the various sectoral ministries. In Europe the most relevant source of funding might be the EC DG CONNECT.

Special allocations should be earmarked for scientific and technological cooperation with Russia. The allocations for cooperation in nanoelectronics should be granted as stimulation and incentive packages. It should also be possible to fund research projects. Large-scale joint projects, comparable to EU research cooperation, would call for funding in conjunction with other sources of funding aimed at relevant subjects and themes. Pursuant to the objectives set for this Strategy, it is assumed that the quality requirements will be met in order for such funding to be provided. Some measures like the establishment of endowed professorships (chairs), etc., must be considered more closely.

The Strategy addresses actions and initiatives that affect researchers and research recruits, research institutions and enterprises. These are the most important target groups for the Strategy, and they must consequently play a leading role in its implementation. The initiation and implementation of the Strategy will ultimately rest on their ability and willingness to follow-up and take advantage of the opportunities that arise.

It will be very important that the institutions themselves follow-up and play an active part in the schemes and initiatives outlined and pave the way for such collaboration. It is crucial for institutions to have a system for receiving visiting foreign researchers and for disseminating information about collaboration and mobility between EU and Russia in their respective scientific communities.